SPS swiss physical society

Österreichische Physikalische Gesellschaft

Gemeinsame Jahrestagung in Basel
04. - 08. September 2023

Universität Basel, Kollegienhaus

Joint Annual Meeting in Basel
4 - 8 September 2023

in Zusammenarbeit mit - in collaboration with

CHIPP Swiss Institute of Particle Physics

NCCR SPIN

SSSN SGN

Universität Basel

Bulletin SPG / SSP Vol 39, 2023; ÖPG Tagungsband Nr. 72

Danksagungen - Acknowledgements

Wir danken...

- der Universität Basel als Gastgeberin der gemeinsamen Jahrestagung, insbesondere dem Departement Physik und dem lokalen Organisationsteam für die grosszügige Unterstützung; sowie für die durch die SPG genutzte Infrastruktur.
- der Akademie der Naturwissenschaften Schweiz (SCNAT) für die Unterstützung der Tagungen und anderer Aktivitäten der SPG.
- der Schweizerischen Akademie der Technischen Wissenschaften (SATW) für die Unterstützung diverser Aktivitäten.
- den Stiftern der folgenden Preise:

  ABB Schweiz AG
  (SPG Preis in allgemeiner Physik)

  IBM Research Rüschlikon
  (SPG Preis in Physik der kondensierten Materie)

  Oerlikon Surface Solutions AG
  (SPG Preis in angewandter Physik)

  Eidgenössisches Institut für Metrologie METAS
  (SPG Preis mit Bezug zur Metrologie)

  COMSOL Multiphysics GmbH
  (SPG Preis in computergestützter Physik)

  Hitachi Energy Switzerland AG
  (SPG Preis mit Bezug zur Energietechnik)

- dem EU Projekt Isabel (*https://emfl.eu/isabel/h2020-project/*) für die grosszügige Unterstützung der eingeladenen Sitzung "Magnetic fields for materials research".
- den Firmen, die durch Inserate, Beilagen und durch ihre Präsenz an der Ausstellung die Tagung unterstützen (siehe Seite 10).

We thank...

- the University of Basel as host of the Joint Annual Meeting, especially the Physics Department and the local organizing team for the generous support; as well as for the SPS being able to use the infrastructure.
- the Swiss Academy of Sciences (SCNAT) for the support of the conferences and further activites of the SPS.
- the Swiss Academy of Technical Sciences (SATW) for the support of various activities.
- the sponsors of the following awards:

  ABB Schweiz AG
  (SPS Award in General Physics)

  IBM Research Rüschlikon
  (SPS Award in Condensed Matter Physics)

  Oerlikon Surface Solutions AG
  (SPS Award in Applied Physics)

  Federal Institute for Metrology METAS
  (SPS Award with relation to Metrology)

  COMSOL Multiphysics GmbH
  (SPS Award in Computational Physics)

  Hitachi Energy Switzerland AG
  (SPS Award with relation to Enery Technology)

- the EU project Isabel (*https://emfl.eu/isabel/h2020-project/*) for the generous support of the invited session "Magnetic fields for materials research".
- the companies supporting the conference by advertisements, supplements and their presence at the exhibition. (see page 10)

Tagungsorganisation

SPG: *S. Albietz, J. Chang, I. Zardo*, sowie die Sektionsleiter
ÖPG: *C. Teichert*, sowie die Fachausschussleiter

CHIPP: *A. Benelli*
NCCR SPIN: *M. Longobardi*
SGN: *M. Janoschek*

Inhalt - Content

Allgemeine Tagungsinformationen - General Information about the Conference

Konferenzwebseite und Anmeldung
www.sps.ch

Tagungsort
Universität Basel, Kollegienhaus, Petersplatz 1, 4001 Basel

Tagungssekretariat
Das Tagungssekretariat befindet sich direkt beim Eingang Seite Spalentor, vor der Aula 033.
Öffnungszeiten:

Mo 04.09.	10:00 - 17:30
Di 05.09 - Do 07.09.	08:00 - 18:00
Fr 08.09.	08:00 - 12:00

Alle Tagungsteilnehmer melden sich bitte vor dem Besuch der ersten Veranstaltung beim Sekretariat an, wo sie ein Namensschild und allfällige weitere Unterlagen erhalten sowie die Tagungsgebühr bezahlen.
Wichtig: Ohne Namensschild ist kein Zutritt zu einer Veranstaltung möglich.

Hörsäle
In allen Hörsälen stehen Projektoren zur Verfügung. Sie können direkt Ihre eigenen Mobilrechner anschließen. Die gängigen Adapter (HDMI, VGA) sind vorhanden. Bringen Sie ggf. Adapter und USB Stick mit.

Postersession
Die Postersession findet am Dienstag Abend sowie am Mittwoch während der Mittagspause in der Halle statt. Die Posterwände sind entsprechend diesem Programm numeriert, sodaß jeder Teilnehmer "seine" Wand leicht finden sollte. Alle Poster müssen an allen beiden Tagen ausgestellt bleiben.
Maximale Postergröße: A0 Hochformat.
Die 3 besten Poster werden am Freitag um 10:30h in einer kleinen Zeremonie ausgezeichnet.

Zahlung
Wir bitten Sie, die Tagungsgebühren im Voraus zu bezahlen. Sie verkürzen damit die Wartezeiten am Tagungssekretariat, erleichtern uns die Arbeit und sparen darüber hinaus noch Geld !

Conference web site and registration
www.sps.ch

Location
Universität Basel, Kollegienhaus, Petersplatz 1, 4001 Basel

Registration Desk
The registration desk is situated near the entrance facing the Spalentor in the hallway.
Opening Hours:

Mon 4.9.	10:00 - 17:30
Tue - Thu 5.9. - 7.9.	08:00 - 18:00
Fri 8.9.	08:00 - 12:00

All participants must imperatively report at the registration desk before visiting any session. You will receive your name badge, possible further documents and can pay still due conference fees.
Attention: Without badge, entry to the lecture rooms will be refused.

Lecture Rooms
All rooms are equipped with projectors. You may connect your own laptop. The most common adapters (HDMI, VGA) are available. If need be, bring your own adapter and USB-key.

Postersession
The postersession will take place on Tuesday evening and during lunchbreak on Wednesday in the hall. The poster boards are numbered according to the program, so every participant will find their board easily. All posters are expected to be on display on both days.

Maximum poster size: A0 portrait.
The winners of the best poster prizes will be awarded on Friday 10:30h in a small ceremony.

Payment
We ask you to pay the conference fees in advance. This way you shorten waiting time at the registration desk, facilitate our work and save even money!

Preise gültig bei Zahlung bis 15. August - Fees valid for payments done before 15 August		
Kategorie - Category	**CHF**	**EUR**
Einzelmitglieder von SPG, ÖPG, CHIPP - Individuels members of SPS, ÖPG, CHIPP	150.-	155.-
Nicht-Mitglieder - Non-members	190.-	195.-
Studenten VOR Master/Diplom Abschluß - Students BEFORE master/diploma degree	100.-	105.-
Plenarsprecher, Eingeladene Sprecher, Preisträger - Plenary and invited speakers, awardees	0.-	0.-
Spezialangebot für "Noch nicht" SPG Mitglieder (s.u.) - Special offer for "not yet" SPS members (see below)	200.-	210.-
Konferenz Abendessen - Conference Dinner	90.-	95.-
Zuschlag für Zahlungen nach dem 15. August sowie Barzahler an der Tagung - Surcharge for payments made after 15 August as well as for cash payments at the registration desk	**20.-**	**20.-**

Die Angaben zur Zahlung werden während der Anmeldung direkt auf der Webseite angezeigt.

Am Tagungssekretariat kann nur bar bezahlt werden (in CHF). Kreditkarten können leider nicht akzeptiert werden.

ACHTUNG: Tagungsgebühren können nicht zurückerstattet werden.

Payment details are shown directly during registration on the conference website.

At the registration desk you can only pay cash (CHF). We can unfortunately not accept any credit cards.

ATTENTION: Fees are not refundable in case of cancellation.

Kaffeepausen, Mittagessen

Kaffeepausen, Apéro (Dienstag) und Lunchbuffet (Mittwoch) finden in der Halle bei der Händlerausstellung statt. Diese Leistungen sind in der Konferenzgebühr enthalten.
Für das Mittagessen an den anderen Tagen können die die Mensen sowie umliegende Restaurants genutzt werden.

Coffee Breaks and Lunch

The coffee breaks, aperitif (Tuesday evening) and the lunch buffet on Wednesday will take place near the exhibition. These services are covered by the conference fee.
The campus mensa as well as nearby restaurants are at your disposal for lunch on the other days.

Konferenz-Abendessen

Das Abendessen findet am Donnerstag im Restaurant Ayledo im Anschluß an die Parallelsessions statt. Der Preis beträgt CHF 90.- pro Person (beinhaltet, 3-Gänge Menü und Getränke). Die Anzahl der Plätze ist limitiert, bitte registrieren Sie sich unbedingt im Voraus, damit wir disponieren können. Eine Anmeldung vor Ort ist nicht möglich !

Conference Dinner

The dinner will take place on Thursday in the restaurant Ayledo after the parallel sessions. The fee is CHF 90.- per person (including 3-course meal and drinks). The number of places is limited. Please register in any case in advance so we can plan accordingly. A registration on site is not possible!

Spezialangebot für "Noch-Nicht" SPG Mitglieder

Planen Sie, an unserer Tagung teilzunehmen sowie Mitglied der SPG zu werden ? Sie können nun beides zum äusserst günstigen Preis von nur CHF 200.- (CHF 220.- nach dem 15. August). Dieser Betrag deckt die Konferenzgebühr sowie die Mitgliedschaft für 2023. Wählen Sie einfach bei der Online Registrierung die Kategorie "Special Offer", laden Sie das Anmeldeformular (*https://www.sps.ch/fileadmin/doc/Formulare/anmeldeformular_d-f-e.pdf*) für neue Mitglieder herunter, und schicken es ausgefüllt an das SPG-Sekretariat zurück.

Dieses Angebot gilt nicht für Studenten oder Doktoranden. Diese profitieren sowieso von der Gratis-Mitgliedschaft im ersten Mitgliedsjahr, und zahlen nur die in der Tabelle angegebene Konferenzgebühr.

Special offer for "not yet" SPS members

Do you plan to participate in our meeting and want also to become a member of the SPS ? Then take advandage of our special offer of CHF 200.- covering the conference fees and the membership for 2023. (CHF 220.- after 15 August) ! Just fill out the registration form, choose the option "Special offer", then download the admission form for new members (*https://www.sps.ch/fileadmin/doc/Formulare/anmeldeformular_d-f-e.pdf*), and return it filled and signed as soon as possible to the SPS Secretariat.

(This offer does not apply for students and Ph.D. students. They still profit from the free first-year-membership and have only to pay the conference fee shown in the table .)

Anreise und Unterkunft

Alle Informationen zur Anreise und Hotelreservation finden Sie auf unserer Webseite.
https://www.sps.ch/events/gemeinsame-jahrestagung-2023/anreise-und-unterkunft

Arrival and Accomodation

All information on arrival and hotel reservation can be found on our webpage.
https://www.sps.ch/en/events/joint-annual-meeting-2023/arrival-and-accommodation

Internet

Während der gesamten Konferenz steht für die Teilnehmer Internet Zugang über das ***eduroam*** Netzwerk bereit.
Personen ohne Zugang zu ***eduroam*** können auch das ***unibas-visitor*** Netz verwenden (einmalige Anmeldung benötigt).

Anleitung:
https://its.unibas.ch/de/anleitungen/netzwerkzugang/anleitung-wlan/#c3073

Internet

During the whole conference the ***eduroam*** wireless network is available for the participants.
Persons without access to ***eduroam*** can use the ***unibas-visitor*** network (first-time registration needed).

Instructions:
https://its.unibas.ch/en/manuals/network-access/anleitung-wlan-fuer-gaeste/

Aussteller - Exhibitors

Basel Precision Instruments GmbH
CH-4056 Basel
www.baspi.ch

COMSOL Multiphysics GmbH
CH-8005 Zürich
www.comsol.com

Dr. Eberl MBE Komponenten GmbH
DE-71263 Weil der Stadt
www.mbe-komponenten.de

kiutra GmbH
DE-81369 München
www.kiutra.com

mechOnics AG
DE-81825 München
www.mechOnics.de

Menhir Photonics AG
CH-8152 Glattbrugg
https://menhir-photonics.com/

Qnami AG
CH-4132 Muttenz
www.qnami.ch

Quantum Design AG
CH-1723 Marly
https://qd-europe.com/ch/

Springer Verlag GmbH
DE-69121 Heidelberg
www.springer.com

TOPTICA Photonics AG
DE-82166 Gräfelfing
www.toptica.com

Inserate - Advertisements

TOPTICA Photonics AG
DE-82166 Gräfelfing
www.toptica.com

Zurich Instruments
CH-8005 Zürich
www.zhinst.com

Tagungsübersicht - Conference Overview

Generalversammlungen - General Assemblies

Montag 04. September 2023, 18:15h - Monday 4 September 2023, 18:15h

SPG - SSP - SPS	ÖPG
Aula 033	***Hörsaal 117 - Room 117***

Preisverleihungen - Award Ceremonies

SPG Preise, ÖPG Preise, SGN Preise, Charpak-Ritz Preis,
EPS Emmy Noether Distinction
SPS Awards, ÖPG awards, SNSS Awards, Charpak-Ritz Award,
EPS Emmy Noether Distinction

Dienstag 05. September 2023, 11:00h, Aula 033 -
Tuesday 5 September 2023, 11:00h, Aula 033

Preise für die besten Poster - Best Poster Awards

Freitag 08. September 2023, 10:30h, Aula 033 -
Friday 8 September 2023, 10:30h, Aula 033

Letzte Aktualisierung des Programms - Last update of the program

04.09.2023

Montag, 04. September 2023 - Monday, 4 September 2023

TIME	Rooms			TIME
	Aula 033 (ground floor)	117 (first floor)	118 (first floor)	
	Registration			
			Satellite Event: **Women in Physics Career Symposium**	
08:30			81 Jamie Gloor	08:30
08:45			*Keynote 1*	08:45
09:00				09:00
09:15				09:15
09:30	**SPS Board Meeting**	**ÖPG Board Meeting**	82 Tomas Brage	09:30
09:45			*Keynote 2*	09:45
10:00			***Coffee Break***	10:00
10:15				10:15
10:30			83 Mitali Banerjee	10:30
10:45			*Career Talk 1*	10:45
11:00			84 Ruth Durrer	11:00
11:15			*Career Talk 2*	11:15
11:30			*Mentors and mentees*	11:30
11:45			*introduce themselves*	11:45
12:00				12:00
12:15				12:15
12:30			***Lunch***	12:30
12:45	**Conference Opening**		*organised only for Speakers,*	12:45
	Physics Funding in Switzerland		*Mentors and Mentees*	
	400th Birthday of Blaise Pascal			
13:00	31 Bernd Gotsmann (i)			13:00
13:15	32 Ben Kilminster (i)			13:15
13:30	33 Philipp Treutlein (i)			13:30
13:45	*Discussion*		89 Safia Agueni	13:45
14:00			85 Heidi Potts	14:00
14:15			*Career Talk 3*	14:15
14:30	1 Dominique Descotes (p)		86 Zoë Holmes	14:30
14:45			*Career Talk 4*	14:45
15:00			*Mentor-Mentee meetups*	15:00
15:15	2 Helena van Swygenhoven (p)			15:15
15:30				15:30
15:45				15:45
16:00	***Coffee Break***	***Coffee Break***	***Coffee Break***	16:00
16:15				16:15
16:30	3 Michael Korey (p)		87 Andrea Biedermann	16:30
16:45			*Career Talk 5*	16:45
17:00			88 Tracy Northup	17:00
17:15	4 Thomas Schulthess (p)		*Career Talk 6*	17:15
17:30			*Podium Discussion*	17:30
17:45				17:45
18:00	*Buffer time*			18:00
18:15	**SPS GENERAL ASSEMBLY**	**ÖPG GENERAL ASSEMBLY**		18:15
18:30			***Break***	18:30
18:45				18:45
19:00				19:00
19:15				19:15
19:30			**Dinner**	19:30
19:45			*Speakers, Mentors*	19:45
			and Mentees only	

(p) = Plenary Talk, (i) = Invited talk

Dienstag, 05. September 2023 - Tuesday, 5 September 2023

TIME	Aula 033 (ground floor)	114 (first floor)	115 (first floor)	TIME
08:00	Registration			08:00
	PLENARY SESSION			
09:00	11 Anna Sfyrla (p)			09:00
09:15				09:15
09:30				09:30
09:45	12 Felix Mayer (p)			09:45
10:00				10:00
10:15				10:15
10:30	*Coffee Break*	*Coffee Break*	*Coffee Break*	10:30
10:45				10:45
11:00	AWARD CEREMONY			11:00
11:15				11:15
11:30				11:30
11:45				11:45
12:00				12:00
12:15	13 Bruno Mansoulié (i)			12:15
12:30				12:30
12:45	*Lunch*	*Lunch*	*Lunch*	12:45
13:00				13:00
13:15				13:15
13:30				13:30
13:45				13:45
	KOND	Nanotechnology: From Hype to Application	New prospects in ARPES for quantum materials	
14:00	101 Michele Simoncelli (i)	51 T. Stöferle & A. Fuhrer **	501 Neil Wilson (i)	14:00
14:15		52 Dominik Ziegler (i) *		14:15
14:30	102 Jin Jiang	53 Thomas Kornher (i) *	502 Michael Straub	14:30
14:45	103 Tathagata Paul	54 Peter Fankhauser (i) *	503 Sandy Adhitia Ekahana	14:45
15:00	104 Joel Hutchinson		504 Julia Issing	15:00
15:15	105 Wojciech Pudelko	55 Cesare Alfieri (i) *	505 Chun Lin	15:15
15:30	106 Zekang Zhou	56 David Pires (i) *	506 Christian S. Kern	15:30
15:45	107 Paritosh Karnatak	57 Silke Traut (i) *	507 Yun Yen	15:45
16:00	108 Mario Di Luca		508 Victor Rosendal	16:00
16:15	109 Virginia Carnevali	58 Samuel Sonderegger (i) *	509 Tom van Waas	16:15
16:30	*Coffee Break*	*Coffee Break*	*Coffee Break*	16:30
16:45				16:45
17:00	111 Gediminas Simutis	59 Fabian Könemann (i) *	511 Gunther Springholz (i)	17:00
17:15	112 Friedrich Krien	60 Adam Kubec (i) *		17:15
17:30	113 Tejas Parasram Singar		512 Frédéric Chassot	17:30
17:45	114 Neven Barisic	61 Arnd Müller (i) *	513 Vladimir N. Strocov	17:45
18:00	115 Trpimir Ivsic	62 Barbara Stadlober (i) *	514 Michael Schüler (i)	18:00
18:15	117 Benjamin Klebel-Knobloch	63 Philipp Oertle (i) *		18:15
18:30	118 Denis Sunko		515 Dominik Brandstetter	18:30
18:45			517 Anna Hartl	18:45
19:00	*Poster Session and Apéro*	*Poster Session and Apéro*	*Poster Session and Apéro*	19:00
19:15				19:15
19:30				19:30
19:45				19:45
20:00				20:00
20:15				20:15
20:30				20:30

(p) = Plenary talk, (i) = Invited talk, * = 20 min talk, ** = 10 min talk

116 *cancelled*

516 *cancelled*

TIME	*Rooms* 116 (first floor)	117 (first floor)	118 (first floor)	TIME
08:00	*Registration*			08:00
09:00				09:00
09:15				09:15
09:30				09:30
09:45				09:45
10:00				10:00
10:15				10:15
10:30	***Coffee Break***	***Coffee Break***	***Coffee Break***	10:30
10:45				10:45
11:00				11:00
11:15				11:15
11:30				11:30
11:45				11:45
12:00				12:00
12:15				12:15
12:30				12:30
12:45	***Lunch***	***Lunch***	***Lunch***	12:45
13:00				13:00
13:15				13:15
13:30				13:30
13:45				13:45
	Atomic Physics and Quantum Optics	**Gravitational Waves**	**TASK - FAKT**	
14:00	401 Mohammad Bereyhi (i)	481 Shubhanshu Tiwari *	301 Tiziano Bevilacqua	14:00
14:15		482 Mudit Garg *	303 Davide Lancierini	14:15
14:30	402 Maryse Ernzer		304 Martin Andersson	14:30
14:45	403 Jodok Happacher	483 Matthias Kruckow *	305 Kevin Hinze	14:45
15:00	404 Pietro Tassan	484 Yumeng Xu *	306 Vitalii Lisovskyi	15:00
15:15	405 Diana Shakirova	485 Stefan Strub *	307 Maria Carolina Feliciano Faria	15:15
15:30	406 Virginia Oddi		308 Florian Hechenberger	15:30
15:45	407 Aaron Daniel	486 Shaikh Saad *	309 Luis Miguel Garcia Martin	15:45
16:00	408 Ksenija Simonović			16:00
16:15	409 Marcin Bialek			16:15
16:30	***Coffee Break***	***Coffee Break***	***Coffee Break***	16:30
16:45				16:45
17:00	411 Helmut Ritsch	491 Simone Bavera *	312 Katharina von Schoeler	17:00
17:15		492 Eleanor Hamilton *	313 Anastasia Doinaki	17:15
17:30	412 Francesca Orsi		314 Stergiani Marina Vogiatzi	17:30
17:45	413 Tommaso Faleo	493 Franziska Riegger *	315 Ritwika Charkaborty	17:45
18:00	414 Paolo Colciaghi	494 Zepei Xing *	316 Timothy Hume	18:00
18:15	415 M. Janovitch Broinizi Pereira	495 Lara Bohnenblust *	317 Chavdar Dutsov	18:15
18:30	416 Mohammadamin Tajik			18:30
18:45	417 Daniel James Murtagh			18:45
19:00	***Poster Session and Apéro***	***Poster Session and Apéro***	***Poster Session and Apéro***	19:00
19:15				19:15
19:30				19:30
19:45				19:45
20:00				20:00
20:15				20:15
20:30				20:30

(i) = Invited talk, * = 20 min talk

302	*cancelled*
311	*cancelled*

MITTWOCH, 06. SEPTEMBER 2023 - WEDNESDAY, 6 SEPTEMBER 2023

TIME	Rooms: Aula 033 (ground floor)	114 (first floor)	115 (first floor)	TIME
08:00	Registration			08:00
	PLENARY SESSION			
09:00	14 Markus Valtiner (p)			09:00
09:15				09:15
09:30				09:30
09:45	15 Louise Harra (p)			09:45
10:00				10:00
10:15				10:15
10:30	***Coffee Break***	***Coffee Break***	***Coffee Break***	10:30
10:45				10:45
11:00	16 Bodo Wilts (p)			11:00
11:15				11:15
11:30				11:30
11:45	17 Nikola Opačak (i)			11:45
12:00				12:00
12:15	18 Elisabetta Nocerino (i)			12:15
12:30				12:30
12:45	***Poster Session and Lunchbuffet***	***Poster Session and Lunchbuffet***	***Poster Session and Lunchbuffet***	12:45
13:00				13:00
13:15				13:15
13:30				13:30
13:45				13:45
14:00				14:00
14:15				14:15
	KOND	**History and Philosophy of Physics**	**ÖPG Thesis Awards**	
14:30	121 Shih-Chi Yang (i)	41 Reinhard Folk	71 Bernd Aichner (i)	14:30
14:45				14:45
15:00	123 Yashpreet Kaur	42 Franz Sachslehner	72 Josef Leutgeb (i)	15:00
15:15	124 Maurizio Musso			15:15
15:30	125 Jiyu Chen	43 Bruno Besser	73 Igor Sokolovic (i)	15:30
15:45	126 Sebastian Lamb-Camarena			15:45
16:00		44 Martin C. E. Huber		16:00
16:15				16:15
16:30	***Coffee Break***	***Coffee Break***	***Coffee Break***	16:30
16:45		**Surfaces, Interfaces and Thin ...**	**Spintronics and Magnetism at...**	16:45
17:00	131 Sujay Ray	201 Katharina Kaiser (i)	601 Hans J. Hug (i)	17:00
17:15	132 Simone Di Cataldo			17:15
17:30	133 Peter Mlkvik	202 Igor Sokolovic	602 Loghman Jamilpanah	17:30
17:45	134 Julian Arnold	203 Claudia López-Posadas	603 Michele Aldeghi	17:45
18:00	135 Philipp Münzer	204 Moritz Eder	604 Ji Zou	18:00
18:15	136 Tianlun Yu	205 Martin Heinrich	605 Min-Gu Kang	18:15
18:30	137 Afonso dos Santos Rufino	206 Francesco Presel	606 Lauren Riddiford	18:30
18:45	138 Yuan Wei	207 Philipp Maier	607 Marek Bartkowiak	18:45
19:00	139 Jiawei Yan	208 Chunlei Wang	608 Xanthe Verbeek	19:00
19:15		209 Panukorn Sombut	609 David Schmoll	19:15
19:30				19:30

(p) = Plenary talk, (i) = Invited talk

122 *cancelled*

TIME	Rooms: 117 (first floor)	Rooms: 118 (first floor)	TIME
08:00	*Registration*		08:00
09:00			09:00
09:15			09:15
09:30			09:30
09:45			09:45
10:00			10:00
10:15			10:15
10:30	***Coffee Break***	***Coffee Break***	10:30
10:45			10:45
11:00			11:00
11:15			11:15
11:30			11:30
11:45			11:45
12:00			12:00
12:15			12:15
12:30			12:30
12:45	***Poster Session and Lunchbuffet***	***Poster Session and Lunchbuffet***	12:45
13:00			13:00
13:15			13:15
13:30			13:30
13:45			13:45
14:00			14:00
14:15			14:15
	Neutron Science	**TASK - FAKT**	
14:30	701 Ellen Fogh	321 Victoria Kletzl	14:30
14:45	702 Danielle Yahne	322 Wenting Chen	14:45
15:00	703 Xavier Boraley	323 Cornelis B. Doorenbos	15:00
15:15	705 Amirreza Hemmatzade	324 Nathalie Ziehl	15:15
15:30	706 Artur Gregor Glavic	325 Dieter Achim Ries	15:30
15:45	707 Marc Janoschek	326 Philipp Peter Blumer	15:45
16:00	708 Jonas Philippe	327 Carina Killian	16:00
16:15		328 Angela Gligorova	16:15
16:30	***Coffee Break***	***Coffee Break***	16:30
16:45			16:45
17:00	711 Ivo Schulthess (i)	331 Louis Henry	17:00
17:15		332 Meinrad Moritz Schefer	17:15
17:30	712 Daniel Mazzone	333 Federico Ronchetti	17:30
17:45	713 Mina Akhyani	334 Maximinio Adrover	17:45
18:00	714 Irina Pradler	336 Yifeng Wang	18:00
18:15	715 Sarah Weick	337 Chiara Magliocca	18:15
18:30	716 Alex Backs	338 Daniele dal Santo	18:30
18:45	717 Mirco Große	339 Matthieu Heller	18:45
19:00	718 Richi Kumar	340 Matteo Milanesio	19:00
19:15	719 *cancelled*		19:15
19:30			19:30

(i) = Invited talk

704 *cancelled*	335 *cancelled*

Donnerstag, 07. September 2023 - Thursday, 7 September 2023

TIME	Rooms: Aula 033 (ground floor)	Rooms: 114 (first floor)	Rooms: 115 (first floor)	TIME
08:00	*Registration*			08:00
	PLENARY SESSION			
09:00	19 Peter Puschnig (p)			09:00
09:15				09:15
09:30				09:30
09:45	20 Christian Wüthrich (p)			09:45
10:00				10:00
10:15				10:15
10:30	***Coffee Break***	***Coffee Break***	***Coffee Break***	10:30
10:45				10:45
11:00	21 Anton Zeilinger (p)			11:00
11:15				11:15
11:30				11:30
11:45	22 Simone Gargiulo (i)			11:45
12:00				12:00
12:15	23 Franz Embacher (i)			12:15
12:30				12:30
12:45	***Lunch***	***Lunch***	***Lunch***	12:45
13:00				13:00
13:15				13:15
13:30				13:30
13:45				13:45
	KOND	**Surfaces, Interfaces and Thin Films**	**Spintronics and Magnetism at the Nanoscale**	
14:00	141 Aline Ramires	211 Christian Teichert	611 Santa Pile (i)	14:00
14:15	142 Barbora Budinská			14:15
14:30	143 Loic Herviou	212 Roland Resel	612 Sebastian Knauer	14:30
14:45	144 Pierre Fromholz	214 Gyanendra Panchal	613 Khrystyna Levchenko	14:45
15:00	145 Bartholomew Andrews	215 Hang Li	614 Rostyslav Serha	15:00
15:15	147 Even Thingstad	216 Jonas Knobel	615 Noura Zenbaa	15:15
15:30	148 Zurab Guguchia	217 Jeong Ha Hwang	616 Aishwarya Vishwakarma	15:30
15:45	146 Zurab Guguchia	218 Dominik Lüthi	617 Tara Tosic	15:45
16:00	149 Titus Mangham-Neupert	219 Noah J. Hourigan	618 Andreas Apseros	16:00
16:15	150 Mark Fischer		619 Jamie Robert Massey	16:15
16:30	***Coffee Break***	***Coffee Break***	***Coffee Break***	16:30
16:45			**Magnetic fields for materials...**	16:45
17:00	151 Kacper Prech	221 Fabian Paschke	681 Charles Simon (i)	17:00
17:15	152 Jens Oppliger	222 Bareld Wit		17:15
17:30	153 Xuan Dang Dang	223 Josef Simbrunner	682 Ana Akrap (i)	17:30
17:45	154 Qi He	224 Jiri Pavelec		17:45
18:00	155 Ishita Pushkarna	223 Alexander Syböck	683 Alexander Steppke (i)	18:00
18:15	156 Mithilesh Nayak	226 Luis Rosillo		18:15
18:30	157 Ding Peng	227 Paul Ryan	684 Matija Čulo (i)	18:30
18:45		228 Giulio de Vito		18:45
19:00	***Transfer to Dinner***			19:00
19:15				19:15
19:30	***Conference Dinner***			19:30
19:45				19:45
20:00				20:00
22:30				22:30

(p) = Plenary talk, (i) = Invited talk

213 *cancelled*

TIME	116 (first floor)	117 (first floor)	118 (first floor)	TIME
	Rooms			
08:00	*Registration*			08:00
09:00				09:00
09:15				09:15
09:30				09:30
09:45				09:45
10:00				10:00
10:15				10:15
10:30	***Coffee Break***	***Coffee Break***	***Coffee Break***	10:30
10:45				10:45
11:00				11:00
11:15				11:15
11:30				11:30
11:45				11:45
12:00				12:00
12:15				12:15
12:30				12:30
12:45	***Lunch***	***Lunch***	***Lunch***	12:45
13:00				13:00
13:15				13:15
13:30				13:30
13:45				13:45
	Quantum Computing	**Biophysics, Soft Matter and Medical Physics**	**Accelerator Science and Technology**	
14:00	801 Dominik Zumbühl	901 Claire Dessalles	381 Nicolas Vallis	14:00
14:15	802 Daniel Egger (i)	902 Daphne Laan	382 Douglas Martins Araujo	14:15
14:30		903 Simone Cicolini	383 Bernhard Auchmann	14:30
14:45	803 Kyrylo Simonov	904 Mathieu Dedenon	384 Henrique Garcia Rodrigues	14:45
15:00	804 Samson Wang	905 Shiling Liang	385 Cristobal Garcia	15:00
15:15	805 Han Zheng	906 Vincent Hickl	386 Leon van Riesen-Haupt	15:15
15:30	806 Zoe Holmes (i)	907 Friso Douma	387 Sofia Carolina Johannesson	15:30
15:45		908 Vojislav Gligorovski	388 Christophe Lannoy	15:45
16:00	807 Stefano Bosco	909 Mukund Krishna Kothari	389 Giuseppe Lospalluto	16:00
16:15	808 Bence Hetényi	910 Marco Labagnara	390 Elena Benedetto	16:15
16:30	***Coffee Break***	***Coffee Break***	***Coffee Break***	16:30
16:45			**TASK - FAKT**	16:45
17:00	811 Lieven Vandersypen (i)	911 Suliana Manley (i)	341 Pasquale Andreola	17:00
17:15			342 Benjamin Banto Oberhauser	17:15
17:30	812 Manuel Rudolph	912 Sahand Rahi	343 Martina Mongillo	17:30
17:45	813 Arianna Nigro	913 Lorenzo Scutteri	344 Giovanni Dal Maso	17:45
18:00	814 Andrea Hofmann (i)	914 Augustin Muster	345 Anni Kauniskangas	18:00
18:15		915 Maxime Scheder	346 Martina Ferrillo	18:15
18:30	824 Ben Lanyon (i)	916 Elif Gencturk	347 Jeremy Atkinson	18:30
18:45		917 Paolo de los Rios	348 Marta Babicz	18:45
19:00	***Transfer to Dinner***		349 Saul Alonso Monsalve	19:00
19:15				19:15
19:30	***Conference Dinner***			19:30
19:45				19:45
20:00				20:00
22:30				22:30

(i) = Invited talk

Freitag, 08. September 2023 - Friday, 8 September 2023

TIME	Aula 033 (ground floor)	114 (first floor)	TIME
08:00	*Registration*		08:00
	PLENARY SESSION		
09:00	24 Karina Morgenstern (p)		09:00
09:15			09:15
09:30			09:30
09:45	25 Sascha Schmeling (p)		09:45
10:00			10:00
10:15			10:15
10:30	**POSTER AWARD SESSION**		10:30
10:45	***Coffee Break***	***Coffee Break***	10:45
11:00			11:00
11:15	26 **Sustainable Research**		11:15
11:30	**in Physics**		11:30
11:45	*Panel Discussion*		11:45
	KOND	**Applied Physics and Plasma Physics**	
12:00	161 Mirjana Dimitrievska	952 Dorian Brandmüller	12:00
12:15	162 Fareeha Hameed	953 Daniele Hamm	12:15
12:30	163 Rainer Lechner	954 Emanuel Huett	12:30
12:45	164 Aswathi Kanjampurath Sivan	955 Martim Zurita	12:45
13:00	166 Robert Schwarzl	956 Antonia Frank	13:00
13:15	167 Siham Benhabib	957 Cosmas Heiß	13:15
13:30	168 Rafael Winkler	958 Haomin Sun	13:30
13:45	169 Ola Kenji Forslund	959 Cyrille Sepulchre	13:45
14:00	170 Xunyang Hong		14:00
14:15			14:15
14:30	***END***		14:30

(p) = Plenary talk, (i) = Invited talk

165 *cancelled*	951 *moved to poster 974*

TIME	116 (first floor)	117 (first floor)	118 (first floor)	TIME
08:00	*Registration*			08:00
09:00				09:00
09:15				09:15
09:30				09:30
09:45				09:45
10:00				10:00
10:15				10:15
10:30				10:30
10:45	***Coffee Break***	***Coffee Break***	***Coffee Break***	10:45
11:00				11:00
11:15				11:15
11:30				11:30
11:45				11:45
	Quantum Computing	**Biophysics, Soft Matter and Medical Physics**	**TASK - FAKT**	
12:00	821 Georgios Katsaros (i)	921 Vivek Maradia (i)	351 Richard Diurba	12:00
12:15				12:15
12:30	822 Rafael Eggli	922 Davide Cois	353 Christian Wittweg	12:30
12:45	815 Alexei Orekhov	923 Maximilian Sohmen	354 Mariana Rajado Silva	12:45
13:00	825 Jann Hinnerk Ungerer	924 Nils Plähn	355 Paloma Cimental Chavez	13:00
13:15	826 Alicia Ruiz	925 Peter Strassmann	356 Luca Marin	13:15
13:30		926 Mahsa Barzegarkeshteli	357 Rituparna Maji	13:30
13:45		927 Matthieu Schmidt	358 Caterina Trimarelli	13:45
14:00				14:00
14:15				14:15
14:30	***END***			14:30

(i) = Invited talk

823 *cancelled*

352 moved to talk 349

POSTERSITZUNG, 05. - 06 SEPTEMBER 2023 - POSTERSESSION, 5 - 6 SEPTEMBER 2023

Postersession: Tue: 19:00 - 20:30 ; Wed: 12:45 - 14:30

It is expected that ALL posters are on display on both days !

KOND	**Spintronics and Magnetism at the Nanoscale**
181 Subhrangsu Sarkar	631 Tianyue Wang
182 Ilaria Villa	632 Kristýna Davídková
183 Jose Manuel Sojo Gordillo	633 Davide Pecchio
184 Oksana Shliakhtun	634 Ales Hrabec
185 Bernhard Lüscher	635 Sourav Sahoo
186 Zakaria Jouini	636 Aleksandra Pac
187 Samuel Louis Nyckees	637 Samuel Treves
188 Sara Mustafi	638 Akash Gupta
189 Olivier Gauthé	639 Andreas Höfinger
	640 Luca Berchialla
	641 Gavin Macauley
Surfaces, Interfaces and Thin Films	642 Andrey Voronov
	643 Ryan Thompson
241 Stefan Müllegger	644 Alexis Rary-Zinque
242 Reshma Peremadathil Pradeep	645 Liza Žaper
243 Gyanendra Panchal	
	Neutron Science
TASK	
	731 Marek Bartkowiak
361 Stefan Hochrein	732 Alberto José Saavedra García
362 Manbing Li	733 Sergey Ermakov
363 Viktoria Kraxberger	734 Brigitte Decrausaz
364 Andrej Maraffio	735 Tobias Neuwirth
365 Alina Weiser	736 Stavros Samothrakitis
366 Nikolaus Schneider	
	Quantum Computing
Atomic Physics and Quantum Optics	
	841 Marcin Kisiel
431 Christian Mangeng	842 Taras Patlatiuk
432 Moritz Weegen	843 Artemii Efimov
433 Mikolaj Franciszek Roguski	844 Jessica Richter
434 Mikhail Popov	845 Sacha Lerch
435 Pietro Vahramian	846 Pierre Chevalier Kwon
436 Richard Ferstl	847 Simon Svab
437 Tabea Nelly Clara Bühler	848 Tianyang Shen
438 Florian Goschin	849 Nicolas Forrer
439 Christoph Amtmann	850 Florian Emaury
New prospects in ARPES for quantum materials	**Applied Physics & Plasma Physics**
531 Enrico Della Valle	971 Haomin Sun
~~532~~ *moved to talk 517*	~~972~~ *moved to talk 959*
533 Yann Alexanian	973 Sonali Mayani
534 *cancelled*	974 Sascha Ranftl

Satellite Event: Women in Physics Career Symposium

This event is supported by Universität Zürich, PSI Villigen, SPS, SCNAT, and Zurich Instruments.

Monday, 04.09.2023, Room 118

Time	ID	Women in Physics Career Symposium *Chair: Philipp Schmidt-Wellenburg, PSI Villigen*
08:30	**81**	Keynote 1: ***Jamie Gloor***
09:30	**82**	Keynote 2: ***Tomas Brage***
10:00		***Coffee Break***
10:30	**83**	Career Talk 1: ***Mitali Banerjee***
11:00	**84**	Career Talk 2: ***Ruth Durrer***
11:30		*Mentors and Mentees introduce themselves*
12:30		***Lunch (organised for Speakers, Mentors, Mentees)***
13:45	**89**	Presentation of the *Women-in-Tech* Organisation: ***Safia Agueni***
14:00	**85**	Career Talk 3: ***Heidi Potts***
14:30	**86**	Career Talk 4: ***Zoë Holmes***
15:00		*Mentor - Mentee Meetups*
16:00		***Coffee Break***
16:30	**87**	Career Talk 5: ***Andrea Biedermann***
17:00	**88**	Career Talk 6: ***Tracy Northup***
		Moderation: Anna Fontcuberta i Morral, EPFL
17:30		*Podium Discussion*
18:30		***Break***
19:30		***Dinner (for Speakers, Mentors, Mentees)***

Sessions

Special: Physics funding in Switzerland

Monday, 04.09.2023, Aula 033

Time	ID	Official Conference Opening
12:50		Welcome note
		Physics funding in Switzerland *Chair: Johan Chang, Universität Zürich*
13:00	31	**Trends and developments in funding by the Swiss National Science Foundation** *Bernd Gotsmann, IBM Research Zürich*
13:15	32	**Funding Swiss researchers in international large scale scientific projects** *Ben Kilminster, Universität Zürich*
13:30	33	**Funding fundamental physics research, a researcher's perspective** *Philipp Treutlein, Departement Physik, Universität Basel*
13:45		*Discussion*
14:25		***END***

Public Symposium: 400th Birthday of Blaise Pascal

Monday, 04.09.2023, Aula 033

Time	ID	400TH BIRTHDAY OF BLAISE PASCAL *Chair: Teresa Montaruli, Université de Genève*
14:30	1	**Order and disorder in Pascal's Pensées** *Dominique Descotes, Université Clermont Auvergne* The history of criticism, particularly in the 19th century, has tended to portray Pascal as an author who was the victim of serious intellectual and medical disorders, as evidenced by the appearance of the manuscript of his Pensées (owned by the BNF). An examination of this manuscript leads to different conclusions, both literary and psychological.
15:15	2	**Pascal's law and the Pascal unit in material science and engineering** *Helena van Swygenhoven, EPFL & Paul Scherrer Institut Villigen* Pascal's law had an enormous impact on material science and engineering. The law states that a change in pressure at any point in an enclosed incompressible fluid at rest is transmitted undiminished to all points in the fluid. The pressure, defined as the amount of force that is exerted per unit area, is in the International System of Units (SI) expressed in Pascal (Pa), which is equivalent to 1 Newton of force applied over an area of 1 square meter. The Pascal (Pa) unit is however also used to quantify stress. Stress and pressure are both words that are commonly mistaken for one another. Pressure is a scalar quantity. Stress, defined as the internal resistive force to deformation per unit area, has a magnitude and direction, and the angle with the plane on which the stress is acting is important. Therefore, stress is a tensor. 1 Pa is inconveniently small compared to the stresses most structures experience or the pressure in closed environments, one often encounters 10^3 Pa = 1 kPa, 10^6 Pa = MPa, or 10^9 Pa = GPa. Using examples, this talk will make the link between the physics contained in Pascal's law and some applications in material science and engineering. Well known applications of Pascal law are the hydraulic lift used in car garages or at the dentist, hydraulic cranes, and hydraulic brake systems in cars. But there are also applications in medicine, as for instance the first aid procedure "abdominal thrusts", also known as Heimlich maneuver, or the blood pressure device. This talk will also illustrate the use of the unit Pascal to quantify stress. The role of the directionality of stress is shown in examples where mechanical anisotropy poses a major challenge in manufacturing processes.
16:00		***Coffee Break***
		Chair: Bernhard Braunecker
16:30	3	**Mechanical Thinking: The Pascaline and its Planetary Predecessors** *Michael Korey, Staatliche Kunstsammlungen Dresden, Mathematisch-Physikalischer Salon* The *Pascaline* is often hailed as the oldest surviving mechanical calculator, and the Mathematisch-Physikalischer Salon in Dresden proudly holds the largest of the extant machines by Blaise Pascal. Starting from an analysis and visualization of this machine, the talk moves to consider earlier analog calculators, in particular planetary automata designed to represent the real-time, 'true' movement of all stars and planets visible to the naked eye in accordance with Ptolemaic theory. Four such automata from the 16th-century survive (in Paris, Vienna, Kassel, and Berlin) and may rightly lay claim to being the most intricate machines of their era. This richly illustrated talk will present recent research underscoring the mechanical thinking manifest in these subtle machines and attempt to explain how and why their makers – mathematicians, astronomers, and mechanicians – used surprisingly varied means to achieve putatively similar ends.

17:15	**4**	**From Pascaline to Piz Daint in the Alps infrastructure: a modern day view of computing in science** *Thomas Schulthess, ETH Zürich & Swiss National Supercomputing Center (CSCS) Lugano* "Piz Daint" is our flagship supercomputer system at CSCS. The current instance was introduced in 2017 and includes five thousand computing nodes accelerated with general purpose graphic processing units (GPGPU) NVIDIA dubbed "Pascal". It has been the workhorse of our User Laboratory over the past decade, leading the way for Europe's adoption of GPGPU in scientific computing. While the allure of supercomputing system's arithmetic performance remains, physics has forced the balance of computing devices to change, and we now must pay much more attention to data flow than arithmetic efficiency. Moreover, as we embrace the evolving digital age, the demands of scientific computing are shifting towards more complex workflows. These were the primary motivations to begin developing the new "Alps" infrastructure. As "Piz Daint" transitions into the "Alps" infrastructure, it will essentially become a software-defined cluster within "Alps." The current Pascal accelerators will be substituted with the latest GPGPUs, with vastly improved memory performance. Observing the progression of energy efficiency is intriguing; however, performance enhancements come at the cost of higher power consumption. These performance gains now come at higher cost, making a new trend that underscores the dusk of Moore's Law.
18:00		***END***
18:15	***General Assemblies of SPS and ÖPG ****	
19:15		***END***

* ÖPG: Room 117

Plenary Session

Tuesday, 05.09.2023, Room Aula 033

Time	ID	PLENARY SESSION I *Chair: Teresa Montaruli, Université de Genève*
09:00	11	**Looking forward to new physics with the LHC** *Anna Sfyrla, Université de Genève* The Large Hadron Collider (LHC) experiments are currently gathering massive amounts of data to study the Standard Model and search for new physics that could unlock the secrets of matter and interactions. In a few years, the upcoming high-luminosity LHC phase will deploy upgraded detectors of unparalleled precision, allowing us to collect data that is at least 10 times larger than our current dataset. At the same time, innovative experiments investigating uncharted areas of the parameter space in the forward direction of LHC collisions offer tantalizing potential for discovering new physics. This talk will provide an overview of recent progress and results in the search for new physics at the LHC, and will discuss thrilling prospects that lie ahead.
		Chair: Andreas Fuhrer, IBM Rüschlikon
09:45	12	**Sensirion: From start-up to a global player** *Felix Mayer, Sensirion* 25 years ago, Sensirion was founded by Moritz Lechner and me as a spin-off company of ETH Zurich. What started with two physicists and two measurement parameters is today a company that employs more than 1'200 people worldwide (700 of them in Switzerland). Around 100 of the employees originally studied physics. Today we offer around 15 sensor families which have many different variants covering a multitude of physical and chemical sensing applications. Every year Sensirion produces and sells more than 200 million sensors. Each sensor is individually calibrated. This means, that we "do a lot of physics", before we can sell our products. In my presentation, I will introduce individual measuring parameters and measuring principles and use some examples to show where physicists contribute to our success.
10:30		***Coffee Break***
11:00		***Award Ceremony***
		Chair: Henri Mariette, Société Française de Physique
12:15	13	**From Z to Higgs, and beyond!** *Bruno Mansoulié, Université Paris-Saclay* Hadron collisions at large accelerators have proven amazingly efficient in exploring the elementary particles and their interactions. The first important milestone was the discovery at CERN in 1984 of the W and Z bosons, mediators of the electroweak interaction. Then in 1995 the TeVatron, at Chicago, found the last known constituent of matter: the top quark. Finally at CERN, after a long design and construction period, the largest ever particle accelerator, the LHC, was commissioned in 2010. After a short operation period, the large collaborations ATLAS and CMS were able to announce the discovery of the Higgs boson, in 2012. With the ever-increasing performances of the LHC, this new particle is now observed in many production and decay modes. The wealth of data gathered and combined by powerful statistical methods allows to verify the theory of the Standard Model with an excellent accuracy. It also offers many possibilities to hunt for deviations, which would indicate a sign of new physics.
12:45		***Lunch***
14:00		***Topical Sessions***
19:00		***Postersession with Apéro***
20:30		***END***

Wednesday, 06.09.2023, Room Aula 033

Time	ID	**Plenary Session II** *Chair: Roland Resel, TU Graz*
09:00	**14**	**High-resolution and operando analysis for understanding surface and interface processes** *Markus Valtiner [1], M. Olgiati [2], P. Bilotto [2], Laura L. E. Mears [1], A. T. Celebi [1]* *[1] Vienna University of Technology, Institute of Applied Physics, Wiedner Hauptstraße 8-10/E134, AT-1040 Vienna* *[2] CEST Competence Center of Electrochemical Surface Technology GmbH, Viktor-Kaplan Str. 2, AT-2700 Wiener Neustadt, and Stahlstr. 2-4, AT-4020 Linz* Function and properties of electrified interfaces are controlled by a complex and concerted competition of specific and unspecific interaction of reactive surfaces with ions and water in an electrolyte. For instance, the local interface structure determines transition state barriers for electrocatalytic reactions and controls electron transfer from a surface toward a solution species, or vice versa. Further, properties such a lubrication and friction are controlled by molecular interfacial structures. Atomic force microscopy techniques provide an unprecedented resolution of complex surface structures, in both gaseous and recently also liquid environments. In this contribution I will discuss our understanding of ion exchange processes, and competitive molecular interaction at the interface of Muscovite mica, and will show first results on electrochemical interfaces. Starting from highly resolved data interfacial ion/water adsorption, it is possible to understand an predict competitive adsorption, and to derive quantitative thermodynamic information of molecular interactions at a complex solid/liquid interface. I will show different examples, how molecular resolution studies can provide an understanding of the emerging properties such as friction, reactivity or adhesion at electrified interfaces.
		Chair: Philippe Jetzer, Universität Zürich
09:45	**15**	**A journey to the Sun: why, how and what is being discovered** *Louise Harra, Physikalisch-Meteorologisches Observatorium Davos / World Radiation Center (PMOD/WRC), Dorfstrasse 33, CH-7260 Davos Dorf & ETH Zürich* The ESA Solar Orbiter space mission's goal is to observe close into the Sun and then slowly climb out of the ecliptic to view the solar poles for the first time. The first science perihelia took place in March 2022. Solar Orbiter aims to make significant breakthroughs in our understanding both of how the inner heliosphere works, and of the effects of solar activity on it. The spacecraft is taking in situ measurements will be used alongside remote sensing close to the Sun to uncover the source regions of the solar wind. I will summarise the latest results of the mission and look to future opportunities.
10:30		***Coffee Break***
		Chair: Maurizio Musso, Universität Salzburg
11:00	**16**	**Amorphous photonic networks in insects** *Bodo Wilts [1,2], Viola Bauernfeind [1], K. Djeghdi [1], Alessandro Parisotto [1], Ulrich Steiner [1]* *[1] Adolphe Merkle Institute, University of Fribourg, Switzerland* *[2] Department of Chemistry and Physics of Materials, University of Salzburg, Austria* Photonic nanostructures can vary in their degree of local order and their final optical appearance is the result of light interacting with these nanostructures that can further vary in their chemical composition. Insect are particularly interesting due to their large diversity of colored displays and their associated nanostructures. Here, we will show recent results on the research of weevils and longhorn beetles that all display vivid colors and rely on varying degrees of (dis)order combined with pigments. Using light microscopy, FIB-SEM tomographyand FDTD simulations, we investigated the mechanisms underlying the angle-independent color patterns and highlight the important contributions of disorder to the final appearance of the animals. This work illustrates the complex interplay of structural and pigmentary color and show pathways to use this in synthesizing novel optical materials.

<table>
<tr><th>Time</th><th>ID</th><th>Chair: Christian Teichert, Montanuniversität Leoben</th></tr>
<tr><td>11:45</td><td>17</td><td>From self-starting frequency combs to optical solitons in semiconductor lasers

Nikola Opačak, TU Wien, Institute of Solid State Electronics, AT-1040 Wien,
Harvard University, School of Engineering and Applied Sciences, Cambridge, MA 02138, USA

Optical frequency combs (OFCs) stand as the cornerstone of modern optics, with applications ranging from fundamental science to sensing and spectroscopy. Semiconductor lasers are especially appealing as OFC generators due to their compactness, electrical driving, and broadband gain. Beyond this, the fast carrier dynamics of these lasers yields a large resonant Kerr nonlinearity, which can be several orders of magnitude greater when compared to the bulk material. The giant optical nonlinearity is exploited to form self-starting frequency combs without the need of any external optical elements. When the laser active material is embedded in a monolithically-integrated ring cavity, it forms a new type of optical dissipative soliton, called the Nozaki-Bekki (NB) soliton. It forms spontaneously with the tuning of the laser bias and eliminates the need of an external optical pump. The NB soliton emerges as a traveling localized dark pulse, which is extensively characterized using both phase-sensitive measurements and numerical simulations. The solitonic nature of these confined waveforms is additionally corroborated by demonstrating multisoliton states as well. We explain the appropriate dispersive and nonlinear conditions that lead to NB solitons. Ring semiconductor lasers offer an electrically-driven platform for direct soliton generation, targeting applications in the mid-infrared spectral region.</td></tr>
<tr><td></td><td></td><td>Chair: Marc Janoschek, PSI Villigen</td></tr>
<tr><td>12:15</td><td>18</td><td>A Comprehensive Experimental Approach to Multifunctional Quantum Materials & their Physical Properties: Geometry and Physics in Condensed Matter.

Elisabetta Nocerino, Stockholm University & PSI Villigen

This thesis ranges within the vast framework of experimental condensed matter physics, producing results on several different systems and their characteristic physical phenomena, which are collected and presented here in a structuralist perspective. In fact, we show how, in solid condensed matter, the underlying arrangement of atoms, the symmetry of their structure, and their mutual interactions, underpin the form and the nature of their collective emergent properties. Our effort in this work was focused on unveiling complex magnetic ground states in newly synthesized materials (such as the low-dimensional colossal magnetoresistance compound $NaCr_2O_4$, and the triangular lattice antiferromagnets $LiCrSe_2$ and $LiCrTe_2$), as well as in the clarification of unconventional symmetry breaking phenomena in highly debated systems (such as the superconductor $LiTi_2O_4$, the charge density wave system $LaPt_2Si_2$, and the topological insulator $ZrTe_5$). In all cases, we could understand the physics of such systems only when we elucidated the details, and temperature dependent evolution, of their structures. To explore these structure-properties relationships, extensive experimental studies using large-scale research facilities were employed, with particular relevance given to neutron scattering.</td></tr>
<tr><td>12:45</td><td></td><td>Postersession with Lunchbuffet</td></tr>
<tr><td>14:30</td><td colspan="2">Topical Sessions</td></tr>
<tr><td>19:30</td><td></td><td></td></tr>
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Thursday, 07.09.2023, Room Aula 033

Time	ID	PLENARY SESSION III *Chair: Markus Aichhorn, TU Graz*
09:00	19	**Photoemission orbital tomography: imaging molecular orbitals at intrinsic length and time scales** *Peter Puschnig* *Institut für Physik, FB Theoretische Physik, Universität Graz, Universitätsplatz 5, AT-8010 Graz* Photoemission orbital tomography has emerged as a powerful technique that relates measured pho- toemission angular distributions from oriented films of organic molecules with the molecular or- bitals from which the electrons have been emitted. I will highlight its recent applications including the imaging of orbitals in three dimensions, the in-depth characterization of molecule/ substrate hy- bridizations and the identification of surface reaction products. Finally, using femtosecond pump- probe spectroscopy, a new window into the dynamics of excited states has recently been opened. It brings us one step closer to the dream of directly watching in slow-motion videos how electrons move in quantum mechanical orbitals and how this motion shapes the functionalities of condensed matter.
		Chair: Bruno Besser, ÖAW Graz
09:45	20	**Out of nowhere: The emergence of spacetime in quantum gravity** *Christian Wüthrich, Université de Genève* Quantum gravity attempts to fuse insights from quantum physics, which has so successfully contributed to our understanding of the constitution of matter, and from general relativity, our best theory of gravitation. This is necessary in order to describe the physics of black holes and the very early universe. Such a theory is of great interest to the philosopher of nature: the conceptions of space and time arising from our manifest image of the world have already been challenged by general relativity, and adding quantum effects to the mix promises to add significant complications. As it turns out, most approaches to quantum gravity suggest that our world is ultimately neither spatial nor temporal. How can one conceptualize such a non-spatiotemporal world? May necessary conditions for empirical research in a such world even be violated? How can space and time not be fundamental, but instead emerge from a non-spatiotemporal structure just as the liquidity of water emerges from molecules which are themselves not liquid? Using a concrete example of a theory of quantum gravity, I will explain - and answer - these questions.
10:30		***Coffee Break***
		Chair: Christian Teichert, Montanuniversität Leoben
11:00	21	**Classical and Quantum Information** *Anton Zeilinger, Universität Wien* In the talk an overview will be given of experiments which led from single particle interference to quantum entanglement. That finally led to realizations of basic primitives of quantum information. In the end I will present my arguments for quantum states as representations of logical propositions.
		Chair: Hugo Zbinden, Université de Genève
11:45	22	**Electromagnetic processes of nuclear excitation** *Simone Gargiulo, EPFL* Since their first identification in 1921, long-lived nuclear excited states, known as isomers, have held promise for realization of compact energy storage as they can hold these excitations for millions of years and beyond, also surpassing the age of the Universe; however, a process that could efficiently exploit their potential has yet to be discovered. We explore and propose several electromagnetic processes of nuclear excitation, including those that use the atomic surrounding, as possible tools that may enable the activation of isomers and the indirect manipulation of their lifetime.

Time	ID	*Chair: Maurizio Musso, Universität Salzburg*
12:15	**23**	**Educational considerations on the physics of global warming** *Franz Embacher, Faculties of Mathematics & Physics, University of Vienna* One of the goals of school education is to familiarize the younger generation with basic facts about climate and climate change, and to stimulate their independent thinking about these issues. For physics teachers, this is not an easy task and raises numerous didactic questions. After all, phenomena and concepts needed in order to explain why the earth is warming (such als thermal radiation, absorption and emission by invisible gases, and the Stefan-Boltzmann law) are not really prominent among the traditional topics of physics education. Moreover, when it comes to address the inertia of the climate system, the role of the oceans as a huge heat reservoir, and the future of the earth's climate, as measured in centuries and millennia, we encounter the problem that thermodynamics as usually taught in school does not tell us much about time scales of equilibration processes. In the talk, some contact points between school physics and the physics of global warming are identified.
12:45		***Lunch***
14:00		***Topical Sessions***
19:00		***Transfer to Dinner***
19:30		***Conference Dinner***

Friday, 08.09.2023, Room Aula 033

Time	ID	**PLENARY SESSION IV** *Chair: Christian Teichert, Montanuniversität Leoben*
09:00	**24**	**Tailoring the environment to steer laser-driven reactions at surfaces: Solvation, confinement, and more** *Karina Morgenstern* *Physical Chemistry I, Ruhr University of Bochum, Universitätsstr. 150, DE-44803 Bochum* Laser pulses are an intriguing tool for driving non-adiabatic processes at surfaces. Amongst others, they may be utilized for tailoring adsorbed molecules or the surfaces themselves with the aim of custom-made properties that cannot be achieved under equilibrium conditions. We advance the microscopic understanding of the fundamental steps involved in such processes and the details of the dynamics induced by fs-lasers on specific surface sites by a real-space analysis of the resulting products and structures on the sub-nanometer scale, combining short-pulse lasers with scanning tunnelling microscopes. The microscale understanding of the influence of the immediate environment on laser-driven processes, may be used to tailor it for a desired outcome. In this talk, I will present our recent advances in the field.
		Chair: Christof Aegerter, Universität Zürich
09:45	**25**	**Science Education in an International Context** *Sascha Marc Schmeling, Head of Teacher and Student Programmes, CERN, Geneva* CERN is one of the oldest European intergovernmental organisations. In summer 1953, the final draft of the CERN Convention was agreed upon and it laid out the ways its Member States would contribute, as well as its commitment to the dissemination of the research results, international peaceful collaboration, and the education of the scientists of tomorrow. From Mach's first definition of the "Nature of Science" to today's challenges, the field of science education has evolved significantly and its importance for future generations has grown. This presentation will highlight the Organization's current involvement in education and its research including links to national efforts, as well as science outreach, and give a personal outlook and ideas for science education on an international scale.

10:30		***Poster Award Session***
10:45		***Coffee Break***
		SUSTAINABLE RESEARCH IN PHYSICS *Moderation: Hugo Zbinden, Université de Genève*
11:15	26	***Panel Discussion*** **Introduction, the carbon footprint of research in Switzerland, sustainability at EPFL** *Muranaka Tamoko, EPFL* **Particle Physics, Technologies for sustainable accelerators** *Mike Seidel, PSI Villigen + EPFL* **The efforts at ETHZ** *Anna Soter, ETH Zürich* **A grassroot approach to sustainable research** *Philipp Treutlein, Universität Basel*
12:00		***Topical Sessions***
14:30		***CONFERENCE END***

History and Philosophy of Physics

Wednesday, 06.09.2023, Room 114

Time	ID	History and Philosophy of Physics *Chair: Bruno Besser, ÖAW Graz*
14:30	**41**	**Richard Kirwan and the Power of Magnetic Order** *Reinhard Folk, Johannes Kepler Universität Linz* The Irish scientist Richard Kirwan (1733 - 1812) is well known as chemist, mineralogist, geologist, and meteorologist. Less established is, his contribution to ferromagnetism. His name is connected to the so called *Rotation Hypothesis* which considered natural magnets as solids which contain rotatable ‘atomic’ magnets rather than ‘magnetic’ fluids perfusing through the solid as in the so called *Separation Hypothesis*. Kirwan considered magnetism in solids as ordering phenomenon like crystallization due to attracting and repelling interactions. In the Bohr Sommerfeld quantum mechanics this idea were revived by Alfred Landé’s Synchronism and Walter Schottky’s Rotoactivity of circling electrons. Surprisingly after Pauli’s spin Kirwan’s ideas dropped out of the history of magnetism.
15:00	**42**	**Kaleidoscope of a historical physics collection** *Franz Sachslehner, Universität Wien, Fakultät für Physik* The historical physics collection at the University of Vienna offers numerous possibilities to study basic concepts and important developments of physics. Historical instruments and objects come to life in experiments. Many of them still work and make fascinating experiments. The following devices are shown briefly by means of photos or video: the flame probe with the electroscope, the Atwood machine, Lippich’s falling apparatus, Maxwell’s wheel, birefringence in artfully designed gypsum crystals and stressed glasses, the string galvanometer, the Page motor, a grating spectrograph, a vibration microscope and a tuning fork interrupter. Where it is helpful, some mathematics is also given.
15:30	**43**	**“Austrian” Observatories in the Travelogues of Johann III Bernoulli** *Bruno Besser, Nora Pärr, Österreichische Akademie der Wissenschaften* Johann III Bernoulli, director of the Berlin Observatory, paid tribute to the observatories of present-day Austria with detailed descriptions of their construction and instruments in his extensive travel descriptions. Maximilian Hell (1720 - 1793), Vienna University Observatory Director, as well as Placidus Fixlmillner (1721 - 1791), Director of the "Astronomical Tower" of Kremsmünster Abbey in Upper Austria, are of particular interest. In terms of institutional history, not only the observatories will be dealt with, but also Bernoulli's long-standing place of activity, the Berlin Academy of Sciences. Networking between the research institutions mentioned was given by Hell's participation in the world-wide project for the observation of the transit of Venus in 1761 and 1769. The discovery of Uranus in 1781 led to lively correspondence. A high degree of internationality was achieved through the publication of astronomical yearbooks.

16:00	**44**	**Daniel Bernoulli's Research in Basel and the "Physikalisches Kabinett" in the "Stachelschützenhaus"** *Martin C. E. Huber (Zürich), Martin Mattmüller, Ernst Meyer, Friedrich-K. Thielemann (Basel)* Daniel Bernoulli (1700 - 1782) studied initially medicine in Basel, Heidelberg, and Strasbourg, concluding with a thesis on respiration (containing experimental and mathematical approaches). During his scientific life he worked across many disciplines (with a focus on physics and its mathematical foundations). In 1725 he was appointed to the St. Petersburg Academy. In 1726 Leonhard Euler followed him to St. Petersburg. Later on Bernoulli intended to return to Basel for a chair in physics. But as appointments to professorships there were (in those days) often taken by drawing lots among the top three candidates, Bernoulli was first successful in 1733 with obtaining a professorship in anatomy and botany, being offered finally a professorship in physics in 1750. He then taught physics until 1776. His most comprehensive work, the “Hydrodynamica” of 1733/1738 achieved a fundamental advance in hydrodynamics and laid the foundation for later progress, which included the well-known “Bernoulli Principle”, relating the speed of a fluid to its potential energy. He published 74 papers and won a total of 10 Grand Paris Academy Prizes for topics in astronomy, physics, and applications to nautical problems. Bernoulli's predecessor as professor of physics at the University of Basel, Benedict Staehelin (1695 - 1750), had started a collection of physics devices and instruments that he had acquired for demonstration purposes. These pieces were set up in the 'Physics Cabinet' (the south wing of the "Stachelschützenhaus", built in 1729). Bernoulli added many more apparatuses for his research and lectures on physics – among them the experiment for the "Demonstration of the Hydrostatic Paradox" – which demonstrates that the pressure in a liquid is independent of the shape of the vessel and depends only on the height of the liquid column. Bernoulli had thus significantly expanded the collection of Basel's "Physics Cabinet". The instruments that had been housed in the "Physics Cabinet" now belong to the Historical Museum, and are exhibited at different locations in the city. While the “Stachelschützenhaus” has later been used by various other University Institutes (presently it hosts the Clinical Virology), it was the place, where Daniel Bernoulli worked for a quarter of a century, undertook research and gave his public experimental physics lectures that enjoyed great popularity. For this reason the EPS has decided to make the “Stachelschützenhaus” an ‘EPS Historic Site’ (inauguration 22 September 2023).
16:30		***END; Coffee Break***

Nanotechnology: From Hype to Application

Tuesday, 05.09.2023, Room 114

Time	ID	**Nanotechnology: From Hype to Application** *Chair: Peter Korczak, Christian Teissl, Werkstätte Wattens, Andreas Fuhrer, IBM Rüschlikon, Thilo Stöferle, IBM Rüschlikon*
14:00	**51**	**Introduction** *Thilo Stöferle & Andreas Fuhrer*
14:10	**52**	**Nanosurf: 25 years of riding the nanotechnology wave** *Dominik Ziegler, Nanosurf* Emerging as a startup from the University of Basel, Nanosurf is today a leading company offering innovative solutions for nanoscale metrology in life sciences, material sciences, and industry. The talk highlights the history and successes of Nanosurf over the last 25 years, and shows how scanning probe microscopes have turned into a widely used tool to visualize nanoscale phenomena, that advance nanoscale research and enable many future technologies.
14:30	**53**	**BTO-enhanced silicon photonics – a scalable PIC platform based on Pockels modulation** *Thomas Kornher, Lumiphase AG* Controlling light with electrical signals is one of the most critical functions in a photonic integrated circuit for optical communication, sensing, and switching. Lumiphase develops and manufactures photonic chips powered by a unique BTO Pockels technology. The BTO material properties translate into electro-optical modulation functionalities with benefits in cost, speed, transparency, power-consumption, and footprint compared to standard silicon solutions. The Pockels-enhanced chips enable next-generation transceivers and a wide range of other photonic applications ranging from sensing, over data processing to switching, where large numbers of ultra-efficient, integrated phase shifters are needed.
14:50	**54**	**Scratch resistance furniture films** *Peter Fankhauser, Senco Research & Development GmbH & Co. KG* In the talk, current application examples of nanotechnology in furniture lacquers will be presented. The high demands on furniture surfaces can be achieved by using nanoscale particles in furniture lacquers. These nanocomposite lacquers are characterised by excellent mechanical and viscoelastic properties. Among other things, scratch and abrasion resistance are improved and chemical resistance is increased. The inorganic nanoparticles firmly integrated into the lacquer matrix do not impair the transparency and gloss of the furniture lacquer.
15:10	**55**	**3D printing of miniaturized glass devices** *Cesare Alfieri, Andrea Lovera, Femtoprint* The unique mechanical and thermal properties of glass, combined with transparency, electromagnetic immunity and biocompatibility, significantly enrich the possibilities of micro- and nanofabrication in high-tech industrial fields, from Photonics to Life Sciences, from Medicine to Quantum. However, the capability to miniaturize complex glass shapes with the required precision still represents a challenge. The FEMTOprint technology platform offers cost-effective and scalable 3D fabrication of glass devices with sub-micron accuracy. We demonstrate the versatility of the FEMTOprint production process presenting the realization of fiber and lens arrays, microfluidic chips, biosensors and ion traps. We comment on the accuracy achieved and highlight the metrology challenges involved in the industrialization of miniaturized components.

15:30	**56**	**Designing optical thin films using polarized light** *David Pires, Rolic Technologies* Rolic is a cutting-edge technology firm, subsidiary of BASF and headquartered near Basel. The company develops and sells functional materials for display, optical and opto-electrical applications. Using its patent-protected LCMO (Light Controlled Molecular Orientation) technology, Rolic can manipulate surfaces on a nanoscale level using polarized light to produce distinctive optical effects by controlling the arrangement of liquid crystal molecules. The multidisciplinary development projects undertaken by our R&D department involve material science and device engineering across a range of fields, including display, light management, energy harvesting, and sensing. To support the conception process, we have developed a polarization optics modelling platform, which enables accurate modelling and optimization of the optical stacks.
15:50	**57**	**Industry and Academia: The Power of Partnership in Scientific Discovery** *Silke Traut, Dectris* Dectris emerged from one of the most significant experiments in particle physics: the CMS experiment. PSIs visionary efforts to transfer the detection technology to a company made photon counting detectors available to a broader scientific community. In my talk, I will elaborate on the impact this has made on structural analysis in life or material science, as well as plasma spectroscopy in energy science. For the next generation detectors multiple technologies must be developed and mastered. We partner with universities and companies on fast data pipelines, novel materials, AI, and Micro-Nanotechnologies. This will allow us to bring back detectors with unique new properties to the scientific community for novel research.
16:10	**58**	**Challenges in bringing a manual laboratory technology closer to the semiconductor fab** *Samuel Sonderegger, Christian Monachon, Attolight* Cathodoluminescence (CL) has been around even before the advent of electron microscopy and is well known for its capability to detect crystallographic defects in compound semiconductors at the nanometer scale. At the same time, CL is also well known to be a sometimes difficult to use laboratory technology. During this presentation we will look into key aspects between a lab and a fab technology and present key milestones and challenges we met over the last years bringing the CL technology closer to the semiconductor fab by automating it for specific applications.
16:30		***Coffee Break***
17:00	**59**	**NanoFrazor technology: enabling advanced nanodevices and unique applications** *Fabian Könemann, Heidelberg Instruments Nano* The range of applications for t-SPL is broad, spanning from ultra-high resolution 2D and 3D patterning, to chemical and physical modification of matter at the nanoscale. Nanometer-precise markerless overlay and non-invasiveness to sensitive materials are among the key strengths of the technology. Overlay is shown to work with sub-5 nm precision even for nanowires and 2D material flakes that are buried under resist layers, thanks to the highly sensitive in-situ reading capability of the NanoFrazor tool. These unique capabilities allow for the realization of novel nanodevices with emerging 1D and 2D materials, and for nanometer-precise 3D (grayscale) surfaces in optics and fluidics.

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<tr><td>17:20</td><td>60</td><td>

**XRnanotech - Nanostructured Diffractive Optics –
New Opportunities at Short Wavelengths**

Adam Kubec, XRnanotech

X-rays offer unrivaled insights into intricate samples with their high penetration and sensitivity, necessitating constant X-ray-optics advancement. Nanostructured-diffractive-optics, facilitated by recent nanotechnology, have catalyzed major scientific discoveries in premier research-facilities. Utilizing nanolithography techniques like electron-beam-nanolithography, two-photon polymerization, and direct laser writing, we've opened new doors in the field. This has led to the creation of transmission achromatic X-ray optics, ultra-high resolution zone plates, and blazed reflection gratings from materials like diamonds, metals, and 3D nanoprinted polymers. This offers wide-ranging X-ray energy efficiency and unique optical functionalities. We'll showcase recent developments, including high-resolution X-ray zone plates, silicon reflection gratings, and high-stability diamond gratings, demonstrating nanolithography's potential in enhancing X-ray research.

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<tr><td>17:40</td><td>61</td><td>

Big Data and Artificial Intelligence in PVD coating development

Arnd Müller, Keith Thomas, Balzers Oerlikon

Hard coatings produced by physical vapour deposition (PVD) are used in a wide range of applications. Coated cutting tools for instance enable more severe cutting conditions and/or longer life, resulting in lower cost per workpiece.
The development and improvement of such coatings can involve combinatorial approaches, but is still usually done through conventional trial and error. Technologies such as Optical Character Recognition (OCR) or image analysis help to generate a broad dataset that can be used as a starting point for future developments based on machine learning. This talk will show some examples of how this is already being used.

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<tr><td>18:00</td><td>62</td><td>

PyzoFlex® matrix: How to combine printed ferroelectric sensors and organic transistors for vital parameter, tactile pressure and proximity sensing

*Barbara Stadlober [1], Andreas Petritz [1], Esther Karner-Petritz [1], Herbert Gold [1], Bernhard Lamprecht [1], Manfred Adler [1], Andreas Tschepp [1], Martin Zirkl [1], Takafumi Uemura [2], Teppei Araki [2], Micael Charbonneau [3], Romain Coppard [3], Marco Fattori [4], Eugenio Cantatore [4], Tsuyoshi Sekitani [2]
[1] Joanneum Research Forschungsgesellschaft, [2] Osaka University
[3] CEA-LITEN, [4] Eindhoven University of Technology*

In the context of ultraflexible scalable nanosensors I will present several combinations of ferroelectric polymer transducers based on P(VDF:TrFE) with organic thinfilm transistors (OTFTs) fabricated on (ultra)flexible substrates for tactile pressure sensing, proximity detection, pulse rate as well as blood pressure monitoring.
After presenting the basics of our printed ferroelectric sensor technology PyzoFlex® I will discuss an ultra-compliant active-matrix tactile pressure sensor, where OTFTs are monolithically integrated with the ferroelectric transducers on a just 1 μm thin polymer substrate. The final demonstration is an in-pixel amplified flexible proximity-sensing surface for work security and robotics based on an all-printed OTFT-backplane with an all-printed pyroelectric sensor frontplane.

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18:20	**63**	**ARTIDIS technology revolutionizes cancer care by using physical characterization of tissue** *Philipp Oertle, ARTIDIS* Aggressive & Treatment Resistant cancers that metastasize kill > 90 % of cancer patients. Until now there have been no diagnostics to detect the tumors' ability to metastasize. ARTIDIS can address this unmet need and improve cancer care. The ARTIDIS Imaging System, based on Atomic Force Microscopy (AFM), provides quantitative measurements of tissues' Nanomechanical Signature. The Nanomechanical Signature informs the tissue phenotype, the sum of functional properties of different tissue components like cells, matrix and immune landscape and identifies imminent disease aggressiveness based on presence of soft and thus metastatic cells. Published studies show uniform but distinct stiffness distribution between normal and benign tissues, while malignant cells and their tumor microenvironment (TME) have variable stiffness and highly aggressive (i.e. potentially metastatic) cells present a lower stiffness peak. Additional studies show that patients with soft tumors are more likely to be successfully treated with chemotherapy / immunotherapy. Furthermore, there is evidence showing that proper dosing of radiation treatment based on stiffness characterization enhances systemic antitumor immune responses by overcoming inhibitory tissue. To address these unmet needs, ARTIDIS is performing ongoing clinical studies to bring AFM based technology through regulatory approval and to clinics for the first time. *This talk will also be presented as poster.*
18:40		***END***
19:00		***Postersession with Apéro***

ÖPG Thesis Awards

Wednesday, 06.09.2023, Room 115

Time	ID	ÖPG Thesis Awards *Chair: Benjamin Klebel-Knobloch, TU Wien*
14:30	**71**	**Creating The World's Toughest Obstacle Course for Magnetic Flux Quanta in High-T_c Superconductors** *Bernd Aichner [1], Lucas Backmeister [1], Max Karrer [2], Katja Wurster [2], Philipp A. Korner [1], Christoph Schmid [2], Sandra Keppert [3], Reinhold Kleiner [2], Johannes D. Pedarnig [3], Edward Goldobin [2], Dieter Koelle [2], Wolfgang Lang [1]* *[1] Faculty of Physics, University of Vienna, Austria* *[2] Physikalisches Institut, Center for Quantum Science (CQ) and LISA+, Universität Tübingen, Germany* *[3] Institute of Applied Physics, Johannes Kepler University Linz, Austria* Controlling the movement of magnetic flux quanta in high-temperature superconductors such as $YBa_2Cu_3O_{7-\delta}$ is essential for most applications. It demands the introduction of artificial defect structures that serve as obstacles for the moving flux quanta. Using a helium ion microscope's well-controllable focused beam, we create ultra-dense periodic patterns of hills and hollows in the potential landscape in which the vortices move. This artificial nano-scaled obstacle course for magnetic flux-quanta leads to exciting electronic transport effects, such as commensurability effects, magnetic vortex caging and the emergence of an ordered Bose glass phase. Besides their potential for superconductivity research, these complex pinning landscapes for magnetic flux quanta are an essential step toward low-dissipative superconducting electronics.
15:00	**72**	**Holographic QCD and the Anomalous Magnetic Moment of the Muon** *Josef Leutgeb, TU Wien* The primary source of the estimated error in the standard model's prediction for the anomalous magnetic moment of the muon originates mainly from hadronic vacuum polarization and hadronic light-by-light scattering. The latter is dominated by the exchange of neutral pseudoscalars and axial-vector mesons. By employing holographic QCD, we can compute these contributions and address the problem of most phenomenological models in meeting the established short-distance constraints of the hadronic light-by-light tensor. Notably, this includes the constraint implied by the axial anomaly identified by Melnikov and Vainshtein.
15:30	**73**	**Understanding complex oxide surfaces at the atomic level through ncAFM and DFT** *Igor Sokolović, Institute of Applied Physics and Institute of Microelectronics, TU Wien* Solid oxide compounds constitute the vast majority of all solids on Earth. Their variety is responsible for a wide range of intriguing physical properties, and their abundance opens a possibility for wide-spread technical use. Each solid interacts with the environment through the exposed surfaces, and Surface Science aims to understand these processes and a fundamental level. The structure of a surface can be directly recorded with non-contact atomic force microscopy (ncAFM) with single-atom precision. The observed configurations can be theoretically modeled with quantum mechanics through density functional theory (DFT). In this talk, I will introduce and demonstrate these state-of-the-art Surface Science techniques on a surface of a prototypical TiO_2 oxide.
16:00		***END***
16:30		***Coffee Break***

KOND

Tuesday, 05.09.2023, Room Aula 033

Time	ID	KOND I: (Thermal) Transport in 2D systems *Chair: Ilaria Zardo, Universität Basel*
14:00	101	**Modern theory of thermal transport in solids** *Michele Simoncelli *, Nicola Marzari* *Theory and Simulation of Materials (THEOS) and National Centre for Computational Design and Discovery of Novel Materials (MARVEL), École Polytechnique Fédérale de Lausanne, CH-1015 Lausanne* **Current address: Theory of Condensed Matter Group of the Cavendish Laboratory, University of Cambridge (UK)* We explore the atomistic mechanisms of thermal transport in solids, extending established formulations and developing the computational framework to solve them. Starting from a density-matrix formalism, we show how the phonon Boltzmann equation is missing a tunneling term that becomes pivotal in disordered or defective materials. Thus, we derive a unified 'Wigner formulation' that comprehensively describes heat conduction in crystals, glasses, and intermediate cases such as thermoelectrics. Also, we show how in crystalline conductors the microscopic transport equations can be coarse grained into a set of viscous heat equations that describe both Fourier diffusion and heat hydrodynamics; thus, we employ these to rationalize pioneering experiments, and to devise strategies to amplify and control heat hydrodynamics.
14:30	102	**Thermodynamic transport fingerprints in Twisted monolayer-bilayer graphene** *Jin Jiang [1], Sheng Chen [1], Zekang Zhou [1], Kenji Watanabe [2], Takashi Taniguchi [3], Mitali Banerjee [1]* *[1] Laboratory of Quantum Physics (LQP), Institute of Physics, EPFL, CH-1015 Lausanne* *[2] Research Center for Functional Materials, National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan* *[3] International Center for Materials Nanoarchitectonics, National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan* Twisted monolayer-bilayer graphene (TMBG) exhibits renormalized nearly flat bands harboring various exotic physical phenomena. Stacking an additional monolayer graphene on the TMBG paves a new way to extract single particle bandgap, the charge neutrality point (CNP) gap and bandwidth. The Dirac cone in the decoupled monolayer graphene serves as a perfect chemical potential sensor when the Landau levels (LLs) cross the bands, whereas the LLs are well separated and are not hybridized with flat bands. At D = 0.53 V /nm, the isospin flavor symmetry-broken correlated gap at flat-band filling $\nu = 1$ is largest and bandwidth is narrowest. This is a versatile tool which can be used in various similar systems to find thermodynamic properties.
14:45	103	**Electronic Poiseuille Flow in Hexagonal Boron Nitride Encapsulated Graphene FETs** *Tathagata Paul, Wenhao Huang, Mickael L. Perrin, Michel Calame, EMPA* In most conductors, diffusive scattering from defects and lattice vibrations results in Ohmic transport. Alternatively, transport is ballistic, when the channel dimensions are the smallest length scale. However, when electron-electron interactions are sufficiently strong, charge transport can mimic the viscous flow of fluids. In the current work, we explore this analogy and observe that the electrical signatures of viscous effects, characterized by measuring the differential resistance as a function of channel width and effective electron temperature, survives close to room temperature. Our findings open up new directions for designing devices exploiting viscous charge flow such as geometric rectifiers like a Tesla valve and charge amplifiers based on electronic Venturi effect.

15:00	**104**	**Dipole charge density ordering in bilayer semiconductors** *Joel Hutchinson, Jelena Klinovaja, Daniel Loss, Dmitry Miserev, University of Basel* Advances in the manipulation of van der Waals materials have shown that bilayers offer a unique platform for studying strongly correlated physics in two-dimensions (2D). Bilayers are importantly different from monolayers in that there exist long-range interactions between electrons in both the intra- and inter-layer channels, which differ only slightly. We show that the electronic charge susceptibility has peaks arising from scattering across the Fermi surfaces, not seen in the usual Lindhard function. In a bilayer system, these peaks give rise to an enhanced response of out-of-plane dipoles to local potential differences across the layers. This response is not diminished by screening and becomes larger in the low-density limit.
15:15	**105**	**Probing the electronic structure of chemically-induced van der Waals heterostructures in V_xTaS_2** *Wojciech Pudelko [1], Eduardo Bonini Guedes [1], Johan Chang [2], Ron Cohn-Wagner [2], Julia Küspert [2], Hang Li [1], Huanlong Liu [2], Francesco Petocchi [3], Nicholas Clark Plumb [1], Andreas Schilling [2], Philipp Werner [3], Karin von Arx [2]* *[1] Paul Scherrer Institut* *[2] Physik-Institut, Universität Zürich, Winterthurerstrasse 190, CH-8057 Zürich* *[3] University of Fribourg* Layered transition metal dichalcogenides exhibit numerous exotic electronic phases, which are known to be highly sensitive to minute changes in virtually any external parameter. We found that vanadium intercalation into the TaS_2 (V_xTaS_2) leads to intriguing changes in its properties. Upon increasing x, the electronic structure evolves from the pure 2H phase known for its charge density wave (CDW) and superconductivity to a pure 1T structure characterized by CDW and Mott interactions, with a clear coexistence of both at intermediate range. By exploiting V intercalation as a means to assemble 2H/1T layered heterostructures, we are granted a spectroscopic window into each layer type, as well as the interplay between them.
15:30	**106**	**Understanding pairing mechanism in magic angle twisted trilayer graphene** *Zekang Zhou [1], Jin Jiang [1], Kenji Watanabe [2], Takashi Taniguchi [3], Mitali Banerjee [1]* *[1] Laboratory of Quantum Physics (LQP), Institute of Physics, EPFL, CH-1015 Lausanne* *[2] Research Center for Functional Materials, National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan* *[3] International Center for Materials Nanoarchitectonics, National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan* Flat bands in twisted graphene systems offers plethora of strongly correlated states, among these, correlated insulator, superconductor and chern insulator are to name of few. Twisted trilayer graphene has shown robust superconductivity which drastically deviates from conventional weak-coupling BCS type superconductivity. In particular, twisted trilayer graphene may even host prag- matic example of strong coupling superconductivity – BEC type superconductivity. A full understanding of such superconductivity still needs more experimental works. In this talk, I will present our transport data of magic angle twisted trilayer graphene and highlight its unconventional nature.

15:45	**107**	**Origin and nature of defect states coupled to a van der Waals superconductor** *Paritosh Karnatak [1], Zarina Mingazheva [1], Kenji Watanabe [2], Takashi Taniguchi [3], Helmuth Berger [4], László Forró [4], Christian Schönenberger [1]* *[1] Department of Physics, University of Basel, CH-4056 Basel* *[2] Research Center for Functional Materials, National Institute for Material Science, 1-1 Namiki, Tsukuba 305-0044, Japan* *[3] International Center for Materials Nanoarchitectonics, National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan* *[4] Institute of Condensed Matter Physics, EPFL, CH-1015 Lausanne* We perform tunnel spectroscopy on $NbSe_2$ by utilizing MoS_2 or hexagonal Boron Nitride (hBN) as a tunnel barrier. We observe subgap excitations and probe their origin by studying various heterostructure designs. We show that the edge of $NbSe_2$ hosts many defect states. By isolating the $NbSe_2$ edge and comparing MoS_2 and hBN tunnel barriers, we suggest defects in MoS_2 as the origin of the subgap features. We study the evolution of the subgap excitations and reveal both singlet and doublet type ground states, which indicates a competition of various energy scales. Based on nearly vanishing g-factors or avoided-crossing of subgap excitations we also highlight the role of strong spin-orbit coupling.
16:00	**108**	**Fabry-Perot interferometry in bi-layer graphene** *Mario Di Luca [1], Kenji Watanabe [2], Takashi Taniguchi [3], Mitali Banerjee [1]* *[1] Laboratory of Quantum Physics (LQP), Institute of Physics, EPFL, CH-1015 Lausanne* *[2] Research Center for Functional Materials, National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan* *[3] International Center for Materials Nanoarchitectonics, National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan* In solid-state systems, strong correlations cause the emergence of quasiparticles that are immune to local environmental perturbations. An example of such a system is the Quantum Hall Effect, in which electrons confined in two dimensions and subjected to a high perpendicular magnetic field give rise to fractionally charged quasiparticles (anyons) that are topologically protected. The statistics of anyons can be studied by interferometry techniques. To study the statistical behavior of anyons we use bilayer graphene in Fabry-Perot interferometer geometry. In this paper I will describe the techniques used in the fabrication process and some interferometry results.
16:15	**109**	**In-situ buried interface passivation enables efficient and stable inverted perovskite solar modules** *Virginia Carnevali, Lin Li, Mingyang Wei, Nikolaos Lempesis, Lorenzo Agosta, Mathias Dankl, Ursula Roethlisberger, Michael Graetzel, EPFL* Scaling-up perovskite solar cells (PSCs) is a prerequisite to the adoption of perovskite photovoltaics. However, the performance and stability of perovskite solar modules (PSMs) have lagged behind those of lab-scale PSCs. The development o PSMs requires interfacial passivation, yet this is challenging for the buried interface, owing to the dissolution of passivation agents during perovskite deposition. Here, we overcome this limitation with in-situ buried interface passivation – achieved via directly adding a cyanoacrylic acid-based molecular additive into the perovskite precursor solution. The preferential buried interface passivation results in facilitated hole transfer and suppressed surface recombination. We report a power-conversion efficiency (PCE) of 20.3% for inverted-structure PSMs.
16:30		***Coffee Break***

Time	ID	**KOND II: Cuprates** *Chair: Henrik Rønnow, EPF Lausanne*
17:00	**111**	**Uniaxial Control of Quantum Matter. Application to Cuprates** *Gediminas Simutis, Paul Scherrer Institut, 5232 Villigen PSI* Quantum matter is characterised by competing and intertwined orders. Here we will present our recent advances in using uniaxial pressure as a clean "surgical" tool to tune quantum phases while simultaneously obtaining microscopic insights via scattering experiments. To achieve the fine-tuning, we have designed a new in-situ uniaxial device for large-scale facility research based on an actuator-motor mechanism, efficient feedback loops and the sample-holder design enabling rapid exchange of the samples. I will demonstrate the advanced capabilities of this device by reporting the control of charge and structural degrees of freedom in an archetypical cuprate.
17:15	**112**	**A strong-coupling mechanism for the pseudogap from spin fluctuations** *Friedrich Krien, Patrick Chalupa-Gantner, Karsten Held, Alessandro Toschi, Paul Worm, TU Wien* The mechanism of the pseudogap observed in hole-doped cuprates remains one of the central puzzles in condensed matter physics. We analyze this phenomenon via a Feynman-diagrammatic inspection of the Hubbard model. Our approach captures the pivotal interplay between Mott localization and Fermi surface topology *beyond* weak-coupling spin fluctuations. Our analysis naturally explains puzzling features of the pseudogap observed in experiments, such as Fermi arcs being cut off at the antiferromagnetic zone boundary and the subordinate role of hot spots.
17:30	**113**	**Investigating the periodic electronic modulations in $Bi_2Sr_2Ca_1Cu_2O_{8+\delta}$ by Scanning Tunneling Microscopy** *Tejas Parasram Singar [1], Genda Gu [2], Ivan Maggio-Aprile [1], Christoph Renner [1]* *[1] University of Geneva, [2] CMPMS Division, Brookhaven National Laboratory* In this work, we will discuss our latest investigations of the $Bi_2Sr_2Ca_1Cu_2O_{8+\delta}$ cuprate superconductor using Scanning Tunneling Microscopy (STM). We focus on the atomic scale periodic charge modulations as a function of doping and magnetic field. Specifically, we try to address the nature and origin of the $4a_0 \times 4a_0$ and $(4/3)a_0 \times (4/3)a_0$ modulations (a_0: crystallographic unit cell) using different acquisition modes of STM. The periodic conductance modulations we observe do not reveal the characteristic features usually associated with charge density waves in STM experiments, suggesting they are rather quasiparticle interferences.
17:45	**114**	**High-T_c cuprates – story of two electronic subsystems** *Neven Barisic, TU Wien, Austria & PMF Zagreb, Croatia* Based on now well-established universal transport and optical conductivity properties, we show that the phenomenology of cuprates across the phase diagram is fully captured by the charge conservation relation: $1 + p = n_{loc} + n_{eff}$ with the superfluid density that simply corresponds to: $\rho_S = n_{eff} \cdot (O_S \cdot n_{loc})$ where p is doping, n_{eff} is the carrier density, which can be directly determined experimentally, while O_S is a compound-dependent constant. We attribute the distinction between low- and high-T_c cuprates to the fine-tuning of the p–d–p fluctuation of the Cu-localized hole (n_{loc}) visiting the neighboring planar–oxygen atoms, which is the reason for the material-dependence embodied in the constant O_S.

18:00	**115**	**Murunskite: A Bridge Between Cuprates and Pnictides** *Trpimir Ivsic [1], Davor Tolj [2], Ivica Zivkovic [2], Konstantin Semeniuk, Eduardo Martino, Ana Akrap [3], Priyanka Reddy [4], Benjamin Klebel-Knobloch [1], Ivor Loncaric [4], László Forró [2], Neven Barisic [1,4], Henrik Rønnow [2], Denis Sunko [4]* *[1] Technische Universitat Wien, [2] EPFL, [3] University of Fribourg, [4] University of Zagreb* Exploring novel materials as the candidates for unconventional superconductors can help to understand the mechanism of this exotic phenomenon but also lead to synthesis of compounds with important technological applications. The main compound of interest is murunskite, a material isostructural to iron-based superconductors with iron and copper occupying the same crystal site. I will discuss the synthesis methods of single crystals and measurements of structural, electronic and magnetic properties. Murunskite structure has been successfully altered by substitution and doping on all three crystallographic positions. Effects on the electronic and magnetic properties towards the metallization will be discussed.
	~~116~~	*cancelled*
18:15	**117**	**Cuprates in Magnetic Field** *Benjamin Klebel-Knobloch [1], Neven Barisic [1,2], Osor S. Barisic [3], C. M. N. Kumar [1], Petar Popcevic [3], Wojtek Tabis [4,1]* *[1] TU Wien, [2] PMF Zagreb, Croatia, [3] Institute of Physics, Zagreb, Croatia* *[4] AGH University of Science and Technology, Krakow, Poland* We investigate the magnetic response on transport properties in cuprates. Firstly, we show that the Hall coefficient in the low-field/high-temperature regime is accurately described by Boltzmann transport equations. Secondly, we validate Kohler's rule for the magnetoresistance across the phase diagram. Thirdly, we determine that field promoted charge density wave correlations at $p \sim 0.12$ doping reconstruct the Fermi surface from arcs to a pocket. Remarkably, the high-field/low-temperature transport properties agree with those calculated for the Fermi surface determined by quantum oscillations. Finally, Umklapp scattering emerges as the dominant process in cuprates' phase diagram.
18:30	**118**	**Ionic effects in cuprates: from Fermi arcs to superconductivity** *Denis Sunko, Department of Physics, Faculty of Science, University of Zagreb* Extensive experimental evidence indicates that the mobile carriers in the normal state of high-T_c superconducting cuprates are a Fermi liquid with practically the same transport parameters for all compounds and dopings. A comprehensive theoretical framework is laid out to explain such an outcome, despite the large Coulomb scales affecting the mobile carriers, and despite the superconducting planes being two-dimensional. Conduction occurs via the O 2p and Cu 4s orbitals, and NOT through the Cu 3d orbital. Fermi arcs are a simple kinematic projection effect of the local ionic disorder in cuprates, and have nothing to do with carrier interactions at the Fermi energy.
18:45		
19:00		***Postersession with Apéro***

Time	ID	**KOND III: Devices and Applications** *Chair: Aswathi K. Sivan, Universität Basel*
14:30	**121**	**High performance bifacial $Cu(In,Ga)Se_2$ solar cells with silver promoted low-temperature process** *Shih-Chi Yang, Empa & ETHZ* Bifacial photovoltaic (PV) systems have shown great promise in generating higher annual energy yields compared to conventional monofacial-based PV systems. They offer advantages in building-integrated PVs, vertically mounted bifacial PVs, and agrivoltaics, with low-carbon emissions and a cost-effective levelized cost of electricity. However, bifacial thin-film solar cells, specifically bifacial $Cu(In,Ga)Se_2$ (CIGS) cells, have not kept pace with their monofacial counterparts. The efficiencies of bifacial CIGS cells remain low, hindering their adoption in various applications. Challenges such as the detrimental GaO_x interlayer formation at the CIGS/TCO (transparent conductive oxide) interface during high-temperature deposition have degraded device performance, leading to stagnation in the development of TCO-based CIGS devices. To overcome these limitations, a groundbreaking study introduced an Ag-promoted low-temperature CIGS deposition process. This innovative approach enabled high-quality CIGS growth at lower temperatures, preventing oxidation reactions at the CIGS/TCO interface. It resulted in higher Ga gradings, enhancing carrier collection under rear illumination. Optimizing the substrate temperature achieved a record bifacial CIGS solar cell with efficiencies of 19.77 % (front) and 10.89 % (rear) under one-sun illumination, independently certified by Fraunhofer ISE. Additionally, the study directly fabricated bifacial CIGS solar cells on flexible substrates without lift-off process, offering scalability and cost reduction for larger-scale production. Furthermore, the demonstration of the first-ever bifacial perovskite/CIGS tandem solar cell in a 4-terminal configuration achieved a power generation density of 28.0 mW/cm^2 BiFi300, opening possibilities for various device architectures. These advancements hold great potential for the photovoltaic community, offering high performance and expanding the range of clean and sustainable energy applications.
	~~122~~	*cancelled*
15:00	**123**	**Thermal circuit elements with Telescopic nanowires** *Yashpreet Kaur [1], Ilaria Zardo [1], Saeko Tachikawa [1], Milo Yaro Swinkels [1], Matteo Camponovo [1], Miquel Lopez-Suarez [2], Anna Fontcuberta I Morral [3], Riccardo Rurali [2]* *[1] University of Basel* *[2] Institut de Ciencia de Materials de Barcelona (ICMAB–CSIC)* *[3] Laboratory of Semiconductor Materials, Institute of Materials, EPFL* Heat dissipation has become a critical problem in the performance of electronic devices, thus, reducing their lifespans. Therefore, to manipulate and control heat, thermal circuit elements analogous to electronic ones like thermal diodes, transistors, and thermal logic gates are needed. In our current research, we have experimentally studied telescopic nanowires for their thermal rectification capabilities giving a rectification ratio of up to 8 % as a function of applied temperature bias, thus, exhibiting the thermal diode effect. This is the first experimental study on telescopic nanowires indicating rectification and an important contribution towards the development of thermal circuit elements.

15:15	**124**	**Chemical and structural characterization of tannin-furanic foams using X-Ray micro-CT, FTIR imaging and UV Resonant Raman scattering** *Maurizio Musso [1], Diana Bedolla [2], Raphael J. F. Berger [1], Francesco D'Amico [2], Giulia Saccomano [2], Thomas Schnabel [3], Thomas Sepperer [3], Lisa Vaccari [2]* *[1] University of Salzburg, Department of Chemistry and Physics of Materials* *[2] Elettra - Sincrotrone Trieste S.C.p.A.* *[3] Forest Products and Timber Construction Department, Salzburg University of Applied Sciences* Tannin-furanic foams are green lightweight materials, presenting quite good compression resistance and thermal insulation, and being suitable as a wastewater treatment agent, therefore getting more attention as alternatives to oil-based lightweight materials. Within the Interreg V-A Italy-Austria project ITAT1059 InCIMa4, and within the CERIC proposal 20217081, mechanically and structurally improved tannin-furanic foams have been characterized by the complementary use of infrared spectroscopy and UV Resonance Raman spectroscopy to study similarities and differences in their chemical structures. Additionally, their internal tridimensional micro-architecture was investigated by synchrotron radiation computed micro-tomography (SRµCT) to assess porosity based on the relative abundance of voids, demonstrating differences in pore network and pore size distribution.
15:30	**125**	**Understand the photoinduced phase transition of the monoclinic VO_2 with the nonequilibrium DMFT** *Jiyu Chen, Francesco Petocchi, Philipp Werner, University of Fribourg* The ultrafast dynamics in the quantum many-body systems introduces the novel photoinduced phase transition (PIPT) to the family of quantum phase transitions. In the VO_2, although the thermal-induced metal-to-insulator transition due to the lattice distortion has been explained with cluster DMFT since 2005, it was verified only a few years ago in the experiment that the photoexcitation is also able to induce the PIPT from the insulating phase to a transient metal state without crystallographic change. In our work, with the state-of-the-art realistic nonequilibrium DMFT simulation, we consistently demonstrated the strategies of the ultrafast in-gap charge carriers, which are sensitive to the frequency and polarization of the laser pump.
15:45	**126**	**3D Magnonic Conduits by Direct Write Nanofabrication** *Sebastian Lamb-Camarena [1,2], Fabrizio Porrati [3], A. Kuprava [3], Qi Wang [4], Michal Urbánek [5], Sven Barth [3], Denys Makarov [6], Michael Huth [3], Oleksandr V. Dobrovolskiy [1]* *[1] Nanomagnetism and Magnoniocs, Faculty of Physics, University of Vienna, Boltzmanngasse 5, AT-1090 Vienna* *[2] Vienna Doctoral School in Physics, University of Vienna, Boltzmanngasse 5, AT-1090 Vienna* *[3] Physikalisches Institut, Goethe-Universität, Max-von-Laue-Str. 1, DE-60438 Frankfurt am Main* *[4] School of physics, Huazhong University of Science and Technology, Wuhan 430074, China* *[5] CEITEC BUT, Brno University of Technology, CZ-61200 Brno* *[6] Helmholtz-Zentrum Dresden-Rossendorf e.V., Institute of Ion Beam Physics and Materials Research, Bautzner Landstrasse 400, Dresden, Germany* Magnonics is a rapidly developing domain of nanomagnetism, with application potential in information processing systems. Realisation of this potential and miniaturisation of magnonic circuits requires their extension into the third dimension. However, so far, magnonic conduits are largely limited to thin films and 2D structures. Here, we introduce 3D magnonic nanoconduits fabricated by the direct write technique of focused-electron-beam induced deposition (FEBID). We use Brillouin light scattering (BLS) spectroscopy to demonstrate significant qualitative differences in spatially resolved spin-wave resonances of 2D and 3D nanostructures, which originates from the geometrically induced non-uniformity of the internal magnetic field. This work demonstrates the capability of FEBID as an additive manufacturing technique to produce magnetic 3D nanoarchitectures and presents the first report of BLS spectroscopy characterisation of FEBID conduits.
16:00		
16:30		***Coffee Break***

Time	ID	**KOND IV: VARIA** *Chair: Maurizio Musso, Universität Salzburg*
17:00	**131**	**Non-thermal superconductivity in photo-doped multi-orbital Hubbard systems** *Sujay Ray, Philipp Werner, University of Fribourg* Superconductivity in laser-excited correlated electron systems has attracted considerable interest due to reports of light-induced superconducting-like states. We explore the possibility of non-thermal superconducting order in strongly interacting multi-orbital Hubbard systems, using non-equilibrium dynamical mean field theory. We find that a staggered η-type superconducting phase can be realized on a bipartite lattice in the high photo-doping regime, if the effective temperature of the photo-carriers is sufficiently low. The η superconducting state is stabilized by Hund coupling – a positive Hund coupling favors orbital-singlet spin-triplet η-pairing, whereas a negative Hund coupling stabilizes spin-singlet orbital-triplet η pairing.
17:15	**132**	**Pressure dependence of unconventional superconductivity in rare-earth nickel oxides** *Simone Di Cataldo [1], Paul Worm [1], Liang Si [2], Karsten Held [1]* *[1] TU Wien, [2] School of Physics, Northwest University* Superconductivity in nickelates was discovered only four years ago, and sparked great interest in this family of superconductors. Although the underlying mechanism for superconductivity is still under debate, DΓA could successfully predict the occurrence of a superconducting dome. In short, the T_c is inversely proportional to the ratio between the Hubbard interaction *U* and the hopping *t*, and might be optimized by a careful tuning of this ratio. Using first-principles calculations, we explore the effect of pressure and doping on the $Pr_{1-x}Sr_xNiO_2$ nickelate superconductor. While pressure does not change the interaction *U*, it increases *t* up to a factor of two, which has a significant effect on the superconducting T_c.
17:30	**133**	**First-principles modelling of the metal-insulator transition in vanadium dioxide using a bond-centered orbital basis** *Peter Mlkvik, Claude Ederer, Nicola Spaldin, ETH Zürich* Vanadium dioxide (VO_2) is a prototypical metal-insulator transition (MIT) material, hosting both intriguing physical phenomena and industrial application potential. The VO_2 MIT originates from a complex interplay between Peierls-like dimerization and Hubbard-Mott correlations that is difficult to capture with standard theoretical models or computational techniques. Here, we present simulations of VO_2 using an unconventional set of bond-centered basis functions. Combining density-functional theory (DFT) and dynamical mean-field theory (DMFT) with these orbitals, we provide a complementary view on the interplay of dimerization and electronic correlation in VO_2 that treats both effects on the same footing.
17:45	**134**	**Mapping out phase diagrams with generative classifiers** *Julian Arnold [1], Frank Schäfer [2], Christoph Bruder [1]* *[1] Department of Physics, University of Basel, [2] CSAIL, Massachusetts Institute of Technology* One of the central tasks in condensed matter physics is the characterization of phase diagrams. Traditionally, this is done by a physicist who identifies a small set of characteristic quantities, like response functions or order parameters, guided by his human intuition. This process can be automated by casting the problem of mapping out a phase diagram as a classification task. We show that such classification tasks are naturally suitable to be solved using generative classifiers. This constitutes an alternative approach compared to discriminative classifiers and benefits from generative modeling concepts native to the realm of statistical and quantum physics, as well as recent advances in machine learning.

18:00	135	**Probing ferroelectricity in Zr/Nb-substituted barium titanate relaxors by PFM** *Philipp Münzer [1], Marco Deluca [2], Markus Kratzer [1], Christian Maier [3], Klaus Reichmann [3], Christian Teichert [1]* *[1] Institute of Physics, Montanuniversität Leoben, [2] Materials Center Leoben* *[3] Institute for Chemistry and Technology of Materials, TU Graz* $BaTiO_3$-relaxors are promising materials for energy storage applications in microelectronics. These lead-free dielectrics are thermally stable and suitable for high-temperature operation due to their broad and high permittivity response and low electric coercivity. Relaxor behaviour is induced by homo- or heterovalent substitution of the central Ti^{4+} ions, which disrupts the long-range ferroelectric order. We investigated ferroelectricity in homovalent (Zr^{4+}) and heterovalent (Nb^{5+}) substituted polycrystalline $BaTiO_3$ relaxors utilizing Piezoresponse Force Microscopy (PFM). We probed spontaneous polarization, conducted local polarization switching, and recorded PFM-hysteresis loops utilizing Switching-Spectroscopy-PFM. The results suggest that indicators of ferroelectricity vanish at different substitution levels and that traces of ferroelectricity can even be found in highly substituted systems.
18:15	136	**Spin-polarized electron-hole pair excitations in $Co_3Sn_2S_2$ studied by magnetic circular dichroism resonant inelastic X-ray scattering** *Tianlun Yu, Wenliang Zhang, Yuan Wei, Dariusz Jakub Gawryluk, Loïc Roduit, Vladimir Strokov, Gabriel Aeppli, Thorsten Schmitt, Yona Soh, Paul Scherrer Institute* $Co_3Sn_2S_2$ is a Weyl ferromagnet ($T_c \sim 177$ K) with kagome layers stacked along its c-axis. A recent resonant inelastic X-ray scattering (RIXS) study with linear polarized X-rays reported correlation driven near-flat band Stoner excitations. However, our RIXS measurements employing a magnetic circular dichroism (MCD) analysis suggests that the reported “near-flat band” is dispersive and its intensity reduces upon approaching T_c. We suggest these excitations correspond to the electron-hole pair excitations between spin-polarized occupied and unoccupied bands that are s directly related to the magnetic order. Furthermore, the MCD RIXS spectrum shows opposite sign compared to spin waves in the ferromagnetic topological metal Fe_3Sn_2 due to the orbital moment involvement.
18:30	137	**Tensor network investigation of the finite temperature behaviour of the $J_1 - J_2 - J_3$ Kagome Ising Antiferromagnet** *Afonso dos Santos Rufino, Jeanne Colbois, Frédéric Mila, Samuel Louis Nyckees, EPFL* The finite temperature behavior of the Kagome Ising Antiferromagnet with farther neighbor interactions (J_1, J_2, J_3) is investigated with the Corner Transfer Matrix Renormalization Group (CTMRG) algorithm. In the parameter region $J_1 > J_3 > J_2 > 0$, the system breaks a $\mathbb{Z}_3$ rotation symmetry and a $\mathbb{Z}_2$ translation symmetry in the ground state. These symmetries are restored at higher temperature either in a single first-order transition or through a couple of transitions separated by an intermediate nematic phase, depending on the value of J_2. In the limit $J_1, J_3 >> J_2$, the rotational symmetry is restored in a sequence of first-order transitions whose discrete character can be understood from the quantisation of the density of extended defects (Domain Walls).
18:45	138	**Spin-orbital excitations encoding the magnetic phase transition in the van der Waals antiferromagnet $FePS_3$** *Yuan Wei [1], Yi Tseng [1], Hebatalla Elnaggar [2], Wenliang Zhang [1], Teguh Citra Asmara [1], Eugenio Paris [1], Gabriele Domaine [1], Vladimir Strokov [1], Luc Testa [3], Virgile Favre [3], Andrew Wildes [4], Henrik Rønnow [3], Frank Groot [5], Thorsten Schmitt [1]* *[1] Paul Scherrer Institut, [2] Sorbonne Université, [3] EPFL, [4] ILL, [5] Utrecht University* Magnetic van der Waals (vdW) materials offer exciting opportunities to study exotic magnetic phases and collective behavior in two-dimensional limits. $FePS_3$ is an $S = 2$ zig-zag quasi-two-dimensional antiferromagnetic insulator with a honeycomb lattice, making it an ideal candidate for investigating dimensionality and interlayer coupling on magnetic behavior. In this talk, Resonant inelastic X-ray scattering (RIXS) was used to study spin-orbital excitations in $FePS_3$ and their relation to magnetism, revealing the essential role of the trigonal lattice distortion and negative metal-ligand charge transfer. This approach provides a perspective of studying low-energy electronic properties in relation to the magnetic state.

19:00	139	**Quantum transport theory in disordered interacting systems: A dynamical mean-field approach** *Jiawei Yan, Philipp Werner, University of Fribourg* We introduce a non-equilibrium dynamical mean-field theory (DMFT) for studying an inhomogeneous Anderson-Hubbard lattice that contains both electron-electron interactions and chemical disorders, which are treated on an equal footing. The theory reduces to conventional DMFT in the presence of only electron interactions and to coherent potential approximation (CPA) with only disorders. An 8-site cube is employed to benchmark our method, showing high agreement in the spectral function in both weak and strong coupling cases. A serial double quantum dot sandwiched by two leads under a step-shaped voltage bias is also studied. Our method provides a generic framework for studying quantum transport problems with both interaction and disorder degrees of freedom.
19:15		

Thursday, 07.09.2023, Room Aula 033

Time	ID	**KOND V: Superconductivity** *Chair: Ding Peng, PSI Villigen*
14:00	141	**Driven-dissipative engineering: A generalized fitness criterion for the superconducting transition temperature** *Aline Ramires [1], Ramasubramanian Chitra [2], Rui Lin [2]* *[1] Paul Scherrer Institut, [2] ETH Zürich* Floquet engineering has attracted significant interest given the recent developments in experimental techniques such as ultrafast spectroscopy and the potential to enhance the stability of phases of matter such as superconductivity. Here we explore how an external drive and intrinsic dissipation jointly affect superconductivity. Inspired by the fitness criterion for static superconductors, we recognize the distinct effects of external drives on superconductors based on their commutativity or anticommutativity with the superconducting order parameter within the Floquet-Keldish formalism. Our proposal goes beyond standard mechanisms, such as phonon squeezing and dynamical localization. It opens the door for further studies toward driven-dissipative engineering of exotic phases of complex matter in solid-state systems.
14:15	142	**Vortex Counting and Velocimetry for Slitted Superconducting Thin Strips** *Barbora Budinská [1], Volodymyr Bevz [2], Mikhail Mikhailov [3], Sebastian Lamb-Camarena [1], Stanislava Shpilinska [1], Andrii Chumak [1], Michal Urbánek [4], Markus Arndt [1], Wolfgang Lang [1], Oleksandr Dobrovolskiy [1]* *[1] University of Vienna, AT-1090 Vienna* *[2] V. Karazin Kharkiv National University, Kharkiv 61022, Ukraine* *[3] B. Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine, Kharkiv 61103, Ukraine* *[4] CEITEC, Brno University of Technology, Brno 61200, Czech Republic* At low magnetic fields, the approach to deduce the energy relaxation times from current-voltage curves fails. The problem arises given the fact that the number of vortices, deduced from the applied magnetic field only, is in fact larger. Here, we provide a method to count the number of vortices in samples at zero magnetic field. Experiments were performed on MoSi samples with focused ion beam milled-out slits. Every time the number of vortices crossing the sample is increased by one, a current-voltage kink appears. The number of kinks corresponds to the number of vortices. This information allows one to correct the previously unphysical energy relaxation times at low magnetic fields.

14:30	143	**Particle-hole symmetry in the 5/2 Quantized Hall State at small magnetic field** *Loic Herviou, Frédéric Mila, École Polytechnique Fédérale de Lausanne* The nature of the experimentally-measured fractional conductance plateau at filling 5/2 in Quantum Hall states remains an open question. After a decade of debate, the theoretical consensus settled on the non-Abelian Antipfaffian while recent experimental results measured an incompatible quantized thermal conductance of 5/2. We revisit previous theoretical approaches with a more careful treatment of the Landau level mixing, the parameter controlling the interaction between different Landau levels. I will present the challenges behind this approach, and our main results: an inversion of the gaps at mixings well below the experimental regime and the important role of frozen spin degrees of freedom.
14:45	144	**Coupled chain construction for a fractional spin quantum Hall effect** *Pierre Fromholz [1], Even Thingstad [1], Flavio Ronetti [2], Daniel Loss [1], Jelena Klinovaja [1]* *[1] University of Basel, [2] ix Marseille Univ, Universite de Toulon, CNRS, CPT* While the topological classification of non-interacting spin excitation band structures has successfully been applied to understand many magnetic insulators, intrinsic magnon-magnon interactions can modify the topological properties significantly. Using a coupled wire approach, we show that the system of weakly coupled spin chains with modulated Dzyaloshinskii-Moriya coupling strengths can be engineered to host Abelian and non-Abelian fractional spin quantum Hall effects controlled by tuning the chain magnetizations. The associated spin fractionalization can be detected through the spin conductance. We argue that these phases can be realized in systems of synthetic spin chains and ultracold atoms.
15:00	145	**Characterizing fractional quantum Hall states using isometric tensor networks** *Bartholomew Andrews, Zhehao Dai, Yantao Wu, Michael Zaletel, UC Berkeley* The simulation of strongly-correlated quantum many-body systems is a long-standing numerical challenge. Although the ground-state properties of one-dimensional systems may be efficiently distilled using the density matrix renormalization group, now understood in the framework of matrix product states, generalizing this procedure to higher dimensions is problematic, since the exact evaluation of tensor network states becomes exponentially expensive. In this talk, we remedy this by employing isometric tensor networks (isoTNS), a recently-proposed restriction of the projected entangled pair state ansatz. We evaluate isoTNS algorithms for bosons and fermions, and present current progress in applying them to characterize fractional quantum Hall states.
15:15	147	**Topological interlayer superconductivity mediated by magnons** *Even Thingstad, Joel Hutchinson, Jelena Klinovaja, Daniel Loss, University of Basel* Most proposals to realize topological superconductivity rely on exploiting the properties of a topologically trivial superconductor through the proximity effect. An alternate route is to search for systems where the pairing interaction directly gives rise to topologically non-trivial superconductivity. We show that magnon-mediated superconductivity in heterostructures of transition metal dichalcogenides coupled to magnetic insulators provides a promising route to this end. Considering a trilayer heterostructure consisting of an antiferromagnetic insulator sandwiched between two transition metal dichalcogenides, we show that magnons can mediate topologically non-trivial interlayer superconductivity.

15:30 | **148**

Tunable unconventional kagome superconductivity in charge ordered RbV_3Sb_5 and KV_3Sb_5

Zurab Guguchia [1], Charles Mielke III [2], Debarchan Das [1], Ritu Gupta [1], J.-X. Yin [3], H. Liu [4], Q. Yin [5], M. H. Christensen [6], Z. Tu [5], C. Gong [5], N. Shumyia [7], Md. S. Hossain [7], Ts. Gamsakhurdashvili [1], M. Elender [1], P. Dai [8], Alex Amato [1], Youguo Shi [4], Hechang Lei [5], R. M. Fernandes [9], M. Z. Hasan [7], Hubertus Luetkens [1], Rustem Khasanov [1]

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We utilized pressure-tuned and ultra-low-temperature muon-spin spectroscopy to uncover the unconventional nature of superconductivity in kagome metals $(Rb,K)V_3Sb_5$. At ambient pressure, the superconducting state displays a nodal energy gap and a reduced superfluid density, which is attributed to the competition with the charge order. Upon applying pressure, the charge-order is suppressed, the superfluid density increases, and the superconducting state evolves from nodal to nodeless. Once optimal superconductivity is achieved, we find a superconducting pairing state that is not only fully gapped, but also spontaneously breaks time-reversal symmetry. Our results offer unique insights into the nature of the pairing state.

15:45 | **146**

Magnetic Impurity Effect in the Kagome Superconductor $LaRu_3Si_2$

Zurab Guguchia [1], Charles Mielke III [1], Jonathan Spring [2], Dariusz Jakub Gawryluk [1], H. Nakamura [3], Soohyeon Shin [1], Huanlong Liu [2], Vahid Sazgari [1], Jike Lyu [1], Toni Shiroka [4], Marisa Medarde [1], Alex Amato [1], Satoru Nakatsuji [3], Rustem Khasanov [1], Hubertus Luetkens [1], Debarchan Das [1]

[1] Paul Scherrer Institut, [2] University of Zürich, [3] ISSP Tokyo, [4] ETH Zürich

The rich interplay of unconventional superconductivity and symmetry-breaking states lies at the frontier of physics and materials science. Here we report muon spin rotation (μSR) experiments of the magnetic impurity effect on the superconducting and normal state properties in the prototypical kagome superconductor $LaRu_3Si_2$. In the normal state, zero-field μSR experiments reveal a hidden magnetism in the undoped system which is enhanced by Fe-doping. From measurements of magnetic penetration depth λ, doping induces a change of gap structure from nodeless s-wave to nodal gap symmetry. The T_c/λ^{-2} ratio is comparable to that of unconventional superconductors. Taken together, these results suggest unconventional superconducting and normal states in this kagome system.

16:00 | **149**

Two-dimensional Shiba lattices as a platform for crystalline topological superconductivity

Titus Mangham-Neupert, Martina Soldini, Glenn Wagner, University of Zürich

Localized or propagating Majorana boundary modes are the key feature of topological superconductors. Lattices of Yu-Shiba-Rusinov bound states – Shiba lattices – that arise when magnetic adatoms are placed on the surface of a conventional superconductor can be used to create topological bands within the superconducting gap of the substrate. I will discuss results using scanning tunnelling microscopy to create and probe adatom lattices with single atom precision.Our results highlight the potential of Shiba lattices as a platform to design the topology and sample geometry of 2D superconductors.

16:15	**150**	**Mechanisms for π phase shifts in Little-Parks experiments on single crystals** *Mark Fischer, Universität Zürich, Patrick A. Lee, MIT, Jonathan Ruhman, Bar Ilan University* The Little-Parks effect, the periodic change in the critical temperature upon threading magnetic flux through a superconducting cylinder, exhibits a maximum or a minimum at zero flux in the presence of time-reversal symmetry. The latter situation, referred to as π rings, is only expected for polycrystalline rings of an unconventional superconductor. Interestingly, recent measurements of the Little-Parks effect in single-crystal rings of 4Hb-TaS_2 show zero and π rings and have been interpreted as evidence of exotic superconductivity. We discuss two scenarios for this unconventional behavior, namely a two-component order parameter and negative interlayer Josephson coupling in a s-wave superconductor, as well as both scenarios' reliance on crystal defects.
16:30		***Coffee Break***
		KOND VI: Methods *Chair: NN*
17:00	**151**	**Entanglement and thermo-kinetic uncertainty relations in coherent mesoscopic transport** *Kacper Prech [1], Philip Johansson, Gabriel Landi [2], Elias Nyholm, Patrick Potts [1], Peter Samuelsson [3], Claudio Verdozzi [3]* *[1] University of Basel, [2] University of Rochester, [3] Lund University* Some aspects concerning coherence in open quantum systems remain poorly understood. On the one hand, coherence leads to entanglement and nonlocality. On the other, it leads to a suppression of fluctuations, causing violations of classical thermo-kinetic uncertainty relations. These represent its different manifestations, one depending only on the state of the system and one depending on two-time correlation functions. We employ these manifestations to determine when mesoscopic quantum transport through a double quantum dot can be captured by a classical jump model, and when such model breaks down implying nonclassical behavior. Quantum tunneling induces Rabi oscillations and results in both manifestations of coherence, indicating the breakdown of a classical description.
17:15	**152**	**Weak-signal extraction enabled by deep-neural-network denoising of diffraction data** *Jens Oppliger [1], Michael Denner [1], Julia Küspert [1], Ruggero Frison [1], Qisi Wang [1], Alexander Morawietz [1], Oleh Ivashko [2], Ann-Christin Dippel [2], Martin von Zimmermann [2], Izabela Biało [1], Leonardo Martinelli [1], Benoît Fauqué [3], Jaewon Choi [4], Mirian Garcia-Fernandez [4], Kejin Zhou [4], Niels B. Christensen [5], Tohru Kurosawa [6], Naoki Momono [6], Migaku Oda [6], Fabian Donat Natterer [1], Mark Hannes Fischer [1], Titus Neupert [1], Johan Chang [1]* *[1] Physik-Institut, Universität Zürich* *[2] Deutsches Elektronen-Synchrotron DESY, Hamburg* *[3] JEIP, USR 3573 CNRS, College de France, PSL University* *[4] Diamond Light Source, Oxfordshire* *[5] Department of Physics, Technical University of Denmark* *[6] Department of Physics, Hokkaido University* We show how data can be denoised via a deep convolutional neural network such that weak signals appear with quantitative accuracy. In particular, we study X-ray diffraction on crystalline materials. We demonstrate that weak signals stemming from charge ordering, insignificant in the noisy data, become visible and accurate in the denoised data. This success is enabled by supervised training of a deep neural network with pairs of measured low- and high-noise data. This way, the neural network learns about the statistical properties of the noise. We demonstrate that using artificial noise does not yield such quantitatively accurate results.

17:30 | **153**

A Versatile Ultrasonic Setup for Quantum Matter Research

Xuan Dang Dang, Marek Bartkowiak, Marc Janoschek, Paul Scherrer Institut

Ultrasound techniques offer a simple and efficient method for studying quantum matter as they are able to detect subtle changes to symmetry and are also sensitive to lattice-spin/charge coupling. There are two distinct measurement paradigms used for ultrasonic studies: Whereas RUS provides a comprehensive view of the elastic tensor of solids, PEUS measures changes in sound wave attenuation and velocity, revealing the coupling of the lattice to spin or charge degrees of freedom. Here we will present versatile ultrasonic setup, which is using the same electronic system and allowing for efficient switching between both methods. The setup is further optimized for studying quantum systems in low-temperature and magnetic field environments.

17:45 | **154**

Infrared ellipsometry study of the charge dynamics in K_3p-terphenyl

Qi He [1], Dionys Baeriswyl [1], Christian Bernhard [1], Florian le Mardelé [2], Sharma Meenakshi [2], Premysl Marsik [1], Bing Xu [1], Andrea Perali [2], Claudio Pettinari [2], Nicola Pinto [2]
[1] University of Fribourg, [2] Università di Camerine

We report an infrared ellipsometry study of the charge carrier dynamics in polycrystalline K_xp-terphenyl samples with nominal x = 3, for which signatures of high-temperature superconductivity were previously reported. A dc resistivity of about 0.3 Ω·cm at 300 K is deduced from the IR data, comparable to values measured by electrical resistivity on a twin sample. Our data might still be compatible with a filamentary superconducting state with a volume fraction well below the percolation limit for which the spatial confinement of the condensate can result in a plasmonic resonance at finite frequency.

18:00 | **155**

Electronic properties of single layer molybdenum disulphide-on-gold heterostructure as a function of twist angle

Ishita Pushkarna, Árpád Pásztor, Christoph Renner
Department of Quantum Matter Physics, University of Geneva, 24 Quai Ernest-Ansermet, CH-1211 Geneva

Transition metal dichalcogenides like molybdenum disulphide (MoS_2) have been studied on metal surfaces, but little is known about twist angle-dependent electronic properties of these simple heterostructures, which indeed offers tremendous opportunities to design functional quantum materials. In this talk, we present a detailed scanning tunnelling microscopy and spectroscopy investigation of electronic properties of monolayer MoS_2 on gold as a function of twist angle. We find that the semi-conducting band edges and hence the band gap are modulated at the moiré wavelength (moiré between MoS_2 and gold) and this modulation progressively vanishes with increasing twist angle.

18:15 | **156**

Field-induced bound-state condensation and spin-nematic phase in $SrCu_2(BO_3)_2$ revealed by neutron scattering up to 25.9 T

Mithilesh Nayak [1], Ellen Fogh [1], Maciej Bartkowiak [2], Hiroshi Kageyama [3], Kazuhisa Kakurai, Frédéric Mila [1], Koji Munakata [4], Hiroyuki Nojiri [5], Bruce Normand [6], Ekaterina Pomjakushina [6], Oleksandr Prokhnenko [2], Henrik Rønnow [1], Jian-Rui Soh [1], Alexandra Angeline Turrini [6], Mohamed E. Zayed [7]
[1] EPFL, [2] Helmholtz-Zentrum Berlin für Materialien und Energie, [3] University of Tokyo
[4] Neutron Science and Technology Center, Comprehensive Research Organization for Science and Society (CROSS)
[5] Tohoku University, [6] Paul Scherrer Institute, [7] Carnegie Mellon University in Qatar

High-field Inelastic Neutron Scattering experiments have been conducted on $SrCu_2(BO_3)_2$ up to 25.9 T and we find a rich set of excitations whose energies and spectral intensities have been measured as a function of magnetic field. Using cylinder matrix-product-states calculations on the Shastry-Sutherland model with Dzyaloshinskii–Moriya interactions, we reproduce experimental spectra. Multiple unconventional spectral features such as the gradients of the one-triplet branches and the persistence of the single-triplet gap point to a condensation of spin-2 bound states, thus realizing a spin-nematic phase. The single-triplet gap reflects a direct analogy with superconductivity, suggesting that the spin-nematic phase in $SrCu_2(BO_3)_2$ is best understood as a condensate of Cooper pairs of hardcore bosons.

18:30	157	**3D ptychography reconstruction** *Ding Peng, Tatiana Latychevskaia, Sara Mustafi, Paul Scherrer Institut* Electron ptychography has demonstrated the world-record highest resolution in imaging two- dimensional materials such as transition metal dichalcogenides (TMD). We are investigating the possibility of applying electron ptychography-related techniques for three-dimensional reconstruction of atomic positions and the associated resolution limits.
18:45		
19:00		***Transfer to Dinner***
19:30		***Conference Dinner***

Friday, 08.09.2023, Room Aula 033

Time	ID	**KOND VII: Diffraction and Spectroscopy** *Chair: Ilaria Zardo, Universität Basel*
12:00	161	**Raman spectroscopy as an ideal tool for probing phonon-carrier interactions in low dimensional materials** *Mirjana Dimitrievska, Angel Labordet Alvarez, Gabriela Borin Barin, Roman Fasel, Michel Calame, EMPA* Low dimensional materials (1D and 2D) are promising candidates as building blocks of future electronics and optoelectronics. Controllable bandgap, strong light-matter interaction, sub-nanometer thickness, and high carrier mobility are among their favorable properties for electronic and optical applications. Comprehensive characterization of these materials is a crucial learning step toward their reliable incorporation in devices. In this work, we will discuss how temperature-dependent, multiwavelength excitation Raman spectroscopy could be effectively used to probe the interaction between the 1D graphene nanoribbons and various substrates (metal, oxides, semiconductors), including the effects on the phonon-carrier interaction, which are crucial for the device performance.
12:15	162	**Three-dimensional microstructural investigation of Silicon Carbide composite materials using synchrotron radiation** *Fareeha Hameed [1], Lucia Mancini [2], Andrea Moriani [3], Halit Tatlisu [4], Silvano Tosti [3]* *[1] Forman Christian College University* *[2] Slovenian National Building and Civil Engineering Institute ZAG* *[3] ENEA, Italian National Agency for New Technologies* *[4] ATI, Vienna University of Technology* Fiber-reinforced silicon carbide composite materials are promising candidates for applications in the aerospace industries as well as future energy sources (fusion and fission). They have structural as well as functional applications. These composites were previously analyzed by methods of neutron scattering and neutron tomography. Recently synchrotron X-ray phase contrast micro-tomography has been performed to get three-dimensional information on the porosity and morpho-textural properties. Porosity plays a major role in their safety and reliability. The length scale of the porosity ranges from macro to micropores. Hence advanced techniques have to be employed to get a complete qualitative and quantitative analysis.

12:30	**163**	**Shape Transformation of Nanocrystals investigated by Model Free X-Ray Scattering Analyses** *Rainer Lechner [1], Max Ritter [2], Agnes Weimer [3], Artur Feld [3]* *[1] Montanuniversität Leoben, [2] Wood Materials Science, ETH Zürich* *[3] Institute of Physical Chemistry, Hamburg University* Chemical synthesis of colloidal nanocrystals (NCs) can produce particles with controlled sizes and complex shapes, which influence their physical properties. For controlling the NCs' morphology, the 3D shape analysis of NCs is a key issue. Small angle X-ray scattering (SAXS) is a leading technique for analyzing NCs in sub-nanometer resolution. From SAXS data the 3D mean shape can be retrieved using model-free techniques. In this study the varying morphology during growth of iron oxide nanocrystals is analyzed. The FeO NCs transform from nanostars to nearly perfect nanocubes. X-ray diffraction experiments link the derived NC-shape to crystallographic directions. The congruence of the results is demonstrated by comparison to TEM analysis.
12:45	**164**	**Phonon engineering in GaAs-GaP Superlattice Nanowires** *Aswathi Kanjampurath Sivan [1], Begoña Abad [1], Tommaso Albrigi [2], Omer Arif [3], Johannes Trautvetter [1], Alicia Ruiz Caridad [1], Chaitanya Arya [1], Valentina Zannier [3], Lucia Sorba [3], Riccardo Rurali [2], Ilaria Zardo [1]* *[1] University of Basel* *[2] Institut de Ciència de Materials de Barcelona, ICMAB-CSIC, Campus UAB, 08193 Bellaterra* *[3] NEST, Instituto Nanoscienze-CNR and Scuola Normale Superiore, Pisa, Italy* Designing materials with tailormade thermal properties is crucial in developing energy-efficient devices. Superlattices (SLs), which are artificially layered superstructures with periodic repetition of two or more materials, offer a promising approach for controlling thermal properties through the modification of the phonon spectrum. To control heat flow, we must manipulate the phonons at the nanoscale. Nanowires (NWs) offer the possibility to combine a wide range of materials at the nanoscale in the form of SLs. In this work, we demonstrate the continuous tuning of the phononic properties of GaAs/GaP SL NWs as a function of SL periodicity through inelastic light scattering experiments corroborated by ab initio calculations.
	~~**165**~~	*cancelled*
13:00	**166**	**Squaraine molecular crystals: Femtosecond dynamics and Davydov splitting** *Robert Schwarzl [1], Davide Giavazzi [2], Pascal Heim [1], Maximilian Jeindl [1], Markus Koch [1], Peter Puschnig [3], Manuela Schiek [4], Frank C. Spano [5], Andreas Windischbacher [3]* *[1] TU Graz, [2] University of Parma, [3] University of Graz,* *[4] Center for Surface and Nanoanalytics (ZONA), Institute for Physical Chemistry (IPC) & Linz Institute for Organic Solar Cells (LIOS), Johannes Kepler University Linz* *[5] Temple University, Philadelphia* Squaraines are a class of organic chromophores which are particularly well-suited as molecular aggregates. Their structure-functionality relationship allows one to manipulate optical properties through the adjustment of side chains. SQIB is investigated via femtosecond transient absorption microscopy in an amorphous PMMA matrix and in its orthorhombic molecular crystal form with four molecules per unit cell in a non-parallel molecular arrangement. This results in multiple Davydov splitting of the excited states. We combine our measurements with simulations based on the essential states model and TD-DFT in order to explain all contributions to the absorption spectrum. The influence of molecular aggregation on dynamics is studied via femtosecond transient absorption microscopy.

13:15 | 167

Non-adiabatic Lifshitz transition in High T_c superconductor Bi2212

Siham Benhabib, Laboratoire de physique des solides, université Paris Saclay, France

The equilibrium tunning of doping generates substantial changes in the electronic states of cuprates. They undergo a gradual transition from Mott insulator to Fermi liquid, crossing d-wave superconductivity. Usually, these changes are accompanied by an abrupt transformation in Fermi surface topology, the so-called Lifshitz transition. Here in this work, we address the effect of ultrashort pulses on the Fermi surface topology of cuprates $Bi_2Sr_2CaCu_2O_{8+\delta}$ by means time-resolved-Angle resolved Photoemission Spectroscopy with pump energy of 1.55 eV.
For the first time, we demonstrate that high fluence pulses are significantly efficient in supplying the Fermi level with additional carriers through the photodoping process, driving non-adiabatically the Fermi surface from hole-like to electron-like.

13:30 | 168

Phase transition driven by ultrashort laser pulses in the charge-density-wave material $K_{0.3}MoO_3$

Rafael Winkler [1], Larissa Boie [1], Yunpei Deng [2], Matteo Savoini [1], Serhane Zerdane [2], Abhishek Nag [2], Sabina Gurung, Davide Soranzio [1], Tim Suter [1], Vladimir Ovuka [1], Janine Dössegger [1], Elsa Souto Gonçalves de Abreu [1], Simone Biasco, Roman Mankowsky [2], Edwin J. Divall [2], Alexander R. Oggenfuss [2], Mathias Sander [2], Christopher Arrell [2], Danylo Babich [2], Henrik T. Lemke [2], Paul Beaud [2], Urs Staub [2], Jure Demsar [3], Steven Johnson [1]
[1] ETH Zürich, [2] SwissFEL, Paul Scherrer Institute, Villigen
[3] Faculty Institute of Physics, Johannes Gutenberg-University Mainz

Blue Bronze ($K_{0.3}MoO_3$) is a quasi 1D material exhibiting a charge density wave with a periodic lattice distortion (PLD). In a time resolved x-ray experiment at SwissFEL, we study the dynamics of the PLD by pumping $K_{0.3}MoO_3$ with short laser pulses and probing it using x-ray diffraction. We construct reciprocal space maps (RSM) of superlattice reflections at different delays. The RSM along the surface normal gets broader at the delay equal to half the amplitude mode oscillation period, indicating a transient inversion of the PLD. For longer delays, this broadening is not visible. However, the diffracted x-ray intensity drops below the unpumped value indicating a molten CDW near the surface.

13:45 | 169

Band structure measurements on the topological magnet PrGeAl

Ola Kenji Forslund [1], Johan Chang [1], Masafumi Horio [1], Kevin Kramer [1], Xiaoxiong Liu [1], Titus Neupert [1], Ekaterina Pomjakushina [2], Pascal Puphal [2], Yasmine Sassa [3], Qisi Wang [1], Jonathan White [4]
[1] Physik-Institut, Universität Zürich, Winterthurerstrasse 190, CH-8057 Zürich
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[4] Laboratory for Neutron Scattering and Imaging (LNS), Paul Scherrer Institut (PSI), CH-5232 Villigen PSI

None zero Berry curvature in condensed matter is the fundamental concept behind the unique responses topological materials exhibit. We report intrinsic spin fluctuations to be enough to realise anomalous hall effect (AHE) in PrGeAl. PrGeAl is a topological ferromagnet and is stabilised in a none centosymmetric structure. Based on muon spin relaxation, transport, angle resolved photo emission spectroscopy (ARPES) measurements and density functional theory calculations, we show AHE in the paramagnetic phase. Our study show that long-range magnetic order and spontaneous time-reversal symmetry breaking are not essential requirements for AHE and can emerge in a wider range of condensed matter systems than previously thought.

14:00	**170**	**Interplay between phonon and charge density wave in Superconducting $La_{1.675}Eu_{0.2}Sr_{0.125}CuO_4$** *Xunyang Hong [1], Johan Chang [1], Jaewon Choi [2], Mirian Garcia-Fernandez [2], S. Pyon [3], Yasmine Sassa [4], H. Takagi [3], T. Takayama [3], Qisi Wang [5], Kejin Zhou [2], Karin von Arx [1]* *[1] Physik-Institut, Universität Zürich, [2] Diamond Light Source, Oxfordshire* *[3] Department of Advanced Materials, University of Tokyo* *[4] Department of Physics, Chalmers University of Technology, SE-412 96 Göteborg* *[5] Chinese University of Hong Kong* We conducted a resonant inelastic X-ray scattering (RIXS) experiment at the O-K edge on $La_{1.675}Eu_{0.2}Sr_{0.125}CuO_4$, leveraging RIXS's high resolution to study charge density wave (CDW) and its interaction with phonons in cuprate superconductor. Three phonon modes are detected in the RIXS spectra, which are assigned to the bond-stretching, bond-buckling, and an acoustic phonon mode respectively. The low-lying acoustic mode displays a sharp peak of spectral weight at q ~ 0.25, slightly larger than the CDW wavevector Q_{CDW} ~ 0.23. Meanwhile, no significant softening of this phonon mode is observed, suggesting a weak interaction between charge and phonon excitation. These results are well explained by our theoretical model within the weak-coupling framework.
14:15		***END***

ID	KOND Poster
181	**RIXS study of Cu-O-Mn superexchange coupling at $YBa_2Cu_3O_7$ / manganite interfaces** *Subhrangsu Sarkar [1], Roxana Gaina Capu [1,2], Yurii Pashkevich [1], Davide Betto [3], Kurt Kummer [3], Roberto Sant [3], Claude Monney [1], Christian Bernhard [1]* *[1] University of Fribourg, [2] West University of Timisoara, RO* *[3] European Synchrotron Radiation Facility, B.P. 220, FR-38043 Grenoble* Here we study the anomalous interface magnetic excitations in the $YBa_2Cu_3O_7$/ manganite heterostructures. Detailed analysis of the inelastic part of the high-resolution Resonant Inelastic X-ray Scattering (RIXS) signal in conjunction with polarimetry show the presence of two magnon modes in the cuprate, including a unique, non-dispersive interface magnon, that appears only due to the interfacial proximity of the manganite layer. We demonstrate that this low energy magnon originates from the interface copper layer in which intralayer exchange decreases due to Cu orbital reconstruction in favor of 3dz2-r2, instead of usual 3dx2-y2. Our work contributes to future studies of oxide interfaces offering perspectives for the design of artificial magnetic meta-materials.
182	**Magnetostriction and heat capacity measurements of quantum spin ice materials at ultra-low temperatures** *Ilaria Villa, Marek Bartkowiak, Romain Sibille* *Laboratory for Neutron Scattering and Imaging, Paul Scherrer Institut, CH-5232 Villigen PSI* In the search for Quantum Spin Liquid (QSL) phases, Rare-Earth pyrochlores are of interest to stabilize Spin Ice states. In QSL candidates, magnetic neutron scattering is a well-established probe for studying magnetic order and interactions. However, in rare-earth elements, degrees of freedom can include magnetic and electric multipoles, which are elusive in scattering experiments. Then, bulk techniques like specific heat and magnetostriction, especially at ultra-low temperatures (ULTs), are crucial to detect phase transitions "hidden" in scattering experiments. We present magnetostriction measurements on Quantum Spin Ice candidates and the development of a heat capacity probe at ULTs.

183 Thermoelectric properties of individual silicon nanotubes

Jose Manuel Sojo Gordillo [1], Saeko Tachikawa [1], Yashpreet Kaur [1], Giulio de Vito [1], Alex Morata [2], Ilaria Zardo [1]
[1] University of Basel, [2] Catalonian Institute for Energy Research

Large amounts of waste heat generated in our economy could be converted into useful electric power using thermoelectric generators. However, the low efficiency, scarcity, high cost, and poor production scalability of conventional thermoelectric material hinder their mass deployment. Nanoengineering has proven an excellent approach for enhancing the thermoelectric properties of abundant and cheap materials such as silicon. Recently, a family of nano-enabled materials in the form of large-area paper-like fabrics made of nanotubes has been developed as a cost-effective and scalable solution for thermoelectric generation. In this project, the thermoelectrical properties of the described nanotubes will be measured using different techniques (such as self-heating, nano calorimeters, and Raman thermography).

184 Neutron scattering on a new organo-metallic quantum magnet

Oksana Shliakhtun, Marc Janoschek, Jonas Philippe, Gediminas Simutis, Paul Scherrer Institut

Quantum spin ladders are fascinating systems with complex excitation spectra that depend on the relative strengths of the leg and rung exchange interactions. Here we report the magnetic properties of a new strong-leg spin ladder obtained by using magnetization, specific heat and neutron scattering measurements. In particular, we performed comprehensive inelastic neutron scattering experiments using both triple-axis and neutron time-of-flight techniques. Our results reveal a gapped excitation spectrum, consistent with the spin-ladder model. In addition, we will also show our magneto-thermodynamic experiments to demonstrate how the system transforms from a quantum paramagnet into a partially spin-polarized state.

185 H_{c2} as a function of the order parameter in unconventional superconductors

Bernhard Lüscher, Mark Fischer, Universität Zürich

The exact symmetries and form of the cooper pair wave function in many unconventional superconductors remains subject of ongoing debate. A possible way to shed some more light upon the matter is by explicitly computing thermodynamic properties given a functional form of the order parameter as well as a microscopic description of the normal state of a material. One such quantity is the upper critical field H_{c2}.
We develop a numerical pipeline interfacing between a normal-state description including a microscopic interaction and thermodynamic quantities such as the upper critical field. This allows us to draw conclusions on the microscopic structure of an unconventional superconductor considering its experimental H_{c2} signature.

186 Emergent U(1) symmetry in non-particle-conserving 1D models

Zakaria Jouini, Natalia Chepiga, Loic Herviou, Frédéric Mila, EPFL

The properties of stable Luttinger liquid phases in models with a non-conserved number of particles are investigated. We study Luttinger liquid phases in one-dimensional models of hard-core boson and spinless fermion chains where particles can be created and annihilated three by three on adjacent sites. We provide an intuitive and systematic method based on the flow equation approach, which accounts for additional terms in the correlations generated by the Z_3-symmetric interactions. We find that despite the emergence of U(1) symmetry under renormalization, the observables are still affected by its breaking in the bare Hamiltonian. In particular, the standard bosonization mapping becomes insufficient to capture the full behavior of correlation functions.

187 Critical line of the triangular Ising antiferromagnet in a field from a C3-symmetric corner transfer matrix algorithm

Samuel Louis Nyckees, Jeanne Colbois, Afonso Dos Santos Rufino, Frédéric Mila, EPFL

We propose a variant of the corner transfer matrix renormalisation group algorithm that contracts infinite tensor networks on the honeycomb lattice. We then apply the algorithm to the conceptually simple yet numerically challenging problem of the triangular lattice Ising antiferromagnet in a field at low temperatures and magnetic fields. We study how the finite temperature three-state Potts critical line in this model approaches the ground-state Kosterlitz-Thouless transition driven by a reduced field (h/T).

188	**Convergent beam electron diffraction of adsorbates on graphene** *Sara Mustafi, Tatiana Latychevskaia, Ding Peng, Paul Scherrer Institut* Convergent beam electron diffraction (CBED) on 2D materials provides a method for high-resolution imaging of individual particles deposited on a 2D material. A single-shot CBED pattern combines a diffraction pattern and a defocused image of the sample. We are investigating the optimal experimental imaging conditions for CBED of nanoparticles deposited on graphene. CBED allows regulating the radiation dose deposited into the sample by moving the sample within the probing convergent beam. This allows us to establish the resolution limits of the technique as a function of the required radiation dose.
189	**Finite temperature investigation of the ferroJ1-J2 model** *Olivier Gauthé, Frédéric Mila, EPFL* We study the spin-1/2 Heisenberg model on the square lattice with ferromagnetic nearest-neighbor coupling J1 $<$ 0 and frustrated antiferromagnetic next-nearest coupling coupling J2 $>$ 0. For spin- 1/2, the zero-temperature phase diagram differs from the J1 $<$ 0 case, with a first order transition to the ferromagnetic state. By combining tensor network methods and spin wave theory, we draw the finite temperature phase diagram of the model. We locate the critical point ending the first order line in addition to the Ising transition at large J2. Our results support the absence of a spin nematic phase in the intermediate region at zero field.

Surfaces, Interfaces and Thin Films

Wednesday, 06.09.2023, Room 114

Time	ID	**Surfaces, Interfaces and Thin Films I: Surface Science** *Chair: Jiri Pavelec, TU Wien*
17:00	**201**	**Creation of the elusive carbon allotrope cyclo[18]carbon; a cyclic carbon molecule** *Katharina Kaiser, IBM Research Zurich, Säumerstrasse 4, CH-8803 Rüschlikon* Cyclo[n]carbons were predicted for decades to exist. Although a synthetic route was elaborated in the 1980's, and glimpses of cyclocarbons were detected in gas phase, they could never be stabilized long enough for characterization. AFM and STM at low temperatures allow triggering certain on-surface chemical reactions by atom manipulation and can facilitate the controlled formation of highly reactive molecules on inert surfaces. Using this approach, we formed cyclo[18]carbon on a thin layer of NaCl. By comparing high-resolution AFM images and AFM simulations of different predicted resonance structures, we identified possible ground state structures of cyclo[18]carbon adsorbed on bilayer NaCl.
17:30	**202**	**Intrinsic defects on $PtSe_2$ vdW single crystals studied with ncAFM** *Igor Sokolovic [1,4], Bing Wu [2], Zdenek Sofer [2], Aleksandar Matkovic [3], Michael Schmid [4], Ulrike Diebold [4], Tibor Grasser [1]* *[1] Institute of Microelectronics, TU Wien* *[2] Dep. of Inorganic Chemistry, University of Chemistry and Technology, Prague, Czech Republic* *[3] Chair of Physics, Montanuniversität Leoben, Leoben, Austria* *[4] Institute of Applied Physics, TU Wien* In this research, surfaces of van-der-Waals-bonded single-crystal $PtSe_2$ cleaved in ultrahigh vacuum (UHV) were studied with non-contact atomic force microscopy (ncAFM) to simultaneously reveal their atomic and electronic structure. Typical ionic and electronic defects present on the cleaved surfaces were characterized with single-atom precision to reveal the proclivity of the layered Dirac semi-metal $PtSe_2$ toward different defect types compared to the synthesized single trilayer thin films of semiconducting $PtSe_2$ and other Pt-based TMDs. Cleaving reveals the intrinsic distribution of defects within the bulk, while such surfaces can also be considered representative of the commonly exfoliated and stacked $PtSe_2$ thin sheets used in complex heterostructures.
17:45	**203**	**Selective adsorption of DHTAP on the nanostructured Cu-CuO stripe phase** *Claudia López-Posadas [1], Antony Thomas [2], Thomas Leoni [2], Olivier Siri [2], Conrad Becker [2], Peter Zeppenfeld [1]* *[1] Institute of Experimental Physics, Johannes Kepler University Linz* *[2] Aix-Marseille University, CNRS, CINaM* We have studied 5,14-dihydro-5,7,12,14-tetraazapentacene (DHTAP) layers on the regularly patterned Cu(110)-(2x1)O stripe phase. Using Reflectance Difference Spectroscopy (RDS) and Scanning Tunneling Microscopy (STM) we find that the DHTAP molecules preferentially adsorb on the Cu(110) stripes, with their long molecular axis aligned parallel to the [-110]-direction. In contrast, on the subsequently covered Cu(110)-(2x1)O stripes, the DHTAP molecules are aligned parallel to the [001]-direction. The evolution of the RDS signal allows to monitor the sequential adsorption and orientation of DHTAP for different oxygen pre-coverages and, hence, different Cu and CuO stripe widths. Interestingly, beyond the first monolayer, the DHTAP molecules adopt a preferential orientation which critically depends on the initial oxygen coverage.

18:00 | 204

Heterogeneous Photocatalysis: Alcohols on Bare and Metal-decorated Titania(110) and Hematite(012)

Moritz Eder [1], Ulrike Diebold [1], Ueli Heiz [2], Gareth Parkinson [1], Jiri Pavelec [1], Philip Petzoldt [2], Michael Schmid [1], Martin Tschurl [2]
[1] Institute of Applied Physics, TU Wien, [2] TU Munich

We investigated the surface (photo)chemistry of alcohols on TiO_2(110) and recently Fe_2O_3(012) single crystals in ultra-high vacuum. Our studies focused on the role of the metal co-catalyst in the photocatalytic reaction by comparing the reactivity of bare and metal-decorated surfaces. We show that photocatalytic reactions are not merely a couple of redox reactions, but an interplay of thermal and photon-driven steps.
On TiO_2(110), the alcohol photoconversion allows for a steady-state production of molecular hydrogen and aldehydes/ketones. We rationalize the findings with a comprehensive mechanism taking into account stoichiometry and charge-carrier dynamics. The identification of surface mechanisms on Fe_2O_3 is less advanced, but there seem to be parallels in the photochemistry.

18:15 | 205

Exploring the surface atomic and electronic structure of the multiferroic Rashba semiconductor $Ge_{1-x}Mn_xTe$

Martin Heinrich [1], Juraj Krempasky [1], Matthias Muntwiler [1], Gunther Springholz [2]
[1] Paul Scherrer Institute
[2] Institut für Halbleiter-und Festkörperphysik, Johannes Kepler Universität, Linz, Austria

GeTe is a IV-VI semiconductor compound with existing applications in optoelectronics and thermoelectrics. In addition to ferroelectricity and a large Rashba spin splitting in GeTe, doping with Mn atoms introduces ferromagnetism, which makes $Ge_{1-x}Mn_xTe$ a magnetoelectric multiferroic with coupled electric and magnetic polarization and a promising candidate for spintronic applications.
In this project, we use synchrotron based photoelectron diffraction (XPD, PhD) and spectroscopy (XPS, ARPES) and scanning tunneling microscopy (STM, STS) to gain a detailed understanding of its surface atomic and electronic structure and the inherent multiferroic couplings.

18:30 | 206

An STM investigation on the CO_2 activation and conversion on Au/MgO(001) ultrathin film

Francesco Presel [1], Hans-Joachim Freund [2], Martin Sterrer [1]
[1] University of Graz, [2] Fritz Haber Institut der Max Planck Gesellschaft

In previous research, we have shown that single-layer Au nanoislands on ultrathin MgO/Ag(001) can catalyze activation of CO_2 to oxalate $(CO_2)_{2-}$ — a stable intermediate for chemicals and synthetic fuels — even below room temperature.
Here we identified with STM the oxalate species present on the surface after reaction, which was only observed in presence of single-layer Au islands after exposure to CO_2 at 200-300 K.
Most surprisingly, this species was not located beside the Au islands: being the adsorbate species not mobile on the surface, this suggests that the reaction might involve a complex process, with electrons first tunnelling through the MgO into the gold, then diffusing over MgO.

18:45 | 207

Structure and nanoscale dynamics at carbon materials and interfaces: From organic aromatics to nucleobases

Philipp Maier [1], Noah J. Hourigan [1], Neubi F. Xavier Jr. [2], Marco Sacchi [2], Peter Fouquet [3], Anton Tamtögl [1]
[1] Institute of Experimental Physics, Graz University of Technology
[2] Departement of Chemistry, University of Surrey
[3] Institut Laue-Langevin

The high scattering cross section of neutron and helium beams towards hydrogen provides experimental access to the structure and dynamics of hydrogen containing molecules at carbon materials, including e.g. the molecular motion of water. I will present experimental and theoretical results of hydrogen containing molecules ad-sorbed on carbon surfaces. These include the structure and dynamics of deuterated pyrazine on graphite, providing insight in how the van der Waals interaction between adsorbates and the substrate influences adsorbate structure and stability. Moreover, I will present recent neutron-spin echo measurements of adenine and thymine ad-sorbed on graphite, to better understand hydrogen bond formation in DNA base pairs, tautomerisation rates, and proton tunnelling.

19:00	**208**	**C_2H_4 Adsorption on Clean and Rh-Decorated Fe_3O_4(001) Surface** *Chunlei Wang [1], Panukorn Sombut [1], Lena Puntscher [1], Manuel Ulreich [1], Jiri Pavelec [1], Matthias Meier [1,2], Ulrike Diebold [1], Cesare Franchini [2,3], Michael Schmid [1], Gareth Parkinson [1]* *[1] Institute of Applied Physics, TU Wien, Austria* *[2] Computational Materials Physics, University of Vienna* *[3] Alma Mater Studiorum, Università di Bologna, Italy* The adsorption of ethylene (C_2H_4) is a crucial step in many important industrial reactions. Recently, novel single-atom Rh_1 heterogeneous catalysts have shown excellent activity and selectivity for hydroformylation reactions (e.g., C_2H_4 + CO + H_2 = CH_3CH_2CHO). However, a fundamental understanding of the catalytic mechanisms remains elusive. As a first step towards this goal, Rh_1 adatoms were deposited on a well-defined single-crystal Fe_3O_4(001) surface, and various surface-sensitive techniques under ultra-high vacuum conditions in combination with density functional calculations were used to investigate the behavior of C_2H_4 adsorption. In addition, the adsorption on clean Fe_3O_4(001) surface is also investigated as control experiments.
19:15	**209**	**Atomic-Level Studies of CO/Rh_1 and $(CO)_2/Rh_1$ Formation on an Fe_3O_4(001) support** *Panukorn Sombut [1], Ulrike Diebold [1], Cesare Franchini [2], Zdenek Jakub [1], Matthias Meier [1], Gareth S. Parkinson [1], Jiri Pavalec [1], Lena Puntscher [1], Michael Schmid [1], Chunlei Wang [1]* *[1] TU Wien, [2] University of Vienna* Understanding the interaction between reactant molecules and “single-atom” active sites is important for comprehending the evolution of single-atom catalysts in reactive atmospheres. Here, we study the interaction between CO and Rh_1 and Rh_2 species supported by Fe_3O_4(001) using DFT and experimental surface science techniques. Stable $Rh_1(CO)_1$ is formed via CO adsorption at both 2-fold and 5-fold to oxygen-coordinated Rh_1 sites. While DFT suggests $Rh_1(CO)_2$ to be energetically favorable, only a minority of these are observed experimentally. Instead, the limited $Rh_1(CO)_2$ is observed experimentally via CO-induced Rh_2 dimer breakup. Experiment and DFT results suggest this process occurs via an unstable $Rh_2(CO)_3$ intermediate.
19:30		

Thursday, 07.09.2023, Room 114

Time	**ID**	**Surfaces, Interfaces and Thin Films II: Thin Films and Heterostructures** *Chair: Chunlei Wang, TU Wien*
14:00	**211**	**Fabrication of two-dimensional magnets by implantating phyllosilicates with Fe ions** *Christian Teichert [1], Muhammad Zubair Khan [1], Ulrich Kentsch [2], Nico Klingner [2], Gregor Hlawacek [2], Aleksandar Matkovic [1]* *[1] Chair of Physics, Montanuniversität Leoben, [2] Helmholtz-Zentrum Dresden-Rossendorf e.V.* Recently, we demonstrated weak ferromagnetism in two-dimensional Fe:talc at room temperature and proposed iron-rich phyllosilicates as a promising platform for air-stable magnetic monolayers. Since these minerals are rather rare and hard to synthesize, we suggest ion implantation to tailor the phyllosilicates' magnetic properties. Nonmagnetic, iron-free single-crystalline talc bulk samples were implanted with 50 keV Fe^+ beams at different substrate temperatures. Ultrathin layers could be exfoliated indicating that the layered crystal structure is maintained after ion irradiation. The Mg-OH Raman peak showed a triplet formation implying a successful substitution of Mg by Fe in the talc layers.

14:30	**212**	**Thin Film Structure of the Asymetric Ph-BTBT-10 Molecule for Application in Organic Thin Film Transistors** *Roland Resel, TU Graz, Yves Geerts, University Libre Brussels* The class of benzothieno-benzothiophene (BTBT) type molecules are among the best performing organic semiconductors in thin film transistors. The asymmetry of the molecule induces specific thin film forming properties and unique crystallographic features. We see the nucleation of the thermodynamic stable phase at the substrate surface and a transition to a metastable phase at the subsequent film growth. Peak broadening effects could be referred to defects by integration of reversed molecules into the crystal structure. This work reveals that the reversal of the molecular orientation at the substrate surface is the dominant effect in the crystallisation kinetics within thin films.
	~~213~~	*cancelled*
14:45	**214**	**Ultrathin $La_{0.8}Sr_{0.2}MnO_3$ films with enhanced magnetic properties** *Gyanendra Panchal, Federico Stramaglia, Frithjof Nolting, Carlos A. F. Vaz, PSI* We report the effect of inserting $LaMnO_3$ and $La_{0.45}Sr_{0.55}MnO_3$ buffer layers on the magnetic properties of epitaxial ultrathin $La_{0.8}Sr_{0.2}MnO_3$ films on $SrTiO_3$(001) substrate. The $LaMnO_3$ induces a bulk-like magnetic moments for $La_{0.8}Sr_{0.2}MnO_3$ down to 1 uc thickness, the $La_{0.45}Sr_{0.55}MnO_3$ induces antiferromagnetic order on the first 3 uc $La_{0.8}Sr_{0.2}MnO_3$ and bulk-like moments at larger thicknesses. In both cases, the bulk-like moment is confirmed by a linear increase in the magnetization, with a slope m = 3.8 μB/Mn. XMCD measurements confirm our magnetic results; XLD demonstrate the presence of an orbital reorganization at 3-4 uc. We attribute the full spin polarization of the $La_{0.8}Sr_{0.2}MnO_3$ films to a charge carrier transfer into the adjacent buffer layer.
15:00	**215**	**Revealing the electronic structures of $SrTiO_3$ membranes and related heterostructures** *Hang Li [1], Alla Chikina [1], Nicholas Clark Plumb [1], Nini Pryds [2], Milan Radovic [1], Ming Shi [1], Shinhee Yun [2]* *[1] Paul Scherrer Institute, [2] Technical University of Denmark* Transition metal oxide (TMO) exhibit exotic physical properties, which generally originated from the strong interplay between the charges, spins, orbitals, and lattice degrees of freedom. Therefore, developing methods for manipulating this coupling yields opportunities for realizing many novel quantum phenomena. Recent studies establish routes to exfoliate free-standing TMO membranes, raising a promising method for realizing 2D TMO systems. In this presentation, I'll introduce our new ARPES studies on high-quality $SrTiO_3$ membranes and $SrNbO_3$ films grown on as-received STO membranes, showing high spectra quality. Our studies demonstrated that STO membranes are an advantageous platform for 2D electronic systems and can be utilized as a wafer for assembling complex oxide heterostructures.
15:15	**216**	**Long Ranged Proximity Induced Interactions in $YBa_2Cu_3O_{7-\delta}Sr_2IrO_4$ Thin Film Multilayers Revealed by X-ray Absorption Spectroscopy** *Jonas Knobel [1], Subhrangsu Sarkar [1], Mathias Soulier [1], Roxana Gaina Capu [2,1], Christian Bernhard [1], Fabrice Wilhelm [3], Andrei Rogalev [3], Peter Nagel [4], Stefan Schuppler [4]* *[1] University of Fribourg, [2] West University of Timisoara, RO, [3] ESRF, [4] KIT* Heterostructures consisting of the high-T_C superconductor $YBa_2Cu_3O_{7-\delta}$ (YBCO) and the iridate Sr_2IrO_4 (SIO) have been predicted to host induced superconducting spin-triplet or Majorana bound states and to find applications in devices such as superconducting diodes. Using X-ray Absorption Spectroscopy, we observe a large charge transfer in multilayers of these materials with holes being transferred from YBCO to SIO, leading to insulating behavior for thin YBCO layers. We also study the influence of the interface on the magnetism of both materials with X-ray circular dichroism. This work provides important insights on the interaction at the interface which is a crucial step towards real life applications and devices made from these heterostructures.

15:30	**217**	**Characterization of Atomically Precise Graphene Nanoribbons by Raman Spectroscopy** *Jeong Ha Hwang, Amogh Kinikar, Mickael Lucien Perrin, Roman Fasel, Gabriela Borin Barin, Empa* Raman spectroscopy has been widely used to characterize graphene nanoribbons (GNRs) as it is possible to probe GNR quality from growth in ultra-high vacuum (UHV) until device integration. However, implementing this technique to study GNRs intrinsic spectroscopic properties remains challenging, as their synthesis requires UHV environment and many of these GNRs are reactive and air-sensitive. Here, we propose a UHV chamber where in-situ growth and Raman characterization are possible. We studied short 7-AGNRs with unique zigzag/armchair aspect ratio that allowed us to investigate the zigzag edge reactivity upon their exposure to air. Further, we will also discuss the effect of controlled oxygen exposure on characteristic Raman transitions of the GNRs.
15:45	**218**	**Intercalation of graphene nanoribbons with carbenes in ultra-high vacuum** *Dominik Lüthi [1], Lin Yang [2], Ji Ma [2], Akimitsu Narita [3,4], Xinliang Feng [2], Pascal Ruffieux [1], Roman Fasel [1], Gabriela Borin Barin [1]* *[1] Empa, [2] TU Dresden, [3] Max Plank Institute for Polymer Research,* *[4] Okinawa Institute of Science and Technology* Atomically precise graphene nanoribbons (GNRs) have been synthesized by on surface-synthesis of specific precursors on metallic substrates in ultra-high vacuum (UHV). The enhanced chemical reactivity of zigzag edge states of reactive GNRs has hindered their transfer and device integration. Here, we studied the intercalation of various GNRs with carbenes (BIM) as a promising route towards dry-transfer of GNRs in UHV. The intercalation occurs due to the formation of a dense self-assembled monolayer (SAM) on the surface, causing stochastic intercalation of GNRs. Intercalation also decreases the interaction with the underneath metal, allowing better access to GNRs electronic characterization and open a pathway to study the interaction of nanographenes with other surfaces.
16:00	**219**	**Measuring Surface Parameters of Intercalated Graphene and their Correlation with the Substrate Coupling Strength** *Noah J. Hourigan [1], Giorgio Benedek [2], Philipp Maier [1], Joshua A. Robinson [3], Anton Tamtögl [1], Maxwell Wetherington [3]* *[1] Institute of Experimental Physics, Graz University of Technology* *[2] Università di Milano-Bicocca, [3] The Pennsylvania State University* Graphene can be grown via chemical vapour deposition on a silicon carbide substrate; thereafter, various elements can be intercalated between the graphene and the substrate. Here, we investigate bilayer graphene atop either intercalated 2D polar gallium, an intercalated hydrogen layer, or a simple carbon buffer layer. Using helium atom scattering (HAS) we probe surface characteristics such as the in-plane thermal expansion relationship, the electronic corrugation, and the electron-phonon coupling strength. We compare how these properties are affected by the intercalated material beneath. Despite HAS exclusively probing the graphene overlayer, we are able to detect subtle differences likely to be related to the substrate coupling strength.
16:15		
16:30		***Coffee Break***

Time	ID	**SURFACES, INTERFACES AND THIN FILMS III: METHOD DEVELOPMENT** *Chair: Moritz Eder, TU Wien*
17:00	**221**	**Distance-Dependence of Orbital Density Mapping Using a CO-Functionalized STM Tip** *Fabian Paschke, Florian Albrecht, Leo Gross, Leonard-Alexander Lieske* *IBM Research Europe - Zurich* In this work we use a CO tip to study the appearance of frontier molecular orbitals of pentacene as a function of the tip-sample distance. STM constant-height imaging reveals a transition from p- to s-wave dominated tunneling. We present a simple model that reproduces the distance-dependency due to the symmetry-dependent decay lengths of the CO tip states. The findings provide an additional control knob to identify molecular electronic and spin states, which often requires STM imaging of orbital densities and careful assignment to calculated molecular orbitals.
17:15	**222**	**Microwave reflectance calibration in a scanning tunnelling microscope** *Bareld Wit [1], Georg Gramse [2], Stefan Müllegger [1]* *[1] Institute of Semiconductor and Solid State Physics, Johannes Kepler University Linz, Austria* *[2] Biophysics Institute, Johannes Kepler University Linz, Austria* Recent advances in near-field scanning microwave microscopy enable characterisation of nanoscale functional materials, surfaces, and nanoelectronic devices up to GHz frequencies and with sub-micron resolution. Material properties, including dielectric permittivity and dopant concentration have been detected in a microwave-adapted atomic force microscope at ambient conditions. We show our STM-based microwave reflectance set-up and report a quantitative in-situ procedure for impedance calibration in ultra-high vacuum at 8 K. These results open the door to microwave impedance spectroscopic fingerprinting down to the scale of single molecules.
17:30	**223**	**Correlation between 2- and 3-dimensional crystallographic lattices for epitaxial analysis** *Josef Simbrunner [1], Jari Domke [2], Oliver T. Hofmann [3], Roland Resel [3], Roman Forker [2], Torsten Fritz [2]* *[1] Medical University Graz, [2] Institute of Solid State Physics, Friedrich Schiller University Jena* *[3] Institute of Solid State Physics, Graz University of Technology* While the crystalline properties of an epitaxially grown thin film can be studied in three dimensions by X-ray methods like grazing incidence X-ray diffraction (GIXD), the first monolayer is only accessible by surface sensitive methods that allow the determination of a two-dimensional lattice like low-energy electron diffraction (LEED). GIXD measurements with sample rotation on epitaxially grown films are compared with distortion-corrected LEED experiments of molecular monolayers. In this work, a combined experimental approach of GIXD and LEED is introduced which can be used to investigate the effect of the epitaxial monolayer on the evolution of molecular crystals with epitaxial order grown on top.
17:45	**224**	**Optimized Infrared Reflection Absorption Spectroscopy for Metal Oxides: Overcoming Challenges of Low Reflectivity and Sub-Monolayer Coverage** *Jiri Pavelec, David Rath, Michael Schmid, Ulrike Diebold, Gareth Parkinson* *Vienna University of Technology* This study presents a new Infrared Reflection Absorption Spectroscopy (IRAS) setup for investigating adsorption on “single-atom” catalysts, addressing the challenges of low reflectivity from oxide supports and sub-monolayer coverage of adsorbates. The setup features improvements such as a high numerical aperture, optimized optical path, controlled incidence angle range, and high mechanical stability. Utilizing adjustable aperture plates, the minimum and maximum incidence angles can be varied to optimize the signal for each sample. This new setup successfully demonstrated enhanced signal-to-noise ratio in D_2O and CO absorbance measurements on a rutile TiO_2(110) surface, agreeing with established literature, with significantly reduced measurement time.

18:00	**225**	**The Surface Tension of Water in its Pure Vapor** *Alexander Syböck, Jan Balajka, Ulrike Diebold, Jiri Pavelec, Paul Ryan, Michael Schmid* *Institute for Applied Physics, TU Wien* Contaminants and other gases are known to greatly affect surface tension values. We have developed a way to measure the surface tension of ultra-clean liquids in contact with their pure gaseous phases. The liquid is condensed onto a small cryostat in a vacuum chamber. A pendant drop is formed and photographed allowing the surface tension of the ultra-pure liquid to be directly determined. Accurate control of the temperature, pressure and optics of the system is of importance. How these parameters are precisely controlled in the instrument design will be discussed along with initial measurements of ultra-pure water.
18:15	**226**	**Surface band-bending response to charge redistribution and adsorbates in the ZnO/electrolyte interface probed by in-situ Spectroscopic Ellipsometry** *Luis Rosillo, Christoph Cobet, Kurt Hingerl, Johannes Kepler Universität Linz* In this work we look at the response of the surface band-bending of the ZnO single crystal polar faces (0001) and (000-1), in contact with an electrolyte, to a variation of charge at the solid-liquid interface by analyzing the effect of the inner electric fields on the excitonic dielectric function using in-situ spectroscopic ellipsometry. Discrete excitons on ZnO have a binding energy of (~ 60 meV) and in space charge region are significantly sensitive to modifications in the surface dipole moment. Hence, making them a siutable probe to study the response of the band-bending.
18:30	**227**	**Quantitative Surface Structure of Water on Hematite: Experiment vs Theory** *Paul Ryan, Matthias Meier, Gareth Parkinson, Ali Rafsanjani-Abbasi, Panukorn Sombut,* *Chunlei Wang, TU Wien* Normal incidence X-ray standing waves (NIXSW) was used to directly determine the adsorption height of adsorbed H_2O and OH on the α-Fe_2O_3(012)-(1x1) surface. The H_2O and terminal OH both sit at the same adsorption height (1.45 Å and 1.46 Å respectively). The bridging OH is found sitting essentially in plane with a projected bulk surface (0.01 Å) implying little surface relaxation. This data corroborates our previous AFM study [Jakub 2019] and can be used to benchmark DFT calculations. The most appropriate functionals are those that produce little outward or inward surface relaxation and expensive Hybrid functionals are not necessarily suited for such systems. These findings are inline with our prior work [Meier 2018, Ryan 2020].
18:45	**228**	**A Novel Four-Terminal Suspended Device** **for Nanoscale Thermal Characterization** *Giulio de Vito [1], Rahul Swami [1], Dominik Koch [1], Tathagata Paul [2], Wenhao Huang [2],* *Michel Calame [2], Bernd Gotsmann [3], Ilaria Zardo [1]* *[1] University of Basel, [2] EMPA, [3] IBM Zurich* 2D-flakes exhibit among the highest thermal conductivity in materials, which make them suitable for heat dissipation in microchip processes. However, it is challenging to produce thin homogenous flakes or transferring one flake onto a target because of the risk of damaging or contaminating the material. Thus, it is important to characterize the intrinsic properties of the materials with a consistent and reliable method. A novel four-terminal device is proposed which involves fabricating suspended four transducers, which can act as thermometer as well as heater, combined with the suspension of an h-BN flake. We demonstrate the capabilities of this novel four-terminal devices through electrical measurements and first results on h-BN flakes.
19:00		***END; Transfer to Dinner***
19:30		***Conference Dinner***

ID	SURFACES, INTERFACES AND THIN FILMS POSTER
241	**Towards dielectric relaxation at a single molecule scale** *Stefan Müllegger [1], Simon Feigl [1], Jindrich Nejedly [2], Eva Rauls [3], Michal Samal [2], Ivo Stary [2], Vitalii Stetsovych [1], Radovan Vranik [1], Bareld Wit [1]* *[1] Institute of Semiconductor and Solid State Physics, Johannes Kepler University Linz* *[2] Inst. of Organic Chemistry and Biochemistry of the Czech Academy of Sciences, Prague, Czech Republic* *[3] Institute for mathematics and physics, University of Stavanger, Norway* Recent advances have turned the scanning tunnelling microscope (STM) into a single molecule identification tool. We apply a radio frequency STM to excite a single molecule junction based on a polar substituted helicene molecule by an electric field oscillating at 2 to 5 GHz. We detect the dielectric relaxation of the single molecule junction indirectly via its effect of power dissipation, which causes lateral displacement. From our data we determine a corresponding relaxation time of about 300 ps – consistent with literature values of similar helicene derivatives obtained by conventional methods of dielectric spectroscopy.
242	**Controlling skyrmion density and formation mechanism by tuning ferromagnetic layer thicknesses in thin film multilayers** *Reshma Peremadathil Pradeep [1], Hans Josef Hug [1,2], Andrada-Oana Mandru [1]* *[1] Empa, Swiss Federal Laboratories for Materials Science and Technology* *[2] Department of Physics, University of Basel* With the goal of controlling the skyrmion density and their formation mechanism, which are highly relevant for spintronic devices using skyrmions, we investigate $[Ir\,(1\text{ nm}) / Co\,(t) / Pt\,(1\text{ nm})]_n$ multilayers with varying Co-layer thickness. We observe that by increasing the Co layer thickness, domains (at zero field) become narrower, and skyrmion density (in an applied field) increases. This can be explained using the critical material parameter $\kappa = D/4 \cdot \sqrt{AK_{eff}}$, with D - interfacial DMI constant, A - exchange stiffness and K_{eff} - effective magnetic anisotropy. Skyrmions are thermodynamically stable for $\kappa > 1$. Here, κ increases as the effective anisotropy approaches zero at a critical Co-thickness. Furthermore, two different skyrmion formation mechanisms (shrinking and fission) are observed.
243	**Magnetoelectric Coupling in $La_{0.9}Ba_{0.1}MnO_3$/ $BaTiO_3$ Multiferroic Heterostructures Imaged by X-ray Photoemission Electron Microscopy** *Gyanendra Panchal [1], Federico Stramaglia [1], Ludovica Tovaglieri [2], Celine Lichtensteiger [2], Frithjof Nolting [1], Carlos A. F. Vaz [1]* *[1] Paul Scherrer Institut, [2] University of Geneva* We report the direct XPEEM imaging of the magnetic response of a 4.8 nm $La_{0.9}Ba_{0.1}MnO_3$ film to the voltage applied across a 5 nm $BaTiO_3$ film. Ferroelectric patterns were written on the $BaTiO_3$ with an AFM in contact-mode and the change in magnetic contrast measured with XPEEM. We observe an increase in the magnetic contrast when going from negative to positive writing voltages. Temperature dependent measurements show a decrease in the Curie temperature for positive voltage above +6 V applied, corresponding to hole-depletion state. The magnetic contrast of the written areas are compared with SQUID-magnetometry results, confirming the behavior for accumulation/depletion states of the $La_{0.9}Ba_{0.1}MnO_3$ for the two polarizations of $BaTiO_3$.

Nuclear, Particle and Astrophysics (TASK - FAKT)

This session has been organised in collaboration with CHIPP.

Tuesday, 05.09.2023, Room 118

Time	ID	**TASK I: LHC Physics and Theory** *Chair: Anna Sfyrla, Université de Genève, Mauro Donegà, ETH Zürich*
14:00	**301**	**Searching for Higgs+charm production in the diphoton final state at CMS** *Tiziano Bevilacqua, University of Zürich, on behalf of the CMS collaboration* The discovery of the Higgs boson at the LHC has opened a whole new chapter of exploration in particle physics, and the measurement of the Higgs boson couplings to second generation fermions is one of the next milestones of the LHC physics program. The associated production of a Higgs boson and a charm quark (c+H) is sensitive to the Higgs-charm coupling, and is yet to be probed experimentally at the LHC. This talk describes first studies to search for H+c production with CMS data in the diphoton channel.
	~~302~~	*cancelled*
14:15	**303**	**Measurement of the lepton universality ratio B(ϕ→μμ) / B(ϕ→ee) using charm hadron decays.** *Davide Lancierini, University of Zürich* I will present a test of lepton flavour universality performed using charm hadron $D^+_{(s)} \to \pi^+ \phi (\ell^+ \ell^-)$ decays, with ℓ indicating either an electron or a muon. This measurement, performed using 5.4 fb^{-1} of data collected by the LHCb experiment, validates our understanding of detection efficiencies of low momentum leptons. The clean experimental signature of these decays allows not only for a detailed comparison of data and simulation for reconstructed electrons in the low q^2 region, but also the mass resolution and $h \to e$ misidentification backgrounds, which are all critical aspects of lepton universality measurements at the experiment.
14:30	**304**	**Branching fraction measurement of the rare decay $B^0 \to K\pi\mu^+\mu^-$** *Martin Andersson, University of Zurich* Measurements of $b \to s\mu\mu$ during the last decade show a consistent pattern of deviations with respect to Standard Model (SM) predictions across a large set of observables in various decay modes. The branching fraction measurement of $B^0 \to K^{*0}(892)(\to K\pi)\mu^+\mu^-$, which includes the well studied $K^{*0}(892)$ resonance, show an abundance in the theory predictions with respect to the experimentally measured value. However to date, relatively little is known of the branching fraction of $B^0 \to K\pi\mu^+\mu^-$, where the $K\pi$-system originates from heavier K^* states. To help further our understanding of the mismatch between theory and experiment in $b \to s\mu\mu$ transition, this project will probe the heavier, relatively unexplored part of the $K\pi$-system in $B^0 \to K\pi\mu^+\mu^-$, with a measurement of the muon-mode branching fraction using 9 fb^{-1} of LHCb data.
14:45	**305**	**Realistic SU(5) GUT with lower dimensional representations** *Kevin Hinze, Stefan Antusch, Shaikh Saad, University of Basel* What is the minimal viable renormalizable SU(5) GUT with representations no higher than adjoints? In this talk I discuss an SU(5) model in which vectorlike fermions $5_F + \bar{5}_F$ as well as two copies of 15_H Higgs fields are introduced in order to accommodate for correct charged fermion and neutrino masses and to reproduce the matter-antimatter asymmetry of the universe. The presented model is highly predictive and will be fully tested by a combination of upcoming proton decay experiments as well as low energy experiments in search of flavor violations.

15:00	306	**Probing multilepton decays with the LHCb experiment** *Vitalii Lisovskyi, EPFL* Recently, a number of tensions has been observed in semileptonic decays of B hadrons to a lighter hadron and two leptons. With the large dataset collected by the LHCb experiment, it becomes possible to study higher-order processes. Emission of a virtual photon from the initial (final) state can create an additional dilepton pair, leading to a final state with four leptons. The experimentally clean multilepton signature allows to suppress background, rendering exploration of such decays interesting for testing the Standard Model. In this talk, multilepton decays of heavy-flavour hadrons will be discussed. Searches for such decays with the dataset collected by the LHCb experiment will be presented.
15:15	307	**Search for the $B^+ \to K^+\tau^+\tau^-$ decay** *Maria Carolina Feliciano Faria, Fred Blanc, Aravindhan Venkateswaran, EPFL* We search for the $B^+ \to K^+\tau^+\tau^-$ decay using data collected by the LHCb experiment, reconstructing the τ leptons in $\tau^+ \to \pi^+\pi^-\pi^+(\pi^0)\bar{\nu}_\tau$. This decay is produced in electroweak penguin loop transitions, highly suppressed in the standard model. New models explaining the tensions observed in $b \to s l^+ l^-$ and $b \to c l \bar{\nu}$ transitions also predict enhancements of the $b \to s\tau\tau$ branching fractions of up to $\mathcal{O}(10^3)$ over the standard model prediction. We present initial studies of the reconstruction of this decay, the analysis of potential background sources and a preliminary estimate of our sensitivity to this channel.
15:30	308	**Vector Glueballs in Holographic QCD** *Florian Hechenberger, Josef Leutgeb, Anton Rebhan, Vienna University of Technology* Gauge/Gravity duality has led to novel insights in the strong coupling behaviour of large Nc QCD. Most notably is the type IIA supergravity construction by Witten, which was extended by Sakai and Sugimoto to include chiral quarks. This setup enables one to study interactions between glueballs, mesons and photons in an almost parameter-free manner. After giving a brief introduction to the model, I will focus on the decay rates of the vector glueball, its mixing with vector mesons as well as its connection to the longstanding $\rho\pi$-puzzle and the Odderon.
15:45	309	**Search for $K_S \to \pi^+\pi^-\mu^+\mu^-$ with the Run II LHCb data** *Luis Miguel Garcia Martin, EPFL, Radoslav Marchevski, CERN* Rare kaon decays are among the most sensitive probes of both heavy and light New Physics. In particular, the $K_S \to \pi\pi\mu\mu$ process is of $O(10^{-14})$ in the SM, and can be enhanced by up to a 100 times by exotic BSM models. Unlike the challenges faced by feasibility studies of $K_S \to \pi^+\pi^-\mu^+\mu^-$ decays due to the presence of electrons, $K_S \to \pi^+\pi^-\mu^+\mu^-$ is expected to be very clean given the LHCb performance on pion and muon reconstruction. Additionally, this decay presents an opportunity to test for CP violation. We report the status of the first $K_S \to \mu\mu\pi\pi$ decay search using Run 2 LHCb data.
16:00		
16:30		***Coffee Break***

Time	ID	**TASK II: Muon** *Chair: Anna Sótér, ETH Zürich*
	~~311~~	*cancelled*
17:00	312	**Towards High-Resolution X-Ray Spectroscopy of Muonic Lithium using Metallic Magnetic Microcalorimeters** *Katharina von Schoeler, ETH Zürich, for the QUARTET Collaboration* Precision measurements of nuclear charge radii provide important inputs for modern nuclear theory, helping to improve our understanding of nuclear forces. The spectroscopy of muonic atoms is known as a highly precise method for such measurements. However, in the case of low- to medium-Z nuclei, the covered energy range has so far been difficult to access using laser spectroscopy or conventional solid-state detectors. The new QUARTET collaboration addresses this gap for the first time using metallic magnetic microcalorimeters, combining high quantum efficiencies, broadband-spectra and record-resolving power. This contribution presents plans and status of a first experiment aiming at the spectroscopy of muonic ^{6}Li and ^{7}Li at the Paul Scherrer Institute.
17:15	313	**The Injection Channel of the muEDM Experiment** *Anastasia Doinaki, Philipp Schmidt-Wellenburg, Paul Scherrer Institut* At the Paul Scherrer Institute we are setting up an experiment to search for the muon EDM. This talk focuses on the off-axis injection of the muons into a 3 T storage solenoid. The injection channel needs to be magnetically shielded, so muons can pass from the exit of the beamline, low magnetic field region, into the high magnetic field region of the solenoid. In the fringe magnetic field, below 1 T, we will use an iron tube, while inside the solenoid bore, above 1 T, we will use a superconducting (SC) shield. The effectiveness of three SC-shield prototypes will be tested by measuring their shielding factors and calculating the muon injection efficiency.
17:30	314	**Muonic atom spectroscopy with radioactive targets** *Stergiani Marina Vogiatzi, Paul Scherrer Institut, for the MUX collaboration* MuX, an experiment running at PSI, aims to measure the nuclear charge radius of radioactive isotopes, such as ^{226}Ra and ^{248}Cm, using muonic atoms. With safety regulations imposing the usage of only microgram quantities of radioactive material the standard method to form a muonic atom by direct muon capture cannot be implemented. A technique that employs muon transfer reactions in a high-pressure cell filled with D_2/H_2 mixture is used instead. This enabled the measurement of ^{226}Ra and ^{248}Cm in 2019. Despite no 2p $\rightarrow$ 1s muonic x rays being observed for radium, we are close to determining the charge radius in ^{248}Cm. This contribution presents the status of the muX experiment.
17:45	315	**Optimization of muon EDM experimental setup using simulations** *Ritwika Charkaborty, Paul Scherrer Institut, for the muEDM collaboration* The potential discovery of non-zero electric dipole moments (EDMs) of leptons implies Charge-Parity violation beyond the Standard Model. This makes the experimental search for lepton EDMs a valuable tool to test scenarios explaining observations like matter-antimatter asymmetry, non-zero neutrino masses, and dark matter. A dedicated experimental search for the muon EDM is underway at PSI using the frozen spin technique, which suppresses the anomalous spin precession of muons in a storage ring by applying a radial electric field. The experiment has two phases, with the first phase demonstrating the frozen spin technique. This talk describes the optimization of the first phase of the experiment through simulations studies.

18:00	**316**	**Development of a frozen-spin muon trap for the search for a muon electric dipole moment** *Timothy Hume, Philipp Schmidt-Wellenburg, Paul Scherrer Institute, on behalf of the muEDM Collaboration* The muEDM Collaboration is searching for the muon EDM by implementing, for the first time, the frozen-spin technique [Farley et al. (2004), PRL:93:052001]. A factor 1000 improvement upon the current limit $d_\mu < 1.8 \cdot 10^{-19}$ ecm (95 % C.L.) [Bennett et al. (2009), PRD:80:052008] is expected from this approach. A sub-microsecond trapping scheme is being developed to store 28 MeV/c muons on a circular orbit exposed to a 0.3 MV/m radial electric field inside a 3 T solenoid. A pulsed magnetic field will accordingly kick the longitudinal momentum of injected muons, thereafter axially confined by a static weakly-focusing magnetic field. Prototypes are being tested to explore different field geometries and study the effect of eddy currents on the frozen-spin conditions.
18:15	**317**	**Systematic effects in the search for the muon EDM using the frozen-spin method** *Chavdar Dutsov, Paul Scherrer Institut, on behalf of the muonEDM collaboration* At the Paul Scherrer Institute we are developing a high precision instrument to measure the electric dipole moment (EDM) of the muon using the frozen-spin method to suppress the anomalous precession of the muon spin. With this technique, the expected statistical sensitivity for the EDM after one year of data taking is 6×10^{-23} e · cm. Reaching this goal necessitates a comprehensive analysis on effects that mimic the EDM signal. This work discusses a quantitative approach to study systematic effects when searching for the muon EDM. Equations for the motion of the muon spin in the electromagnetic fields of the experimental system are analytically derived and validated by simulation.
18:30		
19:00		***Postersession with Apéro***

Wednesday, 06.09.2023, Room 118

Time	ID	TASK III: Low Energy and Antimatter *Chair: Eberhard Widmann, Österreichische Akademie der Wissenschaften*
14:30	**321**	**The n2EDM experiment – A high-sensitivity search for physics beyond the Standard Model** *Victoria Kletzl, Paul Scherrer Institut, on behalf of the NEDM collaboration* The existence of a neutron electric dipole moment (nEDM) would simultaneously violate parity and time symmetries, representing an additional channel of charge-parity violation. Therefore, it is an excellent testing ground for physics beyond the Standard Model (BSM). The international nEDM collaboration is currently commissioning the n2EDM experiment at the ultra cold neutron (UCN) source at the Paul Scherrer Institute. It aims for a tenfold improvement in sensitivity relative to the current best upper limit of $1.8 \cdot 10^{-26}$ e·cm (90 % C.L.) measured by our collaboration with the predecessor apparatus. This talk will present an overview of the new experiment and commissioning measurements. This work is supported by SNF#188700.
14:45	**322**	**The ^{199}Hg co-magnetometer in the n2EDM experiment** *Wenting Chen, Paul Scherrer Institut, on behalf of the NEDM collaboration* The n2EDM experiment at the Paul Scherrer Institut searches for a permanent neutron electric dipole moment. For the purpose of correcting magnetic field fluctuations in its setup, a laser-based ^{199}Hg co-magnetometer has been developed. The optical pumping of the ^{199}Hg atoms (I=1/2) with a UV laser leads to the nuclear spin polarization. The laser is also used to extract the spin precession frequency of ^{199}Hg atoms cohabiting in the same volume as the neutrons.

<table>
<tr><td></td><td></td><td>This talk will present the principle of the ^{199}Hg co-magnetometer, improvements in laser stabilization, setting up the laser light transport over 20 meters, and a study of the ^{199}Hg-related systematic effects.
SNF#204118 supported</td></tr>
<tr><td>15:00</td><td>323</td><td>Commissioning of the ultracold neutron guide system for the n2EDM experiment at PSI

Cornelis Bernardus Doorenbos, Paul Scherrer Institut, on behalf of the nEDM collaboration

In the search for the neutron electric dipole moment, we are setting up the n2EDM experiment (Eur. Phys. J. C 81, 512 (2021)) at the ultracold neutron (UCN) source at PSI. We created a new, efficient UCN guide system to transport neutrons from the source to the experiment. The UCN guides are made of glass and highly polished aluminium, and are coated inside with a nickel-molybdenum alloy for high reflectivity. I will present the status of the commissioning of the guide system. This includes quality control, such as checking for magnetic impurities, UCN transmission measurements, and Monte Carlo UCN transport simulations to understand our measurements.
Supported by SNF Grant #188700</td></tr>
<tr><td>15:15</td><td>324</td><td>An active magnetic shield for the n2EDM experiment

Nathalie Ziehl, ETH Zürich

The search for the neutron electric dipole moment at PSI requires a stable, uniform magnetic field environment in the experimental chamber. To shield the n2EDM-experiment from slowly varying magnetic fields caused by neighbouring experiments we have constructed an intricate system of coils around the experiment, designed to compensate magnetic fields through an active feedback loop. The design for the active magnetic shield (AMS) was first presented in 2019. Now the AMS is fully constructed and able to compensate static and variable fields of up to 50 μT in the sub-Hertz frequency range. We will present the apparatus as built, performance measurements and strategies for further improvements of the system.</td></tr>
<tr><td>15:30</td><td>325</td><td>Measuring the free neutron lifetime with the τSPECT experiment at the Paul Scherrer Institute

Dieter Achim Ries, Paul Scherrer Institut

Ultracold Neutrons (UCN) provide a unique tool for fundamental low energy particle physics and in particular measurements with neutrons with long observation times. The τSPECT experiment, which has been developed and built at Johannes Gutenberg University Mainz, Germany, and is currently being set up at the UCN source at Paul Scherrer Institute, aims to utilize this fact in order to precisely measure the free neutron lifetime.
τSPECT is the first neutron lifetime experiment using 3-dimensional magnetic storage of spin polarized UCN and uses the spin-flip loading technique to transport UCN into the trap.
The τSPECT experiment and first results from commissioning with neutrons at PSI will be presented.</td></tr>
<tr><td>15:45</td><td>326</td><td>Status of GBAR: First results of Antihydrogen production

Philipp Peter Blumer, Paolo Crivelli, ETH Zürich

The GBAR collaboration at CERN aims to directly test the Weak Equivalence Principle with a free fall of ultracold antihydrogen H in Earth's gravitational field. The main principle is to first produce an antihydrogen ion H^+ and sympathetically cool it to μK temperature. The excess positron is then photodetached and the neutral anti-atom experiences a classical free fall. By measuring the time of flight and the annihilation position of the H we determine its acceleration with a precision of 1 % in a first phase. I will present first evidence of H production in 2022, a milestone for the experiment, as well as the status and future prospects of GBAR.</td></tr>
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16:00	**327**	**GRASIAN:** **Towards the first demonstration of gravitational quantum states of atoms** *Carina Killian [1], Philipp Peter Blumer [2], Paolo Crivelli [2], Otto Hanski [3], Valery Nesvizhevsky, Francois Nez [4], Katharina Schreiner, Sergey Vasiliev [3], Eberhard Widmann [1], Pauline Yzombard* *[1] Austrian Academy of Sciences, [2] ETH Zürich, [3] University of Turku, [4] Laboratoire Kastler Brossel* At very low energies, an atom above a horizontal surface can experience quantum reflection due to the attractive Casimir-Polder potential. The quantum reflection holds the atom against gravity and leads to quantum gravitational states (GQS), in analogy to what has been observed with ultracold neutrons. The GRASIAN-collaboration pursues the first measurement of GQS of atomic hydrogen. The use of hydrogen is not only motivated by the fact, that GQS have never been observed with atoms. The enhanced statistics available through the use of hydrogen atoms (versus ultracold neutrons) will increase the sensitivity to deviations from Newtonian Gravity.
16:15	**328**	**Validation of Monte Carlo Simulations for Antiproton-Nucleus Annihilation at Rest Using Thin Targets** *Angela Gligorova, Austrian Academy of Sciences* Several approaches have been proposed for modelling antiproton-nucleus annihilation at rest, but a complete description of the process is still lacking, as well as systematic data. This talk focuses on recent experimental results from annihilation measurements at the ASACUSA experiment, using slow extracted antiprotons and targets of 1-2 µm thickness. The prongs from individual annihilation events in carbon, molybdenum and gold were detected combining two detectors, resulting in their multiplicity and energy distributions, which are compared to current Monte Carlo simulations. The discrepancies will be discussed quantitatively and qualitatively. The A-dependence of the average multiplicities for heavy prongs, usually stopped in the target in previous experiments will be also shown.
16:30		***Coffee Break***
		TASK IV: DETECTOR / DAQ AND ALGORITHMS *Chair: Paolo Crivelli, ETH Zürich*
17:00	**331**	**The Hybrid seeding: flexibility begets flexibility** *Louis Henry, CERN* The Hybrid seeding is the standalone reconstruction algorithm of the forward tracker at LHCb, originally designed to run on CPUs at a 1MHz throughput. We will explore how, through reformulations and better memory handling, a version of this algorithm is now a core part of the 30 MHz LHCb GPU-based trigger. In this presentation, we will discuss the main takeaways of this challenging endeavour and the way dedicated GPU programming can unlock signatures that seemed impossible to reach when designing the detector.
17:15	**332**	**Machine Learning Techniques for Triggering Forward Electrons using the General Purpose Calorimetry Framework Lorenzetti Showers** *Meinrad Moritz Schefer, Universität Bern* Triggering forward electron and photon candidates in high-energy physics experiments is difficult where no tracking information is available and one has to rely only on calorimetric endcap detectors . It becomes even more challenging in extreme pile-up conditions as they will be faced by the experiments at CERN in Run 4 after the High Luminosity LHC upgrade. The all-purpose Geant4 based calorimeter framework Lorenzetti Showers is presented which provides an ideal tool to simulate and study these complex scenarios generically. Machine learning techniques are investigated using Lorenzetti Showers data to distinguish forward electrons from strongly interacting particle showers in high pile-up conditions.

17:30	**333**	**Monitoring of the radiation damage induced aging of the LHCb SciFi tracker SiPMs during the first year of Run 3.** *Federico Ronchetti, Guido Haefeli, Elisabeth Maria Niel, EPFL* We studied the radiation induced damage of the SiPM photo-detectors of the LHCb SciFi Tracker during the first year of Run 3. The bias current monitoring allows to evaluate the Dark Count Rate (DCR) and leads to an estimation of the detector aging as a function of the integrated luminosity. During the YETS the detector was monitored at room temperature and the effect of annealing (reduction of DCR in absence of the beam) was observed. In early 2023 a dedicated cooling temperature scan was performed and the DCR as a function of temperature in the [-50, 20]°C range was recorded and compared to expected values from R&D.
17:45	**334**	**New Hardware for Next-Generation Detectors:** **Studying the Performance of R12699-406-M4 PMTs in Cryogenic Xenon** *Maximinio Adrover, Alexander Bismark, University of Zürich* The proposed next-generation dark matter experiment DARWIN, an underground multi-tonne scale detector with a time projection chamber at its core, aims to reach unprecedented sensitivities in probing further into the WIMP parameter space and other new physics interactions, such as neutrinoless double beta decay. To achieve these ambitious goals, extensive R&D campaigns are currently in progress, one of which consists of characterizing promising novel photosensors. We will present performance studies of Hamamatsu R12699-406-M4 flat panel photomultiplier tubes in xenon, conducted at our test facility MarmotX at the University of Zürich. Furthermore, a kg-scale TPC design to study the PMT performance in realistic experimental conditions is presented.
	~~335~~	*cancelled*
18:00	**336**	**The DAQ system of the Mu3e SciFi detector** *Yifeng Wang, ETH Zürich* Looking for beyond Standard Model phenomena, Mu3e is an experiment under construction at PSI dedicated to the search of the charged lepton flavor violating $\mu \rightarrow eee$ decay at branching fractions above 10^{-16}. Achieving such sensitivity requires a high rate of muons and excellent time resolution to suppress the accidental background. To this end, the scintillating fiber (SciFi) sub-detector system is designed to achieve a very precise time measurement (~250 ps). Consequently, its associated DAQ sub-system is aimed to readout the detector with up to 1MHz event rate per channel. In this talk, the DAQ system of SciFi detector is presented.
18:15	**337**	**The monolithic ASIC for the high precision preshower detector** **of the FASER experiment at the LHC** *Chiara Magliocca [1], Giuseppe Iacobucci [1], Lorenzo Paolozzi [2], Stefano Zambito [1],* *Thanushan Kugathasan [2], Roberto Cardella [1], Jorge Andres Sabater Iglesias [1],* *Carlo Alberto Fenoglio [2], Théo Moretti [1], Rafaella Eleni Kotitsa [1], Andrea Pizarro Medina [2]* *[1] Université de Genève, [2] CERN* The FASER experiment at the LHC will be instrumented with a high precision W-Si preshower to identify and reconstruct electromagnetic showers produced by two O(TeV) photons at distances down to 200 μm. The new detector features a monolithic silicon ASIC with hexagonal pixels of 100 μm pitch, extended dynamic range for the charge measurement, and capability to store charge information for thousands of pixels per event. Analog memories inside the pixel area allow for a frame-based event readout with minimum dead area. A description of the pre-shower and its expected performance will be presented, together with the design rationale of the monolithic ASIC and the results of the pre-production ASIC characterisation.

18:30	**338**	**The ATLAS ITk Pixel Optosystem** *Daniele dal Santo, Universität Bern* After Run III the ATLAS detector will be upgraded to cope with the harsher radiation environment and increased number of proton interactions in the high luminosity LHC. One of the key projects in this suite of upgrades is the ATLAS Inner Tracker (ITk). The Pixel Detector of the ITk must be read out accurately and at an extremely high rate and for this it relies on the Optosystem, which performs optical-to-electrical conversion of signals from the pixel modules. Recent Optosystem results on the test of the performance of the data transmission chain pivoted on the Optoboards and on the design, testing and production of the Optopanels will be presented.
18:45	**339**	**The SST-1M: A new stereoscopic Imaging Atmospheric Cherenkov Telescope system** *Matthieu Heller, Université de Genève* The SST-1Ms are two single-mirror small-sized telescope prototypes developed by a team of Swiss, Polish and Czech institutes. The telescopes adopt a Davies-Cotton optical design, with a dish of 4 m diameter and a focal of 5.6 m. With a wide field of view of 9 degrees, SST-1M is designed to detect gamma rays in the energy range between 500 GeV and 100 TeV. SST-1M is equipped with the DigiCam camera composed of 1296 pixels, which incorporates a fully digital readout and trigger system running at 250 MHz. Each pixel consists of a hexagonal hollow light guide coupled to silicon photomultipliers (SiPM). Currently, two SST-1M telescopes are undergoing commissioning at the Ondrejov Observatory in the Czech Republic. A fully automatic and remote operation of the two telescopes has allowed for numerous hours of observations of the Crab Nebula and the nearest and brightest blazars Mark 421 and 501. Recently, the acquisition of stereoscopic data has been enabled improving significantly the sensitivity of the system. This contribution will provide an overview of the telescope and camera design, including the performance evaluation of the SST-1M telescopes. Additionally, preliminary results obtained from the commissioning data collected at the observatory will be presented.
19:00	**340**	**MONOLITH - picosecond time stamping capabilities in fully-monolithic highly-granular silicon pixel detectors** *Matteo Milanesio [1], Roberto Cardella [1], Giuseppe Iacobucci [1], Thanushan Kugathasan [2], Théo Moretti [1], Lorenzo Paolozzi [2], Antonio Picardi [1], Stefano Zambito [1]* *[1] Université de Genève, [2] CERN* The MONOLITH ERC Advanced project aims at producing a monolithic silicon pixel ASIC with 50μm pixel pitch and picosecond-level time stamping. The two main ingredients of the project are fast and low-noise SiGe BiCMOS electronics and a novel sensor concept, the Picosecond Avalanche Detector (PicoAD). Testbeam measurements of the proof-of-concept PicoAD prototype show full efficiency and time resolutions of 13 ps at the center of the pixel and 25 ps at the pixel edge, for an average of 17ps over the pixel surface. A second monolithic prototype with improved electronics, produced on a 350 Ωcm substrate without an internal gain layer, provides 20 ps time resolution.
19:15		

Thursday, 07.09.2023, Room 118

Time	ID	TASK V: Collider Dark Sector and Neutrinos *Chair: Vitalii Lisovskyi, EPFL*
17:00	**341**	**Search for Dark Sector particles at LHCb** *Pasquale Andreola, University of Zurich* The Dark Sector is a collection of hypothetical particles that would interact very weakly with Standard Model particles. Thanks to its forward instrumentation and its excellent vertex resolution, the LHCb experiment plays a unique role in the search for Dark Sector particles at LHC. Some results from searches for hidden-sector particles (e.g. dark photons, heavy neutral leptons and dark matter candidates produced from heavy-flavour decays) will be presented. An outlook on future measurements in some of these channels, such as axion-like particles decaying into hadrons, will be discussed.
17:15	**342**	**Latest results of NA64 searching for Dark Sectors at the CERN SPS** *Benjamin Banto Oberhauser, Martina Mongillo, Paolo Crivelli, ETH Zürich* NA64 is a fixed-target frontier experiment running at the CERN SPS. NA64 searches for possible candidates of mediators between the dark sector and the standard model by looking for missing energy events in an active beam dump. After resuming data taking in 2021, NA64 has tripled its statistics, allowing us to set leading constraints to dark sector mediators in the light dark matter parameter space. This talk will focus on the latest results from the analysis of the 2021-2022 data as well as the current status of the experiment.
17:30	**343**	**Semi-visible dark photons at the NA64 experiment** *Martina Mongillo, Benjamin Banto Oberhauser, Paolo Crivelli, ETH Zürich* Beyond the minimal kinetically-mixed dark photon scenarios predicting fully visible and fully invisible mediator decays, next-to-minimal theories have been considered as compelling frameworks for thermal dark matter and some low-energy anomalies, as the muon g-2. This talk will showcase the potential of the NA64 experiment in the exploration of rich dark sectors in which the dark photon is semi-visible. The NA64 invisible results have been re-interpreted in the context of two inelastic dark matter models to account for the different signal signature, entailing both missing energy and visible final states.
17:45	**344**	**Measurement of the X17 anomaly with the MEG II detector** *Giovanni Dal Maso, Paul Scherrer Institut, for the MEG II Collaboration* In 2016 the ATOMKI collaboration measured an anomaly in the angular distribution of the pair produced by the M1 transition of the isoscalar 1+ state on ^{8}Be, which might be explained by creation and decay of a boson, the X17, with mass 17.0 MeV/c^2. The result was later confirmed in the 0-/0+ transition in Helium. The apparatus of the MEG II experiment has been employed at the beginning of 2023 to measure such anomaly with a LiPON target and a different detection technique based on the COBRA spectrometer and the Cylindrical Drift Chamber. We present the details of the set-up and the current status of the analysis.
18:00	**345**	**The SND@LHC detector** *Anni Kauniskangas, EPFL* SND@LHC is a compact stand-alone experiment designed to study neutrinos produced at the LHC. The detector consists of a hybrid target made of emulsion cloud chamber walls interleaved with scintillating fibre planes, followed by a hadronic calorimeter and muon system based on scintillating bars. The active detectors are read out with silicon photomultipliers and custom electronics that allow for amplitude measurement and precise timing. The data acquisition operates trigger-lessly, with online event building and noise suppression being performed on a central server. This talk will focus on describing the SND@LHC detector system, its commissioning, and the first years of data taking.

18:15	**346**	**Observation of collider neutrinos with SND@LHC** *Martina Ferrillo, University of Zürich* The SND@LHC is a recently approved and running experiment at the Large Hadron Collider (LHC) performing neutrino physics and searches for feebly interacting particles. It collects human-made neutrinos in the uncharted TeV energy scale from pp collision at the ATLAS interaction point. This talk will focus on the first physics result of the experiment, namely the observation of collider neutrinos at the LHC.
18:30	**347**	**Status of FASERnu and development of neutrino energy reconstruction algorithms** *Jeremy Atkinson, Universität Bern* FASERnu, in the LHC-FASER experiment at CERN, studies collider neutrinos. It consists of 730 alternating emulsion films and tungsten plates, resulting in a target mass of 1.1 tonnes. Data-taking began in 2022, and will continue until the end of 2025. In 2022, due to the track occupancy in emulsion, three data-taking periods were successfully carried out, each requiring darkroom assembly and development campaigns. To measure neutrino interaction cross-sections, the energy of incident neutrinos must first be reconstructed. This is investigated using both model-independent variables and Neural Network techniques. In this talk, I will report on the status of FASERnu and discuss the development of energy reconstruction algorithms.
18:45	**348**	**The LEGEND experiment in a search for neutrinoless double beta decay** *Marta Babicz, University of Zürich* The LEGEND experiment is designed to detect lepton-number violation and shed light on neutrino masses by hunting for neutrinoless double beta decay. The experiment employs high-purity, enriched in ^{76}Ge germanium detectors and an active liquid-argon shield to minimize background events. In the first phase, the experiment will use 200 kg of Ge crystals to reach a half-life discovery sensitivity of 10^{27} years. In the second phase, 1000 kg of detectors will be deployed to boost the discovery sensitivity beyond 10^{28} years. Thanks to its exquisite energy resolution and ultra-low background levels, LEGEND will perform a quasi-background-free search for an unambiguous signature at the Q-value of the decay of 2039 keV.
19:00	**349**	**Deep learning methods for neutrino event reconstruction** *Saul Alonso Monsalve, ETH Zürich* Deep learning methods are becoming key in the data analysis of particle physics experiments. One clear example is the improvement of neutrino detection using neural networks. Current neutrino experiments are leveraging these techniques, which, in combination, have exhibited to outperform standard tools in several domains, such as identifying neutrino interactions or reconstructing the kinematics of single particles. In this talk, I will show various deep-learning algorithms used in the context of voxelised neutrino detectors. I will present how to design and use advanced deep-learning techniques for tasks such as fitting particle trajectories and understanding the particles involved in the vertex activity. All these methods report promising results and are crucial for improving the reconstruction of the interacting particle kinematics and enhancing the sensitivity to future physics measurements.
19:15		***Transfer to Dinner***
19:30		***Conference Dinner***

Friday, 08.09.2023, Room 118

Time	ID	TASK VI: DARK MATTER AND NEUTRINOS *Chair: Ben Kilminster, Universität Zürich*
12:00	351	**Overview of Neutrino Physics in Switzerland** *Richard Diurba, Universität Bern* Neutrino physics is a field of high energy physics measuring neutrino properties, such as cross sections, masses, and oscillation parameters. Currently, the field lies at a crossroads. A new generation of neutrino experiments, such as DUNE and Hyper-K, are planned in the following decades, requiring significant resources in detector design and construction efforts. Additionally, physicists have been measuring cross sections and creating tools for future experiments while simultaneously continuing to make fundamental measurements. Switzerland reflects this trend and has scientists on past, current, and future experiments across neutrino energy ranges. The talk represents a survey of the experiments and projects with Swiss participation and an outlook on the upcoming plans of the field. The talk will highlight how and why current analyses impact the next-generation neutrino experiments.
	~~352~~	*moved to talk 349*
12:30	353	**Recent results from XENONnT** *Christian Wittweg, Physik-Institut, University of Zürich, on behalf of the XENON collaboration* XENONnT is a direct dark matter search experiment located at Laboratori Nazionali del Gran Sasso in Italy. Due to its unprecedentedly low background and the large target mass of 5.9 tonnes of liquid xenon in a dual-phase time projection chamber, it is sensitive to a wide range of signals within and beyond the Standard Model. These include weakly interacting massive particles, solar axions, bosonic dark matter, solar neutrinos and rare nuclear decays. In this contribution, I will present the XENONnT experiment and show results from its first science run.
12:45	354	**DARWIN: a next-generation observatory for dark matter and neutrino physics** *Mariana Rajado Silva, Uni Zürich* The long-awaited detection of dark matter is dependent upon the design of sufficiently large, radio- pure and sensitive detectors. DARWIN is a next-generation dark matter observatory which will probe the accessible parameter space for WIMPs. It will comprise a dual-phase time projection chamber containing 40 t of liquid xenon. Ultra-low background levels are ensured by the selected low-emanation materials. Its low-energy threshold and high energy resolution will also allow for the exploration of other science channels, such as solar axions or neutrinoless double beta decay of ^{136}Xe. This talk will focus on the status of DARWIN, its broad science reach, and the main R&D topics being developed within the project.
13:00	355	**Xenoscope - a full scale vertical demonstrator for the DARWIN observatory** *Paloma Cimental Chavez [1], Marta Babicz [1], Laura Baudis [1], Alexander Bismark [1],* *Jose Javier Cuenca Garcia [2], Michelle Galloway [1], Frédéric Girard [1], Ricardo Peres [1],* *Mariana Rajado Silva [1], Diego Ramírez García [3], Christian Wittweg [1]* *[1] Physik-Institut, University of Zürich, [2] Karlsruhe Institute of Technology (KIT),* *[3] Universität Freiburg im Br.* The DARWIN observatory is a proposed next-generation experiment for dark matter detection and neutrino physics. Darwin will feature a 50-ton liquid xenon target enclosed in a dual-phase time projection chamber. The realization of this multi-ton scale detector requires addressing a series of technological challenges; to this end, a full-scale vertical demonstrator, Xenoscope, was built at UZH. The Xenoscope facility will be used to demonstrate the drift of electrons in LXe over a 2.6 m distance, as well as to perform electron cloud diffusion studies and measurements of the LXe optical properties. We present an overview of the Xenoscope facility, its current status, and future measurement campaigns.

13:15	356	**Density-functional theory description of xenon for light dark matter direct detection** *Luca Marin [1], Marek Matas [1], Nicola Spaldin [1], Einar Urdshals [2], Riccardo Catena [2]* *[1] ETH Zürich, [2] Chalmers University of Technology* We present a detailed density functional theory (DFT) study of the electronic structure of atomic and liquid xenon, as a first step in quantifying the event rates in operating xenon-based detectors based on dark matter (DM) - electron scattering. Our main goal is to determine whether explicit modelling of the inter-atomic interactions in the liquid state changes the predicted event rates compared with current state-of-the-art models based on isolated Xe atoms.
13.30	357	**COSINUS: Investigating the Dark Matter Origin of DAMA/LIBRA Results Using NaI as a Cryogenic Calorimeter** *Rituparna Maji, HEPHY and TU Wien* The DAMA/LIBRA experiment has been reported to observe an annually modulating signal compatible with the expected dark matter (DM) event rate for more than two decades. However, these results have not been confirmed by any other direct DM searches, emphasizing the need for a model-independent validation using the same detector material: sodium iodide (NaI) crystals. Cryogenic Observatory for SIgnals seen in Next-generation Underground Searches (COSINUS) will provide a reliable comparison with DAMA/LIBRA by operating NaI as cryogenic calorimeters. COSINUS is expected to begin taking data at the beginning of 2024. In this presentation, we will present its key features and challenges including its current status, and future goals.
13:45	358	**The NUSES space mission** *Caterina Trimarelli, Université de Genève* The NUSES space mission is a novel project based on a satellite developed by TAS-I housing two payloads known as TERZINA and ZIRÈ. ZIRÈ is designed to explore low-energy cosmic rays and gamma rays for instance from gamma-ray bursts. ZIRÈ will conduct measurements of electrons, protons, and light nuclei ranging from a few to hundreds of MeV and new tools for detecting cosmic MeV photons and monitoring magnetosphere-ionosphere-lithosphere coupling (MILC) signals. TERZINA, the detector on which the presentation focuses, is a pathfinder for Cherenkov detection from space emitted by atmospheric showers created by ultra-high-energy cosmic rays (UHECRs) in the limb of the Earth's atmosphere. TERZINA is a pathfinder also towards the detection of high-energy astrophysical neutrinos skimming the Earth's surface. Additionally, NUSES aims to pave the way for technology in space for future missions by testing silicon photomultipliers and innovative low-power-consuming electronics. TERZINA will provide valuable insights for potential future physics missions, such as POEMMA, which is focused on UHECR detection and UHE neutrino astronomy. This presentation will discuss the current status of the NUSES project design, as well as the scientific and technological objectives of the mission.
14:00		***END***

ID	TASK Poster
361	**Prospects to the PIONEER Experiment** *Stefan Hochrein, ETH Zürich* Towards a next-generation rare pion decay experiment located at PSI.

362 Measurement of the Isotopic Composition of Light Nuclei in Cosmic Rays with AMS

Manbing Li, Universite de Genève

The Alpha Magnetic Spectrometer operating on the International Space Station is a cutting-edge detector that is measuring spectra of cosmic ray particles and nuclei, including the isotopic composition of light nuclei, which is essential to understand cosmic ray propagation and origin. The $^{10}Be/^{9}Be$ ratio measures the cosmic ray propagation volume in the Galaxy, and the $^{6}Li/^{7}Li$ ratio tests the existence of primordial lithium. Current measurements are limited to energies below 2 GeV/n and are affected by large uncertainties. AMS is able to extend the measurement of the isotopic compositions up to 11 GeV/n. In this contribution, measurements of Lithium, Beryllium and Boron isotopic fluxes with AMS data will be presented.

363 Study of Low Energy Antiproton Annihilations on Nuclei

Viktoria Kraxberger, Angela Gligorova, Austrian Academy of Sciences

The experiments at CERN's Antiproton Decelerator detect antimatter through its annihilation, making the antiproton-nucleus ($\bar{p}A$) interaction one of the main processes of interest. As the annihilation mechanism itself is not well understood, a beamline for sub-keV antiprotons is built at the ASACUSA facility to measure the $\bar{p}A$ annihilation at rest for a variety of nuclei. Surrounding a thin target foil a detection system using Timepix4 detectors measures the total multiplicities of prongs and their kinetic energies. Minimum and heavily ionising particles will be identified and individual annihilation events reconstructed. This experiment will allow a precise study of possible final state interactions and its results will be implemented into simulation models.

364 Calibration of Xenoscope, the full-scale vertical DARWIN Demonstrator

Andrej Maraffio, Uni Zürich

DARWIN is a proposed next-generation dark matter observatory that aims to detect Weakly Interacting Massive Particles (WIMPs) using 40 t of instrumented liquid xenon. Due to its large dimensions together with the technical and scientific challenges involved, Xenoscope, a full-scale vertical demonstrator, was built to test and refine the necessary technologies. This prototype was constructed to demonstrate electron drift in liquid xenon over a 2.6-m distance, thus serving as a key R&D component for the DARWIN. Calibrations are needed to estimate the electron lifetime in liquid xenon. In this contribution, I will present an overview of how radioactive sources are used in the calibration phase of Xenoscope.

365 A positron trap for observing molecules containing positronium

Alina Weiser, Austrian Academy of Sciences

A positron trap is a powerful tool for performing experiments with positrons and positronium. This type of device can typically produce ~105 e^+/s in bunches with a diameter of 1 - 2 mm and an energy spread of approximately 50 meV.
We aim to use these positron pulses to observe molecules containing positronium, such as PsH and PsO via collisions in gases such as methane and carbon dioxide. By using a high-mass resolution ion spectrometer to detect fragments from dissociation, precise measurement of their binding energy will be performed.
This poster will describe the positron beam, trap, and ion spectrometer and show first trapping results from the newly constructed positron beamline.

366 Measurement of the Branching Fraction $\mathcal{B}(B^+ \to \overline{D}^0 K^+)$ using 186.75 fb^{-1} of Υ(4S) data from Belle II

Nikolaus Schneider, Cristhian Xavier Brito Ricaurte, Christoph Schwanda, Austrian Academy of Sciences

We present a measurement of the Branching Fraction $\mathcal{B}(B^+ \to \overline{D}^0 K^+)$ using 186.75 fb^{-1} of Υ(4S) Belle II data gathered from 2019 to 2021. To extract the signal yield, we fit over reconstructed events corresponding to $B^+ \to \overline{D}^0 K^+$ with $\overline{D}^0 \to K^+ \pi^-$ which are distributed over the beam to B energy deviations at center-of-mass, ΔE. The beam energy furthermore constrains the invariant mass of the B products.
Our focus lies on the appropriate fitting analysis methods used on a Monte Carlo simulated event dataset and how its analysis can serve to obtain a reliably unbiased measurement of a branching fraction from a real dataset.

Accelerator Science and Technology

Thursday, 07.09.2023, Room 118

Time	ID	Accelerator Science and Technology *Chair: Mike Seidel, PSI Villigen*
14:00	381	**The P^3 Experiment: A Positron Source Demonstrator at PSI in 2025** *Nicolas Vallis [1,2], Paolo Craievich [1], Mattia Schaer [1], Riccardo Zennaro [1]* *[1] PSI Villigen, [2] EPFL* The long-standing difficulty to handle the extreme e^+ emittance and energy spread generated at converter targets has been a major limiting factor for future large e^+ machine designs such as high- luminosity lepton colliders. The PSI Positron Production (P-cubed or P^3) experiment, framed in the FCC-ee study, is a demonstrator for a e^+ capture system with potential to improve the state-of-the-art e^+ yield by an order of magnitude. The experiment will be hosted at the SwissFEL facility at PSI as of 2025, where installation works are ongoing. This presentation is an overview of P^3, with a particular focus on the novel capture system, e^+ beam dynamics and experiment diagnostics.
14:15	382	**PSI CHART Superconducting Magnets Roadmap: from Powered Samples to Hybrid Magnets** *Douglas Martins Araujo [1], Bernhard Auchmann [1,2], André Brem [1], Michael Daly [1], Thomas Michlmayr [1], Dmitry Sotnikov [1], Attilio Milanese [2]* *[1] PSI Villigen, [2] CERN* In the context of accelerator-magnet technology to enable a next generation of HEP colliders, many superconducting magnet solutions are being considered. These solutions include Low-temperature, High-temperature and hybrid magnets. At the Paul Scherrer Institute (PSI), we have been working on the design of stress-managed magnets, for example the successfully tested CCT magnet CD1, as a means to decrease Nb_3Sn coil stress and prevent its degradation. In order to bring meaningful innovation to our developments, the High-Field-Magnet Roadmap aims to allow a fast-turnaround and consistent development of LTS, HTS and Hybrid magnets. All elements composing this roadmap will be presented and in particular the status of each of its programs.
14:30	383	**ReBCO High-Temperature Superconductors for Application in High Field Accelerator Magnets.** *Bernhard Auchmann [1,2], Michal Duda [1], Henrique Garcia Rodrigues [1], Jaap Kosse [1], Douglas Martins Araujo [1], Attilio Milanese [2], Stephane Sanfilippo [1], Dmitry Sotnikov [1]* *[1] PSI Villigen, [2] CERN* High-temperature superconductors (HTS) promise a significant increase in performance of accelerator magnets. This presentation examines challenges related to today's ReBCO tape conductor and lays out an R&D roadmap towards a consistent magnet technology for the FCC-hh's main dipole system in terms of cable- and coil configurations, cryogenic, mechanical, and protection concepts. Numerical modeling is accompanied by sample testing and the construction of sub-scale demonstrator coils and magnets. A first program goal is the identification of ramp-losses and adequate cooling concepts for a magnet based on optimized ReBCO-based cable.

14:45	**384**	**High temperature superconducting magnets for FCC-ee** *Henrique Garcia Rodrigues [1], Jaap Kosse [1], Bernhard Auchmann [1,2], M. Koratzinos [1], Michal Duda [1]* *[1] Paul Scherrer Institut, [2] CERN* High temperature superconductor (HTS) technology has attractive features for use in accelerator magnets. Two distinct benefits compared to low-temperature superconductors are the ability to operate at higher magnetic fields and/or at higher temperatures. We illustrate the advantages of HTS magnets by means of two potential use-cases for FCC-ee. The first concerns a compact defect-tolerant 15 T capture solenoid for FCC-ee's positron source. The second use-case investigates the possibility of replacing the normal conducting magnets in FCC-ee's short straight sections by HTS variants, allowing a reduction in energy consumption from ~ 50 MW to below 10 MW. Additional benefits are an increase in dipole filling-factor, and flexibility in the optics.
15:00	**385**	**HTS FCC-ee energy efficient beam optics** *Cristobal Garcia, EPFL* The FCC-ee project takes a step forward towards the discovery of new physical phenomena beyond the frontier of the standard model, by aiming at unprecedented center of mass energies and luminosities in a double-ring lepton collider. In order to explore potential improvements to the current beam optics design,this work looks at the use of combined function magnets for the main dipoles and quadrupoles within the short straight sections of the arc cells to increase the bending radius, decreasing the synchrotron radiation(SR).The use of High Temperature Superconductors(HTS) and normal conducting technology for the combined function magnets is explored with comparisons to the current baseline aiming for potential savings above 10 % of the SRpower.
15:15	**386**	**Simulation Tools for Future Colliders** *Leon van Riesen-Haupt [1], Tatiana Pieloni [1], Xavier Buffat [2], Riccardo De Maria [2], Giovanni Iadarola [2], Peter Kicsiny [1]* *[1] EPF Lausanne, [2] CERN* As colliders become more complex, it is crucial to consider physical phenomena in simulations including complex effects such as radiation, beam-beam, and impedance. However, existing simulation tools are often outdated or focus on single aspects. To address this, the CHART collaboration is developing a software framework integrating existing tools and actively contributing to new simulation tools in collaboration with external colleagues. The project's main focus is the Future Circular Collider, for which the tools enable studies of beam stability, luminosity, and lifetime, incorporating multiple effects simultaneously. We will provide an overview of the collaboration's work on simulation tools and present beam dynamics studies for the FCC obtained using these tools.
15:30	**387**	**Investigating LHC Electron Cloud Instabilities through Linearized Vlasov Method** *Sofia Carolina Johannesson [1], Giovanni Iadarola [2], Mike Seidel [3], Tatiana Pieloni [1]* *[1] EPFL, [2] CERN, [3] PSI Villigen* The Vlasov approach models e-cloud driven instabilities on time scales beyond conventional Particle-In-Cell simulations. It uses a linear description of electron cloud forces that accounts for both the betatron tune modulation along the bunch and the dipolar kicks. Chromaticity effects can also be included. Benchmarked against macroparticle simulations using the same e-cloud force formalism, both methods agreed for strong electron clouds and experience a stabilizing effect from positive chromaticity. This stabilizing effect is consistent with observations from the LHC. For positive chromaticity the Vlasov approach predicts weak instabilities not observed in the macroparticle simulations, suggesting the existence of damping mechanisms not captured by the Vlasov approach.

15:45	**388**	**LHC Schottky Spectrum from Macro-particle Simulations** *Christophe Lannoy [1,2], Kacper Lasocha [2], Diogo Miguel Louro Alves [2], Nicolas Mounet [2], Tatiana Pieloni [1]* *[1] EPFL, [2] CERN* We introduce a method for computing Schottky spectra, which can be used for non-invasive beam diagnostics, from time-domain, macro-particle simulations. For LHC beam conditions the use of a standard Fast Fourier Transform (FFT) algorithm is computationally intractable memory-wise, hence a semi-analytical method was developed to efficiently handle the Fourier transform. Since Schottky spectra can be strongly affected by collective effects, thereby preventing the extraction of machine and beam parameters from the spectra, the use of macro-particle simulations where such effects can be included is well suited to study their impacts on the spectrum. Using this approach first results on the effect of a broad-band resonator as longitudinal impedance are obtained.
16:00	**389**	**A muon beam of small phase space** *Giuseppe Lospalluto [1], Aldo Antognini [2], Malte Hildebrandt [2], Ryoto Iwai [1], Klaus Kirch [1,2], Andreas Knecht [2], Patrick Mullan [1], Jonas Nuber [1], Angela Papa [2], Joanna Peszka [1], Claude Petitjean [2], Mikio Sakurai [1], David Taqqu, Bastiano Vitali, Taylor Yan [1]* *[1] ETH Zürich, [2] Paul Scherrer Institut* High precision experiments including the measurement of the muon g–2, muonium spectroscopy and muonium gravity would benefit from intense high-quality and low-energy muon beams. At the Paul Scherrer Institute, the muCool device is being developed to compress the phase space of a standard μ^+ beam by a factor of 10^9 with 10^{-4} efficiency. This is achieved with a cryogenic helium gas cell and complex E and B-fields. Once compressed, the beam is extracted from a small orifice into a vacuum and into a magnetic field free region. This talk will outline the present status and future prospects of the experiment with a special focus on the extraction stage.
16:15	**390**	**Compact Synchrotrons for Hadron Therapy:** **Development and Synergies with HEP Projects.** *Elena Benedetto, SEEIIST Association (CH)* Carbon-ion therapy has advantages over X-rays, because of the Bragg peak, and proton therapy, because of radio-biology properties that allow treating radio-resistant tumours. Accelerator development aims at size reduction: within EU-funded projects and CERN, we study a super-conducting synchrotron and a gantry, based on a concept of TERA Foundation. The super-conducting magnets, of CCT type, are strongly curved and require extensive R&D and new tools for beam-optics. Another development, with several beam-dynamics challenges, is accumulating 20-times larger intensity for FLASH irradiation, i.e. delivering high dose rates to spare healthy tissues. SEEIIST, federating SE-European countries, will implement these developments and build a medical facility, to foster collaboration and scientific excellence.
16:30		***END; Coffee Break***
19:30		***Conference Dinner***

Atomic Physics and Quantum Optics

Tuesday, 05.09.2023, Room 116

Time	ID	ATOMIC PHYSICS AND QUANTUM OPTICS I *Chair: Jean-Philippe Brantut, EPFL*
14:00	401	**Ultra-low quantum decoherence nano-optomechanical systems** *Mohammad Bereyhi, EPFL* Thermal motion of a room-temperature mechanical resonator typically dominates the quantum backaction of its position measurement. Optomechanics provides a path towards quantum control of the mechanical motion by dominating the thermal effects with optical backaction. In this work we design, fabricate, and characterize three different classes of nanomechanical resonators with Q factors exceeding 3 billion at room temperature and demonstrate their optical readout using an integrated nearfield nano-optomechanical transducer using high stress silicon nitride. Our approach allows individual optimization of optical and mechanical resonators, while maintaining a high optomechanical coupling rate.
14:30	402	**Optical coherent feedback control of a mechanical oscillator** *Maryse Ernzer, Manel Bosch Aguilera, Matteo Brunelli, Gian-Luca Schmid, Thomas Karg, Christoph Bruder, Patrick P. Potts, Philipp Treutlein* *Department of Physics and Swiss Nanoscience Institute, University of Basel, Klingelbergstr. 82, 4056 Basel* We employ coherent feedback as strategy to improve quantum control of an optomechanical system, by implementing a feedback platform that avoids measurements and their associated decoherence. This is implemented via an optical light beam that sequentially interacts twice with a nanomechanical membrane placed inside an optical cavity. Theoretically this scheme allows for ground-state cooling even in the unresolved cavity sideband regime. Experimentally, tuning the optical phase and delay of the feedback improves our motional state control and allows to cool the membrane to a state with $n_m = 4.89 \pm 0.14$ phonons which lies below the theoretical limit of cavity dynamical backaction cooling in the unresolved sideband regime.
14:45	403	**Photophysics of single NV centers in diamond and its application to electric field detection at cryogenic temperatures** *Jodok Happacher, Juanita Bocquel, Patrick Maletinsky, University of Basel* We present the strain and magnetic field dependent photophysics of individual Nitrogen-Vacancy (NV) color centers in diamond from cryogenic to ambient conditions. Our experimental results and matching model predictions offer new insights into the structure of the NVs' excited states and its significant effect on the optical spin contrast, which directly relates to the performance of NV centers as quantum sensors. Based on the high sensitivity of the NV's orbital excited states to electric fields, we present a study of charge dynamics in the diamond host as well as a low-temperature, all optical electromagnetic field sensing scheme.

15:00	**404**	**Integrated polariton condensate in silicon-on-insulator high contrast grating microcavities** *Pietro Tassan [1], Darius Urbonas [1], Bartos Chmielak [2], Thorsten Wahlbrink [2], Ullrich Scherf [3], Rainer Mahrt [1], Thilo Stöferle [1]* *[1] IBM Research Europe, [2] AMO GmbH, [3] Bergische Universität Wuppertal* Integrated all-optical logic could define a new paradigm for computing architectures. Strong light-matter coupling based all-optical transistors exhibiting ultra-fast switching and room-temperature operation have recently been demonstrated using free-space optical setups. Here, we leverage silicon-on-insulator (SOI) technology to realize high-index contrast grating (HCG) as mirrors to form microcavities filled with an organic polymer (MeLPPP) as photoactive material to demonstrate room temperature strong light-matter interaction and polariton condensation on chip. This opens the door to integrated all-optical transistors with the scalability to enable more complex optical logic circuits to operate at room temperature with sub-picosecond switching times.
15:15	**405**	**Chiral sensing with void modes** *Diana Shakirova, Adrià Canós Valero, Thomas Weiss, University of Graz* Chirality is a property of living organisms molecules, chemicals and drugs, which makes their detection and analysis an extremely important task in biology, chemistry, and pharmacology. One of the most well known methods for detecting chiral matter handedness is the measurement of circular dichroism (CD) that can be defined as the difference in the transmission of right- and left-handed circularly polarized light. In this work we present a system supporting bound state in the continuum and radiative void modes for CD enhancement. Different types of modes interaction, including weak coupling, strong coupling and exceptional point regimes are demonstrated, and the efficiency of each for chiral sensing is analyzed.
15:30	**406**	**Polarimetric measurements of the bright triplet emission of single cesium lead halide perovskite quantum dots at cryogenic temperature** *Virginia Oddi [1], Michael Becker [1], Dmitry Dirin [2,3], Maksym Kovalenko [2,3], Rainer Mahrt [1], Gabriele Rainò [2,3], Yesim Sahin [2,3], Thilo Stöferle [1], Chenglian Zhu [2,3]* *[1] IBM Research Europe – Zurich, Säumerstrasse 4, CH-8803 Rüschlikon* *[2] Department of Chemistry and Applied Biosciences, ETH Zürich – Vladimir Prelog Weg 1, CH-8093 Zürich* *[3] Laboratory for Thin Films and Photovoltaics, Empa, CH-8600 Dübendorf* Cesium lead halide perovskite quantum dots (QDs) have recently emerged as promising platform for quantum light sources. They exhibit exceptional photoluminescence properties due to the emission from a bright triplet exciton state with dominantly but not fully linear emission polarization. Here, we are investigating the polarization properties of individual cesium lead halide perovskite QDs by advanced polarimetric techniques that allow to measure the complete Stokes polarization vector at cryogenic temperature for each fine structure line. The presentation will discuss the characteristics of the small fraction of circularly polarized emission and its potential origin.
15:45	**407**	**A Keldysh Path Integral Approach to Input-Output Theory** *Aaron Daniel, Matteo Brunelli, Patrick Potts, Universität Basel* Input–output theory is a well–known tool in cavity electrodynamics and ubiquitous in the description of quantum systems interacting with the environment. We present a new approach to input–output theory using the Keldysh path integral formalism. This approach allows us to get perturbative results for non–linear systems. We apply this novel approach to a single mode in a cavity solvable through standard input–output theory and then treat a Kerr oscillator to showcase the specific strength of our approach to yield perturbative results.

16:00	**408**	**Exploring molecular properties using far-field matter-wave diffraction** *Ksenija Simonović [1], Markus Arndt [1], Christian Brand [2], Alfredo Di Silvestro [3], Richard Ferstl [1], Klaus Hornberger [4], Lukas Martinetz [4], Marcel Mayor [3], Armin Shayeghi [5], Benjamin Stickler [4]* *[1] University of Vienna, Faculty of Physics, [2] Deutsches Zentrum für Luft- und Raumfahrt (DLR)* *[3] Department of Chemistry, University of Basel, [4] University of Duisburg-Essen* *[5] Institute for Quantum Optics and Quantum Information - IQOQI Vienna, Austrian Academy of Sciences* We report on first single-grating diffraction of molecular matter-waves at a continuous 266 nm optical grating. While pulsed UV gratings are already used in molecular interferometry, continuous ones have so far been hindered by lack of high-power lasers and fast degradation of UV optics in vacuum. Our focus is on applications for quantum-assisted measurements of molecular electronic properties, such as polarizabilities and absorption cross-sections at 266 nm. The deep UV diffraction grating paves the way for studying photophysical and photochemical processes of biologically and technologically relevant molecules in matter-wave diffraction. Furthermore, it explores new grating mechanisms for interferometry of complex biomolecules, such as depletion gratings based on single photon-induced photocleavage.
16:15	**409**	**Cavity-mediated coupling of terahertz antiferromagnetic resonances in distant crystals** *Marcin Bialek, Jean-Philippe Ansermet, EPFL* In the regime of strong light-matter coupling, polaritons are formed that are hybrids of a cavity mode and a matter excitation. Recently, magnon-polaritons were researched using ferromagnets in the microwave range. Exploring antiferromagnets rises magnon-polariton frequencies into the terahertz range. We report on coupling of antiferromagnetic resonance (AFMR) in two parallel-plane crystals of hematite (alpha-Fe_2O_3) placed at a well controlled gap, forming a tunable Fabry-Perot cavity. Frequency of AFMR in each crystal was independenty controlled by changing their temperatures. Reflection spectra in the range 0.2 - 0.3 THz, collected as a function of temperature difference between the two crystals, show avoided crossings of AFMR from both slabs mediated by Fabry-Perot cavity modes.
16:30		***Coffee Break***
		Atomic Physics and Quantum Optics II *Chair: Tilman Zibold, Universität Basel*
17:00	**411**	**Minimalistic efficient quantum devices build of dipole coupled nano arrays of quantum emitters** *Helmut Ritsch, Universität Innsbruck* An array of closely spaced, dipole coupled quantum emitters exhibits collective energy shifts as well as super- and sub-radiance with characteristic tailorable spatial radiation patterns. As striking example we identify a sub-wavelength sized ring of exactly 9 identical dipoles with an extra identical emitter with a extra loss channel at the center as the most efficient configuration to deposit incoming photon energy to center without reemission. For very tiny structures below a tenth of a wavelength a full quantum description exhibits an even larger enhancement than predicted from a classical dipole approximation. Adding gain to such systems allows to design minimalistic classical as well as non-classical light sources.

17:30	**412**	**Cavity-QED Quantum Simulator of Random Spin Models** *Francesca Orsi, Rohit Bhatt, Gaia Bolognini, Jean-Philippe Brantut, Jonas Faltinath, Nick Sauerwein, EPFL* Cavity QED systems have proved valuable for quantum simulations, specifically for the long-range interactions that the cavity field mediates between the atoms. We have realized a random spin model with atoms in a cavity where we introduce controlled disorder in the the atomic transition frequencies with a light-shift of the excited state. We study the competition between the collective many-body physics and the disorder. In the dispersive regime, we observe the ferromagnetic gap of our system closing as a function of the disorder strength. I will also discuss how we plan to use a modulation of our light-shifting beam to locally control the atom-cavity coupling and tailor the long-range interactions.
17:45	**413**	**Entanglement-induced collective multiparticle interference** *Tommaso Faleo [1], Eric Brunner [2], Jonathan W. Webb [3], Christoph Dittel [2], Gregor Weihs [1], Gabriel Dufour [2], Alessandro Fedrizzi [3], Robert Keil [1]* *[1] University of Innsbruck, [2] University of Freiburg, [3] Heriot-Watt University* Multiparticle interference phenomena have been crucial to the understanding of quantum physics. In two-particle systems, Hong, Ou, and Mandel showed how particles' indistinguishability forbids retrieving information about the pairwise exchange process, playing a key role in witnessing interference. Contrarily, in systems of $N \geq 3$ partially distinguishable particles, multiple interference terms originate from the different exchange processes, enabling the observation of genuine N-particle interference that is no longer fully determined by pairwise indistinguishability. Here, we introduce yet another fundamental feature of quantum physics, i.e., quantum entanglement, to demonstrate the genuine four-particle interference of photons which, however, only interfere in pairs at two separate and independent beamsplitters, thus suggesting a nonlocal collective interference.
18:00	**414**	**Einstein-Podolsky-Rosen experiment with two Bose-Einstein condensates** *Paolo Colciaghi, Yifan Li, Philipp Treutlein, Tilman Zibold* *Department of Physics, University of Basel, CH-4056 Basel* We observe for the first time the famous Einstein-Podolsky-Rosen (EPR) paradox with two spatially separated, massive many-particle systems. We split a spin-squeezed Bose-Einstein condensate into two spatially separated parts, on which we perform independent spin measurements to demonstrate the paradox. Our results show that the conflict between quantum mechanics and the classical understanding of locality and realism does not disappear as the system size is increased to over 1000 massive particles. Furthermore, we demonstrate the individual control of both systems on the quantum level, which is a necessary condition to exploit EPR entanglement as a resource for quantum technology.
18:15	**415**	**The Wave-Particle Duality in Quantum Heat Engine** *Marcelo Janovitch Broinizi Pereira, Matteo Brunelli, Patrick Potts, Universität Basel* According to the wave-particle duality (WPD), quantum systems show both particle- and wave-like behavior, and cannot be described using only one of these classical concepts. The WPD implies that comparison to one classical model is generally insufficient; one wave and one particle model should be considered. We exploit this insight, contrasting a bosonic quantum heat engine with particle and wave counterparts. While both classical models reproduce the average output power of the quantum engine, neither reproduces its fluctuations. We find regimes where wave and particle descriptions agree with the quantum, and a regime where neither classical model is adequate, revealing the role of the WPD in non-equilibrium bosonic transport.

18:30	**416**	**Verification of the area law of mutual information in a quantum field simulator** *Mohammadamin Tajik [1], Ivan Kukuljan, Spyros Sotiriadis [2], Bernhard Rauer [1], Thomas Schweigler [1], Federica Cataldini [1], João Sabino [1], Frederik Møller [1], Philipp Schüttelkopf [1], Si-Cong Ji [1], Dries Sels [3], Eugene Demler [4], Jörg Schmiedmayer [1]* *[1] TU Wien, [2] FU Berlin, [3] New York University, [4] ETH Zürich* Understanding scaling laws of entropies and mutual information has benefited studying correlated states of matter, quantum field theory, and gravity. Measuring von Neumann entropy experimentally in quantum many-body systems is challenging. In my talk, I will present our measurements of von Neumann entropy of subsystems in an ultracold atom simulator of Klein-Gordon field theory, verifying a foundational property of equilibrium states of gapped quantum many-body systems - the area law of quantum mutual information (Tajik, M. et al. Nat. Phys. 2023). I will also discuss the effect of temperature and subsystem separation on mutual information. Finally, I will address the challenges of measuring entanglement in many-body systems.
18:45	**417**	**Positron manipulation and control at ASACUSA** *Daniel James Murtagh, Austrian Academy of Sciences* The ASACUSA-Cusp experiment aims to perform spectroscopy of the hyperfine structure of anti-hydrogen by producing a beam of cold, spin polarised, ground state antihydrogen. Recently, a major technological milestone was achieved by the collaboration. Previously, it has not been possible to cool plasma below 130 K, however, a new electrode stack and coldbore with a focus on blocking microwaves from the room temperature region has allowed particles to cool to 25 K maintaining the large open solid angle for the beam to escape. In this presentation I will discuss the methods used by the ASACUSA Cusp experiment to manipulate and control positrons and give details on the most recent work
19:00		***END; Postersession with Apéro***

ID	Atomic Physics and Quantum Optics Poster
431	**Laser cooling and shuttling of trapped ions in strongly inhomogeneous magnetic fields** *Christian Mangeng, Richard Karl, Stefan Willitsch, Yanning Yin, University of Basel* We demonstrate laser-cooling of Ca^+ ions confined in a segmented linear Paul trap and in presence of a strongly inhomogeneous magnetic field. We show that by employing two cooling lasers with properly adjusted wavelengths and polarizations, the trapped ions can efficiently be cooled to millikelvin temperatures despite strong position-dependent Zeeman shifts. The experimental results are complemented by a theoretical analysis. We further demonstrate successful shuttling of the ions through these magnetic field gradients. These experiments pave the way for studying cold collisions and reactions between ions and neutral molecules in hybrid traps composed of a Paul trap and a magnetic trap.
432	**Coupling a mechanical Oscillator to single trapped Ions** *Moritz Weegen, Panagiotis Fountas, Martino Poggio, Stefan Willitsch, University of Basel* Ultracold ions in linear radiofrequency traps are well-established and highly controllable quantum systems with a variety of applications in the quantum sciences. The combination with a charged nanomechanical oscillator may offer novel ways for state preparation and readout by coupling both systems within a single quantum device. Here we demonstrate the transfer of energy from a mechanically driven oscillator to the motion of trapped ions in a classical regime. This is obtained by coupling one of the oscillator mechanical modes to the ion motion of matching frequency. We further characterise the interaction by varying different defining parameters such as the mechanical drive amplitude and the effective charge on the oscillator.

433	**Precision spectroscopy and coherent manipulation of single trapped nitrogen molecules** *Mikolaj Franciszek Roguski, Aleksandr Shlykov, Richard Karl, Prerna Paliwal, Mudit Sinhal, Stefan Willitsch, University of Basel* Complex energy-level structure of molecules with rotational and vibrational degrees of freedom provides transitions with various properties but also presents challenges toward molecular state initialization, manipulation, and readout. We followed a quantum-logic protocol that uses a single co-trapped atomic ion as a probe for the molecular state, and demonstrated a quantum non-demolition state detection with fidelities > 99 %. Currently, we are implementing precision-spectroscopic measurements on a narrow infrared quadrupole transition referenced to the Swiss primary frequency standard at METAS in Berne. The present method paves the way for the implementation of molecular qubits, for establishing new frequency standards in the mid-IR regime, and for investigating state-to-state dynamics of chemical reactions.
434	**Towards quantum control of polyatomic molecular ions** *Mikhail Popov, Prerna Paliwal, Stefan Willitsch, University of Basel* Complete control over the quantum state of single molecules possesses significant challenges due to the complexity of their energy level structure and was demonstrated only recently for diatomic molecular ions. We report on the progress of a generalization of a quantum control scheme that employs quantum logic spectroscopy with a co-trapped atomic ion of calcium to polyatomic molecules. This will open the possibility of studying chemical reactions and ultracold collisions on a state-to-state level and conducting precision spectroscopy with polyatomic species.
435	**Towards OH-ion reaction studies at astrochemically relevant conditions** *Pietro Vahramian, Dominik Haas, Claudio von Planta, Yanning Yin, Dongdong Zhang, Thomas Kierspel, Stefan Willitsch, University of Basel* In interstellar space, reactions involving neutral dipolar molecules and ions are the main mechanism with which new molecules are formed, yet there is sparse data about reactivities in this range. Here we present an experiment aimed at studying radical-ion reactivities at conditions relevant for astrochemistry – high vacuum and temperatures down to few Kelvins. A Stark decelerator slows down to temperatures of a few K a beam of radicals, which are then shot onto trapped, laser cooled Ca^+ ions. I will report on advancements on the deceleration and detection of the OH molecules and on prospects to couple them to the trapped ion.
436	**Investigation of the dipole moment of 6,11-dihydroxy-5,12-naphthacenedione using molecular diffraction** *Richard Ferstl [1], Markus Arndt [1], Anders Barlow [2], Christian Brand [3], Armin Shayeghi [4], Ksenija Simonovic [1]* *[1] University of Vienna, Faculty of Physics* *[2] University of Melbourne, Faculty of Engineering and Information Technology* *[3] Deutsches Zentrum für Luft- und Raumfahrt (DLR)* *[4] Institute for Quantum Optics and Quantum Information - IQOQI Vienna, Austrian Academy of Sciences* Permanent electric dipole moments have been found to significantly reduce the interference contrast in molecular diffraction experiments at nanomechanical gratings. Dephasing caused by the interactions with implanted charges in the nanogratings has been presented as a possible explanation for this behavior. Here we investigate the polarity of 6,11-dihydroxy-5,12-naphthacenedione, which could be assumed to be polar by its lack of inversion symmetry, yet shows a surprisingly high interference contrast. This may suggest a reduction of the electric dipole moment, attributed to coherent or fast incoherent proton transfer between adjacent functional groups. We will report on the comparison of these results with diffraction of molecules that are known to be polar.

437	**Charge and pair density waves induced by light in a strongly interacting Fermi gas**
	Tabea Nelly Clara Bühler [1], Timo Zwettler [1], Giulia Del Pace [2], Jean-Philippe Brantut [1] *[1] Ecole Polytechnique Fédérale de Lausanne, Institute of Physics, CH-1015 Lausanne* *[2] Istituto Nazionale di Ottica del Consiglio Nazionale delle Ricerche (CNR-INO) and European Laboratory for Nonlinear Spectroscopy (LENS), University of Florence, IT-50019 Sesto Fiorentino*
	Quantum gas experiments provide the unique opportunity to study complex quantum many-body systems. Starting from a dilute gas non-local, all-to-all interactions can be implemented by means of a high-finesse optical cavity. In our experiment we prepare a degenerate, strongly interacting Fermi gas of ^{6}Li atoms trapped inside a high-finesse optical cavity. We induce long-range atom-atom, atom-pair and pair-to-pair interactions mediated by cavity photons. We observe a density-wave ordering phase transition in the presence of these interactions, suggesting a pair-density-wave state of the gas. We characterize the transition threshold and the lifetime of this state as we vary the strength and sign of the long-range interactions.
438	**Levitated optomechanics in ultra-high vacuum**
	Florian Goschin, University of Innsbruck
	We envision preparing mesoscopic motional quantum states by coupling the motion of a levitated particle to a trapped ion qubit. First, we levitate a charged silica nanoparticle in a Paul trap in ultra-high vacuum resulting in an ultra-high quality factor ($Q = 1.6(4) \times 10^{10}$) of mechanical oscillations. Second, we control the particle's center-of-mass motion by applying measurement-based active feedback cooling. To increase the particle detection efficiency we implement a detection method based on self-interference of the particle with its image. Finally, we introduce the trapped ion qubit into the system. For the first time, we experimentally realize the simultaneous trapping of a single ion and a nanoparticle in the same Paul trap.
439	**The Scalar Magnetometer on board ESA's JUICE Mission and its Potential as a Vector Magnetometer**
	Christoph Amtmann [1], Martín Agú [2], Alexander Betzler [2], Irmgard Jernej [2], Sunny Laddha [1], Roland Lammegger [1], Werner Magnes [2], Andreas Pollinger [1] *[1] Institute of Experimental Physics, Graz University of Technology* *[2] Space Research Institute, Austrian Academy of Sciences*
	The scalar magnetometer on board ESA's JUICE mission is an optically pumped magnetometer, based on the coherent population trapping (CPT) effect in the atomic vapour of the rubidium isotope 87. The CPT effect is a quantum mechanical interference effect which allows the precise detection of the external magnetic field strength by measuring the so-called Zeeman shifts. The instrument excites and couples several CPT resonances to enable a measurement principle which is inherently drift and dead-zone free. The presentation will give an overview of the scalar magnetometer for the JUICE mission as well as the first results of its potential for vector measurements.

Gravitational Waves

Tuesday, 05.09.2023, Room 117

Time	ID	GRAVITATIONAL WAVES I *Chair: Steven Schramm, Université de Genève*
14:00	481	**Searching for generic gravitational waves transients in LIGO-Virgo-KAGRA** *Shubhanshu Tiwari, University of Zürich* Routine detections of gravitational waves by the LIGO-Virgo-KAGRA collaboration has put the gravitational waves astronomy on a firm path. In this development of gravitational waves astronomy morphology independent algorithms have played a key role, from the first detection of GW150914 to the recent detection of first intermediate mass black hole merger GW190521. In this talk I will outline the capabilities, limitations and opportunities presented by the morphology independent searches. I will also discuss various applications of such searches for the case of compact binary mergers and other sources as well like Neutron Star glitches, non-linear memory etc.
14:20	482	**The minimum detectable eccentricity in gravitational waves from LISA massive black hole binaries** *Mudit Garg, Shubhanshu Tiwari, Andrea Derdzinski, Lucio Mayer, University of Zürich* We explore the eccentricity detection threshold of the future space-based mission LISA for gravitational waves (GWs) radiated by massive black hole binaries (MBHBs) with BH masses in the range $10^4 – 10^6\ M_\odot$ at redshift $z = 1$. We will generate mock high-order post-Newtonian eccentric waveforms, project them in LISA arms to perform time delay interferometry to cancel laser noise, and use both Fisher and Bayesian inference via MCMC to see how well we can constrain injected parameters as a function of the waveform's signal-to-noise ratio. This study is much needed as eccentricity can be a unique tracer of the environment where these MBHBs evolve to reach the merger phase in the LISA band.
14:40	483	**Double Neutron-Star Binaries** *Matthias Kruckow, Uni Genève* Neutron stars, the final fate of massive stars, are mostly observed as radio pulsars in the Milky Way. Two of them in a binary system allow very precise measurements of the orbits, which caused the first (indirect) detection of gravitational-wave emission. The first observation of a merger of two neutron stars by their gravitational-wave radiation with the ground based gravitational-wave detectors got jointly observed in the electromagnetic spectrum as kilonova and gamma-ray burst. This mile-stone event (and further detections) lead to the question, whether there are differences between the galactic and extra galactic double neutron-star binaries.
15:00	484	**Role of Non-Linear Memory in Resolving Distance-Inclination Degeneracy in Ground-Based Gravitational Wave Detectors: Present and Future** *Yumeng Xu [1], Michael Ebersold [2], Shubhanshu Tiwari [1]* *[1] University of Zürich, [2] Laboratoire d'Annecy de Physique des Particules* Gravitational wave detection is a powerful tool that provides us with new ways to understand the universe. However, certain parameters, such as inclination and distance, are degenerate. This limitation hinders our ability to accurately measure other important factors like precession. Breaking the degeneracy between inclination and distance can also give us new insights into formation channels and cosmology. The memory effect, a unique characteristic of gravitational waves, can aid in breaking this degeneracy, especially in symmetric mass systems. In this work, we conducted a Parameter Estimation study to investigate the memory effect and its potential to enhance our interpretation of gravitational wave signals.

15:20	**485**	**Accelerating global parameter estimation of gravitational waves from Galactic binaries using a genetic algorithm and GPUs** *Stefan Strub, Cedric Schmelzbach, Luigi Ferraioli, Simon Stähler, Domenico Giardini, ETH Zürich* The Laser Interferometer Space Antenna (LISA) is aimed to measure gravitational waves in the mili-Hertz frequency band, which is dominated by millions of Galactic binaries. While some of these binaries produce signals that are extractable, most of them blur into a confusion foreground. We introduce a new approach to extract the best-fitting solutions for Galactic binaries across the entire frequency band from data with multiple overlapping signals. Furthermore, we use these best-fitting solutions to omit the burn-in stage and to take full advantage of GPU-accelerated signal simulation, allowing us to compute posterior distributions in just 2.3 seconds per signal on a laptop-grade GPU.
15:40	**486**	**Singling out SO(10) GUT models using recent PTA results** *Shaikh Saad, Universität Basel* In this work, we construct promising model building routes towards SO(10) GUT inflation and examine their ability to explain the recent PTA results hinting at a stochastic gravitational wave (GW) background at nanohertz frequencies. We consider a supersymmetric framework within which the so-called doublet-triplet splitting problem is solved without introducing fine-tuning. Additionally, realistic fermion masses and mixings, gauge coupling unification, and cosmic inflation are incorporated by utilizing superfields with representations no higher than the adjoint representation. Among the three possible scenarios, two of these cases require a single adjoint Higgs field, and do not lead to cosmic strings. In contrast, the third scenario featuring two adjoints, can lead to a network of metastable cosmic strings that generates a GW background contribution compatible with the recent PTA findings and testable by various ongoing and upcoming GW observatories.
16:00		
16:30		***Coffee Break***
		GRAVITATIONAL WAVES II *Chair: Philippe Jetzer, Universität Zürich*
17:00	**491**	**Unraveling the origins of stellar-mass black hole mergers** *Simone Bavera, University of Geneva* The LIGO and Virgo gravitational-wave detectors have observed a sample of around 90 merging binary black holes. However, to date, their formation origins remain a mystery. In my presentation, I will briefly review current theoretical predictions regarding the astrophysical formation channels of merging binary black holes and their model predictions. These models leverage binary population synthesis techniques to make predictions of the observable properties of merging binary black holes, such as the black hole masses, spins, and redshifts of the merger. Finally, leveraging the observed sample, I will demonstrate how one can use Bayesian hierarchical model selection to constrain the formation origins of merging binary black holes.
17:20	**492**	**Precision modelling of black-hole-binaries** *Eleanor Hamilton, University of Zürich* Accurate signal models are essential in the analysis of gravitational wave events, from parameter estimation to astrophysical interpretation. As detectors get increasingly advanced it becomes ever more crucial to develop precision models of signals from a wide range of physical systems, including black-hole-binaries with generic spins. Evidence for a population of such systems has already been seen by the LIGO-Virgo-Kagra Collaboration and is expected to become stronger in the upcoming run. I will discuss recent developments that have resulted in the first complete inspiral-merger-ringdown model of the gravitational wave signal from a precessing binary where the precession effects have been tuned to numerical relativity through merger and ringdown.

17:40	**493**	**The windowed Fast Galactic Binary algorithm: a fast and accurate method to simulate the LISA response to Galactic Binaries** *Franziska Riegger, Fredrik Andersson, Johan Robertsson, ETH Zürich* The Fast Galactic Binary (FGB) method is an algorithm to simulate the LISA response to galactic binaries, which are expected to emit most of the gravitational waves detected by LISA. This algorithm operates in the time and frequency domains. However, the standard algorithm generates waveforms that exhibit artifacts, yielding notable approximation errors. These artifacts are due to discontinuity effects introduced when moving between the domains. We present a new modified FGB algorithm where these artifacts are eliminated and which allows for simulating more complex detector geometries. The proposed algorithm is well-suited for GPU implementations, and several tens of millions of events are accurately evaluated in seconds on a desktop computer.
18:00	**494**	**Detailed Binary Population Synthesis Study of Merging Black Hole Neutron Star Binaries at Solar Metallicity** *Zepei Xing, Jeff Andrews, Simone Bavera, Aaron Dotter, Tassos Fragos, Konstantinos Kovlakas, Devina Misra, Kyle Rocha, Philipp Srivastava, Meng Sun, Emmanouil Zapartas* *Université de Genève* Neutron star – black hole (NSBH) merger events bring us new opportunities to constrain theories of stellar and binary evolution and to understand the nature of compact objects. In this work, we investigate the formation of merging NSBH binaries at solar metallicity by performing a binary population synthesis (BPS) study with the new BPS code POSYDON, which incorporates extensive grids of detailed single and binary evolution models, covering the entire evolution of a double compact object progenitor. We explore the evolutionary paths of individual NSBHs originating from different formation channels. Then, we present the population properties and discuss the possibilities of associated electromagnetic counterparts.
18:20	**495**	**New methodologies to generate waveforms from a scattering amplitude approach** *Lara Bohnenblust, Uni Zürich* The next generation of gravitational wave detectors will require precise waveform templates for binaries with high mass ratios and eccentricities. One tantalizing method is the post-Minkowskian (PM) expansion. Using tools from particle physics the scattering angle and a conservative potential have been found up to 4th order in G. We discuss two methods to generate waveforms using the PM expansion. The first formalism is based on quantum observables where one can extract the full waveform directly from the scattering amplitudes. The second method makes use of the resummation into an effective one body potential and the mode expansion.
18:40		***END***
19:00		***Postersession with Apéro***

New prospects in ARPES for quantum materials

Tuesday, 05.09.2023, Room 115

Time	ID	NEW PROSPECTS IN ARPES FOR QUANTUM MATERIALS I *Chair: Felix Baumberger, Université de Genève*
14:00	501	**2D with a twist** *Neil Wilson, Department of Physics, University of Warwick, UK* A new parameter space to explore has been added to the beautiful world of 2D materials (2DMs); the twist angle between neighbouring layers. This is exemplified by 'magic-angle' twisted graphene, engineering strongly correlated behaviour through moire interactions, an effect also used to trap ordered arrays of excitons in transition metal dichalcogenide (TMDC) heterobilayers. Moire effects conventionally require a moire wavelength much longer than the atomic scale. But for larger lattice mismatch, Umklapp processes can result in unexpected electronic structure changes. Here, I will present our recent studies of twisted 2DMs, including twisted graphenes and TMDCs. I will discuss initial-state and final-state effects, and the twist-angle dependence of inter-layer interactions.
14:30	502	**Different electronic phases on the surface of bulk 1T-$TaSe_2$** *Michael Straub, Yann Alexanian, Gianmarco Gatti, Catherine Witteveen, Fabian von Rohr, Felix Baumberger, Anna Tamai, Université de Genève* Recent STM experiments revealed a variety of different correlated states to coexist on the surface of bulk 1T-$TaSe_2$. The different regions have the same in-plane charge density wave ordering, yet range from insulating to strongly correlated metal. By utilizing microfocus ARPES, we have resolved the quasiparticle dispersion in the different spatial domains. In the metallic regions, we found heavy quasi-particles forming a chiral Fermi surface, whereas, in the insulating domains our measurements are consistent with a band insulator. We will discuss the origin of this spatial inhomogeneity in terms of the interplay between electron-electron interactions and interlayer coupling.
14:45	503	**Observing Electronic Band Structure of Antiferromagnetic Phase in Topological Weyl Semimetal $Co_3Sn_2S_2$** *Sandy Adhitia Ekahana [1], Felix Baumberger [2], Dariusz Jakub Gawryluk [1], Satoshi Okamoto [3], Loïc Roduit [1], Yona Soh [1], Anna Tamai [2]* *[1] Paul Scherrer Institute, [2] Université de Genève, [3] Oak Ridge National Laboratotry* $Co_3Sn_2S_2$ has been reported to be a magnetic Weyl semimetal expanding our understanding of topological materials. This material is considered to be ferromagnetic as demonstrated experimentally and also by DFT calculations. However, recent muon measurement suggests a co-existence of antiferromagnetism and ferromagnetism around the magnetic transition temperature, which has been neglected previously in the discussion of $Co_3Sn_2S_2$. In this talk, we present our micro-ARPES measurement revealing the presence of an antiferromagnetic phase co-existing as a minority phase with the majority ferromagnetic phase. We confirm the magnetic nature of the phase by studying the temperature dependence of the electron band. Our result provides the first spatial visualization of the aforementioned co-existence.
15:00	504	**First micro-ARPES measurements of encapsulated monolayer Td-$MoTe_2$** *Julia Issing, Ignacio Gutiérrez-Lezama, Fabian von Rohr, Alberto Morpurgo, Anna Tamai, Felix Baumberger, University of Geneva* Bulk orthorhombic Td-$MoTe_2$ is a type-II Weyl semimetal with topological Fermi arc surface states and becomes superconducting at a critical temperature of T_c = 0.1 K. Remarkably, superconductivity becomes far more robust in the 2D limit, contrary to generic models and the established trend in ultrathin metal films. Recent transport measurements reported an increase in T_c for decreasing thickness with T_c reaching 7.6 K in the monolayer. The reasons for the strong increase in T_c as well as the nature of the superconducting state remain unknown. To address the opened questions, we will present the electronic structure of exfoliated monolayer $MoTe_2$ encapsulated between graphite and graphene probed by micro-focused ARPES.

15:15 **505**

Strain tuning the band structure in a charge-order Kagome system

Chun Lin [1], Julia Küspert [1], Armando Consiglio [2], Ola Forslund [1], Wojciech Pudelko [3], M. Michael Denner [1], Hechang Lei [4], Youguo Shi [5], Zurab Guguchia [3], Qisi Wang [1], Gerardina Carbone [6], Mats Leandersson [6], Craig Polley [6], Balasubramanian Thiagarajan [6], Alex Louat [7], Matthew Watson [7], Timur Kim [7], Cephise Cacho [7], Giorgio Sangiovanni [2], Titus Neupert [1], Johan Chang [1]
[1] University of Zurich, [2] University of Würzburg, [3] Paul Scherrer Institut,
[4] Renmin University of China, [5] Chinese Academy of Sciences, [6] MAX IV Laboratory
[7] Diamond Light Source

Kagome-lattice investigations are growing vigorously owing to the simultaneous realisation of topologically non-trivial electronic structure including Dirac fermions, flat bands, and Van Hove singularities (VHS). As an effective external stimulus, uniaxial strain manifested in a form of physical pressure, is playing an increasingly important role in engineering the band structure and hence physical properties of quantum materials. Utilising high-resolution ARPES, we have successfully applied uniaxial strain and tuned the energy gaps as well as the VHSs in the charge-order state of a Kagome superconductor CsV_3Sb_5.

15:30 **506**

Photoemission Orbital Tomography for Pump-probe Photoelectron Spectroscopy

Christian S. Kern, Andreas Windischbacher, Peter Puschnig, University of Graz

In order to interpret and simulate recent time- and angular-resolved photoemission spectroscopy (tr-ARPES), we extend the successful method of photoemission orbital tomography (POT) to excited states. Our theory retains the intuitive orbital picture of POT, while respecting both the entangled character of the electron-hole exciton wave function and the energy conservation in the photoemission process. Going beyond simple HOMO-LUMO transitions in organic molecules, we classify generic exciton structures and give an intuitive interpretation of tr-ARPES data in terms of natural transition orbitals. It is further shown how this new method for excited-states POT can be independently validated by real-time simulations of tr-ARPES from time-dependent density functional theory.

15:45 **507**

Circular Dichroism and Orbital Angular Momentum in chiral Weyl semimetals PdGa/PtGa

Yun Yen [1,2], Jonas A. Krieger [3], Niels B. M. Schröter [3], Maia G. Vergniory [4], Iñigo Robredo [5], Michael Schüler [1,6], Qun Yang [7], Mengyu Yao [5]
[1] Paul Scherrer Institute, [2] EPFL, [3] Max Planck Institute of Microstructure Physics
[4] Donostia International Physics Center, [5] Max Planck Institute for Chemical Physics of Solids
[6] Department of Physics, University of Fribourg, [7] Weizmann Institute of Science

In this work, we show that circular dichroism angle resolved photoemission spectroscopy (CD-ARPES) can map topology in chiral Weyl semimetals PdGa/PtGa, where multifold nodes host large Chern number. We successfully simulate the CD intensity using our in-house code dynamics- w90. The correspondence between local OAM and dipole matrix elements depends on orbital characters and experimental geometry. Pd/Pt local OAM can be measured by CD, where d orbital contribution is dominated by $m = \mp 2$ complex orbitals. Although the total CD signal consists of interatomic interference terms, they still exhibit radial structure. We conclude that one can see the reminiscence of radial OAM structure, which comes from the topological nature of the Weyl nodes.

16:00 **508**

Band topology induced by strain in $SrNbO_3$

Victor Rosendal [2], Alla Chikina [1], Hang Li [1], Mads Brandbyge [3], Eduardo Bonini Guedes [1], Marco Caputo [1], Dirch Hjorth Petersen [2], Felix Baumberger [4], Milan Radovic [1], Nini Pryds [3]
[1] Paul Scherrer Institute
[2] Department of Energy Conversion and Storage, Technical University of Denmark
[3] Department of Physics, Technical University of Denmark
[4] University of Geneva

Transition metal oxides could also be a platform for conceiving novel quantum properties, such as nontrivial topology induced by crystal structure modification. In this study, we investigate the effect of strain on the electronic structure and band topology of ultra-thin $SrNbO_3$ films. By employing angle-resolved photoemission spectroscopy (ARPES) and density functional theory (DFT)

		calculations, we gain insight into band structure of $SrNbO_3$ strained tetragonal phases. We will discuss a formation of nontrivial Dirac band crossings in $SrNbO_3$ films originating from in-phase and out-of phase octahedral tilting. Our study provides direct evidence and proves that heteroepitaxial strain can be effectively used for engineering quantum phases in transition metal oxides.
16:15	**509**	**Photoemission matrix element correction for accurate quantification of electronic spectral functions: the case of TiO_2-terminated $SrTiO_3$** *Tom van Waas [1], Igor Sokolovic [2], Martin Setvín [2], Eduardo Bonini Guedes [3], Hugo Dil [4], Samuel Poncé [1]* *[1] Université catholique de Louvain, [2] TU Vienna, [3] PSI Villigen, [4] EPFL* In ARPES, access to the electronic spectral function $A(E, \boldsymbol{k})$ is obscured by the photoemission matrix elements $M_{k_f,k}$. We provide a heuristic approach based on the sum rule to obtain the momentum dependence of these elements. We show how matrix element correction (MEC) enables extraction of the Eliashberg spectral function from both light band branches of a TiO_2-terminated $SrTiO_3$ surface state. Finally, we illustrate how the MEC allows for direct comparison of $A(E, \boldsymbol{k})$ from ARPES and first principles.
16:30		***Coffee Break***
		New prospects in ARPES for quantum materials II *Chair: Claude Monney, Université de Fribourg*
17:00	**511**	**ARPES of quantum confined semiconductor and topological insulator heterostructures grown by molecular beam epitaxy** *Gunther Springholz, Johannes Kepler Universität, Linz* Angle resolved photoemission spectroscopy (APRES) has emerged as a powerful tool to assess the electronic band structure of quantum materials. Here, it is applied to study quantum confined states in IV-VI semiconductor and topological insulator heterostructures produced by molecular beam epitaxy. This allows to study a large variety of low dimensional structures revealing the electronic spectra with high resolution, as is exemplified for zero gap Dirac quantum wells, double quantum wells, as well as Volkov-Pankratov heterojunctions. We reveal the significant probing depth of APRES stemming from the emergent wave functions, which opens up a new realm for ARPES applications.
17:30	**512**	**Persistent Rashba splitting in the bulk bands of SnTe in the paraelectric phase** *Frédéric Chassot [1], Aki Pulkkinen [2], Geoffroy Kremer [3], Hugo Dil [4], Juraj Krempasky [5], Ján Minár [2], Gunther Springholz [6], Claude Monney [1]* *[1] Department of Physics and Fribourg Center for Nanomaterials, Université de Fribourg, CH-1700 Fribourg* *[2] New Technologies-Research Center, University of West Bohemia, Plzeň, Czech Republic* *[3] Institut Jean Lamour, UMR 7198, CNRS-Université de Lorraine, Nancy, France* *[4] Institute of Physics, Ecole Polytechnique Fédérale de Lausanne, CH-1015 Lausanne* *[5] Photon Science Division, Paul Scherrer Institut, CH-5232 Villigen PSI* *[6] Institut für Halbleiter-und Festkörperphysik, Johannes Kepler Universität, Linz, Austria* SnTe is a ferroelectric semiconductor with similar properties as GeTe, which has already been extensively studied, notably for applications in spintronics. However, the lower critical temperature of SnTe (around 100K) makes it an ideal candidate to investigate the ferroelectric transition. Here we present a study of its bandstructure with photoemission spectroscopy. We follow the evolution of the Rashba splitting induced by the ferroelectric distortion in the bulk and discover drastic deviations from a mean-field-like transition. In particular, the persistence of a splitting at room temperature supports an order-disorder type of transition, questioning the topological nature of surface states. We conclude by showing ongoing work on time-resolved photoemission spectroscopy.

17:45	**513**	**Are high-energy photoemission final states free-electron-like?** *Vladimir N. Strocov [1], Fatima Alarab [1], Procopious Constantinou [1], Leonid L. Lev [2], Jan Minár [3], Lorent Nicolaï [3], Jan Očenášek [3], Thorsten Schmitt [1], Taylor J. Z. Stock [4]* *[1] Swiss Light Source, Paul Scherrer Institute, [2] Moscow Institute of Physics and Technology* *[3] University of West Bohemia, Plzeň* *[4] London Centre for Nanotechnology, University College London* Three-dimensional (3D) electronic bandstructure is fundamental for a vast diversity of physical phenomena in solid-state materials, including topological phases, interlayer interactions in van-der-Waals materials, etc. Interpretation of ARPES data in terms of 3D bandstructure is commonly based on the free-electron approximation for the photoemission final states. Our soft-X-ray ARPES data on various metals and semiconductors reveal, however, that even at high excitation energies the final states can be quite complex, where several Bloch waves with different out-of-plane momenta form a complex structure of the spectral peaks. Our findings are essential for accurate determination of the 3D bandstructure from the ARPES experiment over a wide range of materials and excitation energies.
18:00	**514**	**Observing and manipulating orbital textures in quantum materials** *Michael Schüler [1,2], Samuel Beaulieu [3], Ralph Ernstorfer [4], Rupert Huber [5], Ulrich Höfer [6], Suguru Ito [6], Niels Schröter [7], Michael Sentef [8], Yun Yen [1]* *[1] Paul Scherrer Institute, [2] University of Fribourg, [3] University of Bordeaux, [4] TU Berlin, [5] University of Regensburg, [6] University of Marburg, [7] MPI Halle, [8] University of Bremen* Angle-resolved photoemission spectroscopy (ARPES) provides an unprecedented “zoom” into the electronic degrees of freedom. Besides mapping the band structure, fingerprints of wave-function aspects such as the orbital texture, associated orbital angular momentum (OAM) and Berry curvature are contained in ARPES. Extracting such wave-function information is a challenge due to the complexity of the photoemission process. Based on accurate theory, we discuss the principles of how exploiting the photon polarization degree of freedom and the crystal orientation can provide wave-function information. We will demonstrate these principles by joint experimental and theoretical work on the transition metal dichalcogenide WSe_2 and the topological chiral semimetal PdGa.
18:30	**515**	**Real-time pump-probe simulations within time-dependent density functional theory** *Dominik Brandstetter, Christian S. Kern, Peter Puschnig, University of Graz* Real-time time-dependent density functional theory provides an ab-initio framework to directly simulate (sub-)femtosecond pump-probe ARPES experiments. Incident light field(s) of any shape and magnitude can be incorporated, electron correlations are considered at a mean-field level and no assumptions regarding the final state of the escaping electron are required. In this contribution, we study a resonantly driven HOMO-LUMO transition of an organic rod-line molecule to study the intra-molecular charge transfer upon the optical excitation. We simulate the oscillatory behavior in the population of the frontier orbitals resembling detuned Rabi oscillations and study the characteristics of the intramolecular charge transfer by simulating photoemission momentum maps to be compared with time-resolved-ARPES experiments.
	~~**516**~~	*cancelled*
18:45	**517**	**Photon-energy-dependence of the circular dichroic ARPES with InAs(110)** *Anna Hartl [1], Dmitry Usanov [1], Enrico Della Valle [1], Ján Minár [2], Vladimir Strokov [1]* *[1] Paul Scherrer Institut, [2] University of West Bohemia, Plzeň* In ARPES, coupling of polarized light to the valence-band states contains valuable information about their orbital and spin texture. This information, however, is distorted by non-trivial behavior of the photoemission matrix elements. We explored the circular dichroism in InAs(110) over a broad photon-energy range from VUV to soft X-rays, focusing on the Fermi-surface maps. Supported by ARPES computations based on the multiple-scattering Green’s function approach (SPR-KKR), we analyzed the experimental data in terms of photon-energy-dependent final states and dichroic matrix elements. Our methodology paves the way towards ARPES investigations of the orbital and spin texture in complex quantum materials.
19:00		***END; Postersession with Apéro***

ID	New prospects in ARPES for quantum materials Poster
531	**Momentum-space imaging and chemical gating of the novel polarization induced two-dimensional electron and hole gases on AlN single crystals**

Enrico Della Valle [1,2], Debdeep Jena [3], Guru Khalsa [3], Thai-Son Nguyen [3], Vladimir Strokov [2], Zexuan Zhang [3]
[1] ETH Zürich, [2] PSI Villigen, [3] Cornell

Lattice-matched interfacing of two large band-gap semiconductors such as AlN, AlGaN, and GaN can induce high-mobility electron and hole charge carriers without addition of dopants. Determining this phenomenon are the pseudomorphic strain and the spontaneous polarization along the (0001) direction. To access the physics of the interfacial charge carriers confined in quantum-well states, we have measured their k-resolved band structure with soft-X-ray ARPES. Additionally, we have experimentally demonstrated how deposition of atoms with different electron affinities can move the Fermi level within the heterostructure and eventually increase or deplete the concentration of interfacial electrons and holes.

ID	
~~532~~	*moved to talk 517*
533	**Doping and temperature dependence evolution of the electronic properties of electron-doped Sr_2IrO_4 seen by ARPES**

Yann Alexanian [1], Anna Tamai [1], Felix Baumberger [1], Robin Perry [2]
[1] University of Geneva, Department of Quantum Matter Physics
[2] London Centre for Nanotechnology Faculty of Maths & Physical Sciences

Sr_2IrO_4 is a layered perovskite isostructural to the cuprate superconductor La_2CuO_4. The combination of strong spin-orbit coupling inherent to Ir^{4+} ions and modest Coulomb interaction induces a Mott insulating ground state with Heisenberg spin dynamics. Theses striking similarities with cuprates extend to the unusual metallic state of lightly doped Sr_2IrO_4 characterized by Fermi arcs and a pseudogap. Here, I will present new ARPES data on bulk crystals with higher doping than reached previously. Our results show that nodal states become more coherent with increased doping. At the same time, an antinodal pseudogap persists up to the highest doping, in contrast to previous results on surface doped Sr_2IrO_4.

ID	
~~534~~	*cancelled*

Spintronics and Magnetism at the Nanoscale

Wednesday, 06.09.2023, Room 115

Time	ID	**Spintronics and Magnetism at the Nanoscale I** *Chair: Aleksandr Kurenkov, ETH Zürich & PSI*
17:00	**601**	**High-Sensitivity and quantitative Magnetic Force Microscopy for the Analysis of Magnetic Multilayers supporting Skyrmions** *Hans J. Hug, EMPA, Swiss Federal Laboratories for Materials Science and Technology and Department of Physics, University of Basel* The development of magnetic thin film multilayers that support skyrmions through interfacial Dzyloshinskii-Moriya interaction can benefit greatly from high-resolution magnetic imaging techniques, such as magnetic force microscopy. Achieving highest sensitivity in MFM imaging requires operating in vacuum using cantilevers with quality factors of up to 1 million. However, this requires new operation modes to achieve a reproducible tip-sample distance control when the temperature is changed, or external magnetic fields are applied. Reproducible imaging conditions are essential for differential imaging techniques that can disentangle the contrast from the stray fields arising from the micromagnetic state of the sample from other contributions, such as signals arising from van der Waals force variations from the topography, local variations in the contact potential, or magnetic fields arising from spatial variations of the sample thickness and roughness. To obtain the stray field from the measured frequency shift contrast or to test the fidelity of MFM data simulated from the stray field of candidate micromagnetic model structures, a calibration of the MFM tip response to magnetic stray fields can be performed.
17:30	**602**	**Developing Metallic Multilayers Hosting Different Skyrmion Types Toward Local Control via Electric Fields** *Loghman Jamilpanah [1], Artur Braun [1], Hans Josef Hug [1,2], Andrada-Oana Mandru [1]* *[1] Empa, Swiss Federal Laboratories for Materials Science and Technology, CH-8600 Dübendorf* *[2] Department of Physics, University of Basel, CH-4056 Basel* The coexistence of two skyrmion types in a single system is highly relevant for future racetrack memory devices using such solitons. Here, we demonstrate a metallic ferromagnetic/ferrimagnetic (FM/FI) bi-layer system in which two skyrmion types are successfully stabilized at room temperature. This system has a simpler structure compared to the previous demonstration of the same observation in a FM/FI/FM trilayer. We show also how the two skyrmion types can be tuned by changing the magnetic properties of the FI. The simpler structure together with the FI control layer provide the opportunity for subsequent local control of the skyrmion type and pave the way for device implementation.
17:45	**603**	**Nanomagnets for manipulation of spin qubits** *Michele Aldeghi, Rolf Allenspach, Gian von Salis, IBM Research Zurich* The stray field of micro- and nanomagnets is exploited to manipulate the spin state of electrons confined in semiconductor quantum dots. Current devices use micromagnets that are uniformly magnetized along the direction of an external magnetic field. Here we introduce “U”-shaped Fe nanomagnets, where shape anisotropy sets a non-uniform magnetization pattern. We study the influence of size, shape and external applied magnetic field on such structures by micromagnetic simulations and spin-polarized scanning electron microscopy. We measure surface magnetization patterns for magnets down to 50 nm in width and discuss how nanomagnets are suitable for driving silicon spin qubits.

<table>
<tr><td>18:00</td><td>604</td><td>Domain wall qubits on magnetic racetracks

Ji Zou [1], Stefano Bosco [1], Jelena Klinovaja [1], Daniel Loss [1], Banabir Pal [2], Stuart Parkin [2]
[1] University of Basel, [2] Max Planck Institute of Microstructure Physics

We propose a scalable implementation of a quantum computer based on hardware-efficient mobile domain walls on magnetic racetracks. In our proposal, quantum information is encoded in the chirality of the spin structure of nanoscale domain walls. We estimate that these qubits are long-lived and could be operated at sweet spots reducing possible noise sources. Single-qubit gates are implemented by controlling the movement of the walls in magnetic nanowires, and two-qubit entangling gates take advantage of naturally emerging interactions between different walls. These gates are sufficient for universal quantum computing and are fully compatible with current state-of-the-art experiments on racetrack memories. Possible schemes for qubit readout and initialization are also discussed.</td></tr>
<tr><td>18:15</td><td>605</td><td>Orbital-torque-induced switching of perpendicular magnetization

Min-Gu Kang [1], Soogil Lee [2], Dongwook Go [3], Benjamin J. Jacot [1], Byong-Guk Park [2]
[1] Department of Materials, ETH Zürich
[2] Department of Materials Science and Engineering, KAIST
[3] Peter Grünberg Institut & Institute for Advanced Simulation, Forschungszentrum Jülich & JARA

Spin-orbit torque (SOT) has been intensively studied to realize energy efficient magnetization switching in spintronic devices. Recently, proposed orbital torque (OT) suggested that the large SOT can be generated even in weakly spin-orbit-coupled light metals by the orbital current. It is a consequence of the orbital Hall and/or orbital-Rashba effect and subsequent orbital-to-spin conversion via spin-orbit coupling. In this talk, we present the current-induced switching of perpendicular magnetization via orbital torque, which is efficiently tailored by orbital-to-spin conversion engineering. Our study suggests that the orbital current can be utilized to further enhance the magnetization switching efficiency in spin-orbit-torque-based spintronic devices.</td></tr>
<tr><td>18:30</td><td>606</td><td>Spin-orbit torques and thermal contributions to spin transport in CoFeB / $LaTiO_3$ / $SrTiO_3$

Lauren Riddiford, Sauviz Alaei, Yuri Suzuki, Shan X Wang, Fen Xue, Xin Yu Zheng
Stanford University

The Rashba-type spin orbit coupling found at the interface of two dimensional electron gases (2DEGs) is of great interest for spintronic applications. Here, we uncover the nature of spin transport from a 2DEG to magnetic metal via second harmonic Hall measurements, spin-torque ferromagnetic resonance, and temperature-dependent ferromagnetic resonance (FMR). While FMR indicates enhanced spin current absorption by the 2DEG, second harmonic Hall measurements reveal a large thermoelectric signal suggesting a strong in-plane thermal gradient generated by passing current through the $LaTiO_3$.</td></tr>
<tr><td>18:45</td><td>607</td><td>Spin-orbit control of antiferromagnetic domains without a Zeeman coupling

Marek Bartkowiak, Damaris Tartarotti Maimone, Michel Kenzelmann
Laboratory for Neutron Scattering and Imaging, Paul Scherrer Institut

Encoding information in antiferromagnetic (AFM) domains is a promising solution for the ever growing demand in magnetic storage capacity as the vanishingly small stray fields eliminate cross-talk between different domain states. However, the absence of macroscopic magnetization is detrimental to the manipulation and detection of AFM domains. We report evidence for a new AFM domain selection mechanism where the charge transport response is controlled by the rotation of the magnetic field not affecting the Zeeman term. A pronounced new anisotropic magnetoresistance effect is found in the AFM phases of bulk materials $Nd_{1-x}Ce_xCoIn_5$. Our results indicate that this constitutes a universal effect across multiband materials, opening new perspectives for AFM spintronics.</td></tr>
</table>

19:00	**608**	**Interfacing antiferromagnets with different magnetic ordering** *Xanthe Verbeek, Mayan Si, Nicola Spaldin, ETH Zürich* We study the structural, electronic, and magnetic properties of interfaces between two easy-axis antiferromagnets, Cr_2O_3 and α-Fe_2O_3. Cr_2O_3 is the prototypical linear magnetoelectric, in which an applied magnetic field induces an electric polarization, whereas isostructural α-Fe_2O_3 has a different antiferromagnetic ordering that does not allow a linear magnetoelectric response. We use density functional theory to study crystallographically distinct interface environments and extract magnetic interaction parameters, which we input into Monto Carlo simulations to determine the finite-temperature magnetic properties. We find interfacial magnetizations and antiferromagnetic domain orderings that are strongly interface-structure dependent.
19:15	**609**	**Propagating Spin-Wave Spectroscopy Studies in a Millikelvin Temperature Environment** *David Schmoll [1], Sebastian Knauer [1], Rostyslav Serha [1], Roman Verba [2], Andrey Voronov [1], Carsten Dubs [3], Andrii Chumak [1]* *[1] University of Vienna, Faculty of Physics, Boltzmanngasse 5, Vienna, Austria.* *[2] Institute of Magnetism of NAS of Ukraine and MES of Ukraine* *[3] INNOVENT e. V. Technologieentwicklung, Prüssingstraße 27 B, Jena, Germany* Technological advancements in the access to millikelvin temperatures allow first steps towards the investigation of individual magnons in the field of quantum magnonics. Such experiments require millikelvin base temperatures, to ensure a thermal magnon-free system. Here, we measured spin-wave transmission at temperatures below 45 mK in a yttrium-iron-garnet (YIG) film on a 500 μm-thick gadolinium-gallium-garnet (GGG) substrate, using a cryogenic propagating spin-wave spectroscopy (PSWS) setup. These experiments revealed an increase of the spin-wave damping due to the paramagnetic GGG substrate, which was further investigated in temperature dependent ferromagnetic resonance (FMR) studies and k-dependent PSWS experiments. The obtained results consolidate the understanding of spin waves at cryogenic temperatures.
19:30		

Thursday, 07.09.2023, Room 115

Time	**ID**	**Spintronics and Magnetism at the Nanoscale II** *Chair: Jeffrey Brock, ETH Zürich & PSI*
14:00	**611**	**The Spin-wave Asymmetry in Confined Rectangular $Ni_{80}Fe_{20}$ Microstrips** *Santa Pile [1], Andreas Ney [1], Kilian Lenz [2], Ryszard Narkowicz [2], Jürgen Lindner [2], Sebastian Wintz [3], Johannes Förster [3], Sina Mayr [4], Markus Weigand [5]* *[1] Johannes Kepler University Linz, [2] Helmholtz-Zentrum Dresden-Rossendorf* *[3] Max Planck Institute for Intelligent Systems, [4] Paul Scherrer Institut, Villigen PSI* *[5] Helmholtz-Zentrum Berlin für Materialien und Energie* The design of a microstructure can affect the internal field distribution and, therefore, the spin-wave (SW) behaviour. Under the uniform excitation only symmetric SW interference pattern is expected. Changes in the geometry of the structure can cause breaking of the symmetry. In this work the asymmetry parameter (AP) of SW dynamics in confined rectangular permalloy microstrips is suggested and applied to the TR-STXM results and micromagnetic simulations. In this work profiles of the out-of-plane component of the dynamic magnetization are analyzed. The results show a higher asymmetry for a strip when a second perpendicular microstrip is placed at the distance of 2 μm.

14:30	612	**Propagating spin-wave spectroscopy in a liquid-phase epitaxial nanometer-thick YIG film at millikelvin temperatures** *Sebastian Knauer [1], Kristýna Davídková [2], David Schmoll [1], Rostyslav Serha [1], Andrey Voronov [1], Qi Wang [3], Roman Verba [4], Oleksandr Dobrovolskiy [1], Morris Lindner [5], Timmy Reimann [5], Carsten Dubs [5], Michal Urbánek [2], Andrii Chumak [1]* *[1] Faculty of Physics, University of Vienna, Boltzmanngasse 5, Vienna* *[2] CEITEC BUT, Brno University of Technology, Purkyňova 123, Brno, Czech Republic* *[3] Huazhong University of Science and Technology* *[4] Institute of Magnetism, Kyiv* *[5] INNOVENT e.V. Technologieentwicklung, Prüssingstraße 27 B, Jena, Germany* To realise large-scale integrated magnonic circuits for quantum applications it is required to perform propagating spin-wave spectroscopy in nanostructures at low temperatures. In this work, we demonstrate all-electrical spin-wave propagation in a 100 nm-thick yttrium-iron-garnet (YIG) film at temperatures down to 45 mK. The extracted spin-wave group velocity and the YIG saturation magnetisation agree well with the theoretical values. We show that the gadolinium-gallium-garnet (GGG) substrate influences the spin-wave propagation characteristics only for the applied magnetic fields beyond 75 mT, originating from a GGG magnetisation up to 62 kA/m (45 mK). Our results demonstrate that the developed fabrication and measurement methodologies enable the realisation of integrated magnonic quantum nanotechnologies at millikelvin temperatures.
14:45	613	**Fast isotropic exchange spin waves in Ga:YIG for future magnonic networks** *Khrystyna Levchenko [1], Tobias Böttcher [2,3], Moritz Ruhwedel [2], Qi Wang [1,4], Hryhorii Chumak [5], Maksym Popov [5], Igor Zavislyak [5], Carsten Dubs [6], Oleksii Surzhenko [6], Burkard Hillebrands [2], Andrii Chumak [1], Philipp Pirro [2]* *[1] NanoMag research group, Faculty of Physics, University of Vienna* *[2] Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern* *[3] MAINZ Graduate School of Excellence, Mainz* *[4] Huazhong University of Science and Technology (China)* *[5] Faculty of Radiophysics, Electronics and Computer Systems, Taras Shevchenko National University of Kyiv (Ukraine)* *[6] INNOVENT e.V. Technologieentwicklung, Jena* To facilitate magnonics technology, the delay time in nanostructures should be improved. Hence, single-crystalline sub-100 nm thick films of Ga:YIG and reference YIG were fabricated and characterised via VSM, FMR and BLS. Ga:YIG demonstrates a perpendicular magnetic anisotropy, reduced magnetisation, good Gilbert damping, and an enhanced exchange stiffness, which results in improved (~ 3.4 times) group velocities for $k > 30$ rad/µm. The spin waves soon (from $k \approx 4$ rad/µm) start to exhibit an exchange nature and their dispersion is more isotropic compared to pure YIG. Therefore, Ga:YIG opens access to the operation with fast isotropic exchange spin waves in future magnonic applications.
15:00	614	**Influence of paramagnetic GGG substrate on YIG films at millikelvin temperatures** *Rostyslav Serha [1], Andrey Voronov [1], David Schmoll [1], Roman Verba [2], Sabri Koraltan [1], Kristýna Davídková [3], Barbora Budinská [1], Qi Wang [4], Oleksandr Dobrovolskiy [1], Michal Urbánek [3], Morris Lindner [5], Timmy Reimann [5], Carsten Dubs [5], Claas Abert [1], Dieter Suess [1], Sebastian Knauer [1], Andrii Chumak [1]* *[1] University of Vienna, Faculty of Physics, Boltzmanngasse 5, 1090 Vienna* *[2] Institute of Magnetism, Kyiv* *[3] CEITEC BUT, Brno University of Technology, Purkyňova 123, Brno, Czech Republic* *[4] Huazhong University of Science and Technology* *[5] INNOVENT e. V. Technologieentwicklung, Prüssingstraße 27 B, Jena, Germany* It is known that YIG films on GGG substrates worsen their magnetic properties important for magnonics at low temperatures. We present experimental results, simulations, and an analytical theory to clarify the influence of the GGG substrate on a 97 nm-thick YIG film at ultralow temperatures. At low temperatures, the paramagnetic GGG substrate can be magnetized by an external magnetic field. The GGG magnetization creates a stray field in the YIG film that affects its magnetization

dynamics. In the case of in-plane magnetization of YIG/GGG the FMR frequency is shifted to lower values. Simultaneously, the magnetic damping of YIG increases by more than eight times compared to measurements at room temperature.

15:15 | 615

Non-reciprocal magnonic directional coupler

Noura Zenbaa [1], Qi Wang [2], Kristýna Davídková [3], Sebastian Knauer [1], Moritz Ruhwedel [4], Oleksandr Dobrovolskiy [1], Sabri Koraltan [1], Claas Abert [1], Carsten Dubs [5], Michal Urbánek [3], Philipp Pirro [4], Dieter Suess [1], Andrii Chumak [1]
[1] Faculty of Physics, University of Vienna, Boltzmanngasse 5, 1090 Vienna
[2] Huazhong University of Science and Technology
[3] CEITEC BUT, Brno University of Technology, Purkyňova 123, Brno, Czech Republic
[4] Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern
[5] INNOVENT e. V. Technologieentwicklung, Prüssingstraße 27 B, Jena, Germany.

We use a bilayer of YIG/CoFeB to construct waveguides of the directional coupler to induce non-reciprocity in the spin-wave propagation and add new functionalities to the directional coupler. The non-reciprocity due to the symmetry breaking leads to Δk being different in the two propagation directions when magnetized in the Damon-Eschbach configuration (+*k* –*k*). Therefore, the coupling length differs in the two directions. At a frequency, where $L_{-k} = 2L_{+k}$, the directional coupler operates as a Y-circulator. The spin-wave dispersion curves are numerically investigated in nm-thick bilayers of YIG(100)/CoFeB(40) and YIG(100)/SiO_2(5)/CoFeB(40) plane films as well as in nano-scale waveguides and measured using Ferromagnetic Resonance (FMR) spectroscopy and k-resolved Brillouin Light Scattering (BLS) spectroscopy.

15:30 | 616

Probing magnetic coupling of spins on surfaces using EPR-STM

Aishwarya Vishwakarma, S. Kovarik, R. Schlitz, D. Ruckert, Pietro Gambardella, S. Stepanow
Department of Materials, ETH Zürich, CH-8093 Zürich

Manipulating spins and magnetic interactions for quantum computing encounters challenges due to invasive measurements. We employ spin-polarized scanning tunnelling microscopy (STM) to conduct electron paramagnetic resonance (EPR) experiment which probes magnetic interaction between spins delocalized into molecular orbitals of pentacene dimers. Spins in these organic molecules couple through overlapping orbitals within μeV regime, sensitive to exceptional energy resolution of EPR-STM. The dominant exchange coupling is investigated for different dimer configurations on MgO/Ag(100). Despite the anticipated antiferromagnetic coupling, we report ferromagnetic coupling due to current-induced pumping effect. This study aims to offer a non-invasive approach to intrinsic properties of remotely-driven spin.

15:45 | 617

Modelling the dynamics and consequences of frustrated magnetism in the hexagonal manganites

Tara Tosic, Nicola Spaldin, ETH Zürich

Using symmetry analysis, first-principles density functional theory and spin dynamics, we pinpoint the origin of the diffuse neutron scattering observed in hexagonal yttrium manganite (h-$YMnO_3$). h-$YMnO_3$ is a prototype system for studying frustrated magnetism, due to its dominant first nearest-neighbor anti-ferromagnetic coupling on a triangular lattice. We argue that thermal fluctuations departing from the ground state 120° spin configuration - a scenario ruled out in previous modelling attempts - give rise to short-range correlations. Though a hierarchy of nearest-neighbor exchanges and magnetic anisotropy terms, clusters of ordered spins form and interact with each other, creating excitations. Moreover, we simulate the formation of planar and vertical magnetic domains.

16:00 | 618

X-ray Linear Dichroic Tomography

Andreas Apseros [1], Christian Appel [2], Claire Donnelly [3], Zirui Gao [1], Manuel Guizar-Sicairos [2], Mirko Holler [4], Johannes Ihli [5], Valerio Scagnoli [1]
[1] ETH Zürich, [2] EPFL, [3] Max Planch Institute for Chemical Physics of Solids,
[4] Paul Scherrer Institut, [5] University of Oxford

Functional materials, from catalysts to energy storage and load-bearing materials, are hierarchical polycrystalline composites. Their functionality derives from their composition, the 3D arrangement of components and their microstructure; the distribution of crystalline grains and the defects within them. Techniques providing this combination of information are currently either limited to planar

		investigations, provide insufficient spatial resolution, are destructive or don't allow the examination of system-representative volumes, hampering the rational-driven optimization of current and design of next-generation materials. Here, we introduce ptychographic X-ray linear dichroic vector tomography, facilitating a quantitative, non-invasive, and simultaneous intra- and inter-granular characterisation of extended polycrystalline and amorphous samples in 3D with nanometre spatial resolution.
16:15	**619**	**Three-Dimensional Characterization of the Metamagnetic Phase Transition in B2-Ordered FeRh** *Jamie Robert Massey [1,2], Andreas Apseros [1], Peter Derlet [1,2], Claire Donnelly [3], Simone Finizio [2], Michael Grimes [2], Laura Heyderman [1,2], Jörg; Raabe [2], Joakim Reuteler [1], Valerio Scagnoli [1,2], Thomas Thomson [4], Samuel Treves [2,5]* *[1] ETH Zürich, [2] Paul Scherrer Institut, [3] Max Planck Institute, [4] University of Manchester, [5] University of Basel* We use soft x-ray magnetic laminography to characterize the three-dimensional spatial evolution of both the ferromagnetic and antiferromagnetic domains through the FeRh first-order phase transition. We observe different distributions of the nucleating magnetic domains in three-dimensions on heating and cooling. Monte Carlo simulations reveal different sample properties – namely, the sample surface and local variations in the exchange energy - are responsible for the nucleation of domains of differing magnetic order. This asymmetry suggests the microscopic mechanism responsible for the transition differs on heating and cooling, which affects the systems' macroscopic thermodynamic properties.
16:30		***Coffee Break; END***
19:30		***Conference Dinner***

ID	Spintronics and Magnetism at the Nanoscale Poster
631	**Controlling interactions in a kagome artificial spin ice coupled to a cobalt underlayer** *Tianyue Wang, Luca Berchialla, Peter Derlet, Laura Heyderman, Gavin Macauley* *ETH Zürich & Paul Scherrer Institute* Artificial spin ices are arrays of nanomagnets, which are coupled through dipolar interactions. The kagome artificial spin ice is the archetypal, highly frustrated example. It is predicated to exhibit a rich phase diagram but the ground state proves difficult to reach. In this project, we investigate how the presence of a cobalt underlayer and a platinum spacer affects the interactions between nanomagnets, and whether it promotes the formation of a low energy state on thermal annealing. By using magnetic field microscopy and x-ray photoemission electron microscopy, we study how the position of magnetic domains in the thin film layer influences the effective interaction between nanomagnets.
632	**Nonlinear spin-wave transport in the YIG nano-waveguides** *Kristýna Davídková [1], Andrii Chumak [1], Carsten Dubs [2], Sebastian Knauer [1], Morris Lindner [2], Timmy Reimann [2], Michal Urbánek [3], Andrey Voronov [1], Qi Wang [1], Ondřej Wojewoda [3]* *[1] University of Vienna, Faculty of Physics, Boltzmanngasse 5, Vienna, Austria* *[2] INNOVENT e. V. Technologieentwicklung, Prüssingstraße 27 B, Jena, Germany* *[3] CEITEC BUT, Brno University of Technology, Purkyňova 123, Brno, Czech Republic.* We report the nonlinear spin-wave transport in the array of the ten and ninety 260 nm wide YIG nano-waveguides. A new method based on Ar^+ ion beam etching was developed for the nano-waveguide fabrication using a positive CSAR resist as a hard mask. For generating and detecting spin waves, 2 μm wide microwave antennas spaced 5 μm apart are used. The propagating spin-wave spectroscopy is measured in Damon-Eshbach and backward volume configurations for different microwave powers to evaluate the efficiency of the nonlinear multimagnon scattering processes and compare it with the reference case of a continuous YIG film.

633	**Ultrafast Magnetization Dynamics in Arrays of Dipolar-Coupled Permalloy Nanostructures** *Davide Pecchio [1,2], Sergii Parchenko [3], Laura Heyderman [1,2], Kevin Hofhuis [2], Sourav Sahoo [1,2], Valerio Scagnoli [1,2]* *[1] ETH Zürich, [2] Paul Scherrer Institute, [3] European XFEL GmbH* Despite more than two decades of research, the proposed microscopic mechanisms underpinning laser-induced ultrafast demagnetization in magnetic thin films are not fully established. Little attention has been paid so far to nano-sized systems, where dipolar coupling and shape anisotropy may play an important role. We show that the optically-induced ultrafast magnetization suppression in arrays of parallel-oriented permalloy nanostructures can substantially differ from that of unpatterned thin films. In thin films, the Kerr signal increases before the material's demagnetization, suggesting an optically induced spin transfer (OISTR) between the sublattices of the alloy. In contrast, the efficiency of this mechanism is highly reduced in the nanostructures.
634	**Strong lateral exchange coupling and current-induced switching in single-layer ferrimagnetic films with patterned compensation temperature** *Ales Hrabec [1,2], Zhentao Liu [1,2], Zhaochu Luo [3], Ivan Shorubalko [4], Christof Vockenhuber [1], Laura Heyderman [1,2], Pietro Gambardella [1]* *[1] ETH Zürich, [2] Paul Scherrer Institute, [3] Peking University* *[4] Swiss Federal Laboratories for Materials Science and Technology* Magnetic interlayer couplings are widely explored in spintronic architectures, while the lateral couplings are rarely studied. Here we demonstrate a lateral interfacial exchange coupling based effect in ferrimagnetic thin film systems by patterning the device into regions with different compensation temperatures via oxidation and He^+ irradiation. We show that the coupling induced exchange bias can reach up to 2.5 T in nanoscale domain wall track devices. Furthermore, by combining with spin orbit torques, we demonstrate current induced switching of compensated ferrimagnet and lat- eral exchange bias structures. The discovery of lateral exchange coupling opens new possibilities in planar spintronic device designs.
635	**Spin Waves in a Three-Dimensional Artificial Spin Ice Structure** *Sourav Sahoo [1], Anjan Barman [1], Sam Ladak [2], Andrew May [2], Amrit Kumar Mondal [1], Arjen van den Berg [2]* *[1] Department of Condensed Matter and Materials Physics, S. N. Bose National Centre for Basic Sciences* *[2] School of Physics and Astronomy, Cardiff University* Exploration of high-frequency magnetization-dynamics in three-dimensional (3D) magnetic nanostructures may lead to paradigm-shifting in next-generation spintronic and magnonic devices. Despite remarkable progress in fabrication, the measurement and interpretation of magnetization-dynamics in 3D magnetic structures has remained challenging. Here we present the measurement of coherent spin-waves within a 3D artificial spin-ice (ASI) system, fabricated by using two-photon lithography and thermal evaporation. Two spin-wave modes were observed in the Brillouin light scattering (BLS) spectra whose frequencies showed nearly monotonic variation with the applied magnetic field strength. Numerical simulations revealed the collective nature of the modes extending throughout the complex network of nanowires while showing spatial quantization with varying mode quantization numbers.
636	**Full dipolar model for the Archimedean lattices of spin ices** *Aleksandra Pac [1], Gavin M. Macauley [1,2], Jamie R. Massey [1,2], Frédéric Mila [3], Peter M. Derlet [1,2], Laura Heyderman [1,2]* *[1] Paul Scherrer Institute, [2] ETH Zürich, [3] EPFL* Artificial spin ices are arrays of dipolar-coupled single domain nanomagnets, which exhibit rich behaviour. We study a family of artificial spin ices, formed by placing out-of-plane nanomagnets on the vertices of the Archimedean lattices. By demagnetising these arrays using field protocols and imaging their configuration using magnetic force microscopy, we observe different types of magnetic ordering. We use experimental results and the Metropolis Monte Carlo simulations to obtain the residual entropy, magnetic correlations and effective temperatures for various lattice types. This allows us to catalogue the behaviour for lattices with varying frustration in the framework of a full dipolar model.

637	**Remarkable robustness of metastable skyrmion lattice in $NdMn_2Ge_2$ at room temperature**

Samuel Treves [1], Andreas Apseros [2], Simone Finizio [3], Naoya Kanazawa [4], Aki Kitaori [4], Patrick Maletinsky [1], Jamie Robert Massey [2,3], Valerio Scagnoli [2,3], Yoshinori Tokura [4], Victor Ukleev
[1] Department of Physics, University of Basel, 4056 Basel, [2] ETH Zürich, [3] Paul Scherrer Institut, [4] University of Tokyo

Metastable magnetic topological textures are of high interest to the spintronics community, in part because may find applications in future magnetic data storage technologies. $NdMn_2Ge_2$ is a rare-earth complex non-collinear ferromagnet, which has been shown to host metastable skyrmions at room temperature with no applied magnetic field. Here we, present a scanning transmission x-ray microscopy study on a skyrmion lattice within a single crystal $NdMn_2Ge_2$ lamella. We demonstrate the robustness of this lattice to temperature and magnetic field variations, and thereby the potential of this material for future spintronics applications.

638	**Magnetic phase transition in Molybdenum disulfide detected with AFM**

Akash Gupta, Alexina Ollier, Marcin Kisiel, Mehdi Ramezai, Andreas Baumgartner, Urs Gysin, Christian Schönenberger, Ernst Meyer, University of Basel

Low doping electron-electron interactions in monolayer MoS_2 lead to a ferromagnetic spin order,whereas larger occupation of spin-polarized energy bands results in paramagnetism. The electron density of MoS_2 might be tuned with gate voltage, thus providing the switch ability of the ferromagnetic to paramagnetic first-order phase transition. An abrupt phase transition in two-dimensional semiconductor gated MoS_2 monolayer is detected by magnetic force spectroscopy. Spontaneous reproducible changes of the magnetic force were observed at doping concentration equal to $n = 3.0 \times 10^{12}$ cm^{-2} and are attributed to first order ferromagnetic to paramagnetic phase change. Linear dependence of force versus external magnetic field was noted in the paramagnetic state, whereas no dependence was found in ferromagnetic state.

639	**High frequency antennas for all-electrical excitation and detection of propagating spin waves**

Andreas Höfinger, David Schmoll, Andrey Voronov, Sabri Koraltan, Claas Abert, Dieter Suess, Andrii Chumak, Sebastian Knauer
University of Vienna, Faculty of Physics, Boltzmanngasse 5, Vienna, Austria.

A requirement for the realisation of large-scale magnon-based circuits is the low-loss excitation and detection of spin-waves. To minimise radiation losses and to approach single magnon level, an efficient coupling of high frequency microwave signals to propagating spin waves is required. In particular, large-area impedance-matched and on-chip lithographed nanoantennas are necessary. Here we demonstrate an efficient coupling between electromagnetic waves and spin waves with different nanoantenna designs, using finite element and finite difference micromagnetic simulations. Specifically, radiation and reflection losses are investigated. Further, we fabricate and measure the characteristics of the nanoantennas deposited on yttrium-iron-garnet films using vector network analyser.

640	**Phase Transitions and Magnetic Order in a Ruby Lattice Artificial Spin Ice**

Luca Berchialla [1], Peter Derlet [1,2], Laura Heyderman [1,2], Gavin Macauley [1,2], Valerio Scagnoli [1,2], Tianyue Wang [1,2]
[1] Paul Scherrer Institute, [2] ETH Zürich

Artificial spin ice are arrangements of dipolar coupled nanomagnets, which exhibit a range of interesting behaviour. Here, we study an artificial spin ice based on the ruby lattice. This pattern has a complex unit cell with 12 nanomagnets and two lattice constants that define it. By varying the two lattice constants independently, we can change the interaction between nanomagnets. Using x-ray photoemission electron microscopy we observed different ordering mechanisms depending on the lattice constants. Moreover, the system can order in one or two steps as shown by Monte Carlo simulations.

641

Phase Transitions and Magnetic Order in a Twisted Form of the Kagome Artificial Spin Ice

Gavin Macauley [1,2], Luca Berchialla [1], Aleksandra Pac [1], Tianyue Wang [1,2], Rhea Stewart [1,2], Armin Kleibert [1], Valerio Scagnoli [1,2], Peter Derlet [1,2], Laura Heyderman [1,2]
[1] Paul Scherrer Institute, [2] ETH Zürich

Artificial spin ices are arrays of strongly-correlated nanomagnets, which provide a valuable platform to study phase transitions. The kagome artificial spin ice is a highly frustrated example that undergoes two separate ordering transitions. We show how rotating each nanomagnet in the kagome lattice about its centre allows us to access a rich phase diagram. Using a combination of magnetic force microscopy to characterise the as-grown states and x-ray photoemission electron microscopy to observe the thermally-active states, we determine how ordering proceeds in the different arrays. We find that the rotation maps from a spin ice sector near hexagonal geometries to a ferromagnetic phase, and then to a flux closed state.

642

2D curved nano-conduits for magnonic transport made of GaYIG

Andrey Voronov [1], Ondřej Wojewoda [2], Kristýna Davídková [2], Qi Wang [3], Carsten Dubs [4], Michal Urbánek [2], Andrii Chumak [1]
[1] University of Vienna, Faculty of Physics, Boltzmanngasse 5, Vienna, Austria
[2] CEITEC BUT, Brno University of Technology, Purkyňova 123, Brno, Czech Republic
[3] Huazhong University of Science and Technology
[4] INNOVENT e. V. Technologieentwicklung, Prüssingstraße 27 B, Jena, Germany

We present a study on the effective propagation of spin waves in curved nano-conduits made of Gallium-substituted Yttrium Iron Garnet (GaYIG) using micro-focused Brillouin Light Scattering spectroscopy. The investigation was carried out in the Forward Volume geometry to ensure an isotropic in-plane medium for spin-wave propagation. The curved nano-conduits have a thickness of 69 nm and a minimum width of 170 nm. Due to the pronounced uniaxial anisotropy of GaYIG, an external magnetic field of 50 mT is sufficient to magnetise it. Long-range propagation of spin waves was observed because GaYIG has a high exchange stiffness. Our results pave a promising way for efficient information transport in 2D magnonic networks.

643

Anisotropic Spin Orbit Torque in Epitaxial Pt (110) Thin Films

Ryan Thompson, University of Fribourg

Over the past decade of spintronics research, spin-orbit torque (SOT) has emerged as an ultrafast and energy efficient method for electrically switching magnetizations. Ultrathin heavy metal/ferromagnetic bilayers have been the subject of particular interest, due to the strong spin-orbit coupling in heavy metals, as well as having many materials engineering opportunities to tune the SOT. One promising path forward for this has been epitaxial growth, which has been shown to enhance spin Hall angles and lower critical currents. In this work, we show that the SOT and spin Hall angle exhibit anisotropy with regards to crystallographic direction in epitaxial Pt (110) thin films, providing another avenue for tuning the SOT.

644

From randomly distributed to short range ordered spins: Dy/HOPG

Alexis Rary-Zinque, Marina Pivetta, Maria Alfonso Moro, Stefano Rusponi, Harald Brune, François Patthey, EPFL

Magnetization curves recorded with X-ray magnetic circular dichroism on samples with a few % of a monolayer (ML) of Dy atoms on highly oriented pyrolytic graphite (HOPG) indicate two distinct magnetic species with mutual antiferromagnetic interactions. To understand the origin and magnetic interactions of the species, spatial distributions of Dy atoms and small clusters were studied using scanning tunneling microscopy. While deposition at 10 K gave statistical growth, deposition at 40 – 60 K with possible thermal diffusion led to equally spaced atoms suggesting repulsive dipolar interactions caused by charge transfer between the adatom and substrate. The atoms have a direct capture area of a 3-sites radius; atoms landing inside that area form dimers.

645

Nanoscale imaging of materials for memories and quantum bits with Scanning NV Magnetometry

Liza Žaper [1,2], Vicent Borras [2], Robert Carpenter [3], Sebastien Couet [3], Boris Gross [1], Marcus Wyss [4], Patrick Maletinsky [1], Martino Poggio [1,4], Floris Braakman [1], Peter Rickhaus [2]
[1] Department of Physics, University of Basel, [2] Qnami AG, Muttenz, Switzerland
[3] IMEC, Loewen, Belgium, [4] Swiss Nanoscience Institute, University of Basel

Storing information in magnetic bits requires excellent control over their nanoscale magnetic properties. A prime example of this challenge are STT-MRAM (spin transfer torque magnetic random access memory) devices - which have rather high failure rates. In order to investigate the sources of potential failure, a technique that can resolve small magnetic fields with high spatial resolution is required. The request is even more urgent for next-generation magnetic memory materials, such as antiferromagnets, which generate even smaller magnetic signals. Scanning NV magnetometry (SNVM) is an emerging quantum sensing technique that offers the required sensitivity. Here, we will look at the local magnetic properties of bits in state-of-the-art STT-MRAM devices using SNVM, as well as the SNVM results of Co – nanomagnets for spin qubit control.

Magnetic fields for materials research

This session is supported by the EU project Isabel.
(https://emfl.eu/isabel/h2020-project/)

Thursday, 07.09.2023, Room 115

Time	ID	**Magnetic fields for materials research** *Chair: Stefano Gariglio, Université de Genève*
17:00	**681**	**Present and Future scientific opportunities in EMFL (European Magnetic Field Laboratory)** *Charles Simon, Laboratoire national des champs magnétiques intenses (LNCMI)* *CNRS, 25 avenue des Martyrs, FR-38042 Grenoble cedex 09* *CNRS, 143 Avenue de Rangueil, FR-31400 Toulouse* This presentation will review the present and future opportunities in EMFL for high magnetic fields experiments up to 200 T in pulsed fields and 45 T in continuous fields. Some scientific examples will be shown in this presentation, as well as the procedure to request access to high magnetic fields. A fully superconducting magnet of 40 T should be also available in future. EMFL is a European facility located in four sites: Grenoble, Nijmegen, Toulouse and Dresden. EMFL is supported by the European program ISABEL to attract new users especially from Switzerland.
17:30	**682**	**Landau level spectroscopy as a window into topological semimetals** *Ana Akrap, Department of Physics University of Fribourg, Ch. du Musée 3, CH-1700 Fribourg* A strong magnetic field confines band electrons to a discrete set of Landau levels. The material's band structure is directly linked to the energy spectrum of these Landau levels. With infrared light, we can excite transitions of carriers from one level to another, and these are called inter- Landau level transitions. Since the early 1950s, this Landau level spectroscopy has been widely employed as an extremely sensitive probe of semimetal and semiconductor band structures. I will give an overview of our recent progress on Landau level spectroscopy of Dirac and Weyl semimetals. Through advanced techniques, we can resolve intricate complexities of their bands, all while discovering new physics. I will present our new analysis of highly detailed inter- Landau level transition maps in extreme magnetic fields. I will discuss how novel approaches allows us to further exploit the rich magneto-optical spectra, and gain deep knowledge of topological semimetals.
18:00	**683**	**Exploring quantum matter under extreme conditions at the SwissFEL Cristallina endstation** *Alexander Steppke* *Laboratory for X-ray Nanoscience and Technologies, Paul Scherrer Institut, Villigen PSI, &* *Laboratory for Quantum Matter Research, University of Zürich* Brilliant, ultrashort, and coherent X-ray free-electron laser (FEL) pulses are primarily used for investigation of dynamics at the inherent time and length scale of atoms. In addition, the unprecedented peak brilliance also allows for single-shot experiments that are not feasible at other X-ray sources. The latter will be used to image quantum many-body states under extreme conditions at the Cristallina endstation of SwissFEL's hard X-ray beamline. In particular, millisecond high magnetic field pulses will be synchronized to the femtosecond X-ray pulses, enabling X-ray diffraction at both high magnetic field strengths and low temperatures. In this talk, I will review our commissioning progress reaching magnetic field of up to and beyond 40 T, and elaborate on the path towards user operation after the commissioning phase.

18:30	**684**	**Dual nature of charge carriers in the iron-based superconductor $FeSe_{1-x}S_x$** *Matija Čulo [1], Jake Ayres [2], Salvatore Licciardello [3], Maarten Berben [3], Yu-Te Hsu [3], Roemer Hinlopen [2], Shigeru Kasahara [4], Yuji Matsuda [5], Takasada Shibauchi [6], Nigel Hussey [2,3]* *[1] Institut za fiziku, Bijenička cesta 46, HR-10000 Zagreb, Croatia* *[2] H. H. Wills Physics Laboratory, University of Bristol, Tyndall Avenue, Bristol BS8 1TL, UK* *[3] High Field Magnet Laboratory (HFML-EMFL) and Institute for Molecules and Materials, Radboud University, Toernooiveld 7, 6525 ED Nijmegen, Netherlands* *[4] Research Institute for Interdisciplinary Science, Okayama University, 3-1-1 Tsushimanaka, Kita-Ku, Okayama 700-8530, Japan* *[5] Department of Physics, Kyoto University, Sakyo-Ku, Kyoto 606- 8502, Japan* *[6] Department of Advanced Materials Science, University of Tokyo, Kashiwa, Chiba 277-8561, Japan* The discovery of high-temperature superconductivity in materials that contain iron was accepted with surprise in the condensed matter community, since it had been widely believed that iron with a large magnetic moment is harmful to the emergence of superconductivity. Among these iron-based superconductors, $FeSe_{1-x}S_x$ attracted a special attention because of its unique phase diagram, in which superconductivity emerges from a pure electron nematic state, therefore providing an opportunity to study the interplay between nematicity and unconventional superconductivity. The transition to the nematic state in the parent compound FeSe occurs at around 90 K and is followed by the transition to the superconducting (SC) state at around 10 K. This nematic transition can be strongly suppressed by applying a hydrostatic pressure which in turn leads to the stabilization of an antiferromagnetic state. The nematic transition can be strongly suppressed also by changing Se with S, in which case it is believed that it terminates as a nematic quantum critical point (QCP) at the critical S-substitution $x \approx 0.17$ inside the SC state. Here we present our detailed resistivity magnetoresistance and Hall effect study on $FeSe_{1-x}S_x$, conducted on a series of single-crystalline samples with $0 \leq x \leq 0.25$ spanning the nematic QCP, in high magnetic fields (H) up to 38 T, at very low temperatures (T) down to 300 mK and at high pressures up to 15 kbar. Our results indicate that the normal (non-SC) state of $FeSe_{1-x}S_x$ is highly unconventional and that the charge transport there can be decomposed into two distinct components. One component exhibits the standard Fermi liquid behavior such as T_2 resistivity, H_2 magnetoresistance and H-linear Hall response. The other component shows strong signatures of strange metal behavior, the most important of which are T-linear resistivity, quadrature scaling with H-linear magnetoresistance at high H and anomalous Hall response with an exponential tail-off at high H. The strange metal component becomes very pronounced in vicinity of the nematic QCP and weakens significantly with moving away from it either by changing S-substitution, or by applying pressure. Such complex behavior possibly points towards a dual nature of charge carriers in $FeSe_{1-x}S_x$, triggered by the presence of quantum critical nematic fluctuations that selectively influence only certain parts of the Fermi surface.
19:00		***END; Transfer to Dinner***
19:30		***Conference Dinner***

Neutron Science

This session has been organised in collaboration with the Swiss Neutron Science Society.

Wednesday, 06.09.2023, Room 117

Time	ID	**Neutron Science I** *Chair: Gediminas Simutis, PSI Villigen*
14:30	701	**Field-induced bound-state condensation and spin-nematic phase of $SrCu_2(BO_3)_2$ revealed by neutron scattering up to 25.9 T** *Ellen Fogh [1], Maciej Bartkowiak [2], Frédéric Mila [1], Mithilesh Nayak [1], Bruce Normand [3], Ekaterina Pomjakushina [3], Oleksandr Prokhnenko [2], Henrik Rønnow [1]* *[1] École Polytechnique Fédérale de Lausanne* *[2] Helmholtz-Zentrum Berlin für Materialien und Energie* *[3] Paul Scherrer Institute* Chasing new states of quantum matter is a central element in condensed matter physics, motivated both by curiosity but also by the need for understanding of many-body quantum effects. One particularly interesting system is the frustrated Shastry-Sutherland model consisting of orthogonal spin pairs. The network of Cu^{2+} ions in $SrCu_2(BO_3)_2$ is topologically equivalent to this lattice and therefore presents a unique experimental testing opportunity. We study the magnetic excitations in $SrCu_2(BO_3)_2$ upon approaching the first magnetization plateau at 27 T using inelastic neutron scattering. At field values much below the transition an unexpected mode shows up. We set out to identify the nature of this new excitation.
14:45	702	**Mapping the magnon modes of a square skyrmion lattice** *Danielle Yahne [1], Wolfgang Simeth [1], Simon Flury [1], David Voneshen [2], Andrey Podlesnyak [3], Daniel Mazzone [1], Jakob Lass [1], Christof Niedermayer [1], Stephane Raymond [4], Sean Thomas [5], Priscilla Rosa [5], Marc Janoschek [1]* *[1] Paul Scherrer Institut, [2] ISIS Facility, Rutherford Appleton Laboratory* *[3] Spallation Neutron Source, Oak Ridge National Laboratory* *[4] Institut Laue-Langevin, [5] Los Alamos National Laboratory* Intriguing topological magnetic textures, such as skyrmion lattices (SkL), have significant potential for applications to spintronic and memory devices. This potential crucially relies on finding new materials and mechanisms for SkL stabilization. So far, theory has been driving investigations of centrosymmetric SkL's, with only a few bulk material examples, namely Gd_2PdSi_3, $Gd_3Ru_4Al_{12}$, $GdRu_2Si_2$, and $EuAl_4$. Neutron scattering is an ideal probe to understand the interactions leading to SkL formation in these materials, but is practically impossible owing to the large neutron absorption of Gd and Eu. I will present recent neutron spectroscopy on a newly discovered Ce-based square-SkL, which enables a quantitative understanding of SkL stabilization mechanisms in real materials.
15:00	703	**Frustration-induced diffuse magnetic scattering in metallic $HoInCu_4$** *Xavier Boraley [1], Oliver Stockert [2], Oystein Fjellvag [2], Romain Sibille [1], Veronika Fritsch [3], Daniel Mazzone [1]* *[1] Paul Scherrer Institut, [2] Max Plank Institute, [3] Augsburg University* Materials with geometrical frustration are interesting study cases as they often exhibit unconventional phases of matter. While most research on frustrated materials have been performed on insulating spin systems, only little work has been done on metallic systems. Here, I will present recent neutron scattering results of the frustrated metal $HoInCu_4$, which features partial magnetic order where only half of the Holmium atoms exhibit long-range magnetic order, while the other half remain short-ranged. I will present diffuse magnetic scattering data as function of temperature, and discuss how they can be attributed to the magnetic nearest and next-nearest neighbor interactions.
	~~704~~	*cancelled*

15:15	705	**Non-trivial effects of cation disorder on spin-ice-like compound Ho_2ScTaO_7** *Amirreza Hemmatzade [1], Tom Fennell [1], Igor Plokhikh [1], Elsa Lhotel [2], Arkadiy Simonov [3], Dharmalingam Prabhakaran [4]* *[1] Paul Scherrer Institut, [2] Institute Neel, [3] ETH Zürich, [4] University of Oxford* Here we present our most recent results on the effects of charge disorder on classical spin ice. Motivated by our obsrvations in the effects of correlated disorder in both structure and magnetism of fluoride pyrochlore compound $CsNiCrF_6$ we set out to study the effects of charge disorder in B-site of classical spin ice, $Ho_2Ti_2O_7$, our system of choice is Ho_2ScTaO_7. We identify the effects of disorder on the lattice structure, in modification of the crystal electric field potential and in the spin ice state.
15:30	706	**Reverse Monte-Carlo modeling of artificial spin systems** *Artur Gregor Glavic [1], Gavin Macauley [1,2]* *[1] Paul Scherrer Institute, [2] ETH Zürich* Patterns of nano-scale magnets are important systems to investigate potential applications but also fundamental physics of dipole-diple interactions. With certain frustration, artificial spin-ices can be created with highly degenerate ground states. These form only short range magnetic correlations that were predicted by Monte-Carlo simulations. We have used GISANS to study the magnetic correlations in a system of out-of-plane magnetized FeNi cylinders on a triangular lattice. Using the Yoneda line to extract a cut in the in-plane structure factor at various sample rotations we could gather the full 2D structure factor. With the application of reverse Monte-Carlo modeling and DWBA we were able to perform a model free data analysis.
15:45	707	**Complex magnetic order and inverse magnetic melting in Ce_3TiSb_5** *Marc Janoschek [1], Simon Flury [1], Yongkang Luo [2], Wolfgang Simeth [1]* *[1] Paul Scherrer Institut, [2] Huazhong University of Science & Technology* We report high-resolution neutron diffraction on the heavy fermion antiferromagnet Ce_3TiSb_5. Our specific heat and magnetic susceptibility measurements as a function of magnetic field reveal a phase diagram with three distinct magnetic phases. Using neutron diffraction we study the magnetic structure, and uncover a multi-k spin structure in the intermediate field phase. Magnetic multi-k structures are of current interest because they are an important ingredient for topologically non-trivial properties. Finally, our measurements demonstrate that the high-field magnetic phase exhibits inverse melting, where the magnetically ordered state becomes disordered upon cooling, which suggests that the complex magnetic order of Ce_3TiSb_5 is driven via the competition of several degrees of freedom.
16:00	708	**Study of new strong-leg spin ladder with neutron scattering** *Jonas Philippe, Marc Janoschek, Daniel Mazzone, Gediminas Simutis, Paul Scherrer Institut* Quantum simulators are experimentally available materials, which satisfy well-defined quantum Hamiltonians and allow the quantitative prediction of spectacular many-body effects. An example of such materials are ideal spin ladders. So far, only one strong-leg spin ladder was studied. We recently managed, thanks to a breakthrough, to grow a second strong-leg spin ladder in large crystals, and deuterate them – making a study with neutron spectroscopy achievable. Here, we present our neutron spectroscopy measurements where both time of flight and multiplexing instruments were used. We determined the excitation spectrum from which the dispersion and Hamiltonian parameters were extracted. Finally, we will discuss future work to tune this material using uniaxial pressure.
16:15		
16:30		***Coffee Break***

<table>
<tr><th>Time</th><th>ID</th><th>NEUTRON SCIENCE II
Chair: Marc Janoschek, PSI Villigen, Gediminas Simutis, PSI Villigen</th></tr>
<tr><td>17:00</td><td>711</td><td>Search for Axion-Like Dark Matter and Exotic Yukawa-Like Interaction

Ivo Schulthess, Universität Bern

Despite the undoubted success of the Standard Model of particle physics, it fails to answer many longstanding questions. These include the observed dark matter and the baryon asymmetry in our universe. Many theoretical models that try to answer those questions require new particles and gauge bosons, which must be verified or excluded experimentally.
In this talk, I will present the search for two such candidates. The first candidates are ultralight pseudo-scalar particles called axion-like particles (ALPs). We searched for them using a Ramsey-type apparatus for cold neutrons. A hypothetical coupling of ALPs to gluons would manifest in a neutron electric dipole moment signal oscillating in time. Twenty-four hours of data have been analyzed in a frequency range from 23 µHz to 1 kHz, and no significant oscillating signal has been found. Present dark-matter models allow for constraining the coupling of ALPs to gluons. The second candidate is an axial-vector gauge boson that could mediate a Yukawa-like interaction in the millimeter range between Standard Model fermions. We built a tabletop experiment that applies Ramsey's technique to the proton spins of hydrogen in water. We performed a proof-of-principle search for this exotic interaction and measured radio-frequency effects like the Bloch-Siegert shift and dressed spin states.</td></tr>
<tr><td>17:30</td><td>712</td><td>Nonreciprocal chiral magnons in multiferroic Ni_3TeO_6

Daniel Mazzone [1], Jakob Lass [1], Brigitte Decrausaz [2]
[1] Paul Scherrer Institut, [2] Universität Zürich

The interplay among electronic charge, orbital, spin and lattice degrees of freedom in quantum materials can stabilize a variety of collective phenomena. Substantial understanding concerning the microscopic origin of these correlated quantum phases is gained through microscopic studies susceptible to the various degrees of freedom, and their dependencies on external tuning parameters. Here, we will show how the combination of various neutron spectrometers equipped with different sample environments allowed us to clarify the mechanism behind the multiferroic properties of Ni_3TeO_6. Our studies show that its non-chiral crystal structure gives raise to non-reciprocal chiral low-energy magnons, whose condensation trigger a direct coupling between the material's electric polarization and magnetic properties.</td></tr>
<tr><td>17:45</td><td>713</td><td>Towards higher brilliant beam for neutron scattering
under very high pulsed magnetic fields

Mina Akhyani, Henrik Rønnow, EPFL

Neutron scattering experiments under high pulsed magnetic fields offer valuable insights into magnetic structures of materials. However, these experiments are challenging and time-consuming due to low neutron count. To address this, we proposed the idea of a specialized source, designed to increase neutron count and improve brilliance serving only one single instrument. The main features of this source are: an spallation target station fed by an existing high-energy proton accelerator every 5 - 10 minutes, synchronized with magnetic pulses, which drastically decreases the average heat and radiation load. We investigated different target-moderator-reflector geometries and materials to achieve maximum brilliance. By an ideal neutron transfer, we can gain higher count on the sample.</td></tr>
</table>

18:00	714	**Neutron beta-decay experiments** *Irina Pradler, Hartmut Abele, Andreas Doblhammer, Alberto José Saavedra García* *Technische Universität Wien - Atominstitut* High-precision measurements of angular correlations in neutron beta decay address a number of questions which are at the forefront of particle physics. For a new generation of beta decay experiments, like the PERC currently under construction in Munich, frequency-based beta spectroscopy using the cyclotron radiation emitted by electrons in a homogeneous magnetic field have been emerging. PERC is the successor of the PERKEO-III, which established pulsed neutron beam technique. In this talk some PERKEO-III results and status update for PERC will be presented. Design study of CREScent experiment, a proof-of principle experiment aiming to combine the CRES technique with the signal amplification qualities of an RF cavity, will be introduced.
18:15	715	**Neutron radiography investigations of cladding tube materials under interim dry storage conditions** *Sarah Weick, Mirco Große, Conrado Roessger, Martin Steinbrück* *Karlsruhe Institute of Technology* Zirconium alloys are used as nuclear fuel cladding material, but hydrogen is taken up by the cladding during operation and precipitates during cooling. During interim dry storage the cladding tubes are affected by mechanically and thermally induced stresses. In order to investigate zirconium and cladding tubes at similar conditions, we observe in-situ the hydrogen diffusion in dependence of its solubility and elastic tensile stresses. For this purpose, a facility is used that allows tensile tests at different temperatures when installed in neutron beamlines. It is advantageous to use Neutron Radiography for the metal zirconium, because of its very low neutron cross section that, contrarily to hydrogen, attenuates neutrons only weakly.
18:30	716	**Imaging the Magnetization Process of Large Grain Silicon Steel using Polarized Neutrons** *Alex Backs [1,2], Matteo Busi [3], Wai Tung Lee [2], Dmytro Orlov [1], Simon Sebold [4], Markus Strobl [3]* *[1] Lund University, [2] European Spallation Source, [3] Paul Scherrer Institut* *[4] Research Neutron Source Heinz Maier-Leibnitz (FRM II)* Grain-oriented silicon steels are established as high performance magnetic core materials in transformers. Their large crystal grains with strong texture gives them pronounced uniaxial magnetic properties. Polarized neutron imaging is capable of investigating the bulk magnetic properties with spatial resolution. The technique is capable sensitive to magnentic order and disorder in the form of spin rotation and depolarization, respectively. Here we present a spin-rotation analysis of the remanent state of a silicon steel-sheet and depolarization data showing the magnetization process. The experiments were performed with a custom magnetic environment, which was designed and evaluated using finite element field calculations and Monte Carlo simulations of the neutron spin evolution.
18:45	717	**Neutron imaging investigations of the hydrogen distribution in nuclear fuel cladding tubes after simulated accidents** *Mirco Große, Juri Stuckert, Martin Steinbrück, Sarah Weick, Karlsruhe Institute of Technology* The reaction of hot nuclear fuel rods with steam results in production of free hydrogen. The released part of this hydrogen provide the risk of hydrogen detonation The other part is absorbed in the fuel cladding tubes made of zirconium alloys. This is the more dangerous one because it can be result in an embrittlement of the cladding tubes and with it in a destruction of the tubes by thermos-shock if an emergency cooling is initiated. The paper presents results of neutron imaging investigations of cladding tubes after accident simulation tests. Hydrogen concentrations were determined quantitatively with a spatial resolution of better than 50 μm.

19:00	**718**	**Investigation of hydrogen distribution in hybrid Ti-Mg implant materials using neutron tomography** *Richi Kumar [1], Vasil Garamus [1], Pavel Trtik [2], Carsten Blawert [1], Maria Serdechnova [1], Thomas Ebel [1], Wolfgang Limberg [1], Regine Willumeit-Römer [1]* *[1] Helmholtz-Zentrum Hereon, [2] Paul Scherrer Institut* Hybrid implants consisting of a permanent Ti-based part combined with a degradable Mg part, are promising solutions to improve the biocompatibility and stability of current implants. In these implants the Ti provides high strength while temporary Mg part is used for bone stimulation or drug delivery. As Mg degrades hydrogen gas is released which ingresses into the Ti part, leading to changes in its properties. To investigate this phenomenon, sintered hybrid samples prepared using metal injection moulding were subjected to saline degradation for a period of 0 to 120 hours and neutron tomography was used to study the ingress of hydrogen in 3D after the degradation of Mg.
19:15	~~710~~	*cancelled*
19:30		***END***

ID	Neutron Science Poster
731	**BYO Beamline Experiment with FRAPPY** *Marek Bartkowiak [1], Markus Zolliker [1], Georg Brandl [2], Enrico Faulhaber [3], Alexander Zaft [2]* *[1] Laboratory for Neutron and Muon Instrumentation (LIN), Paul Scherrer Institut* *[2] Jülich Centre for Neutron Science (JCNS) at Heinz Maier-Leibnitz Zentrum (MLZ), Forschungszentrum Jülich* *[3] Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II), Technical University of Munich* Frappy is a python framework to implement a device communication and abstraction layer for complex sample environment equipment such as cyostats, cryomagnets, furnaces, humidity chambers and for the integration of measurement devices. It is designed to build up complex setups for beamline experiments as well as for lab based measurements. It enables users of large scale facilities to integrate their own setups into the facility data acquisition work flow utilizing the sample environment communication standard SECoP. SECoP is already in use at SINQ/PSI and FRMII/MLZ and will become available at many other user facilities world wide.
732	**CREScent: High-precision Electron Spectroscopy using Cyclotron Radiation Emissions** *Alberto José Saavedra García, Hartmut Abele, Andreas Doblhammer, Irina Pradler* *Technische Universität Wien - Atominstitut* High-precision measurements of angular correlations in neutron beta decay are at the forefront of particle physics. For a new generation of beta decay experiments, like the PERC (Proton Electron Decay Channel) experiment under construction in Munich, frequency-based beta spectroscopy methods using the cyclotron radiation emitted by electrons in a homogeneous magnetic field have been emerging as new methods for high-precision energy measurements. The CREScent experiment is a proof-of-principle experiment aiming to combine the CRES (Cyclotron Radiation Emission Spectroscopy)-technique with the signal amplification qualities of a RF cavity, naturally compensating for the extremely weak signal power of the expected cyclotron radiation pulses.
733	**COMSOL Simulations of the Active Magnetic Shielding of the n2EDM Experiment** *Sergey Ermakov, Vira Bondar, Klaus Stefan Kirch, Patrick Mullan, Nathalie Ziehl, ETH Zürich* The n2EDM experiment searches for the neutron electric dipole moment, which could help understand the baryon asymmetry of the universe. To allow for high precision measurements, an active magnetic shielding (AMS) and a magnetically shielded room (MSR) for passive shielding ensure a magnetically controlled volume. Using the AMS coil system external magnetic fields can be compensated. The interplay between the AMS-generated fields and the mu-metal cube of the MSR is examined through COMSOL simulations. The poster discusses implementation and simulation methods and effects of the mu-metal cube on the AMS. The simulations also aim to find optimal positions for the AMS feedback sensors.

734	**Competition of Superconductivity and Spin-Density Wave Fluctuations around the Quantum Critical Point of $La_{2-x}Sr_xCuO_4$** *Brigitte Decrausaz [1], Johan Chang [1], Daniel Mazzone [2]* *[1] Universität Zürich, [2] Paul Scherrer Institut* Correlated materials often exhibit co-existing or competing quantum phases. An open question is whether the dominant phase eliminates the other one prior to its emergence. Here, I present a high resolution time-of-flight neutron spectroscopy study on the low-energy incommensurate spin excitations of superconducting $La_{1.855}Sr_{0.145}CuO_4$. We find that the spin excitations observed above the superconducting transition temperature are suppressed by the emergence of a superconducting spin gap. Our results suggest that a dynamic competition between superconductivity and magnetism impedes the condensation of the spin-density wave fluctuations.
735	**Targeted use of residual stress in electrical steel to increase energy efficiency** *Tobias Neuwirth [1], Simon Sebold [1], Ines Gilch [2], Benedikt Schauerte [3], Maximilian Plötz [2], Michael Schulz [1]* *[1] Research Neutron Source Heinz Maier-Leibnitz (FRM II), [2] Chair of Metal Forming and Casting (TUM)* *[3] Institute of Electrical Machines and Chair in Electromagnetic Energy Conversion (RWTH Aachen)* Climate change necessitates a reduction of fossil fuel usage. Particularly, transport relies primarily on fossil fuel. Electric vehicles are key to reduce this reliance. As part of an interdisciplinary project, we aim to develop more efficient electric drives using magnetic flux guidance in the rotor by targeted residual stress instead of cutouts. Increasing the maximum achievable rotational speed of electric drives by increasing the mechanical stability. Stacked electrical steel sheets compose the rotor, in which the magnetic flux needs to be guided. Using neutron grating interferometry, we can directly visualize the magnetic flux guidance, analyze local magnetic properties in the bulk and help refine the introduction of residual stress.
736	**Microstructural Characterization Through Grain Orientation Mapping with Laue Three-Dimensional Neutron Diffraction Tomography** *Stavros Samothrakitis [1], Jan Capek [1], Camilla Buhl Larsen [1], Efthymios Polatidis [1], Marc Raventos [1], Soeren Schmidt [2], Markus Strobl [1], Michael Tovar [3], Robin Woracek [2]* *[1] Paul Scherrer Institute, [2] European Spallation Source, [3] Helmholtz Zentrum Berlin* For polycrystalline materials, key material properties depend significantly on the texture of the crystalline microstructure. Conventional assessment of texture is either limited to surface regions or it is destructive, probing small fractions of a specimen. Only high energy X-rays and neutrons enable quantitative studies of bulk texture. Here, we report how transformative progress in Laue three-dimensional neutron diffraction tomography enables to map several hundred grains and, thus, allows grain orientation assessment in the volume of centimetre-sized samples with statistical significance. The short exposure times and non-destructive nature of Laue3DNDT will support in-situ studies, while future improvements in spatial resolution shall include more accurate grain morphology in corresponding microstructure studies.

Quantum Computing

This session has been organised in collaboration with the NCCR SPIN.

Thursday, 07.09.2023, Room 116

Time	ID	Quantum Computing I *Chair: Dominik Zumbühl, Universität Basel*
14:00	801	**Introduction** *Dominik Zumbühl, Universität Basel*
14:15	802	**Scaling-up demonstrations on superconducting qubits** *Daniel Egger, IBM Research Europe - Zürich* Quantum computers are making significant progress in their performance as measured by their scale, speed, and quality. For instance, in 2022 IBM Quantum announced a 433-qubit quantum processor and a factor of 10 increase in circuit execution speed. Furthermore, coherence times and gate fidelities have also improved as exemplified by T1 times on devices with 127 qubits which typically range from 0.2 ms to 0.3 ms. This increase in device size enables demonstrations of quantum algorithms at a larger scale than what was possible before. In this presentation we will discuss a few recent experiments featuring a large number of qubits. For instance, we will look at Trotter simulations with 127 qubits as well as depth-two quantum approximate optimization on non-planar graphs with 40 nodes. We will explore some of the quantum circuit transpilation methods and error mitigation tools that enable these demonstrations. Increasing the size of such experiments is important for the future of the quantum computing ecosystem. Crucially, this also enables the study of heuristic quantum algorithms designed for noisy hardware.
14:45	803	**Efficient quantification of non-classicality using indefinite causal orders** *Kyrylo Simonov, Uni Wien* Non-classicality is a key resource for quantum technologies and requires its proper and efficient quantification. Manifestation of non-classicality in the form of various phenomena such as existence of non-commutative observables and fundamental invasiveness of measurements suggest different ways to its identification. An efficient recipe is offered by processes featuring indefinite causal order of operations. A particular example is the quantum SWITCH which executes operations in a superposition of their causal orders and can be implemented experimentally. In this talk, we focus on incompatibility of observables and their weak values and show how they can be efficiently quantified via the quantum SWITCH independently on dimensions of the physical system.
15:00	804	**Exponential concentration and untrainability in quantum kernel methods** *Samson Wang [1], Marco Cerezo [2], Zoë Holmes [3], Thanasilp Supanut [3]* *[1] Imperial College London, [2] Los Alamos National Laboratory, [3] EPFL* Kernel methods in Quantum Machine Learning (QML) have attracted significant attention as a potential candidate for quantum advantage in data analysis. In this work, we study the trainability of quantum kernels from the perspective of the resources needed to accurately estimate kernel values. We identify four sources that can lead to exponential concentration and provide associated concentration bounds of quantum kernels. We also show that training a parametrized data embedding with a kernel alignment method is susceptible to exponential concentration. Our results are verified through numerical simulations for several QML tasks, providing guidelines to ensure the efficient evaluation and trainability of quantum kernel methods.

15:15	**805**	**Coherent manipulation of a Ge/Si core-shell nanowire based gatemon qubit** *Han Zheng, University of Basel* Transmon qubits based on superconducting circuits are the most popular platform in NISQ era and have witnessed many significant advancements. However, there are several challenges, such as flux noise, crosstalk between qubits, and thermal load due to flux bias. A possible solution are semiconductor-superconductor hybrid systems. The weak link in transmon is substituted by a gate-tunable semiconductor junction, known as gatemon qubit. In this work, we present a gatemon qubit based on a Ge/Si core-shell nanowire Josephson junction. On this new platform we demonstrate the electrical tunability and coherent manipulation of the gatemon qubit, with coherence times on par with other gatemon platforms.
15:30	**806**	**Hybrid Variational Classical-Quantum Computing: Ingredients to make it work** *Zoë Holmes, EPFL* Parameterized quantum circuits serve as ansätze for solving variational problems and provide a flexible paradigm for programming near-term quantum computers. Here we discuss three fundamental criteria for this paradigm to be effective: expressibility, trainability and generalisability. We will introduce these concepts and present recent analytic progress quantifying to what extent these criteria can be achieved. While more generally applicable, the discussion will be framed around the example of trying to variationally learn an unknown quantum process. We will end with some more open-ended dreaming about the applications of these ideas for experimental quantum physics and quantum compilation.
16:00	**807**	**Quantum computing with hole spin qubits in silicon and germanium quantum dots.** *Stefano Bosco, University of Basel* Hole spin qubits are promising for large-scale quantum computers because of their large spin-orbit interaction (SOI). I will present schemes to engineer SOI, optimizing quantum information processing. Large SOI mediates strong and tunable coupling between spins and photons, that can be engineered to be longitudinal. This coupling enables exact protocols for fast high-fidelity two-qubit gates that work at high temperatures. However, SOI couples the spin to charge noise, causing decoherence. I will discuss qubit designs presenting sweet spots where noise is completely removed. In certain devices, the noise caused by hyperfine interactions with nuclear spins is also strongly suppressed, greatly enhancing coherence, and reducing the need for expensive isotopically-purified materials.
16:15	**808**	**Tailored error correction codes for spin qubits: towards fault-tolerant quantum computing with semiconductor quantum dots** *Bence Hetényi, James Wootton, IBM Research - Zurich* Recent spin-qubit experiments demonstrate gate operations and readout well within 1% error rate. This is the error threshold of the surface code assuming that gate errors, measurement errors, and data qubit errors occur with the same probability. Recent developments in error correction codes present opportunities to improve the threshold and reduce connectivity requirements compared to Kitaev's surface code. In this work, we consider state-of-the-art error correction codes and study their performance under anisotropic circuit-level noise that accounts for distinct error rates for gates, measurement and qubit decoherence during idling. We present the spin-qubit layout required for each of the error correction codes, accounting for additional elements required by spin-qubit architectures.
16:30		***Coffee Break***

Time	ID	**Quantum Computing II** *Chair: Gian von Salis, IBM Rüschlikon*

17:00 — 811

Quantum computation and simulation - the semiconductor way

Lieven Vandersypen, TU Delft

Quantum computation has captivated the minds of many for almost two decades. For much of that time, it was seen mostly as an extremely interesting scientific problem. In the last few years, we have entered a new phase as the belief has grown that a large-scale quantum computer can actually be built. Quantum bits encoded in the spin state of individual electrons in silicon quantum dot arrays, have emerged as a highly promising direction. In this talk, I will present our vision of a large-scale spin-based quantum processor, and ongoing work to realize this vision.
First, we created local registers of spin qubits with sufficient control that we can program arbitrary sequences of operations, implement simple quantum algorithms, and achieve single- and two-qubit gate fidelities of more than 99.5%. In linear quantum dot arrays, we now achieve universal control of up to a record six qubits with respectable fidelities for initialization, readout, single- and two-qubit operations.
Second, we have explored coherent coupling of spin qubits at a distance, via two routes. In the first approach, the electron spins remain in place and our coupled to each other via a microwave photon in a superconducting on-chip resonator. In the second approach, spins are shuttled along a quantum dot array, preserving the spin state.
When combined, the progress along these various fronts can lead the way to scalable networks of high-fidelity spin qubit registers for computation.
Interestingly, the very same quantum dot platform can be used for analog simulation of Fermi-Hubbard physics. We have observed a rich variety of physical phenomena, from Nagaoka ferromagnetism and Heisenberg spin chains to exciton formation.

17:30 — 812

The power and limitations of learning quantum dynamics incoherently

Manuel Rudolph [1], Sofiene Jerbi [2], Joe Gibbs [3], Matthias Caro [4], Patrick Coles, Hsin-Yuan Huang [4], Zoë Holmes [1]
[1] EPFL, [2] University of Innsbruck, [3] University of Surrey, [4] Caltech

Quantum process learning is emerging as an important tool to study quantum systems, but little attention has been paid to whether dynamics of quantum systems can be learned without the system and target directly interacting. Here we provide bounds on the sample complexity of learning unitary processes incoherently and show that, if arbitrary measurements are allowed, then any efficiently representable unitary can be efficiently learned within the incoherent framework. However, when restricted to shallow-depth measurements only low-entangling unitaries can be learned. We demonstrate our incoherent learning algorithm by successfully learning a 16-qubit unitary on ibmq_kolkata, and further demonstrate the scalabilty of our proposed algorithm through extensive numerical experiments.

17:45 — 813

Growth and characterization of Ge/$Si_{1-x}Ge_x$ planar heterostructures for spin qubits applications

Arianna Nigro [1], Nicolas Forrer [1], Alicia Ruiz-Caridad [1], Gerard Gadea [2], Ilaria Zardo [1]
[1] University of Basel, [2] Swiss Nanoscience Institute

The realization of highly stable, controllable, and accessible hole spin qubits is strongly dependent on the quality of the materials hosting them. Ultra-clean germanium/silicon-germanium heterostructures in quantum wells (QWs) are the perfect candidates. Due to their large scalability potential, they pave the way towards the development of realistic and reliable solid state, all-electric quantum computers.
The use of chemical vapor deposition (CVD) allows the epitaxial growth at elevated rates of thin films with high structural quality.
This work shows the results relative to the growth of epitaxial Ge/$Si_{1-x}Ge_x$ heterostructures for QW-based qubits, using a reverse grading approach. The CVD deposition kinetics and crystalline quality of the materials were investigated.

18:00	814	**Germanium as a platform for semi- and superconducting qubits.** *Andrea Hofmann, Universität Basel* High-quality semiconductor heterostructures build the basic ingredient facilitating quantum transport experiments including the promising field of semiconductor spin qubits. Ge quantum wells have recently emerged as a suitable platform for fast spin qubits, due to a combination of favorable properties of the confined states. The Ge platform is furthermore interesting as the Fermi level pinning is close to the valence band, which allows for inducing superconductivity via the proximity effect. We aim to combine the two features and build a platform where we can couple spin and hybrid superconducting qubits via microwave photons.
18:30	824	**Towards long-distance quantum networks using trapped ions in optical cavities** *Ben Lanyon, University of Innsbruck* I have a small research group in Innsbruck that focuses on developing methods to entangle quantum systems in remote locations. Our quantum systems of choice are strings of trapped atomic ions. The strings are confined in linear Paul traps with an integrated optical cavity for the collection of 854 nm photons. In this talk I'll briefly introduce our main experimental methods and then give an overview of two recent papers. In the first paper we entangled two ions in buildings a few hundred meters apart. The second paper demonstrates a telecom-wavelength quantum repeater node. Finally, I'll briefly describe some other projects that we have going on.
19:00		***Transfer to Dinner***
19:30		***Conference Dinner***

Friday, 08.09.2023, Room 116

Time	ID	**Quantum Computing III** *Chair: Zoë Holmes, EPF Lausanne*
12:00	821	**Low field spin qubits in planar Ge** *Georgios Katsaros, Institute of Science and Technology Austria* In the past few years Germanium has attracted lot of attention as a platform for spin qubits, due to the low effective mass, strong spin orbit interaction, which allows electrically driven spin qubits, and its potential for co-integration with superconducting technology. From 2018 and within just three years a Loss-DiVincenzo (LD), a singlet-triplet hole spin qubit, two-qubit gate devices and a four-qubit Ge quantum processor have been realized demonstrating the potential of Ge for quantum information. However, long-distance qubit coupling remains a significant challenge. Superconducting resonators play a prominent role in realizing high fidelity distant two-qubit gates. In this talk I will present our results on Ge hole spin qubits, at fields compatible with Al technology.

12:30 | **822**

Hole Spin Qubits in Silicon Fin Field-Effect Transistors

Rafael Eggli [1], Toni Berger [1], Leon Camenzind [1,2], Andreas Fuhrer [3], Simon Geyer [1], Eoin Kelly [3], Andreas Kuhlmann [1], Gian von Salis [3], Richard Warburton [1], Dominik Zumbühl [1], Carlos Dos Santos [1,4]
[1] University of Basel, [2] RIKEN Center for emergent matter science, Tokyo, Japan
[3] IBM Research - Zürich, Rüschlikon, [4] Université Grenoble Alpes, Grenoble

By leveraging industrial CMOS manufacturing processes, spin qubits in silicon are a promising approach to achieving scalable quantum computing. While electron spin qubits have reached many milestones, hole spins in silicon present an exciting new platform, allowing for fast, all-electrical qubit control, absence of valleys and low susceptibility to hyperfine noise. Here, we present recent progress on hole spin qubits in fin field-effect transistors, which is an industry-standard transistor technology. We demonstrate single and two-qubit gate operations and explore hole-spin physics in the presence of strong spin-orbit interaction. Furthermore, we investigate the prospects for scalable readout and high temperature operation.

~~823~~ | *cancelled*

12:45 | **815**

Capacitive crosstalk in gate-based dispersive sensing of spin qubits

Alexei Orekhov [1], Eoin G. Kelly [1], Matthias Mergenthaler [1], Felix Schupp [1], Nico Hendrickx [1], Stephan Paredes [1], Rafael S. Eggli [2], Andreas V. Kuhlmann [2], Patrick Harvey-Collard [1], Andreas Fuhrer [1], Gian von Salis [1]
[1] IBM Research Zurich, [2] University of Basel

Dispersive gate sensing, where a resonator is directly attached to a quantum dot gate, is a promising spin qubit readout technique. We discuss a potential limitation of this approach arising from capacitive crosstalk. We find that an ac voltage modulation on a plunger gate of a finFET double quantum dot can induce a 20 times larger signal on the neighboring barrier gate attached to a tank circuit with Qi =1000. The corresponding broadening of the inter-dot charge transition limits the operation of the dots as qubits. We explain this effect by capacitive crosstalk between bondpads and discuss further design constrains that need to be addressed when employing this technique.

13:00 | **825**

Circuit QED with a singlet-triplet qubit

Jann Hinnerk Ungerer [1], Alessia Pally [1], Artem Kononov [1], Sebastian Lehmann [2], Joost Ridderbos [1], Claes Thelander [2], Kimberly Dick [2], Ville F. Maisi [2], Pasquale Scarlino [3], Andreas Baumgartner [1], Christian Schönenberger [1]
[1] University of Basel, [2] Lund University, [3] EPFL

Long-range couplers based on individual microwave photons are desirable for realizing spin-based quantumcomputing.
Here, we present a spin-photon interface based on intrinsic spin-orbit interaction in a zinc-blende InAs nanowire. The nanowire hosts a double-quantum dot with epitaxial crystal-phase tunnel barriers and strong spin-orbit interaction. These properties immensely simplify device scalability by rendering electrostatic gates and micromagnets unnecesarry. We integrate such a double-quantum dot in a high-impedance circuit quantum electrodynamics architecture and demonstrate strong coupling between a singlet-triplet qubit and a single microwave photon, a vital step towards scalable quantumcomputing. Furthemore, we make use of this coherent spin-photon interface to determine the qubit coherence and the spin-orbit coupling.

13:15 | **826**

Strain Analysis in Ge Quantum Well by GPA and Raman techniques

Alicia Ruiz, Arianna Nigro, Gerard Gadea Diez, Nicolas Forrer, Johannes Trautvetter, Ilaria Zardo, Universität Basel

Silicon with its long coherence time of spins of localized electrons is a candidate for quantum information processing . Among quantum materials compatible with Si there is germanium (Ge), which has however a 4.2% mismatch. Such a mismatch introduces strains in Si/Ge heterostructures hindering mobility. Thus, scattering must be minimized by diminishing strains. Interestingly, electron and hole qubits can be created in Si and Ge, respectively .
In this work, we grew Ge quantum wells (QWs) embedded in Si/Ge heterostructures. First, we localized the Ge-QW using energy-dispersive X-ray (EDX) spectroscopy. Finally, we studied the local strain in the Ge-QW by Raman spectroscopy and geometric phase analysis (GPA).

13:30		*END*

ID	QUANTUM COMPUTING POSTER
841	**Coupling a mechanical oscillator to the quantum devices** *Marcin Kisiel [1], Alexina Ollier [2], Mehdi Ramezani [1], Akash Gupta [1], Urs Gysin [1], Andreas Baumgartner [1], Christian Schönenberger [1], Ernst Meyer [1]* *[1] University of Basel, [2] Swiss Nanoscience Institut* Understanding mechanisms of energy dissipation is nowadays successfully examined down to the atomic level by means of Atomic Force Microscope (AFM). Graphene bilayers with twist angles are known to host the series of interaction-driven correlated insulating phases with promising applications for nano-electronics, etc. The electron interactions might even lead to the emergence of magnetism, recently reported in monolayer MoS_2. We report on AFM force and energy dissipation on quantum devices: twisted bilayer graphene (TBG) and monolayer MoS_2. Ultrasensitive tips acting as a gate over the TBG shows dissipation peaks attributed to fractional filling of the flat energy bands. In gated monolayer MoS_2 a phase transition is detected with magnetic tip.
842	**Operational Sweet Spot of Hole Spin Qubit** *Taras Patlatiuk [1], Miguel Carballido [1], Erik Bakkers [2], Stefano Bosco [1], Pierre Chevalier Kwon [1], Rafael Eggli [1], J. C. Egues [1], Daniel Loss [1], Simon Svab [1], Dominik Zumbühl [1]* *[1] University of Basel* *[2] Department of Applied Physics, Eindhoven University of Technology, The Netherlands* We demonstrate an operational sweet spot for a Ge/Si core/shell nanowire hole spin qubit, for which both Rabi frequency and spin echo coherence times show a maximum. It is related to the optimal operation point theoretically predicted for hole spins in the group IV crystals. Fitting measured data to a simple model we were able to extract the intrinsic g-factor and estimate the spin-orbit length. We also found a charge configuration of the double dot for which both spins can be individually addressed by two different microwave frequencies. Tuning the interdot tunnel barrier allowed us to control the exchange coupling, paving the way to perform exchange-based two-qubit operations.
843	**Enhancing Coherence in Ge/Si Core/Shell Hole Spin Qubits** *Artemii Efimov [1], Miguel Carballido [1], Pierre Chevalier Kwon [1], Simon Svab [1], Taras Patlatiuk [1], Nicolas Forrer [1], Ilaria Zardo [1], Erik Bakkers [2], Dominik Zumbühl [1]* *[1] University of Basel* *[2] Department of Applied Physics, Eindhoven University of Technology, The Netherlands* We characterize the Ge/Si core/shell nanowires extracting their field effect mobility for various growth parameters. For this, COMSOL simulations are performed to calculate numerically the backgate-to-nanowire capacitance of a realistic device. The observation of sweet spots of the Hahn-echo coherence time of a qubit formed in such a nanowire suggests the presence of low-frequency charge noise. We work on improving nanowire materials to enhance the spin coherence for a new generation of qubit experiments.
844	**Impact of screening gates on reproducible quantum dot formation** *Jessica Richter, Felix Schupp, Michael Stiefel, Stephan Paredes, Andreas Fuhrer, Matthias Mergenthaler, IBM Research Zurich* Hole spin qubits can be implemented by accumulating holes in quantum dots (QDs) along the channel of a silicon fin field effect transistor (finFET). While the finFET design should lead to a field focusing at the tip of the fin, we frequently observe spurious hole accumulation under the gates outside the fin. To mitigate this problem, we implement a planar MOSFET platform including screening gates to constrict the channel. We perform DC measurements to investigate the quantum transport properties of these devices and explore the impact of the screening gates on QD accumulation, shape, and position. Finally, we compare transport properties of the planar MOSFETs with similarly fabricated finFET devices.

845

Trainability barriers and opportunities in quantum generative modeling

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Quantum generative models have the potential to provide a quantum advantage, but their scalability is still in question. We investigate the barriers to training quantum generative models, focusing on exponential loss concentration. The interplay between explicit and implicit models and losses is explored, leading to untrainability of explicit losses (e.g., KL-divergence). Maximum Mean Discrepancy, a commonly-used implicit loss, can be trainable with the appropriate kernel choice. However, the trainability comes with spurious minima due to indistinguishability of high-order correlations. We also propose to leverage quantum computers leading to a quantum fidelity-type loss. Lastly, data from high-energy-physics experiments is used to compare the performance of different loss functions.

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Charge sensing of Ge/Si Core/Shell nanowire quantum dots using a high-impedance NbTiN resonator

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Hole spins in Ge/Si core/shell nanowires show a strong and electrically tunable spin-orbit (SO) interaction, allowing strong coupling between spins and photons. A highly tunable hole spin qubit was demonstrated using this system. However, the readout so far has relied on transport, so the qubit was not operated in the few-hole regime.
We present spectroscopy measurements on Ge/Si nanowire double quantum dot system using a high-impedance NbTiN resonator. Once the DC transport was fully suppressed, we were able to read dozens of transitions using solely spectroscopy. We find first indications of depletion to the last hole. We are aiming now to achieve spin-photon coupling in our system.

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Dispersive charge sensing of quantum dots in Ge/Si core/shell nanowires

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Holes in germanium/silicon core/shell nanowires are a powerful platform to study and optimize properties of spin qubits. This is a consequence of the strong, gate-tunable direct Rashba spin-orbit interaction, arising from strong confinement in the nanowire. So far, experiments in this system have been done in DC transport, preventing single-shot readout.
Here, we show gate-dispersive charge sensing measurements in a Ge/Si nanowire device with a tank circuit on the sample PCB. A strontium titanate ring-varactor is employed to achieve in-situ impedance matching down to 11 mK. We present progress towards depleting the nanowire to fewer holes and establishing fast qubit readout.

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Coherent manipulation of Er^{3+} electronuclear spin states: Towards quantum information processing

Tianyang Shen, Guy Matmon, Andrin Doll, Manuel Grimm, Markus Müller, Simon Gerber, Gabriel Aeppli, Paul Scherrer Institut

Rare-earth ions are promising qubit candidates for quantum information processing due to their narrow homogeneous linewidth and long coherence times. Within this family, erbium owns the feature of transition wavelengths at the telecom C-band, allowing for long-distance transmission. Here, in an Er^{3+}-doped solid-state system, we first introduce a scheme for implementing universal quantum gates, where the high-fidelity two-qubit gates can be realized via the magnetic dipolar Ising interaction. Then, we will explore the potential utilization of their ion pairs. So far, we have demonstrated FTIR spectra to identify different Er^{3+} pairs and built the laser system with microwave modulation to manipulate their electronuclear spin states.

849	**Germanium/Silicon Core Shell Nanowires for Spin / Hole Qubits Fabricated by Chemical Vapour Deposition** *Nicolas Forrer [1], Arianna Nigro [1], Alicia Ruiz-Caridad [1], Gerard Gadea [2], Ilaria Zardo [1]* *[1] University of Basel, [2] Swiss Nanoscience Institute* Ultra-clean germanium/silicon (Ge/Si) core shell nanowires (NWs) have been predicted and proven to host highly stable hole spin qubits, controllable via Rashba spin orbit interaction with a large scalability potential making it possible to develop realistic and reliable quantum computers. To maximise their performance, high quality crystalline NWs grown along ⟨110⟩ direction with well-defined Ge/Si interfaces are needed. We develop ultra clean Ge/Si heterostructures by chemical vapour deposition (CVD) using the vapour liquid solid (VLS) techniques. We have achieved the growth of crystalline Ge/Si core shell NWs, using a low temperature plasma enhanced shell growth. In addition CVD deposition kinetics and crystalline quality were investigated.
850	**Ultra-low noise RF comb using a 1 GHz passively modelocked laser** *Florian Emaury [1], Karolis Balskus [1], Stefan Kundermann [2], Steve Lecomte [2]* *[1] Menhir Photonics AG, Industriestrasse 42 CH-8152 Glattbrugg* *[2] CSEM, Rue de l'Observatoire 58, CH-2000 Neuchâtel* Microwave photonics is an innovative solution for radio frequency (RF) generation and distribution, by interconnecting the field between RF and photonics. Within the MICOR project, Menhir Photonics AG in collaboration with CSEM developed an ultra-low phase noise photonics-based RF source. The innovative RF generation not only generates ultra-low phase noise RF signals, but possesses the key advantage of ultra-low loss RF signal distribution via optical fibers. This approach offers unique possibilities, advantages, and applications. Low noise RF sources are needed as a reference at 10/100/1000/10'000 MHz frequencies for frequency synthesizers, radars, timing distribution over fibers and 5G solutions. Here we show the noise characteristics and outputs of the MICOR project.

Biophysics, Medical Physics and Soft Matter

Thursday, 07.09.2023, Room 117

Time	ID	BIOPHYSICS, MEDICAL PHYSICS AND SOFT MATTER I: COLLECTIVE PHENOMENA *Chair: Christof Aegerter, Universität Zürich*
14:00	901	**Topology and geometry organize the morphogenesis of active nematic surfaces** *Claire Dessalles [1], Tzer Han Tan [2], Aurélien Roux [1]* *[1] University of Geneva, [2] Max Planck Institute of Molecular Cell Biology and Genetics* Morphogenesis, the process by which tissues acquire their shape, hinges on a finely orchestrated collective motion of cells autonomously choreographing themselves to a well-defined final position. The goal of my project is to understand how geometry and topology controls the spontaneous organization of cells that drives morphogenesis, i.e. the growth from a 3D surface to tissues with complex shapes. To investigate this phenomenon, I grow cells on the surface of deformable capsules and monitor the nematic field, cellular flows, and tissue growth. We show that the collective motion of cells is controlled by the nematic order, and topological defects act as morphogenic organizers via active stresses.
14:15	902	**Determining how physical constraints shape organism behaviour** *Daphne Laan, Guillermina Rochelle Ramirez-San-Juan, EPFL* Ciliates are free swimming single-celled organisms that execute complex behaviours such as obstacle avoidance and hunting. These organisms are covered by arrays of thousands of active filaments, known as cilia, that beat to generate flows. To understand if behaviour can be encoded by cilia organization and the trade-offs between locomotion and predation risk, we analyze the interactions between the ciliates Didinium nasutum and Paramecium multimicronucleatum, a well-known predator-prey system. By studying the dynamic of these cells we aim to determine how physical constraints shape an organism's behavioural landscape.
14:30	903	**Signalling-dependent refinement of cell fate choice during tissue remodelling** *Simone Cicolini [1], Sophie Herszterg, Guillaume Salbreux [1], Jean-Paul Vincent [2], Marc de Gennes* *[1] University of Geneva, [2] The Francis Crick Institute* How biological form emerges from cell fate decisions and tissue remodelling is a fundamental question in development biology. We investigate this interplay during the process of vein refinement in Drosophila pupal wing. By following reporters of signalling activity dynamically, together with tissue flows, we show that vein refinement arises from cell fate adjustments controlled by a signalling network involving Notch, Dpp, and EGFR. Perturbing large-scale convergent-extension flows does not affect vein refinement, showing that pre-patterned vein domains are able to intrinsically refine to the correct width. A reaction-diffusion model of cell fate changes recapitulates the intrinsic tissue ability to establish a thin, regular vein independently of large-scale tissue flows.
14:45	904	**Density-dependent active flow transition of biological tissues** *Mathieu Dedenon [1], Carles Blanch-Mercader [2], Karsten Kruse [1]* *[1] University of Geneva, [2] Curie Institute* Biological tissues generate active mechanical stress, originating from cellular force dipoles. Active fluid theory predicts this active stress to drive a spontaneous flow transition in a confined geometry. Indeed, polar cells on a confining disc are observed to rotate with spiral orientation. However at a later stage, tissue growth induces cell reorientation into a static aster. To explain this transition, we introduce a passive theoretical coupling between cell density and polarity. Such coupling can lead to patterning effects, allowing spiral-aster coexistence on a disc. This work shows that cell density gradients can compete with activity to stabilize out-of-equilibrium spatial structures that may be relevant to tissue morphogenetic events.

15:00	**905**	**Universal thermodynamic bounds on symmetry breaking in biochemical systems: from error correction to pattern formation** *Shiling Liang [1], Daniel Maria Busiello [2], Paolo de los Rios [1]* *[1] Institute of Physics, EPFL, [2] Max Planck Institute for the Physics of Complex Systems* Living systems are out-of-equilibrium and exhibit emergent selection phenomena that break equilibrium symmetries. These phenomena are possible because non-equilibrium conditions expand the non-equilibrium phase space where complex biochemical processes can lie in. We use the matrix-tree theorem to derive universal thermodynamic bounds on these symmetry-breaking features in biochemical systems. The bounds are independent of kinetics and hold for closed and open networks. We recover thermodynamic constraints in kinetic proofreading and show that reaction-diffusion patterns are bounded by the non-equilibrium driving force. Our results pave the way to understanding the role of non-equilibrium conditions in biochemical systems.
15:15	**906**	**Collective behaviors in bacterial colonies at curved surfaces** *Vincent Hickl, Bruno Silva, Empa* Collective behaviors at interfaces are ubiquitous in living systems and play a crucial role in guiding macroscale phenomena like tissue morphogenesis and the spread of infections. While collections of biological active particles must contend with complex environments, much remains unknown about the effects of substrate geometry on their self-organization. We use bacterial colonies at interfaces as a model active nematic to investigate how surface curvature affects collective behaviors in active matter. Using custom laser-patterned substrates and advanced microscopy, bacterial activity is quantified with high spatiotemporal resolution. The effect of curvature on orientational order in bacterial monolayers is described. These results elucidate how long-range order depends on geometry in biological systems.
15:30	**907**	**Symmetry breaking and number control at the onset of centriole assembly** *Friso Douma, Pierre Gönczy, EPFL* The centriole is a cylindrical organelle essential for microtubule organization. Centrioles duplicate exactly once every cell cycle through the formation of a procentriole orthogonally to an existing centriole. How the single site of procentriole formation on the cylinder is determined and what mechanisms ensure that precisely one procentriole is formed remains incompletely understood. We use super-resolution expansion microscopy to study the crucial players of procentriole formation in human cells upon varying experimental conditions. High-resolution localization patterns lead us to develop a new theoretical model, providing key insights in centriole duplication dynamics. Ultimately these insights might generalize to unifying principles of self-assembly in biology.
15:45	**908**	**Understanding the principles that govern cell-cycle dynamics using experimental evolution** *Vojislav Gligorovski, Sahand Rahi* *Laboratory of the Physics of Biological Systems, Institute of Physics, EPFL* Cellular doubling time, as a crucial determinant of fitness, was optimized during the course of evolution. However, cells of different species exhibit hugely varying doubling times, ranging from a few minutes, to several days. To understand the constraints and trade-offs that dictate cell-cycle dynamics, we created a budding yeast strain in which the doubling time can be controlled exogenously, using light-activated proteins. By applying pulses of light that triggered cell division more frequently than the average cell-cycle period, we conducted an evolutionary experiment that drove the cells towards faster cycles. Cells propagated this way for 1000 generations have shorter G1 phase, are larger and more fit compared to their ancestors.

16:00	**909**	**Polarity mediated self-organization in cellular aggregates** *Mukund Krishna Kothari, Quentin Vagne, Guillaume Salbreux, University of Geneva* To explore how feedback between cell polarity and mechanics guides self-organization, we develop a theoretical model of cells described as active polar beads mechanically interacting with each other. The model is motivated by the self-organization of stem cells into a rosette structure in the early stages of organoid growth. A key ingredient is the active interaction force $A(\vec{p}_i - \vec{p}_j)$ arising from cells crawling over each other. Analysis of two beads in contact reveals 2 time scales controlling the system's transition from a unique stable steady state to degenerate oscillatory states. Numerical simulations of the aggregate show jamming-unjamming transitions, phase separation into hollow compartments, and spontaneous formation of 1D chains.
16:15	**910**	**Resection of DNA in response to permanent DSBs in S.cerevisiae** *Marco Labagnara, EPFL* When double-strand breaks happens to the DNA, the cell arrests at the DNA damage checkpoint, preventing its entry into mitosis until the breaks are eventually repaired and the cell can proceed to mitosis. If the breaks persist, cells may bypass the checkpoint, this is called override. It is known that the override time depends on the number of breaks, but how the cell measure this number isn't still unknown. The most accepted model claims that cells measure the amount of resected DNA, but it was observed that mutants with less single-strand DNA take longer to override which contradicts the current model. We aim to demonstrate or deny the current model.
16:30		***Coffee Break***
		BIOPHYSICS, MEDICAL PHYSICS AND SOFT MATTER II: **TECHNOLOGY DEVELOPMENT** *Chair: Christof Fattinger*
17:00	**911**	**Mitochondrial structure and dynamics: Mysteries and insights** *Suliana Manley, EPFL* Mitochondria are heterogeneous organelles best known for their role in energy production through oxidative phosphorylation. Yet, they possess their own genetic material, encoding for key ox-phos proteins. Thus, they must divide to proliferate, which they do asynchronously from their host cell cycle. How do they ensure network maintenance and homeostasis? Using a customized structured illumination microscope, we discovered patterns underlying their division and genome organization, linked to biogenesis and quality control. We share new findings on the interplay between these processes and organelle trafficking within the cell. The intermittent dynamics of these processes imply that a constant imaging speed may miss important features. Thus, we also developed event-driven acquisitions, an adaptive microscope control that uses neural networks to enrich datasets for events of interest.
17:30	**912**	**Generative deep learning models for tracking C. elegans** *Sahand Rahi [1], Isinsu Katircioglu [1], Alice Gross [1], Guillaume Obozinski [2]* *[1] Institute of Physics, EPFL, [2] SDSC, EPFL* I will be describing our current efforts using generative deep learning models to create artificial training sets for tracking C. elegans worms using machine learning.

17:45	**913**	**Optogenetic control of the DNA Damage Checkpoint** *Lorenzo Scutteri, EPFL* When faced with chromosomal double-strand DNA breaks, cells activate a complex DNA Damage Checkpoint response that arrests the cell cycle and reprograms gene expression. Although the regulators of the core network have been intensively explored, the mechanism of checkpoint override remains poorly understood. To address this gap, we aim to design optogenetically-controlled checkpoint proteins by leveraging the light-sensitive LOV2 domain. By strategically integrating this optogenetic switch into specific positions of target proteins, we can dynamically and reversibly modulate their activity in response to light exposure. Through perturbation of engineered checkpoint proteins at the single-cell level, we aim to establish a quantitative model of DNA Damage Checkpoint override in Saccharomyces cerevisiae.
18:00	**914**	**Tuning colloidal interactions using random light fields** *Augustin Muster, Luis S. Froufe-Pérez, Diego Romero Abujetas* *Department of Physics, University of Fribourg* Random optical fields induce interactions between colloidal particles. Being the forces induced by the black body radiation the best known example. These fluctuation-induced interactions can be tuned by choosing an appropriate spectral energy density, hence it is possible to engineer the dynamics and equilibrium configurations. Using a coupled electric and magnetic dipoles model we present in this work how these optically induced pure pair interactions can be tuned and what are the limitations. As an application, we discuss the creation of stealth hyperuniform point patterns using such pair interactions. Moreover, we shall discuss the random fields-induced many body colloidal interactions and their properties.
18:15	**915**	**Predicting meiosis with a waddington landscape analogy** *Maxime Scheder, EPFL* Meiosis in S. Cerevisiae is a complex process which is tightly regulated by a large gene regulatory network. Such regulatory networks depend on numerous unknown parameters. Instead of modelling the gene network directly, the interest is set toward modelling the decision process through only few external measurable parameters such as the nutrient concentration. To this end, the analogy of the waddington landscape is literally put to use by fitting a two dimensional potential with experimental data.
18:30	**916**	**Microfluidics and imaging to understand the C. elegans brain development from embryo to adulthood** *Elif Gencturk, EPFL* I regard caenorhabditis elegans, as a first step to understand more complex brains. I believe that microfluidics is the missing ingredient to breakthroughs. I will build microfluidic chips in which a single worm can hatch from an egg, be fed in a controlled manner with bacteria, and be imaged for whole-brain activity throughout its life while receiving stimuli to spark information processing activity. Then I will acquire in molecular biology, genetics, whole-brain imaging, and image analysis to study differences in brain activity in wild-type and mutant worms that fail to develop normally. I will test whether interventions with optogenetics or drugs can rescue brain development, generating useful hints for medicine.

18:45	**917**	**Chaperones-stabilized non-equilibrium native state of proteins** *Paolo de los Rios, Pierre Goloubinoff, Alessandro Barducci, Alberto Sassi, Satyam Tiwari, Bruno Fauvet, Salvatore Assenza* *Institute of Physics, EPFL* Under favourable conditions, proteins fold autonomously, and their native state is the minimum of the free energy. Under adverse conditions, like in the presence of elevated temperatures, non-native states be the true minima of the free energy, leading to protein denaturation and subsequent protein aggregation. All cells possess a set of molecular machines, known as chaperones, that counteract protein misfolding and aggregation. We have shown that, using the energy liberated by ATP hydrolysis, they stabilise proteins in their native states even under denaturing conditions., partly challenging our view of the energy landscape of proteins.
19:00		***Transfer to Dinner***
19:30		***Conference Dinner***

Friday, 08.09.2023, Room 117

Time	ID	Biophysics, Medical Physics and Soft Matter III: Medical and medically relevant Physics *Chair: Rainer Leitgeb, Med. Universität Wien*
12:00	**921**	**Ultra-fast treatment delivery to enhance the potential of proton therapy for cancer treatment** *Vivek Maradia, Paul Scherrer Institute and ETH Zürich* Proton therapy is a promising cancer treatment, but uncertainties due to anatomical changes and motion limit its effectiveness. To overcome this, Ultra-fast treatments might make tumor irradiations within a single. To enable ultra-fast treatment delivery, we investigate methods to reduce beam-on and dead time. By optimizing beam optics, using a dynamic ridge filter, and employing spot-reduced planning, treatment time can be significantly reduced, allowing for effective treatment of moving targets and expanding the potential of proton therapy.
12:30	**922**	**Protein fibrils disassembly by the HSP70 chaperone machinery** *Davide Cois, Paolo de los Rios, Institute of Physics, EPFL* Molecular chaperones are ubiquitous highly conserved proteins across all domains and living systems depend on them for cellular homeostasis. The chaperone machinery is able to disassemble toxic aggregates, which are a hallmark of neurodegenerative diseases. In vitro and in vivo studies, for different species, provide experimental evidence of aggregate dispersal by chaperone activity. However, the underlying fundamental mechanisms of disassembly are still not fully understood. In our work, we build a mesoscopic model based on coarse-grained interactions, aiming at describing the experimentally-observed behaviour of these systems and paving the way for for their better understanding.
12:45	**923**	**Deep-tissue imaging via multi-photon adaptive optics** *Maximilian Sohmen [1], Çağlar Ataman [2], Alexander Jesacher [1], Juan D. Muñoz-Bolaños [1], Pouya Rajaeipour [2], Monika Ritsch-Marte [1]* *[1] Med. Univ. Innsbruck, [2] Phaseform GmbH* Combining adaptive optics (AO) with multi-photon techniques is a powerful approach to image deep into biological tissue. Here, we present a new, fast and robust sensorless multi-photon AO scheme. We study our scheme in numerical simulations and in experiments with a novel, opto-fluidic wavefront shaping device that is transmissive, refractive, polarisation-independent, and broad- band. We demonstrate scatter correction of two-photon-excited fluorescence images of microbeads as well as brain cells. Our method and technology could open new routes for AO that were previously unaccessible to multi-photon microscopy.

13:00	**924**	**Rapid T1, T2 and fraction quantification in two-compartment systems using bSSFP profile asymmetries** *Nils Plähn, Berk Açiköz, Jessica Bastiaansen, Adèle Mackowiak* *Department of Diagnostic, Interventional and Pediatric Radiology (DIPR), Inselspital, Bern University Hospital, University of Bern, & Translation Imaging Center (TIC), Swiss Institute for Translational and Entrepreneurial Medicine, Bern* A novel analytical method in magnetic resonance imaging using phase-cycled balanced steady state free precession (PC-bSSFP) was developed for multi-compartment systems. The approach exploits asymmetries in complex PC-bSSFP signal profiles and enables simultaneous quantification of proton fraction, T1 and T2 relaxation times. Monte-Carlo simulations and experiments at 3 T and 7 T in an acetone-water phantom were performed. The proposed method for multi-parameter quantification in multi-compartment singlet systems was validated with high accuracy, precision, and ultra-rapid reconstruction time. This work provides important insights for PC-bSSFP multi-parameter quantification with PC-bSSFP sequences in presence of multiple compartments and a first steps towards more complex multiplet- systems such as water-fat mixtures.
13:15	**925**	**Secure and versatile data and computing platform for cutting-edge data science in biomedical research compliant with the new Data Protection Act** *Peter Strassmann, ETH Zürich, LeoMed Support* Leonhard Med is a scientific IT-platform to securely store, manage, and process sensitive data. The digitalization of healthcare and medical devices in everyday life allow collecting vast amounts of health-related data, e.g., clinical and -omics data, data from biobanks and from wearables. Researchers transform such data into insights and decision-making tools for precision medicine and personalized health. Yet, data related to human health is sensitive and requires protection measures to protect the integrity of individuals. What options do researchers have for securely managing sensitive data and what are best practices in the daily research with sensitive data? Leonhard Med offers such a secure and customizable platform for researchers in Switzerland.
13:30	**926**	**Predicting behaviour from interneuron activity in C. elegans** *Mahsa Barzegarkeshteli, Alisa Gross, EPFL* We will focus on how C. elegans worm responds to sensory cues depending on its internal brain state. They can be defined as the patterns of neuronal activity that are highly predictive of behaviour. Recent technological advances have made it possible to image whole-brain calcium activity at cellular resolution in freely moving animals. From changes in behaviour and neural dynamics, internal brain states should in principle be inferrable. However, it remains unclear how to identify internal brain states, how they control behaviour, and how neurons can be manipulated to induce state transitions. We will focus on interneurons that integrate sensory information in the sensorimotor pathway to parameterize computational models.
13:45	**927**	**Quantitatively pin-pointing individuality at the single neuron level** *Matthieu Schmidt, EPFL* In this study, I investigate factors contributing to consistent behavior throughout an individual's lifespan in C. elegans. Using optogenetic stimulation, I redefine individuality by examining stimulus-induced behavioral responses. I then explore serotonin's role in maintaining behavioral consistency by optogenetically controlling serotonergic neuron NSM. A custom high-throughput setup tracks individual worms from egg to adulthood, while optogenetic stimulations are applied. An automated data analysis pipeline manages the extensive generated data. This investigation aims to deepen understanding of behavioral consistency and individuality in conspecifics.
14:00		***END***

Applied Physics & Plasma Physics

Friday, 08.09.2023, Room 114

Time	ID	APPLIED PHYSICS & PLASMA PHYSICS (COMBINED SESSION) *Chair: Laurie Porte, EPFL*
	~~951~~	*moved to poster 974*
12:00	952	**Structured matter based ultrasound sensing** *Dorian Brandmüller, Peter Banzer, Robert Nuster, Institute of Physics, University of Graz* Metamaterials are artificially structured materials designed to exhibit extraordinary physical properties not found in nature. They have been utilized for a wide range of applications such as beam shaping, lensing, and microscopy. In recent years, metamaterials have also been explored for their potential in refractive index sensing. A metasurface-based ultrasound sensor can provide high flexibility, sensitivity, resolution, and versatility, making it a promising candidate for various applications, including medical imaging and non-destructive testing. We design and study optical metasurfaces to be utilized as ultrasound wave sensors, demonstrating the potential of metamaterials in multimodal all-optical ultrasound sensing.
12:15	953	**Reaction-Diffusion PDE-based framework for tomographic inversions of Tokamak data** *Daniele Hamm, Basil Duval, Christian Theiler, Matthieu Simeoni, EPFL* We consider the challenging problem of sparse-view computerized tomography, in the context of plasma emissivity reconstruction in Tokamak fusion devices. Inversion techniques deal with strong artifacts and often lack robustness. We present a reaction-diffusion PDE-based framework for tomographic inversions. A reaction term ensures data-fidelity, while a diffusion term promotes smoothness achieving regularization. The proposed model represents a robust and mathematically rigorous unification of existing and new regularization strategies. Moreover, the model admits a Bayesian interpretation, opening the way to hyperparameter estimation and uncertainty quantification. Computation employs the open-source Python computational imaging framework Pycsou. We validate the model with Tokamak simulation data in various plasma regimes.
12:30	954	**Determination of Nitrogen Concentrations in Fusion Plasmas from Filtered Camera Images** *Emanuel Huett, Basil Duval, Artur Perek, Holger Reimerdes, Christian Theiler, EPFL* This study presents methods for determining 2D plasma parameters from filtered camera images in a toroidally symmetric tokamak. Filtered cameras offer high spatial resolution and the ability to generate 2D electron temperature, electron density, neutral density, and impurity species maps. The application of such methods are of interest in divertor physics and for more exotic studies such as plasma generation for machine-wall conditioning. This study will in particular focus on the determination of the nitrogen concentration in the divertor and plasma core, since low-Z impurities are the key to control the power exhaust problem in fusion devices.

12:45	**955**	**Recent improvements in the infrared thermography diagnostic on TCV** *Martim Zurita, Claudia Colandrea, Holger Reimerdes, Dmytry Mykytchuk, Marta Pedrini, and the TCV team, EPFL* Recent problems and solutions related to the infrared camera system of the TCV tokamak are reported. These infrared cameras measure the temperature of the device walls during plasma discharges to infer the heat flux impinging on the material surfaces. It was discovered that the signal of the vertical-viewing camera decreased with time throughout 2021 and 2022, due to a loss of transmittance of the vacuum window. To overcome this issue, a time-dependent calibration was adopted. Furthermore, experiments showed that temperature variations of the camera and the optical system can significantly affect the measured signal. To account for this, thermocouple measurements were used to determine the background signal for each discharge.
13:00	**956**	**Automated steering angle optimization of electron cyclotron heating for fusion plasmas using TORBEAM** *Antonia Frank [1], Federico Felici [1], Cristian Galperti [1], Emanuele Poli [2], Matthias Reich [2], Olivier Sauter [1]* *[1] EPFL, Swiss Plasma Center (SPC), [2] Max-Planck-Institut für Plasmaphysik* One of the main actuators for nuclear fusion experiments is the electron cyclotron (EC) wave, which is used to locally heat and drive current in the plasma. High-performance operation at large fusion devices will require accurate real-time (RT) control of the EC system, including controlling the beam's deposition location in the plasma, which can be modified by adjusting the antenna's steering angles. This work uses the RT-capable beam-tracing code TORBEAM to find the EC de- position characteristics for TCV plasmas. An optimization algorithm for the steering angles is developed as a suitable tool for experiment preparation and a first step towards RT plasma profile and stability control with EC waves.
13:15	**957**	**Comparing Problem Formulations and Solution Methods for the Grad-Shafranov Equation in the MEQ Suite** *Cosmas Heiß, Francesco Carpanese, Federico Felici, André Langmeier, Antoine Merle, Olivier Sauter, Cristian Sommariva, EPFL* Tokamak plasma operation and control requires precise knowledge and control of the plasma MHD force balance equilibrium. The MEQ software is a suite of magnetic equilibrium codes able to reconstruct the magnetic field from measurements on sub-millisecond timescales, predict plasma evolution, and compute required coil currents to achieve a desired plasma state and geometry. We present different strategies for solving the underlying non-linear system posed by the Free- Boundary Grad-Shafranov equation and investigate stability and convergence of Newton solvers for various formulations of the residual. Finally, we discuss future directions, including the integration of machine learning for real-time simulation and control.
13:30	**958**	**Low Momentum Diffusivity Regime in the Toroidal Plasmas** *Haomin Sun, Justin Richard Ball, Stephan Brunner* Sufficiently strong plasma flow shear reduces turbulent transport in tokamaks, thereby improving the prospects for fusion power plants. This is usually accomplished by increasing flow shear drive. Here we explore a novel strategy: decrease the momentum diffusivity to make the plasma "easier to push". A large number of high-fidelity kinetic simulations were conducted using the GENE code. A low momentum diffusivity regime is reached at tight aspect ratio, low safety factor, and low temperature gradient. The effects of magnetic shear and other parameters are also studied. To further explore this regime, we proposed a new quasi-linear model, which enables computationally efficient calculation of the momentum diffusivity for toroidal tokamak plasmas. *This talk will also be presented as poster 971.*

13:45	**959**	**Suprathermal ion transport in complex magnetic geometries on the toroidal plasma experiment TORPEX** *Cyrille Sepulchre, Marcelo Baquero-Ruiz, Ivo Furno, Patrick Quigley, Simon Vincent, EPFL* Understanding the interaction of suprathermal ions with plasmas is a crucial step in the quest for nuclear fusion, because these ions are required to heat the main plasma during ignition and losing them can damage the vessel walls. Basic plasma experiments like TORPEX have made important contributions in this area through studies of suprathermal lithium ion transport in a simple magnetic configuration. Recently, a more complex magnetic configuration (X-point) has been developed and extensively characterized. We present here two X-point scenarios that have been selected for new suprathermal ion transport studies. Simulations and experiments have been performed in these conditions and are presented and compared.
14:00		***END***

ID	APPLIED PHYSICS & PLASMA PHYSICS POSTER
971	→ *see talk 958*
~~972~~	*moved to talk 959*
973	**Towards exascale in Plasma Physics: A massively parallel performance portable C++ Particle-in-Cell framework** *Sonali Mayani [1], Sriramkrishnan Muralikrishnan [2], Matthias Frey [3], Alessandro Vinciguerra [4], Michael Ligotino [4], Antoine Cerfon [5], Miroslav Stoyanov [6], Rahulkumar Gayatri [7], Andreas Adelmann [1]* *[1] Paul Scherrer Institute, [2] Jülich Supercomputing Center, [3] University of St. Andrews, [4] ETH Zürich, [5] Courant Institute of Mathematical Sciences, [6] Oak Ridge National Laboratory, [7] NERSC, USA* We present a IPPL, a C++ framework for Particle-in-Cell methods based on dimension independent particles and fields. IPPL makes use of Kokkos and HeFFTe (part of the Exascale Computing Project), and MPI (Message Passing Interface) to obtain a massively parallel performance portable code which works across various hardware architectures. We showcase its performance and utility using "Alpine", a set of mini-apps which solve electrostatic plasma physics problems. These include weak and strong Landau damping, bump-on-tail and two-stream instabilities, and electron dynamics in a Penning trap. Scaling studies are performed on large architectures such as Perlmutter and Piz Daint. We show weak and strong scaling, and pinpoint kernels requiring performance improvements.
974	**A Connection between Probability, Physics and Neural Networks** *Sascha Ranftl, TU Graz, Institute of Theoretical Physics-Computational Physics* We illustrate an approach to study and design physics-consistent infinite neural networks for regression by falling back on stochastic Gaussian process theory. This mathematical connection allows to hard-code prior physics knowledge expressed in terms of linear (differential) operators directly into the model structure, in contrast to weak constraints with optimization regularization. Prime applications are fast, approximative surrogates or emulators (for expensive simulations or experiments) that need to be physically trustworthy and data-efficient, i.e. generalize well in little data regimes. In another aspect, this mathematical connection paves the way for studying symmetries and spectral properties emerging from given learning model architectures. Examples with the Helmholtz or Heat equation will be discussed.

Autorenverzeichnis - List of Authors

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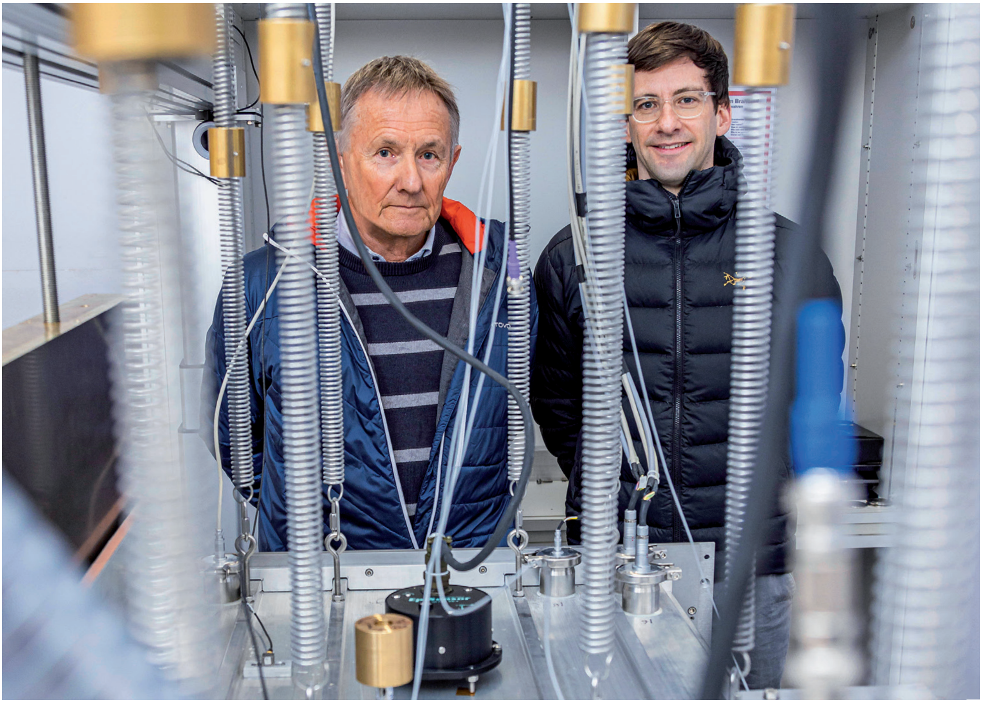
Notizen - Notes



Prof. Jürg Dual und Dr. Tobias Brack, ETH Zürich

Kleine Signale der Gravitationskonstante

Herzliche Gratulation an Prof. Jürg Dual, seine Forschungsgruppe an der ETH Zürich und allen Mitwirkenden zur erfolgreichen Messung von Newtons Gravitationskonstante mit einer neuen Methode basierend auf dynamischer Gravitation. Diese fantastische Leistung wurde mit heterodyner Laserinterferometrie und Lock-in Verstärkung in einer temperaturstabilen Umgebung in den Schweizer Alpen erzielt.

Wir sind begeistert, dass die anspruchsvolle Messung mithilfe von mehreren MFLI Lock-in Verstärkern und dem Multi-Device Synchronization (MDS) Protokoll realisiert werden konnte.

Zurich Instruments