University of Zurich[UZH]

Physik-Institut

Newsletter, September 2021

Peter Stoffer – new SNSF Eccellenza Professor

Peter studied physics at the University of Bern and obtained his PhD in 2014. Afterwards, he spent two years as a postdoc at the HISKP, University of Bonn. From 2017 to 2018, he was an SNSF post-doctoral research fellow at the University of California, San Diego, where he continued as postdoctoral researcher until summer 2020. He then joined the particle physics group of the University of Vienna as a long-term university assistant. Recently, Peter was awarded with an SNSF Eccellenza Professorial Fellowship. His new position is split between the UZH Physik-Institut and Paul Scherrer Institut.

Peter's research focuses on low-energy hadron physics and effective field theories for physics beyond the Standard Model. His current research program is motivated by experimental progress in searches for new physics at the low-energy precision frontier, such as measurements of dipole moments and searches for lepton-flavor-violating processes. These low-energy observables are affected either directly or through virtual quantum effects by the strong nuclear force at low energies. Peter is developing new techniques to describe these hadronic effects and to establish model-independent relations to heavy physics beyond the Standard Model. To this end, he is combining perturbative calculations with non-perturbative methods, such as dispersion relations, effective field theories, and lattice-QCD input. Peter is one of the main developers of the dispersive approach to hadronic light-by-light scattering, which helped to reduce uncertainties in the Standard-Model prediction for the anomalous magnetic moment of the muon.

University of Zurich[UZH]

PhD and Master theses

Following students have defended their PhD or Master theses since February 2021.
We congratulate!

Madhav Mohan (Neupert), Master
Characterizing fractional quantum Hall states in lattice models

Matthäus Heer (Unkelbachi), Master
The Out-of-Distribution Detection Blindspot of Unsupervised Lesion Detection

Samuel Menzi (Osterwalder), PhD
Soft X-Ray Spectroscopy on Liquids

Silvia Fabiano (Unkelbach), PhD
Combined Proton-Photon Radiotherapy

Lisa Grad (Osterwalder), PhD
Charge Carrier Dynamics on Photoelectrode Materials for Solar Energy Conversion

Kenny Choo (Neupert), PhD)
Neural Networks for Variational Quantum Monte Carlo Calculations

Diem Vuong (Unkelbach), PhD
Radiomics as Biomarker in Multi-Modality Treatment of Locally Advanced Non-Small Cell Lung Cancer

Luca Naterop (Signer), Master
Electron positron annihilation into photons at NNLO accuracy

Sara Mustafi (Chang), Master
Magnetic excitations in the infinite layer cuprate $SrCuO_2$

Iaroslava Bezshyiko (Serra), PhD
Testing the Standard Model Lepton Symmetries in Collider and Fixed-Target Experiment

Julia Stark (Jetzer), Master
Probing parity violations with multi-messenger observations of gravitational-wave transients

Eduardo Plörer (Canelli), Master
Quark Gluon Discrimination with ABCNet

Mark Nestor Constantini (Grazzini), Master
q_T subtraction for jets: a study of Higgs plus jet at NLO

Weichuang Lee (Greber), Master
Printed Gate MOS-Devices for Characterization of Two-Dimensional Materials and Gas sensing

Vera Hiu-Sze Wu (Baudis), Master
Low Energy Calibration for GERDA and Characterization of Wavelength-shifters and Reflectors

Vinicius Mikuni (Canelli), PhD
Collider measurements in high jet multiplicity final states

Riccardo Del Burgo (Kilminster), PhD
The CMS Pixel Detector Upgrades and Novel Timing-Sensor Technology

Kay Lehnert (Yoo), Master

A String-Inspired Dark Energy–Dark Matter Interaction Model to Weaken the Hubble Tension
Nastassia Grimm (Yoo), PhD General Relativistic Effects in Cosmological Weak Lensing
Claudia Cornella (Isidori), PhD B-Physics Anomalies: from data to New Physics models
Hantian Zhang (Pozzorini), PhD Rational Terms in Two-Loop Scattering Amplitudes

Awards, grants & promotions

- Florencia Canelli started 1st of September with a 2-years term as CMS physics coordinator
- Titus Neupert is Co-director of the Digital Society Initiative since August 1st
- Luca Rottoli (group Grazzini) and Shubhanshu Tiwari (group Jetzer) receive a SNF Ambizione grant for the next four years
- Kenny Choo (group Neupert) obtained the 2021 PhD Thesis Award from the Swiss Physical Society in the category Computational Physics
- Thomas Gehrmann received an ERC Advanced Grant to develop new methods for precision calculations in particle physics
- Wolfgang Simeth and Gediminas Simutis (group Janoschek) and Marino Missiroli (group Caminada) were awarded a PSI Fellow Fellowship
- Ales Cahlik (group Natterer) received a Swiss Government Excellence Fellowship
- Danyang Liu (group Natterer) won a SNF Mobility Fellowship for a 6 months research stay at FZ Juelich
- Anna Macchiolo (groups Canelli, Kilminster) was selected deputy project manager for the tracker upgrade of the CMS experiment
- Karin von Arx (group Chang) got a UZH Alumni FAN Award

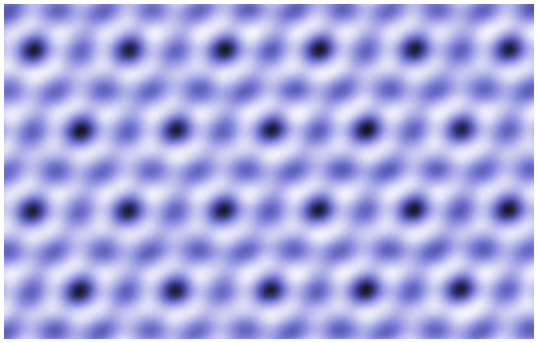
Recent scientific achievements

A Long Drive to Outer Space? Put Gravitational Waves on the Radio

That's a comment on a recent paper by D. Soyuer, L. Zwick, D. D'Orazio, and P. Saha in MNRAS 503, L73–L79 (doi.org/10.1093/mnrasl/slab025).
Radio ranging to any spacecraft is, in principle, a possible detector of gravitational waves, and past missions to Jupiter and Saturn have in fact provided upper limits. The new work points out that the combination of longer ranges from proposed missions to Uranus and Neptune, and prospective improvements in radio ranging, should enable detection of a few supermassive black-hole merger events in gravitational waves. Why bother, when LISA will be more sensitive? The reason is that LISA's sky-localization is rather poor on its own, but improves greatly of another detector is combined with it MNRAS 503, L73–L79 (doi.org/10.1093/mnrasl/slab025) .

Prasenjit Saha

Discovery of a novel charge order in kagome superconductors

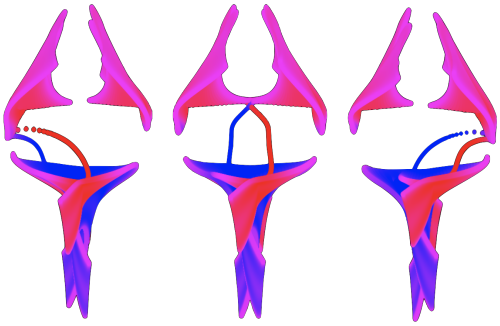


The kagome lattice, named after a pattern of Japanese basketry, is a well-known theoretical playground for exotic electronic phases. However, laking material realizations, experimental verifications have been in waiting. In a study published in Nature Materials, researchers from the group of Titus Neupert and Princeton University have now discovered evidence for sought-after unconventional charge order with finite angular momentum, realized in a novel kagome material class.

Unconventional chiral charge order in kagome superconductor KV3Sb5

Michael Denner

Exceptional Topological Insulators

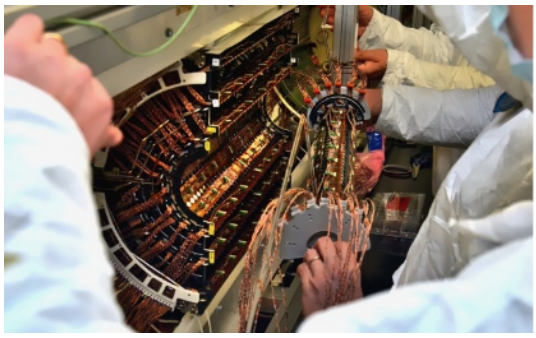


Three-dimensional topological insulators have become a research focal point on topological quantum matter. A recent work led by the group of Titus Neupert now proposes an analogue in dissipative systems, which are described by non-Hermitian operators, the exceptional topological insulator (ETI). Like normal topological insulators, the ETI hosts exotic surface states. Mathematically, they have a band structure with a so-called exceptional point, which can only exist because of the 3D topological bulk embedding. Such a phase could for instance describe the physics of quasiparticles in Weyl semimetals with strong electron-phonon interaction.

arXiv:2008:01090

Michael Denner

Re-Installation of the CMS Pixel Detector



After more than two years of maintenance and upgrade during the LHC shutdown, we have re-installed the pixel detector in the center of the CMS detector. The CMS group at UZH together with colleagues from PSI, ETH and other institutes has been a major player in this endeavour. The innermost layer of the CMS pixel detector, which due to its location closest to the interaction point is exposed to the highest radiation, has been replaced with new modules featuring new readout chips and front-end ASICs. Additional refurbishment and repair of faulty components and connectors allowed to establish a working fraction among the 124 million readout channels of the pixel detector of more than 99%. Calibrations and cosmic data taking is currently ongoing and the CMS pixel detector is ready to record the first collisions during the LHC pilot run at the end of October.

Lea Caminada

Recent results from CMS UZH groups

The first observation of the concurrent production of three J/ψ mesons in proton-proton has been reported by the CMS experiment. This analysis, lead by Stefanos Leontsinis (groups Canelli/Kilminster), provides a novel approach to study multiple hard scatterings in proton proton collisions exploiting, for the first time, the production of three heavy particles, http://cds.cern.ch/record/2776769?ln=en.

Florencia Canelli

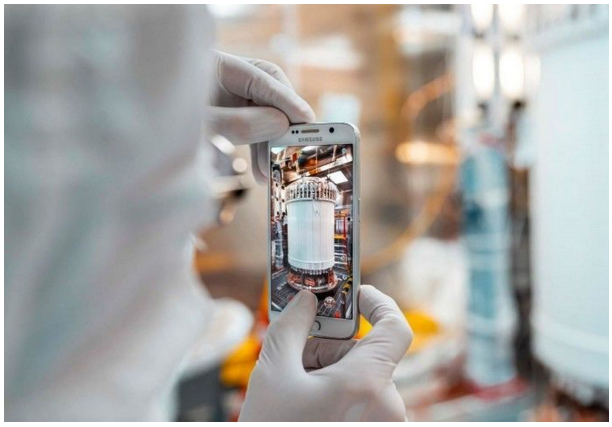
The first collider search for dark matter arising from a strongly-coupled hidden sector is now public. This analysis was part of the PhD thesis of G. Rauco (group Canelli) at UZH.
The results extends the search to unexplored regions of dark matter by looking for a particle mediating the standard model and the dark sector that would decay in a combination of visible matter and dark matter. The results exclude the existence of a mediating particle with masses up to 5.1 TeV at 95% C.L., depending on the other signal model parameters http://cds.cern.ch/record/2778946?ln=en.

Florencia Canelli

The group of Cristina Botta has released results on a challenging search for supersymmetry in compressed spectra at the CMS experiment. The results have already presented at the Rencontres de Moriond 2021, https://cms.cern/news/low-energy-leptons-high-energy-physics.

Cristina Botta

Leading Xenon Researchers unite to build next-generation Dark Matter Detector

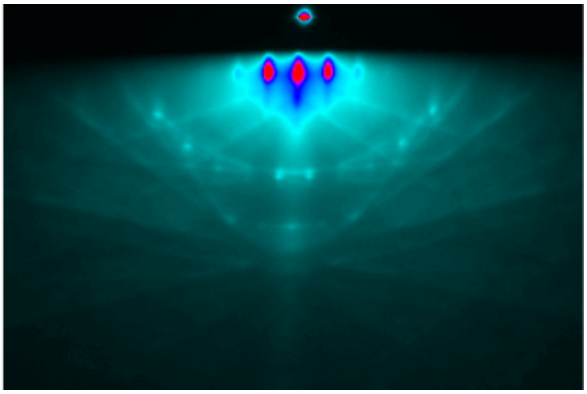


Hundreds of global researchers, including University of Zurich, are planning the most sensitive dark matter detector ever built. The XENON/DARWIN and LUX-ZEPLIN collaborations have now joined forces to work together on the design, construction, and operation of a new, single, multi-tonne scale xenon observatory to explore dark matter. The detector will be highly sensitive to a wide range of proposed dark matter particles and their interactions with visible matter. Over the last 20+ years, experiments using liquefied xenon targets have delivered world-leading results in the global quest for direct dark matter detection. This next-generation detector aims to continue the pursuit (News).

Recent articles:
Nature Italy: Will dark matter be detected at Gran Sasso? https://www.nature.com/articles/d43978-021-00111-9
Il Nuovo Saggiatore: Dark matter searches with liquified Xenon
https://www.ilnuovosaggiatore.sif.it/issue/65

Laura Baudis

New sputtering system with in situ Reflective High Energy Electron Diffraction



The Oxide Interface Physics group around Prof. Marta Gibert has built a new sputtering system with in situ Reflective High Energy Electron Diffraction (RHEED) capabilities. This allows us to track the growth of complex oxide thin films in real time. The film thickness can be monitored with atomic precision making it a crucial tool for our future work on atomically engineered oxide superlattices. The vacuum system was built in-house by the physics mechanical and electrical workshops. The figure shows the diffraction pattern of $SrTiO_3$ substrate after the growth of a La_2NiMnO_6 thin film (News)

Jonathan Spring

Theory meets Experiment: Ultimate precision for the Drell-Yan process

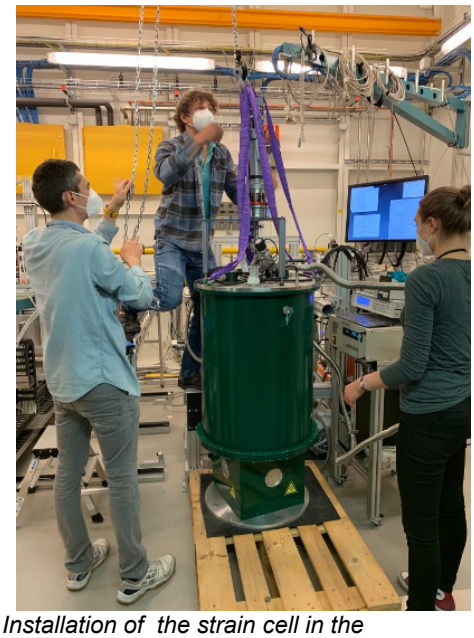
Theoretical particle physicists of the group of Massimiliano Grazzini have completed the first computation of strong-electroweak corrections to the Drell-Yan process. The Drell-Yan process is one of the most classic hard-scattering processes at hadron colliders and led to the discovery of the W and Z bosons at the CERN SpS in 1983. Theoretical particle physicists at the University of Zurich have completed the first computation of the mixed QCD–EW corrections for the neutral-current Drell-Yan process. The calculation is obtained with techniques which combine scattering amplitudes generated with automated tools also developed in Zurich, with sophisticated analytical methods and advanced numerical integration techniques. Such result paves the way to new precision studies for this benchmark process at the LHC.

Publication: https://arxiv.org/abs/2106.11953

Massimiliano Grazzini

New strain cell for neutron and x-ray scattering

“Quantum matter” is any novel phase of a solid with macroscopic and frequently functional properties that are characterized by underlying interactions that are inherently “quantum” in nature. These quantum matter states are of particular interest due to their potential for applications from power management and transmission to quantum computation and novel versatile sensors. Because quantum matter states typically emerge due to a delicate interplay of several atomic-scale interactions, it is often found that they can be tuned with great ease using external perturbations. Recently, a series of astonishing new results have established uniaxial pressure (or strain) as a relevant new tuning parameter that allows to reveal novel quantum states. Notably, strain has been used to stabilize topological magnetic phases, to probe the symmetry of unconventional superconducting pairing and electronic nematic states. Here a key question is whether the application of strain results in symmetry breaking of the underlying chemical lattice, or if new broken symmetries arise solely in spin or charge channels.

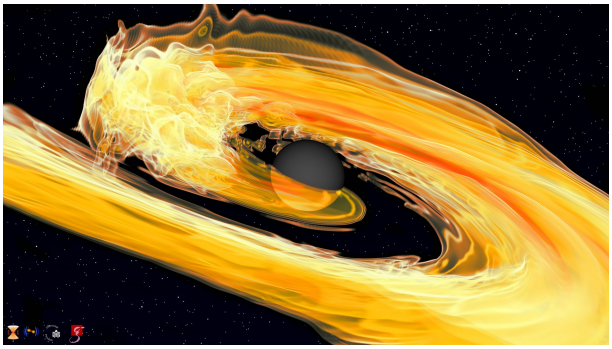


Installation of the strain cell in the cryomagnet at the PETRA III beamline P09.

To answer this question, in a collaboration between the groups of Profs. Chang and Janoschek and the Paul Scherrer Institute (PSI), we have developed a novel strain cell that can be combined with high-resolution synchrotron diffraction techniques. This cell allows to change the strain of a quantum material in-situ while at the same time directly observing the lattice symmetry. To realize this new cell a successful technical collaboration between UZH and PSI emerged, led by Alex Bollhalder (PSI, LIN Mechanical Engineering) and Reto Maier (UZH, workshop Physik Institut). This new pressure cell has been commissioned in a first experiment at the P09 beamline at the PETRA-III synchrotron in Hamburg that was led by graduate student Julia Küspert (group Chang) and postdoc Gediminas Simutis (group Janoschek.

Marc Janochek

First discovery of a neutron star colliding with a black hole



For the first time, gravitational-wave astronomers of the LIGO collaboration, including Maria Haney und Shubhanshu Tiwari from the group of Philippe Jetzer, have confirmed the detection of a collision between a black hole and a neutron star.

The LIGO-Virgo instruments detected not one but two such events occurring just ten days apart in January of 2020. These extreme events made splashes in spacetime that sent gravitational waves rippling across 900 million light-years to reach Earth. In both cases, the neutron star was likely swallowed whole by its black hole partner (News).

Phillippe Jetzer

Recent Results from LHCb Challenge Leading Theory in Physics

The LHCb collaboration has released new intriguing results; their latest measurements strengthen hints for a deviation with respect to the theoretical expectations. When so-called beauty quarks are produced during the collision of high-energy proton beams in the Large Hadron Collider they decay almost immediately. Researchers of the LHCb collaboration reconstruct the properties of the composite particles based on their decay products. According to the established laws of particle physics – the so-called Standard Model – it is expected that beauty quarks decay with the same probability into a final state with electrons and muons, the much heavier siblings of electrons. However, since 2014 measurements at the LHC suggest that this "lepton universality" may be violated in some decays. In these decays the production ratio of the two types of particles is different from the theoretical prediction of one.

Members of the group of Nicola Serra are part of the small research team that worked directly on the measurement. In the newest LHCb analysis, the ratio of decay products containing electrons and muons was determined with much better precision compared to previous measurements, using all the data collected by the LHCb detector so far. The result indicates evidence for a deviation from the ratio of one – and hence a breaking of the “lepton universality” in beauty quark decays with a probability of around 0,1% that the data is compatible with the theoretical prediction. If confirmed, this violation would imply physics beyond the Standard Model such as a new fundamental force in addition to the four fundamental ones: gravity, electromagnetism, weak nuclear interactions responsible for radioactivity and strong nuclear forces that hold matter together (News).

Patrick Owen

Schools, workshops and conferences

MaNEP Mini-Workshop on Complex Oxide Heterostructures, 28 October 2021
https://www.manep.ch/complex-oxide-heterostructures-mini-workshop/

Summary of 12th Workshop on picosecond timing detectors, September 22-24, 2021 at UZH

The 12th Workshop on Picosecond Timing Detectors took place in Zurich from Sept. 9-11. The workshop focused on detectors with timing resolutions in the picosecond range including technological developments and large scale applications in physics experiments. There were 35 talks given in both in-person and through video attendance. The number of in-person participants was 34 while 17 participated remotely. The peer-reviewed proceedings will be published in a special issue of "Instruments" dedicated to "Timing Detectors".Website

Outreach

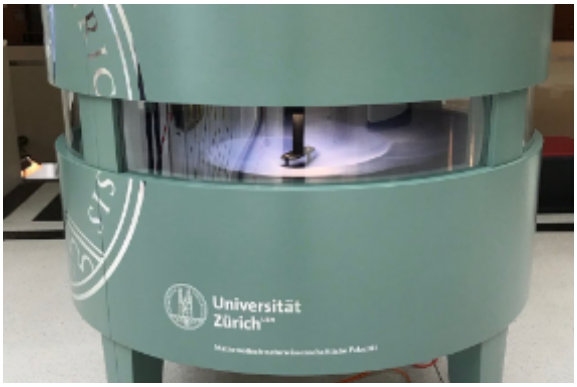
RAI SuperQuark

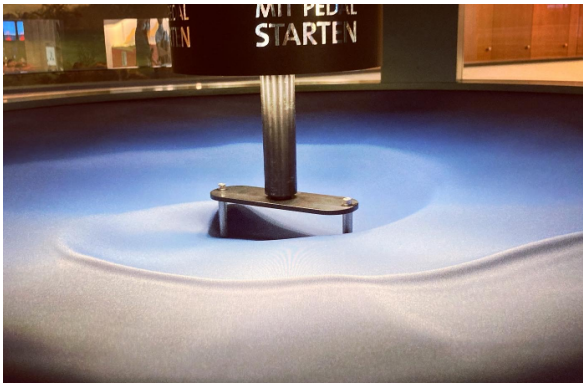
Italian **TV report** on the **Flavour Anomalies** measured at LHCb, featuring Nico Serra and Gino Isidori

Gravitational wave exhibit in focus Terra ETH

Visit the gravitational wave exhibit in the special exhibition "Wellen – tauch ein!" of *focus* Terra ETH.

Our department and Science Lab UZH have developed an exhibit to visualise gravitational waves In the context of the AGORA-Project " the irresistible attraction of gravity" together with the workshops of our department.
It is shown at *focus* Terra ETH in the special exhibition "Wellen – tauch ein!" until March 2023.





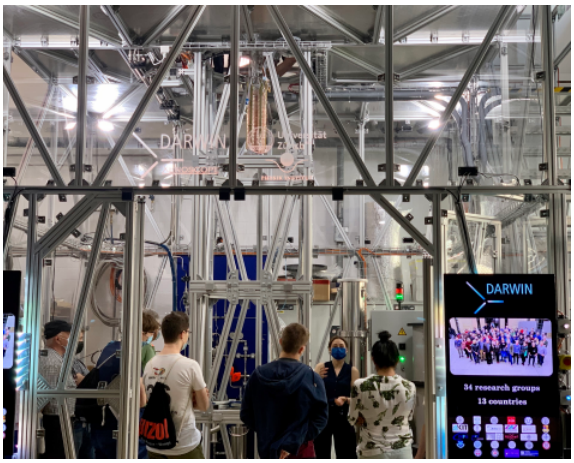
Making the invisible visible

SCNAT portrays Laura Baudis in the series Women Scientists in Former Male Domains.

Scientifica

The topic of this years Scientifica that took place September 4 and 5 was "Synthetic – naturally". About 10'000 visitors came to the main buildings of ETH and UZH, and to the Hönggerberg and Irchel campuses to learn about current research and share the excitement of researchers. Our institute contributed with a lecture on Lisa a tour to XENOSCOPE , a science booth on the XENON and the LHC experiments, a physics show with lots of demonstration experiments and a theatre featuring three black holes at a bar.

Impressions:



Long Night of Museums

Researchers of our institute gave talks at the 'Lange Nacht der Museen', September 5 at the Science Exploratorium UZH on the CMS Experiment, Superconductivity and the Search for Dark Matter.

Agenda

- November 11: Zukunftstag
  Children in the 5th-7th grade have the opportunity to accompany their parents to work. In the morning the kids will be at their parents' workplace, in the afternoon there is an attractive program at the Irchel campus. Registration is possible from October 25:
  https://www.zukunftstag.uzh.ch/de.html
- November 25st and 26nd: Open-day of the physics department
  Thursday, November 25st 15:00-18:00 is dedicated to Bachelor and Master students at our institute and includes also the ceremony for the award of the Dectris prize for the best experimental master thesis.

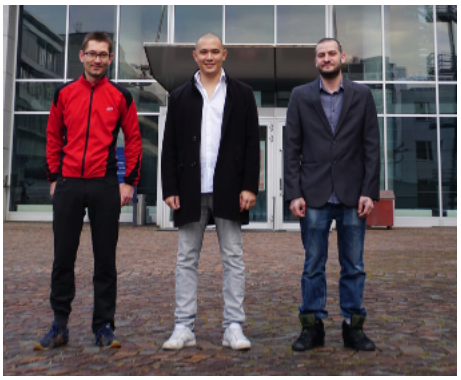
  Friday, November 26nd 15:00-19:00, is the Poster Session and Open Labs Day for Alumni of our institute, members and students of other institutes from the MNF.
  Please register (http://www.physik.uzh.ch/en/events/register_openday_2021) if you would like to present a poster.

Varia

Book

Book in honor of Prof. K.A. Müller for his lifework: From Quantum Paraelectric/Ferroelectric Perovskite Oxides to High Temperature Superconducting Copper Oxides Download

CondenZero



This year the team of condenZero won financial support in several Swiss startup competitions (ESA BIC Switzerland, Venture Kick, BLKB: “100 fürs Baselbiet", Innosuisse Innocheque and Innovation Booster Advanced Manufacturing). In a nutshell, condenZero is a UZH physics institute spin-off developing liquid helium cryostats for transmission electron microscopy with unprecedented cooling performance.

IT security

In the last few months we read about some more or less spectacular hacking incidents like the pipeline hack in the US in April this year or as some of us might have noticed the one against the p4u webshop - an external webshop used by the UZH. IT Security is not the hottest topic to think about but that doesn’t mean you shouldn’t care.
Take a look at some basics rules on our website:
https://www.physik.uzh.ch/en/internal/it-security.html
https://t.uzh.ch/1cW

Sustainability

Together with Johan Chang and the Sustainability Initiative UZH, Fabian Natterer has implemented measures to monitor our and the institute's helium consumption and losses. Recommendations on how to avoid helium losses are detailed on the sustainability website of our institute.