

Preface

Jürg Osterwalder, Department Head

1

With a total of 22 research groups, the Department of Physics of the University of Zurich covers a variety of subfields of physics. Experimental activities include particle and astroparticle physics, hard and soft condensed matter physics, surface physics and nanoscience, as well as the physics of biological systems. Theoretical groups work on precision calculations of processes in quantum chromodynamics and new theories beyond the standard model of particle physics, astrophysics and general relativity, as well as topological concepts in condensed matter physics. Other physics-related groups from within the Faculty of Science and beyond are affiliated to our department, and our home page gives links to their research. Together, we can offer a broad and high quality spectrum of lecture courses as well as Bachelor, Master and semester projects to our students. The infrastructure department consisting of excellent mechanical and electronics workshops as well as efficient IT and administrative support teams complete our attractive research environment.

<https://www.physik.uzh.ch/en/research.html>

The arrival of Andreas Crivellin in January 2019 brought yet another SNF professorship to the department. His research is situated in the field of theoretical particle physics and focuses mainly on flavour physics beyond the Standard Model. With his co-affiliation with the Paul Scherrer Institute, he strengthens further our already strong interchange with this national research institution. Moreover, we welcomed Cristina Botta as the first PRIMA fellow, supported by one of the well funded grants of the SNF aimed at excellent women researchers who show a high potential for obtaining a professorship. Several members of the department won international recognition and awards, most notably Gino Isidori with his ERC Advanced Grant, Laura Baudis with a Visiting Miller Professorship Award of the UC Berkeley, Marta Gibert with the International Workshop on Oxide Electronics Prize and Titus Neupert with the Klung-Wilhelmy Wissenschafts-Preis.

End of October, the department was shaken by the tragic news that Alexey Soluyanov has passed away in St. Petersburg, Russia. Within a bit more than a year he had already built a strong research activity in theoretical condensed mat-

ter physics at our department (see next pages). Thankfully, with the help of Titus Neupert and with the unbureaucratic compliancy of the SNF, solutions could be found for all team members to continue with their projects.

In late August, the Swiss Physical Society Meeting, together with the Meeting of the Austrian Physical Society, took place on Irchel Campus, with Johan Chang acting as the local coordinator. Our institute contributed to the Scientifica 2019 event with a short opening talk on dark matter by Laura Baudis, a show on the magic of physics by Christof Aegerter and a booth concentrating on the topics of antimatter and dark matter. The two Poster Days in November, one for the students and one for the alumni, were again a great success. An impressive number of students showed up and involved the members of the research groups in lively discussions about the presented research posters. A less pleasing incident occurred in October: the laser cutter in the big assembly hall of the mechanical workshop caught fire during operation, which triggered the fire alarm. Most of the physics building was evacuated due to extensive smoke emission, but the fire brigade had the situation soon under control and nobody got harmed. Thanks go to Reto Meier for reacting fast and considerate, and to the university for covering with minimal delay the damage to the prototype DARWIN dark matter detector that was being under construction near the fire.



In spring 2020 the Faculty of Sciences will open the new Science Exploratorium within the space of the current Museum of Anthropology on the Irchel Campus. The model of the CMS detector at CERN's LHC, acquired by the Department of Physics, is the first exhibit of this new showcase for the wide range of research carried out within our faculty.

This booklet aims give a broad idea of the wide range of research pursued in our department and refers the more interested reader to the research websites. Presenting individual highlights with pride, we thankfully acknowledge the continued support from the Kanton Zürich, the Swiss National Science Foundation, the European Commission, and others who have made this fundamental research possible.

The legacy of a topological pioneer - Alexey Soluyanov

3



Prof. Dr. Alexey Soluyanov, SNF professor for theoretical solid-state physics at our department, passed away in October 2019 after bravely fighting a hard struggle against cancer. He will be remembered as an inspiring colleague, mentor, and friend. His discoveries in topological condensed matter physics were visionary.

The University of Zurich has lost in Alexey Soluyanov one of the world's leading experts in theoretical solid-states physics. His contributions to the field of topological states of matter have been both foundational and groundbreaking. His work has led to a deeper understanding of the band theory of crystalline materials, so-called topological insulators. In addition to this fundamental work, he has predicted multiple classes of semimetals, which were experimentally discovered shortly thereafter. Furthermore, he developed two software packages, which have simplified the discovery of new exotic quantum materials. They became the standard way to identify topological materials in theoretical calculations. In a

separate line of research, Soluyanov also contributed to Microsoft's effort to build a quantum computing by identifying the best possible material ingredients for its hardware basis.

Alexey Soluyanov studied physics in the great tradition of the Russian school, in his birth-town of St. Petersburg at the University of St. Petersburg, Russia. He earned his PhD in 2012 under David Vanderbilt at Rutgers University, USA. After that he worked at ETH Zurich, first as a postdoc and then as a senior scientist. Starting in 2018 he has been leading

his own research group at our department.

Alexey Soluyanov has left a lasting mark on the active field of topological materials with his farsightedness and his outstanding physical intuition. From early in his career, he has served as the advisor to the very successful theses projects of several doctoral students. Thus, beyond his passing, his work and passion endures.

<https://www.physik.uzh.ch/en/groups/neupert/Events/Soluyanov-Symposium/Obituary-Alexey-Soluyanov.html>

Statistical Data 2019

5

189
personnel

professors: 20
associated professors: 10
senior researchers: 23
postdoctoral researchers: 44
PhD students: 69
engineers and technicians: 25
administration: 6
+ research assistants

307
students

~55
new students

179	11
bachelor	BSc degrees
43	19
master	MSc degrees
116	18
PhD	PhD degrees

10
SNF prof.
and ERC grants

39 SNF or EU research grants
6 fellowships
34 UZH and other grants

417
publications

362 peer reviewed papers
38 conference proceedings
17 books & others

418
conference and
workshop
contributions

140 invited talks
180 seminar and other talks
57 posters
41 outreach

Outreach

Awards

- Marta Gibert: iWOE prize for excellency in research
- Titus Neupert: Klung-Wilhelmy-Wissenschafts-Prize
- Frank Schindler: Special prize of the Mercator Award jury
- Karin von Arx: Dectris prize for best experimental master thesis
- Denys Suter: SNF & Innosuisse Proof of Concept Grant
- Annual poster award of the Department of Physics for members of the groups Osterwalder, Baudis and Isidori

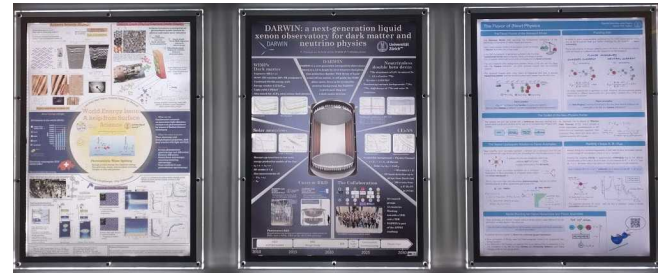
Conferences and Workshops in Zurich

- Zurich Phenomenology Workshop
- Standard model @ LHC
- Strontium Ruthenate:
25 Years of a Puzzling Superconductor
- SPS joint annual meeting Swiss Physical Society and the Austrian Physical Society

Others

- Scientifica 2019: Science fiction – Science Facts
- Schrödinger Colloquium:
M. Massimi, S. Stevenson, Ch. K. Jung, R. Renner
- Pint of Science Festivals
- Masterclass in particle physics
- How Particle Physics works: Episode II (video)
- Open Day of the institute

6



Teaching

bachelor
3
major options

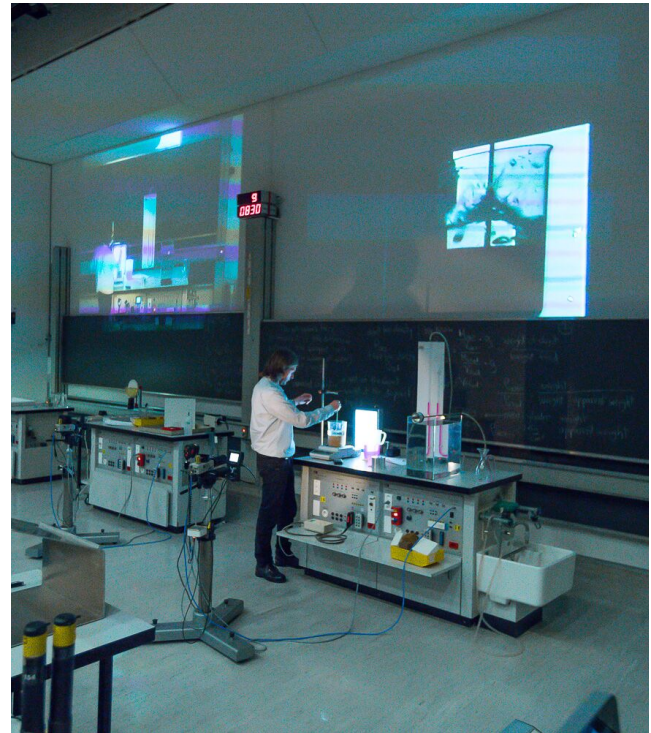
180 ECTS physics
150 ECTS physics/30 ECTS minor
120 ECTS physics/60 ECTS minor

4
master
programs

particle physics
condensed matter
astrophysics & cosmology
bio- & medical physics

service lectures
1166
students

532 medicine
389 biology & biomedicine
170 chemistry
60 teacher
15 minors



Demonstration experiments

A demonstration to visualize time-reversal symmetry in laminar flow

In highly viscous flows, the low Reynolds number leads to laminar flows that are completely time-reversible. This is because in the low Reynolds number regime inertial dynamics can be neglected and forces are proportional to velocities rather than accelerations. To illustrate this, we have created a Taylor-Couette cell consisting of a rotating inner cylinder and a stationary outside cylinder, where highly viscous corn

syrup is placed between the cylinders. With two coloured drops introduced into the liquid (left), it is then sheared continuously until the colours seem to be well mixed (middle). After shearing the liquid in the opposite direction for the same distance, the initial drops are recovered (right), showing the reversibility of the process. Interestingly, the dynamical law at the basis of this counter-intuitive effect is the Aristotelian dynamics still commonly present in many students. Thus, this demonstration can also be used to show the fallibility of this concept.

