

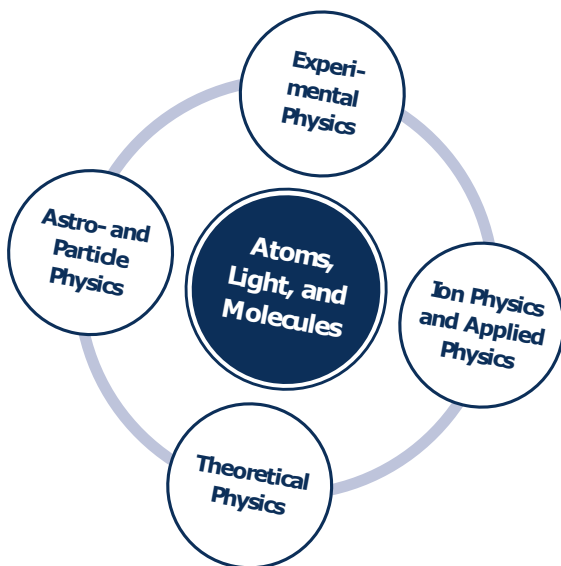
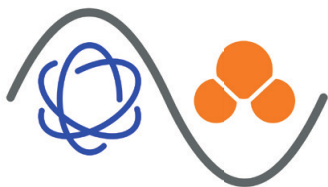


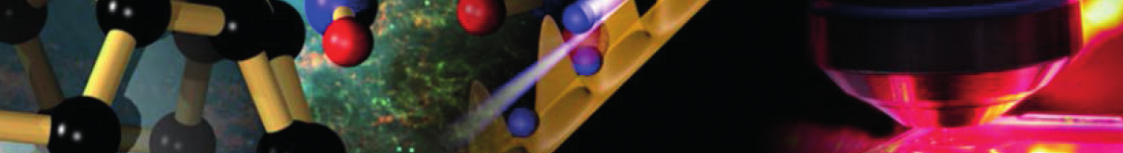
FWF Doctoral Programme Atoms, Light, and Molecules

Summer School 2025

Monday, 19th to Friday, 23rd May 2025

Universitätszentrum Obergurgl
Gaisbergweg 5
6456 Obergurgl, Austria





Monika Ritsch-Marte

Medical University of Innsbruck, Austria



Albert Schliesser

Niels Bohr Institute, Denmark



Elsa Abreu

ETH Zurich, Switzerland



Vera Schäfer

Max Planck Institute for Nuclear Physics,
Germany



Alejandro Pozas-Kerstjens

University of Geneva, Switzerland



Matteo Zaccanti

CNR-INO & LENS, Italy



**David Lederbauer and
Elisabeth Gruber-Tokić**

projekt.service.büro
University of Innsbruck, Austria

Programme

Monday, May 19th

11:15	Shuttle from Campus Technik (Stadtrad parking)
13:00 - 14:00	Lunch
14:00 - 18:00	Seminar 1 (Ritsch-Martel) incl. Coffee Break
18:00 - 19:00	Dinner
19:30	Poster Session

Tuesday, May 20th

07:30 - 09:00	Breakfast
09:00 - 13:00	Seminar 2 (Schliesser) incl. Coffee Break
13:00 - 14:00	Lunch
14:00 - 18:00	Seminar 3 (Abreu) incl. Coffee Break
18:00 - 19:00	Dinner
19:30	Student Meeting

Wednesday, May 21st

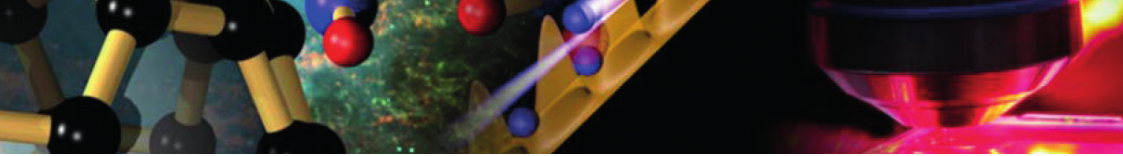
07:30 - 09:00	Breakfast
09:00 - 13:00	Group hike
13:00 - 14:00	Lunch
14:00 - 18:00	Seminar 4 (Schäfer) incl. Coffee Break
18:00 - 19:00	Dinner

Thursday, May 22nd

07:30 - 09:00	Breakfast
09:00 - 13:00	Seminar 5 (Pozas-Kerstjens) incl. Coffee Break
13:00 - 14:00	Lunch
14:00 - 18:00	Seminar 6 (p.s.b) incl. Coffee Break
18:00 - 19:00	Dinner
19:30	Game Night

Friday, May 23rd

07:30 - 09:00	Breakfast
09:00 - 13:00	Seminar 7 (Zaccanti) incl. Coffee Break
13:00 - 14:00	Lunch
14:15	Shuttle from UZE Obergurgl to Innsbruck



Optical and acoustic trapping for tomographic reconstruction



**Monika
Ritsch-Marte**

Optical and acoustic forces are both utilized for contact-free manipulation of biological samples in micro-fluidic chambers. Their respective benefits and limitations will be discussed, in particular for their suitability for particular applications in biomedical research, such as reconstructing a microscopic sample in 3D. While holographic optical tweezers provide fine control of μm -size objects such as cells, acoustic forces are strong enough to handle mm-size samples such as organoids, cancer spheroids or early stage developing organisms. Acoustofluidic actuation, for example, enables the tomographic 3D reconstruction of a zebrafish larva by optical coherence tomography (OCT), which is otherwise impeded by severe attenuation artifacts. A significant challenge here, however, lies in the fact that the exact orientations of the sample are not known a priori, which requires a more sophisticated reconstruction algorithm.



**Albert
Schliesser**

Optomechanics with coherent phonons

In this lecture, we will discuss optomechanical systems, in which phonons are coupled to other quantum degrees of freedom such as light. We will discuss their theoretical description and different experimental implementations, review characteristic phenomena, potential applications and some frontiers of current research.

THz dynamics of quantum materials

Quantum materials exhibit rich phase diagrams, strongly sensitive to external parameters. They are characterized by a variety of intriguing properties, which arise from complex interactions between microscopic degrees of freedom. One approach that has proven successful in decoupling the effect of different degrees of freedom is to perform time-resolved measurements, which yield the out-of-equilibrium response of different components of the system following an ultrafast perturbation. Of particular interest is photoexcitation by a terahertz pulse, where the low photon energy ensures that the out-of-equilibrium sample remains closer to its electronic ground state. I will focus on one example of our work, where we explore the THz response of Mott insulators.



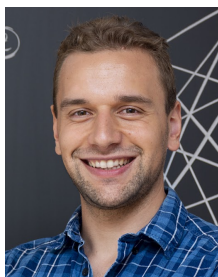
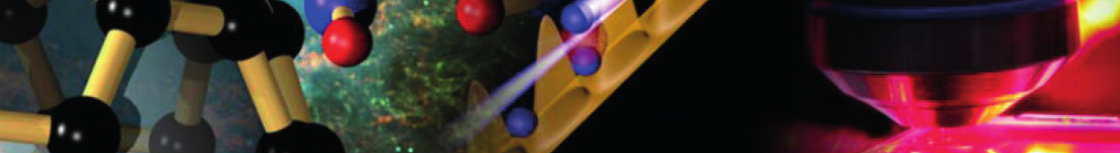
Elsa Abreu

Precision spectroscopy of highly charged ions

Highly charged ions (HCIs) are a promising tool for using precision spectroscopy to search for new physics: their valence electrons are very tightly bound to the nucleus, suppressing many error sources, while making them more sensitive to relativistic effects and different candidates for new physics. However most of their electronic transitions lie deep in the UV, making it difficult to cool and control them with lasers. In this lecture I will present how we can access HCIs for precision spectroscopy and use co-trapped singly charged ions for cooling and readout of the electronic state.



Vera Schäfer



**Alejandro
Pozas-Kerstjens**

Quantum information theory

In the context of the information age and the race for encoding information in ever smaller physical systems, one may wonder: what is the smallest system that we can use to store, transmit and process information? Is it a molecule? An atom? An electron? At these scales, the behavior of physical systems is best described by quantum mechanics, which despite its success is full of unintuitive phenomena such as superposition and entanglement. Are these new phenomena an obstacle for information processing? In this course we will review the rules that govern the quantum world, which limits do they set to information processing (and what this tells us about nature), and how using them we can develop faster computers and more secure communications.



**Matteo
Zaccanti**

Ultracold atomic mixtures

I will provide an overview of ongoing theoretical and experimental research on ultracold atomic mixtures, particularly on those made by two different fermionic species. I will first describe the rich few-body phenomena connected with such systems, and their possible impact at the many-body level. I will then discuss the specific combination of lithium and chromium atoms, realized in our lab, highlighting its peculiar properties, and describing two recent studies of our group: One targeted to the production of quantum gases of paramagnetic polar molecules, and a second one exploring the transport properties of light impurities within a Fermi gas of heavy atoms.



**David Lederbauer and
Elisabeth Gruber-Tokić**

From idea to exploitation – how to acquire and manage third party funded projects

The acquisition, management and potential exploitation of third party funded projects is a requirement for a successful career in research. Therefore, experts from the research support office will provide an overview how you can turn your research interests into third party funded projects. The event will inform you how to navigate the diverse funding landscape and find the funding agency that best suits you. Next, you will learn about the most important project management tools and how to use them. Alongside, the course will touch upon possibilities on how to disseminate and also protect and exploit potential project results, turning ideas into innovation.

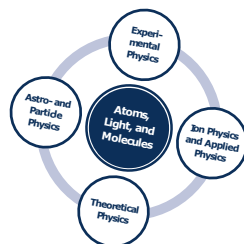
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