Guest Country Symposium Austria: "Selected Highlights of AMOP in Austria" (SYAU)

jointly organised by
the Mass Spectrometry Division (MS),
the Quantum Optics and Photonics Division (Q),
the Atomic Physics Division (A), and
the Molecular Physics Division (MO)

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Austria is the guest country at this SAMOP Spring Meeting. Austria and Germany look back on a long tradition of successful cooperation, a highlight example being the birth of quantum mechanics in 1925 with groundbreaking work by researchers from both Austria and Germany. The formulation of quantum mechanics laid a lasting foundation for our physical understanding of nature, and today, a good 100 years later, has an impact on all areas of culture, science, and technology. With this symposium, the DPG would like to sustainably expand these intensive connections in the fields of atomic and molecular physics, quantum optics, photonics and mass spectrometry. Further highlights will be set by excellent plenary and keynote speakers from Austria.

Overview of Invited Talks and Sessions

(Lecture hall RW 1)

Greeting and Invited Talks

SYAU 1.1	Wed	11:00–11:15	RW 1	**Greeting by the President of ÖPG** — •Alberta Bonanni
SYAU 1.2	Wed	11:15–11:45	RW 1	**Supersolidity: When Superfluid Flow Meets Crystalline Order** — •Francesca Ferlaino
SYAU 1.3	Wed	11:45–12:15	RW 1	**Charged Helium Nanodroplets: A Cold Laboratory for Molecular Ions** — •Elisabeth Gruber
SYAU 1.4	Wed	12:15–12:45	RW 1	**Advances in Broadband Saturation Spectroscopy: Towards Probing New Physics in the Mid-Infrared** — •Oliver Heckl
SYAU 1.5	Wed	12:45–13:15	RW 1	**Precision laser spectroscopy of the Thorium-229 nuclear transition** — •Thorsten Schumm

Sessions

SYAU 1.1–1.5	Wed	11:00–13:15	RW 1	**Selected highlights of AMOP in Austria**

SYAU 1: Selected highlights of AMOP in Austria

Time: Wednesday 11:00–13:15 Location: RW 1

SYAU 1.1 Wed 11:00 RW 1

Greeting by the President of ÖPG — •Alberta Bonanni — Solid State Physics, JKU Linz — President of ÖPG

Invited Talk SYAU 1.2 Wed 11:15 RW 1

Supersolidity: When Superfluid Flow Meets Crystalline Order — •Francesca Ferlaino — Institut für Experimentalphysik, Universität Innsbruck, Austria — IQOQI- Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Innsbruck, Austria

Superfluidity has fascinated physicists for decades, spanning an extraordinary variety of systems - from solids and liquids to dilute gases and even light. At its core, superfluidity arises when many bosonic quantum particles interact collectively. Traditionally, these interactions are short-ranged and isotropic, providing the simplest framework for the emergence of superfluid behavior. But what happens when more complex interactions are allowed to enter the game? What if interactions acquire directionality, extend over longer distances, or compete with one another? Under such conditions, remarkably rich phenomena emerge. Spatially homogeneous systems may spontaneously develop periodic density modulations, raising a cascade of fundamental questions: What does superfluidity mean in the presence of crystalline order? Could a solid, with its crystalline rigidity, exhibit superfluid behavior - or could a superfluid itself acquire crystalline order? These long-standing questions have recently found compelling answers with the experimental discovery of supersolid quantum states - exotic phases of matter that simultaneously display superfluid coherence and crystalline density order. In this colloquium, I will present the experimental realization of supersolidity in magnetic quantum gases, focusing on results obtained in Innsbruck.

Invited Talk SYAU 1.3 Wed 11:45 RW 1

Charged Helium Nanodroplets: A Cold Laboratory for Molecular Ions — •Elisabeth Gruber — Institut für Ionenphysik und Angewandte Physik, Universität Innsbruck, Innsbruck, Austria

Helium nanodroplets provide a highly versatile environment for trapping and cooling dopant species to ultralow temperatures. In particular, highly charged helium droplets open exciting new avenues for investigating fundamental physical and chemical processes.

In this talk, I will focus on the use of highly charged helium droplets for the efficient formation of helium-tagged molecular ions, which enables high-resolution electronic and vibrational spectroscopy of cold molecular ions [1]. This approach allows us to obtain precise absorption spectra of astrochemical relevant ions [2-4]. Furthermore, I will discuss how the unique low-temperature environment of helium nanodroplets can be exploited to study chemical reactions under cryogenic conditions. To extend these studies to longer timescales, up to several seconds or even minutes, we have recently developed a novel setup for trapping charged helium droplets in an electrostatic ion trap [5]. I will present first results from these experiments and provide an outlook on future directions in this research field.

[1] S. Bergmeister et al., Rev. Sci. Instrum. 94, 055105 (2023), [2] L. Ganner et al., Astrophys. J. 993, 47 (2025), [3] L. Ganner et al., ACS Earth Space Chem. 9, 2694 (2025), [4] S. A. Krasnokutski et al., Astrophys. J. 982, 34 (2025), [5] M. Veternik et al., Phys. Rev. Lett., accepted (2025)

Invited Talk SYAU 1.4 Wed 12:15 RW 1

Advances in Broadband Saturation Spectroscopy: Towards Probing New Physics in the Mid-Infrared — •Oliver Heckl — Optica Metrology, Faculty of Physics, University of Vienna, Austria

Broadband precision spectroscopy of rovibrational transitions holds promise for tracking periodic variations in fundamental constants. Such variations may offer evidence supporting the existence of ultralight dark matter and indicate new physics. This talk provides an overview of our efforts in achieving broadband saturation spectroscopy in the mid-infrared. Our focus lies on crystalline super mirrors, featuring a cavity finesse surpassing 400,000, and low-noise high-power frequency combs generating Watt-level output power.

Invited Talk SYAU 1.5 Wed 12:45 RW 1

Precision laser spectroscopy of the Thorium-229 nuclear transition — •Thorsten Schumm — Atominstitut, TU Wien, Stadionallee 2, 1020 Vienna, Austria

Thorium-229 presents a low-energy excited nuclear level, only 8.4 eV above the ground state. This "isomer" can be manipulated by modern VUV lasers, realizing a bridge between precision laser spectroscopy and nuclear physics.

We will present recent advanced in laser-manipulation and spectroscopy of the Th-229 nucleus, including Mössbauer spectroscopy, and CW excitation. We also discuss the sensitivity of the Th-229 nuclear transition to variations of the fine-structure constant.