SYLA 1: Laboratory Astrophysics

Time: Monday 14:00–16:00 Location: Audimax

Invited Talk SYLA 1.1 Mon 14:00 Audimax

Probing chemistry inside giant planets with laboratory experiments — •Dominik Kraus — Institut für Physik, Universität Rostock — Institut für Strahlenphysik, Helmholtz-Zentrum Dresden-Rossendorf

The interiors of giant planets exhibit extreme conditions: High temperatures and enormous pressures create environments which are not fully understood and hard to encompass for state-of-the-art physics models. Applying the largest and most brilliant laser light sources, it is now possible to investigate such conditions in the laboratory. Recent efforts provide seminal insights into chemistry and phase transitions occurring deep inside giant planets such as carbon-hydrogen phase separation and the formation of superionic water. At the same time, highly interesting materials can be formed via these conditions, such as nanodiamonds or hexagonal diamond, so-called lonsdaleite, which, in its pure form, is predicted to exceed the hardness of cubic diamond. I will present a showcase of recent experiments investigating these topics and provide an outlook for future developments.

Invited Talk SYLA 1.2 Mon 14:30 Audimax

Inner-shell photoabsorption of atomic and molecular ions — •Stefan Schippers — Justus-Liebig-Universität Gießen

Recent experimental work on the photoabsorption of atomic and molecular ions will be reviewed that has been carried out at the photon-ion merged-beams setup PIPE [1], a permanently installed end station at the XUV beamline P04 of the PETRA III synchrotron radiation source operated by DESY in Hamburg, Germany. Selected results [2] on, e.g., single and multiple L-shell photoionization of low-charged iron ions and on single and multiple K-shell photoionization of negatively and (multiply) positively charged carbon and silicon ions will be discussed in astrophysical contexts as well as inner-shell photoabsorption of molecular ions. These experimental results bear witness of the fact that the implementation of the photon-ion merged-beams method at one of the world's brightest synchrotron light sources has led to a breakthrough for the experimental study of inner-shell photoabsorption processes with ions.

[1] S. Schippers, T. Buhr, A. Borovik Jr., K. Holste, A. Perry-Sassmannshausen, K. Mertens, S. Reinwardt, M. Martins, S. Klumpp, K. Schubert, S. Bari, R. Beerwerth, S. Fritzsche, S. Ricz, J. Hellhund, and A. Müller, X-Ray Spectrometry **49**, 11 (2020) (doi: 10.1002/xrs.3035).

[2] S. Schippers and A. Müller, Atoms **8**, 45 (2020) (doi: 10.3390/atoms8030045).

Invited Talk SYLA 1.3 Mon 15:00 Audimax

Molecular Astrophysics at the Cryogenic Storage Ring — •Holger Kreckel — Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany

Ever since the first molecular species were detected in interstellar space, more than 80 years ago, their abundance and formation mechanisms have challenged the curious minds of molecular physicists. Today, the molecular composition of the universe is at the forefront of observational astronomy, as modern telescopes target molecular transitions from infrared to millimeter wavelengths. Besides the observational efforts, reliable laboratory data and comprehensive modeling are required to gain insight into the life cycle of molecules in space. The Cryogenic Storage Ring (CSR) was designed as a versatile test bench to prepare atomic and molecular ion beams for detailed merged beams experiments at cryogenic temperatures and extremely low pressure. We will give an overview of the experimental capabilities of the CSR and present recent results for state-selected reaction studies of molecular ions with free electrons and neutral atoms. These processes are of paramount importance for the chemistry of the interstaller medium and the formation of the first stars in universe.

Invited Talk SYLA 1.4 Mon 15:30 Audimax

Observing small molecules in stellar giants - High spectral resolution infrared studies in the laboratory, on a mountain, and high up in the air — •Guido W. Fuchs — 1Laboratory Astrophysics, University of Kassel (Germany)

Close to the end of their lifetime giant stars lose much of their mass in form of stellar winds and outflows. Opposed to carbon-rich (C-type) stars, the processes of molecule and dust formation in oxygen-rich (M-type) or intermediate-type (S-type) stars is not well understood. Small molecules made of refractory material, like metal, carbon, or silicon, seem to play an important role for the chemistry in these environments. The molecular inventory of circumstellar environments is mostly investigated via radio observations. However, infrared (IR) observations can also be performed as these stellar objects shine brightly in the IR range. In this work, the focus is set on IR observations of prototypical M-type and S-type stars as well as accompanying laboratory investigations on the spectra of small metall bearing molecules. The astrophysical observations were done using high resolution spectrographs like TEXES at the IRTF on Mauna Kea (Hawaii) or EXES onboard the SOFIA airplane. In the laboratory, molecules like TiO, VO, Al2O and other species have been investigated to determine their IR spectra. In this talk, the combined laboratory- and observational approach to identify and analyze small molecules made of refractory materials in circumstellar environments is presented.