P 18: Low Temperature Plasmas II

Zeit: Mittwoch 10:30–12:00 Raum: HZO 30

Hauptvortrag P 18.1 Mi 10:30 HZO 30

En route to matter-antimatter pair plasmas — •Eve V. Stenson[1], Uwe Hergenhahn[1], Holger Niemann[1,2], Norbert Paschkowski[1], Haruhiko Saitoh[1], Juliane Stanja[1], Thomas Sunn Pedersen[1,2], Lutz Schweikhard[2], Christoph Hugenschmidt[3], James R. Danielson[4], and Clifford M. Surko[4] — [1]Max Planck Institute for Plasma Physics, Greifswald & Garching, Germany — [2]Ernst Moritz Arndt University of Greifswald, Greifswald, Germany — [3]Technische Universität München, Garching, Germany — [4]University of California, San Diego, La Jolla, U.S.A.

The APEX and PAX projects have as their overarching goal the laboratory creation and confinement of the world's first positron-electron pair plasma. Plasmas of this type have been the subject of hundreds of theoretical investigations and are also believed to play a role in various astrophysical environments. In order to achieve this goal in an experimentally accessible volume (e.g., 10 liters), a record number ($\geq 10^{10}$) of cold ($\sim$ 1 eV) positrons are to be accumulated and combined with a corresponding population of electrons. Notable requirements include a high-intensity positron beam (such as NEPOMUC), a suitable magnetic confinement device for the pair plasma (such as a levitated dipole), high-efficiency tools for bridging the two (i.e., means by which the positrons can be efficiently cooled, trapped, and injected across flux surfaces), and diagnostics not only for the pair plasma, but also for the positron beam and for intermediary non-neutral plasmas. This talk will summarize the project as a whole and recent work by the APEX/PAX team on its various elements.

P 18.2 Mi 11:00 HZO 30

Plasmaoszillation und lokale Störungen in kapazitiv gekoppelten Niederdruck-Plasmen — •Sebastian Wilczek[1], Jan Trieschmann[1], Ralf Peter Brinkmann[1], Julian Schulze[2], Edmund Schüngel[2], Aranka Derzsi[3], Ihor Korolov[3], Zoltán Donkó[3] und Thomas Mussenbrock[1] — [1]TET, Ruhr-Universität Bochum, Germany — [2]Department of Physics, West Virginia University, Morgantown, USA — [3]Wigner Research Center for Physics, Hungarian Academy of Sciences, Budapest, Hungary

In kapazitiv gekoppelten Plasmen wird eine Wechselspannung zwischen den Elektroden angelegt, welche mit einer Frequenz von 1 bis 100 MHz oszilliert. In diesem RF-Regime können nur die Elektronen aufgrund ihrer geringen Masse den von Außen angelegten elektrischen Feldern folgen. Die schweren Ionen hingegen reagieren nur auf das zeitlich gemittelte elektrische Feld. Neben der Anregungsfrequenz gibt es noch eine weitere charakteristische Frequenz, welche die Oszillation der Elektronen vor einem ruhenden Ionenhintergrund beschreibt, die Elektronenplasmafrequenz. Diese kann bei sehr geringen Plasmadichten die Größenordnung der Anregungsfrequenz erreichen. Trifft in diesem Regime beispielsweise die lokale Plasmafrequenz ein Vielfaches der Anregungsfrequenz, kann es zu lokalen Störungen in der Entladung kommen, bei denen sich signifikante Felder im Plasmabulk einstellen. In dieser Arbeit werden im Rahmen von Particle-In-Cell Simulationen solche Störungen im Niederdruckbereich untersucht. Es ist zu erkennen, dass diese Störungen signifikante Auswirkungen auf die stochastische Heizung von hochenergetischen Elektronen haben.

P 18.3 Mi 11:15 HZO 30

Investigation of resonant energy transfers in an argon/hdrogen plasma by laser collisional induced fluorescence — •Emile Carbone[1,2], Jan van Dijk[1], and Gerrit Kroesen[1] — [1]Elementary Processes in Gas Discharges group, Technical University of Eindhoven, The Netherlands — [2]Institute for Plasma and Atomic Physics, Ruhr-University Bochum, 44780 Germany

Laser collisional induced fluorescence (LCIF) is used to probe resonant excitation transfers by heavy particle collisions in an argon/hydrogen plasma. Different radiative transitions between the 1s and 2p states (in Paschen's notation) of argon are optically pumped by a nanosecond laser pulse. The spontaneous fluorescence and collisional responses of the argon and hydrogen systems are monitored by optical emission spectroscopy. For the first time, we give a direct experimental evidence of the existence of an efficient excitation transfer

$$\mathrm{Ar\,(2p) + H\,(n=1) \rightarrow Ar + H\,(n=6,7)}.$$

Additionally, measurements are performed to estimate the resonant energy transfer between the resonant argon $1s_2$ and $1s_4$ states and hydrogen atoms H (n=1) for which no cross sections could be previously measured in the literature. These are extra quenching channels of argon 1s and 2p states that should be included in collisional radiative modeling of argon-hydrogen discharges. LCIF was previously developed to measure electron or species densities locally in the plasma. We demonstrate that it can be advantageously used to probe collisional transfers between very short-lived species as well which exist only in the plasma phase.

P 18.4 Mi 11:30 HZO 30

Influence of a phase-locked RF bias on the E-to-H mode transition in an inductively coupled plasma — •Philipp Ahr[1], Tsanko Vaskov Tsankov[1], Edmund Schüngel[2], Julian Schulze[2], and Uwe Czarnetzki[1] — [1]Institute for Plasma and Atomic Physics, Ruhr University Bochum, 44780 Bochum, Germany — [2]Department of Physics, West Virginia University, 26506 West Virginia, USA

The coupling mechanisms between inductive and capacitive power deposition in inductively coupled discharges (ICP) with a capacitive (CCP) rf bias in hydrogen are investigated. As a new feature the phases of the two power sources are synchronized, allowing for a defined phase difference. Two effects are observed: First, the electron density depends on the applied rf bias power. Second, the E-H-mode transition takes place at lower values of the inductive power with the rf bias power being present. The electron dynamics is observed by phase resolved optical emission spectroscopy. The observed effects are caused by the confinement (trapping) of the electron beams generated by the CCP. The efficiency of the trapping can be adjusted by the phase difference. In order for the coupling to be efficient, the penetration depth of the beam should be lager than the gap between the CCP and the ICP coil window. This sets a upper pressure value. In conclusion the performance of the ICP can be manipulated significantly by the CCP bias.

P 18.5 Mi 11:45 HZO 30

Instabilities in a capacitively coupled RF oxygen plasma — •Christian Küllig, Thomas Wegner, and Jürgen Meichsner — Institute of Physics, University of Greifswald

Instabilities in a capacitively coupled radio frequency (13.56 MHz) plasma (CCP) in oxygen were experimentally investigated using Gaussian beam microwave interferometry, Langmuir probe diagnostics and optical emission spectroscopy. The fluctuating line integrated electron density, spatio-temporally resolved floating potential and optical emission intensity were measured, respectively. Whereby, the appearance of an instable RF plasma depends on the total gas pressure and RF power. The frequency of the periodic fluctuations varies between 0.3 to 3 kHz. The electron density fluctuation is between 0.2×10^{15} and $3.5 \times 10^{15}\,\mathrm{m}^{-2}$, which can be the same order of magnitude as the mean electron density. The temporally resolved floating potential profiles show that the instability represents a kind of discharge breathing. During one fluctuation period the discharge changes between a low and high electronegative mode, whereupon the electric field reversal appears additionally to the RF sheath heating at the high electronegative mode. Furthermore, a perturbation calculation was performed, taking into account four particle balance equations (O_2^+, e, O^-, O_2^-) and 16 elementary processes, which provides a fluctuation frequency in the range comparable to the experimental results. The calculation indicates the important role of the negative ions and the interaction of ionization, attachment and detachment processes for the origin of the instability. // Funded by the DFG CRC, Transregio 24, project B5.