P 10: Invited talks III

Time: Wednesday 11:00–12:30 Location: P-H11

Invited Talk P 10.1 Wed 11:00 P-H11

AI in fusion: assisting plasma exhaust modelling by machine-learning techniques — •Sven Wiesen — Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, D-52425 Jülich, Germany

Rapid computational design of future fusion power plants is usually compromised by a delicate balance between the required numerical effort, e.g. for running first-principle plasma simulations, and an increased complexity in the physics model for relevant operational tokamak plasma scenarios. State-of-the-art exhaust plasma design codes like SOLPS-ITER demand long convergence times when predicting next-step fusion devices like ITER or DEMO. Existing exhaust model frameworks suffer from uncertainties in the underlying atomic physics databases and incomplete sub-models for turbulent plasma transport.

This contribution reflects on the recent progress that enable AI-based model techniques for training of fast exhaust surrogate models. A conceptual basis for an enhanced model predictor scheme is developed that integrates calibrated machine-learning (ML) models like neural networks for 2D/3D edge plasma transport. This approach defers in parts the computational cost of first-principle simulations into the training phase of a surrogate edge plasma model. It is demonstrated how non-linear ML methods help to enhance transport models for the critical region between plasma core and edge taking experimental data as ground-truth. AI-based interpolators and generators are exploited for uncertainty quantification and ML regression analysis illustrate model discovery also for plasma-material interaction physics.

Invited Talk P 10.2 Wed 11:30 P-H11

COMPACT - A new complex plasma facility for the ISS — •Christina A. Knapek — Institute of Physics, University Greifswald, Greifswald, Germany

Complex plasma is a state of soft matter where micrometer-sized particles are immersed in a weakly ionized gas. The particles acquire negative charges of the order of several thousand elementary charges in the plasma, and they can form gaseous, liquid and crystalline states. Direct optical observation of individual particles allows to study their dynamics on the kinetic level even in large many-particle systems. Gravity restricts the research on ground to vertically compressed, inhomogeneous clouds, or two-dimensional systems. A microgravity environment, e.g. the International Space Station (ISS), is therefore essential to study large and homogeneous 3D many-particle systems. The complex plasma facility COMPACT to be operated onboard the ISS builds upon previous studies and hardware developments (PlasmaLab, Ekoplasma) and is envisaged as an international multi-purpose and multi-user facility that gives access to the full three-dimensional kinetic properties of the particles. The heart of COMPACT will be a novel plasma chamber: the Zyflex chamber. It includes a variety of innovations that allow to tune, control and manipulate plasma-particle and particle-particle interaction in various ways. We will present the overall design and research goals of COMPACT, with special focus on the characteristics of the new plasma chamber, supported by plasma simulations and results of experiments performed on ground and during parabolic flights.

Invited Talk P 10.3 Wed 12:00 P-H11

Optical diagnostics of vacuum arc discharges for switching applications — •Sergey Gortschakow[1], Ralf Methling[1], Steffen Franke[1], Diego Gonzalez[1], Dirk Uhrlandt[1], Sergey Popov[2], and Alexander Batrakov[2] — [1]Leibniz institute for plasma science and technology, Greifswald, Germany — [2]Institute of high-current electronics, Tomsk, Russia

Optical diagnostics offers numerous methods for characterization of arc plasmas. The contribution presents selected methods used for determination of arc plasma temperature, anode surface temperature and densities of plasma species during the current pulse and after it termination. The vacuum arcs have been investigated under typical switching conditions - ignition by CuCr contact separation during the AC current flow at several kA magnitude. High-speed cinematography is usually used for observation of arc dynamics and characterization of the anode activity. Optical emission spectroscopy can be applied for determination of dynamics of spectral lines from various species during the active phase, as well as for determination of plasma temperature and electron density. For quantitative characterization of the anode surface temperature, NIR spectroscopy and high-speed camera techniques enhanced by narrow-band filters have been used. Broad band absorption spectroscopy is a suitable techniques for determination of the vapour density close to the current zero crossing and in the early post-arc phase. Advantages and drawbacks of each method along with examples of their application will be presented and discussed.