P 14: Astrophysical Plasmas - Poster

Time: Tuesday 16:15–18:15 Location: Redoutensaal

P 14.1 Tue 16:15 Redoutensaal

Hybrid formulation of guiding-center Hamiltonian theory for astrophysical plasmas — •Felipe Nathan Oliveira[1], Simon Lautenbach[2], Rainer Grauer[2], and Daniel Told[1] — [1]Max-Planck-Institut für Plasmaphysik — [2]Ruhr-Universität Bochum

Higher-order Lie-transform perturbative methods applied to the Hamiltonian formulation of guiding-center motion are widely used to describe the dynamics of particles in plasma physics [1][2][3]. Therewithin, the elegant and compact Lagrangian formulation allows for the derivation of the equations of motion from the $\mathcal{L}$ two-form, or sympletic two-form, $w_L = -dx^i \wedge dp_i \in \Lambda^2 T * M$. Where $T * M$ represents a linear space T tangent to a manifold M [4].

In the present work, a consistent Lagrangian model that encapsulates fully kinetic ions and gyrokinetic electrons for solar wind and fusion electromagnetic turbulence is studied. Using a consistent method [5], both electrons and protons are treated with the same mathematical formalism. We plan to derive and implement a model in which high frequency waves and kinetic electron effects[6] are computed in a cost-effective way.

[1] N. Tronko and A. Brizard. Physics of Plasmas, 2015.
[2] Robert G. Littlejohn. Journal of Mathematical Physics, 1982.
[3] H. Sugama. Physics of Plasmas, 2000.
[4] Robert H. Wasserman. Tensor and Manifolds. 2004
[5] A. J. Brizard and N. Tronko. arXiv:1606.0653v1, 2016
[6] F. Muller P. Astfalk D. Told, J. Cookmeyer and F. Jenko. New Journal of Physics, 2016.

P 14.2 Tue 16:15 Redoutensaal

Nuclear excitation by electron capture in astrophysical plasmas — •Yuanbin Wu, Hyoyin Gan, Christoph H. Keitel, and Adriana Pálffy — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg, Germany

In hot and dense stellar plasmas in which the slow neutron capture nucleosynthesis takes place, nuclei may not be only in their ground states but also in long-lived excited states (isomers). So far studies on the thermal equilibrium of the ground and excited or isomeric nuclear states typically rely on detailed balance. In the astrophysical plasma, high charge states are available, and the timescale of collisional ionizations and photoionization is expected to be much shorter than the one of ionization by internal conversion (IC). The inverse process of IC, nuclear excitation by electron capture (NEEC) [1,2], in such plasmas is therefore not always accompanied by its detailed-balance counterpart due to the loss of the recombined electrons via fast atomic processes. Thus, the isomers might not be thermally equilibrated with the nuclear ground states. We study here the depletion of isomeric states through NEEC in dense stellar plasmas under the s-process environments. The results show that the NEEC rates for the depletion of the isomeric states ^{124m}Sb and ^{152m}Eu should be large, leading to isomer populations significantly different from what is expected via thermodynamic equilibrium.

[1] J. Gunst, Y. A. Litvinov, C. H. Keitel, and A. Pálffy, Phys. Rev. Lett. 112, 082501 (2014).
[2] Y. Wu, J. Gunst, C. H. Keitel, and A. Pálffy, arXiv: 1708.04826.

P 14.3 Tue 16:15 Redoutensaal

Beamtime U305 - High Energy Resolution Spectroscopy of the Target and Projectile X-Ray-Fluorescence — •Sero Zähter[1], Olga Rosmej[2], Ceyhun Arda[1], Philipp Beloiu[1], Björn Borm[1,2], Mohamed El Houssaini[1], Dimitri Khaghani[2], Andreas Schönlein[1], and Joachim Jacoby[1] — [1]Institut für Angewandte Physik, Goethe Universität Fankfurt, Deutschland — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Deutschland

Intense uranium beams, that will be available at the new synchrotron SIS100 in Darmstadt, can be used for volumetric heating of any type of material and generation of extreme states of matter with Mbar pressures and some eV of temperature. Investigation of their EOS is one of the main goals of the plasma physics program at FAIR. Diagnostic of such extreme states of matter demands development of new diagnostic methods and instruments, which are capable to operate in an environment with a high level of radiation damage. The precise knowledge of the energy density distribution of the U-beam on the target is a very important input parameter for numerical simulations of the hydrodynamic response of the target on deposited energy which is required for planning of experiments and interpretation of obtained experimental data. Therefore we propose to use the target and heavy ion beam X-ray fluorescence for imaging of the target expansion and mapping of the heavy ion beam distribution in the interaction region with a high spatial resolution of at least 100 μm. First pilot experiments have been carried out in 2016 at the UNILAC Z6 experimental area in collaboration with the Plasma Physics Group of GSI.

P 14.4 Tue 16:15 Redoutensaal

Mechanism of enhanced energization of heavier ions in collisionless shocks — •Adrian Hanusch[1], Tatyana Liseykina[1], and Mikhail Malkov[2] — [1]Universität Rostock - Institut für Physik — [2]University of California San Diego

The acceleration of particles to high energies is an outstanding problem in space and astrophysical plasmas. One physically simple and robust mechanism of interest is diffusive acceleration (DSA) at collisionless shocks [1]. Before acceleration to high energies can occur, particles must be pre-accelerated above the energies of the background plasma so that they may then keep on crossing the shock front and gain more energy. This injection process is still not fully understood. To simulate the evolution of collisionless shocks and the acceleration of ions we use a hybrid code in which only the plasma ions are treated kinetically and electrons as a massless fluid. In our simulations shocks are generated by sending a super-sonic flow of multi-component plasma, consisting of electrons, background protons and additional ion species with different mass to charge (A/Z) ratios, towards a reflecting wall. To investigate the elemental selectivity of the injection mechanism, we determine the injection efficiency of each particle species included in the simulation. We obtain the energy spectra of all particles downstream of the shock transition from the simulation using a logarithmic binning procedure. Comparing the distributions of the number of shock reflections vs. single particle energy for different A/Z we observe the increasing narrowness of such distribution with A/Z.

[1] A. R. Bell, *MNRAS*, 182, 147-156, (1978).