P 3: Astrophysical Plasmas

Time: Monday 16:30–17:45 Location: CHE/0089

P 3.1 Mon 16:30 CHE/0089

Energy conversion by magnetic reconnection in multiple ion temperature plasmas — •Jeremy Dargent[1], Sergio Toledo-Redondo[2], Andrey Divin[3], and Maria Elena Innocenti[1] — [1]Institut für Theoretische Physik, Ruhr-Universität Bochum, Bochum, Germany — [2]Department of Electromagnetism and Electronics, University of Murcia, Murcia, Spain — [3]St. Petersburg, Russia

Magnetic reconnection is one of the most efficient plasma process to convert magnetic energy into kinetic energy. In this work, we study the impact of the microscopic distribution function on the energy budget of symmetric magnetic reconnection in collisionless plasmas. We run two two-dimensional semi-implicit PIC simulations of symmetric reconnection with the same global parameters, but with different ion distribution functions: one simulation is loaded using Maxwellian distributions, while the other is the sum of two Maxwellian distributions, a hot one and a cold one, resulting in a very peaked distribution with large tails. We measure the evolution of the bulk and thermal kinetic energies in both simulations for each population and compare it to the loss of magnetic energy through a contour surrounding the ion diffusion region. We show that the global energy budget for ions and electrons does not change depending on the distribution function of the plasma, but also that, when focusing on sub-populations, the hot ion population gains more energy than the cold ion population and that the distribution of the energy gain between kinetic and thermal energy also depends on the initial temperature.

P 3.2 Mon 16:45 CHE/0089

Ionization and transport in partially ionized multicomponent plasmas: Atmospheres of hot Jupiters — Sandeep Kumar[1,2], Anna Julia Poser[1], Manuel Schöttler[1], Uwe Kleinschmidt[1], Wieland Dietrich[3], Johannes Wicht[3], Martin French[1], and •Ronald Redmer[1] — [1]Universität Rostock, Institut für Physik, D-18051 Rostock — [2]CASUS, D-02826 Görlitz — [3]MPI for Solar System Research, D-37077 Göttingen

We study ionization and transport processes in partially ionized multicomponent plasmas [1]. The plasma composition is calculated via a system of coupled mass-action laws. The electronic transport properties are determined by the electron-ion and electron-neutral transport cross sections. The electrical and thermal conductivities as well as the Lorenz number are calculated. For the thermal conductivity, we consider also the contributions of the translational motion of neutral particles and of the dissociation, ionization, and recombination reactions. We apply our approach to plasma conditions as typical for atmospheres of hot Jupiters such as HD 209458b. The electrical conductivity profile allows revising the Ohmic heating power related to the fierce winds in the planet's atmosphere in order to explain the observed inflation of HD 209458b. The model is also applied to study possible induction processes in the atmosphere of ultra-hot Jupiters like KELT-9b [2].

[1] S. Kumar et al., Phys. Rev. E 103, 063203 (2021)
[2] W. Dietrich et al., MNRAS 517, 3113 (2022)

P 3.3 Mon 17:00 CHE/0089

M^5 - Mars Magnetospheric Multipoint Measurement Mission: A multi-spacecraft plasma physics mission to Mars — •Cormac Larkin — Max Planck Institut fuer Kernphysik, Heidelberg, Germany — Astronomisches Rechen-Institut, Heidelberg, Germany

We propose the Mars Magnetospheric Multipoint Measurement Mission (M5), a multi-spacecraft mission to study the dynamics and energy transport of the Martian magnetosphere. Particular focus lies on the largely unexplored magnetotail region, where signatures of magnetic reconnection of the Interplanetary Magnetic Field (IMF) have been found. Further, to study the dynamics of the Martian magnetosphere depending on the upstream solar wind conditions, knowledge of those is needed. Finally, to resolve the three-dimensional structure of the Martian magnetosphere and make use of multipoint data analysis techniques, multipoint measurements are required. As a result, M5 is a five spacecraft mission, with one solar wind monitor orbiting Mars in a circular orbit, and four smaller spacecraft in a tetrahedral configuration orbiting Mars in an elliptical orbit. We present a detailed assessment not only of the scientific need for such a mission but also show the resulting mission and spacecraft design taking into account all aspects of systems engineering as well as spacecraft budgets like mass and data rate. The mission outlined in this abstract was developed during the ESA Alpbach Summer School 2022 on the topic of "Comparative Plasma Physics in the Universe".

P 3.4 Mon 17:15 CHE/0089

Berechnung elektronischer Transportkoeffizienten von Wasserstoffplasma mit Dichtefunktionaltheorie — •Martin French[1], Gerd Röpke[1], Maximilian Schörner[1], Mandy Bethkenhagen[1,2], Michael Desjarlais[3] und Ronald Redmer[1] — [1]Universität Rostock, Institut für Physik, D-18051 Rostock — [2]École Normale Supérieure, Université Lyon 1, Lyon, France — [3]Sandia National Laboratories, Albuquerque, USA

Dichtefunktionaltheorie (DFT) ist eine weit verbreitete Methode, um stark gekoppelte Coulombsysteme quantenmechanisch zu beschreiben. Die Berechnung von Transporteigenschaften erfolgt dabei über den Kubo-Greenwood-Formalismus [1]. Eine bislang kontrovers diskutierte Fragestellung ist, ob die Mean-Field-Beschreibung von Elektronen mit DFT den Einfluss von Elektron-Elektron-Stößen korrekt erfassen kann [2]. Diese Frage kann durch die Berechnung elektronischer Transportkoeffizienten im schwach gekoppelten und nicht entarteten Grenzfall beantwortet werden, für den exakte Grenzwerte aus der Spitzer-Theorie bekannt sind. Wir stellen entsprechende Ergebnisse von DFT-Rechnungen zur Thermokraft und Lorenz-Zahl vor und zeigen, dass Elektron-Elektron-Streuprozesse nicht mit dem Kubo-Greenwood-Formalismus in der DFT erfassbar sind [3].

[1] B. Holst, M. French, and R. Redmer, Phys. Rev. B 83, 235120 (2011). [2] M. P. Desjarlais et al., Phys. Rev. E 95, 033203 (2017); H. Reinholz et al., Phys. Rev. E 91, 034105 (2015). [3] M. French, G. Röpke, M. Schörner, M. Bethkenhagen, M. P. Desjarlais, and R. Redmer, Phys. Rev. E 105, 065204 (2022).

P 3.5 Mon 17:30 CHE/0089

Electron polarization in ultrarelativistic plasma current filamentation instabilities — •Zheng Gong, Karen Hatsagortsyan, and Christoph Keitel — Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, 69117 Heidelberg, Germany

By utilizing particle-in-cell simulations, we investigate the plasma current filamentation of an ultrarelativistic electron beam impinging on an overdense plasma. The effect of the radiation-induced electron polarization is self-consistently studied. Here, three different regimes of the current filaments, namely, the normal filament, abnormal filament, and quenching regimes, are identified. We show that electron radiative polarization emerges during the instability along the azimuthal direction in the momentum space, which significantly varies across the regimes. We put forward a Hamiltonian model to trace the origin of the electron polarization dynamics. In particular, we discern the role of nonlinear transverse motion of plasma filaments, which induces asymmetry in radiative spin flips, yielding an accumulation of electron polarization.