P 19: Poster: Theorie und Modellierung

Zeit: Donnerstag 14:00–16:00 Raum: Poster EG

P 19.1 Do 14:00 Poster EG

Herleitung von Momentengleichungen für Elektronen in anisothermen Plasmen — •Markus M. Becker und Detlef Loffhagen — INP Greifswald e.V., Felix-Hausdorff-Str. 2, 17489 Greifswald

Aufgrund des großen Einflusses nichtlokaler elektronenkinetischer Effekte in anisothermen Entladungsplasmen ist die Entwicklung verbesserter Fluid-Modelle, die eine genauere Beschreibung der Elektronenkomponente ermöglichen, nach wie vor von großem Interesse. Ausgehend von der Boltzmann-Gleichung für die Elektronen wurde ein System von Momentengleichungen abgeleitet, welches zeitabhängige Bilanzgleichungen für die Teilchendichte, die Teilchenstromdichte, die Energiedichte sowie die Energiestromdichte der Elektronen umfasst. Unter der Voraussetzung, das die charakteristische Frequenz der Änderung des elektrischen Feldes klein gegenüber der Impulsdissipationsfrequenz der Elektronen ist, lässt sich das Vier-Momenten-Modell zu einem neuen Drift-Diffusionsmodell vereinfachen. Der Abschluss der Momentengleichungen erfolgt über die Einführung geeigneter Transportkoeffizienten, die als Funktion der mittleren Elektronenenergie bereitgestellt und verwendet werden. Am Beispiel eines Benchmark-Modells sowie einer anomalen Glimmentladung in Argon bei Niederdruck wird gezeigt, dass sowohl das Vier-Momenten-Modell als auch das Drift-Diffusionsmodell eine wesentlich genauere Fluid-Beschreibung der Elektronen ermöglicht als konventionelle Fluid-Modelle. Die Arbeit wird von der DFG im Rahmen des SFB-TRR 24 unterstützt.

P 19.2 Do 14:00 Poster EG

Kink Instabilities in Discharge Channels — •Stephan Neff — TU Darmstadt, Germany

The development of kink instabilities has been observed in gaseous discharge channels (1 m long, 50 kA discharge current). In this presentation, the experimental results are compared to theoretical models for the channel evolution and stability.

P 19.3 Do 14:00 Poster EG

Plasma diagnostics applying K-line emission profiles of mid-Z materials — •Yiling Chen, Heidi Reinholz, and Gerd Röpke — Institut für Physik, Universität Rostock, 18051 Rostock

Narrow K-line emission of some keV is known as an appropriate light source for Thomson scattering on warm dense matter with solid and even over-solid electron density. However, as the K-spectra are emitted from a warm dense plasma themselves we are also able to infer plasma parameters by studying the line profiles [1].

Theoretical treatment of spectral line shifts is applied to various moderately ionized mid-Z materials. We focus on the opposing influence of ionization/excitation (blue shift) and plasma polarization effects (red shift). Synthetic spectra of Si K_α are compared with high-resolution Si $K\alpha_{1,2}$ x-ray fluorescence spectra [2].

To describe the x-ray satellite structures $K_\alpha L^N, (N = 0 - 5)$ produced by 11.4 MeV/u Ca projectiles penetrating a low-density SiO_2 aerogel target [3], different configuration of the emitting Si ion have to be considered as well [4, 5].

[1] U. Zastrau, A. Sengebusch, and et al., *High Energy Density Phys.* ***7****, 47-53 (2011).* [2] Zhenlin Liu, Shouichi Sugata, and et al., *Phys.Rev.B* ***69****, 035106 (2004).* [3] J.Rzadkiewicz, A. Gojska, and et al., *Phys.Rev.A* ***82****, 012703 (2010).* [4] Katarzyna Slabkowska and Marek Polasik, *Journal of Phys.* ***163****, 012040 (2009).* [5] R. L. Watson, F. E. Jenson, and T. Chiao, *Phys.Rev.A* ***10****, 4 (1974).*

P 19.4 Do 14:00 Poster EG

Quantum-statistical line shape calculations for dense H and H-like plasmas — •Sonja Lorenzen[1], Heidi Reinholz[1], Gerd Röpke[1], Mark C. Zammit[2], Dmitry V. Fursa[2], and Igor Bray[2] — [1]Institut für Physik, Universität Rostock, 18051 Rostock, Germany — [2]Institute of Theoretical Physics, Curtin University, Perth WA 6845, Australia

Pressure broadening of spectral lines due to surrounding charged particles can be used as a diagnostic tool to determine temperature and electron density of a dense plasma. We apply a quantum-statistical theory to line shapes of Lyman lines of H and H-like emitters (Li^{2+}).

The electronic self-energy describes the influence of plasma electrons on bound state properties and is therefore a crucial quantity. The effect of strong, i.e. close, electron-emitter collisions is considered with the help of an effective two-particle T-matrix. The T-matrix is calculated with a convergent close coupling code taking into account Debye screening. There, different magnetic quantum numbers and spin channels (singlet, triplet) can be distinguished contrary to our standard Born approximation for the electronic self-energy. For H, the effect of screening is analysed exemplary for $k_BT = 1$ eV and $n_e = 10^{25}$ m^{-3}, where width and shift are drastically reduced by the screening.

The ionic self-energy is based on the Stark effect often taken into account only statically. Here, the importance of ion-dynamics is investigated with the help of two different models, namely the model microfield method and the frequency fluctuation model, for different temperatures ($T = 10^4 - 10^7$ K) and densities ($n_e = 10^{23} - 10^{26}$ m^{-3}).

P 19.5 Do 14:00 Poster EG

Breathing mode of trapped correlated quantum particles — Jan Willem Abraham, •Alexei Filinov, David Hochstuhl, Tim Schoof, and Michael Bonitz — Institut für Theoretische Physik und Astrophysik, CAU Kiel, Leibnizstr. 15

We study the quantum breathing mode (monopole mode) of finite quantum systems at low temperature from weak to strong coupling. Using an improved version of the quantum-mechanical sum rule formula of Stringari et al. [1], we perform ab-initio Quantum Monte Carlo simulations to obtain the mode frequencies for dipole-interacting bosons in a harmonic trap [2]. We compare our results to those from other methods and present additional results for fermions [3].

[1] C. Menotti, and S. Stringari, Phys. Rev. A 66, 043610 (2002)
[2] A. Filinov et al., Phys. Rev. Lett. 105, 070401 (2010)
[3] T. Schoof et al., Contrib. Plasma Phys. 51, No. 8, 687-697 (2011)

P 19.6 Do 14:00 Poster EG

Quantum breathing mode of charged fermions in a 2D harmonic trap — Chris McDonald[1], G Orlando[1], Jan Willem Abraham[2], David Hochstuhl[2], •Michael Bonitz[2], and Thomas Brabec[1] — [1]Department of Physics, University of Ottawa, Canada — [2]Institut für Theoretische Physik und Astrophysik, CAU Kiel, Leibnizstr. 15

The N-particle time-dependent Schrödinger equation is solved to investigate the quantum breathing mode of Coulomb-interacting fermions confined in two-dimensional quantum dots. [1] The Multi-Configurational Time-Dependent Hartree-Fock method allows us to obtain the mode frequencies for up to 6 particles in the whole range of coupling parameters, from the ideal quantum gas to Wigner crystallization. Furthermore, a new approximate analytical approach to the quantum breathing mode is presented and shows very good agreement with the simulations.

[1] C. McDonald et al., submitted to Phys. Rev. Lett. (2012)

P 19.7 Do 14:00 Poster EG

Screened potential of a proton in a dense hydrogen plasma: comparing DFT and quantum hydrodynamics — •Michael Bonitz, Eckhard Pehlke, and Tim Schoof — Institut für Theoretische Physik und Astrophysik, CAU Kiel, Leibnizstr. 15

The phase diagram of dense hydrogen is of vital interest for astrophysical objects, such as stars and planets, and laboratory applications, including warm dense matter, laser plasmas and inertial confinement fusion. At high densities neutral hydrogen is known to pressure ionize into an electron-proton plasma. At sufficiently high densities and low temperatures protons may form a crystal [1], for more details on the phase diagram, see Ref. [2]. In a recent letter [3] Shukla and Eliasson claimed the existence of new type of proton crystal based on a "novel attractive potential" of protons in a dense quantum plasma. We test these predictions by performing ab initio density functional calculations [4] and put them in context with previous results.

[1] M. Bonitz, V.S. Filinov, V.E. Fortov. P.R. Levashov, and H. Fehske, Phys. Rev. Lett. 95, 235006 (2005)
[2] J.M. Mc Mahon, M.A. Morales, C. Pierleoni, and D.M. Cerperley, Rev. Mod. Phys. 84, 1607 (2012)
[3] P.K. Shukla and B. Eliasson, Phys. Rev. Lett. 108, 165007 (2012)
[4] M. Bonitz, E. Pehlke, T. Schoof, Phys. Rev. E, accepted (2013),

arxiv: 1205.4922

P 19.8 Do 14:00 Poster EG

Phase Diagram of Bilayer Electron-Hole Plasmas — Jens Schleede[1], •Alexey Filinov[2,3], Michael Bonitz[2], and Holger Fehske[1] — [1]Institute for Physics, Ernst-Moritz-Arndt Universität, Greifswald, Germany — [2]Institute for Theoretical Physics and Astrophysics, Christian-Albrechts-Universität, Kiel, Germany — [3]Joint Institute for High Temperatures RAS, Moscow, Russia

We investigate exciton bound-state formation and crystallization effects in two-dimensional electron-hole bilayers. Performing unbiased path integral Monte Carlo simulations all quantum and Coulomb correlation effects are treated on first principles. We analyze diverse structural properties in dependence on the layer separation, particle density and hole-to-electron mass ratio and derive a schematic phase diagram for the neutral mass-asymmetric bilayer system. Our simulations reveal a great variety of possible phases namely an exciton gas, an exciton crystal, an electron-hole liquid and a hole crystal embedded in an electron gas.

[1] J. Schleede, A. Filinov, M. Bonitz, and H. Fehske, Contrib. Plasma Phys. **52**, 819 (2012).

P 19.9 Do 14:00 Poster EG

Kinetic Monte Carlo Approach to Cluster Growth in Magnetron Plasmas — •Kenji Fujioka, Lasse Rosenthal, Sebastian Wolf, and Michael Bonitz — ITAP University of Kiel, Germany

The control of nanoscale structures is of great importance to the development of technologies. Specifically, the nanoparticle may be considered as the essential building block of a variety of structures. A recent example [1] shows that gold particles can be used as seeds for the growth of nanowires with dimensions and shape controlled by the size of the seed. We present here a kinetic Monte Carlo scheme to simulate the growth [2] and size distributions of metallic clusters formed in a magnetron discharge by the agglomeration of sputtered atoms. Given a set of experimental conditions, we show that the size distribution of emitted clusters can be determined within the growth phase. The use of the *first-reaction* [3] method enables us to significantly speed-up the simulation by following only representative cluster sizes within the system. We present some preliminary results and outline the general ideas to simulate a macroscopic system.

[1] M. Heurlin et al, Nature, 492, 90 (2012). [2] B. Smirnov et al, Phys. Scr., 73, 288 (2006). [3] D. Gillespie, J. Comput. Phys., 22, 403 (1976).

P 19.10 Do 14:00 Poster EG

Coupling of drift-fluid turbulence to large-scale transport codes — •Felix Hasenbeck[1], Dirk Reiser[1], Philippe Ghendrih[2], Yannick Marandet[3], Patrick Tamain[2], and Detlev Reiter[1] — [1]IEK-4 - Plasma Physics, Forschungszentrum Jülich GmbH, Jülich, Germany — [2]CEA-IRFM, F-13108 Saint-Paul-lez-Durance, France — [3]Aix-Marseille Université, CNRS, PIIM, UMR 7345, F-13397 Marseille Cedex 20, France

Radial particle transport in the edge of tokamak plasmas is governed by turbulence. Corresponding simulations of the edge layer are very time consuming due to the high resolution in time and space needed to capture the relevant processes. Large-scale transport codes mostly use empirical coefficients for diffusion/convection, selected to reproduce experimental findings. This work aims at coupling turbulence and large-scale codes to model transport in accordance with drift-fluid physics without increasing the need for computational power enormously. An analysis of correlation lengths and times of drift-fluid turbulence systems has been carried out to gain information about the scales involved. This helps to evaluate in how far scale separation holds and to find appropriate coarse-graining intervals for handing information about the flux to the large-scale code. Both the 2D, two-field code TOKAM-2D and the 3D, four-field code ATTEMPT have been used for analysis. Additionally, simulations with a 1D code with sampled diffusion coefficients, meant to mimic some aspects of turbulence, were carried out. Thereby, the influence of the sampling intervals in time and space on the density profiles was investigated.

P 19.11 Do 14:00 Poster EG

Formation of nanocolumns in a metal-Teflon nanocomposite: Experiments and Kinetic Monte Carlo simulations — Lasse Rosenthal[1], •Michael Bonitz[1], Franz Faupel[2], and Thomas Strunskus[2] — [1]Institut für Theoretische Physik und Astrophysik, CAU-Kiel — [2]Institut für Materialwissenschaft, CAU-Kiel

One-dimensional nanoscale objects are predicted to have growing potential for many possible future nanoscale applications including electrical, optical and magnetic devices [1]. Of particular interest are ferromagnetic arrays [2] containing parallel monodispersed metallic nanocolumns and their potential use for ultrahigh-density magnetic recording media. Experiments [3] have shown that fabrication of such nanocomposites can benefit from the self-organized growth of metallic nanocolumns during the vapor-phase codeposition of metal and polymer, allowing for a single-step production process of ultrahigh-density nanocolumnar structures embedded in a polymer matrix. Our aim is to present a kinetic Monte Carlo approach [4] which provides a detailed understanding of the coupled cluster processes that are crucial for the self-organized formation of metallic nanocolumns. The dependence of the metallic filling factor and different column geometries on the deposition parameters is discussed and opposed to experimental results.

[1] S. Ge *et al.*, Adv. Mater., **17**, 56 (2005).
[2] S. Khizoroev and D. Litvinov, J. Appl. Phys., **95**, 4521 (2004).
[3] H. Greve *et al.*, Appl. Phys. Lett. **88**, 123103 (2006).
[4] M. Bonitz *et al.*, Contrib. Plasm. Phys., **52**, 890 (2012).

P 19.12 Do 14:00 Poster EG

Study of the influence of surface properties in fluid modelling of low pressure CCRF discharges in oxygen — •Igor Sheykin[1], Markus M. Becker[1], Kristian Dittmann[2], Christian Küllig[2], Jürgen Meichsner[2], and Detlef Loffhagen[1] — [1]INP Greifswald, Felix-Hausdorff-Str. 2, 17489 Greifswald — [2]Institute of Physics, University of Greifswald, Felix-Hausdorff-Str. 6, 17489 Greifswald

Capacitively coupled radio frequency (CCRF) oxygen plasmas are widely used for surface treatment applications. Plasma discharges in a configuration with plane parallel electrodes separated by 2.5 cm have been performed using a time-dependent, spatially one-dimensional fluid model. The coupled system of Poisson's equation, balance equations for the densities of 17 heavy particle species and electrons as well as the electron energy balance equation taking into account about 180 collision processes in the reactive scheme has been solved to trace the spatiotemporal discharge behaviour of the periodic state of CCRF oxygen plasmas at 30 Pa. In the present contribution, the influence of the surface properties, such as secondary electron emission by ion impact and reflection of metastable molecules at the electrodes, on the discharge characteristics has been studied for applied voltages in the range from 200 to 1000 V. In particular, the impact on the density of electrons and negative ions and on the excitation of atomic oxygen has been analysed. Significant changes of the discharge behaviour have been found when varying the reflection coefficients. A comparison of modelling results with experimental data is represented and discussed.

The work has been supported by DFG CRC/Transregio 24.

P 19.13 Do 14:00 Poster EG

Numerische Simulation des Gasmanagements und der elektrischen Feldverteilung in einem Mikrowellen-Plasmabrenner — •Sandra Gaiser, Jochen Kopecki, Martina Leins, Andreas Schulz, Matthias Walker und Thomas Hirth — Institut für Plasmaforschung, Universität Stuttgart, Pfaffenwaldring 31, 70569 Stuttgart

Das Atmosphärendruckplasma eines Mikrowellen-Plasmabrenners soll optimiert und damit die Effizienz der plasmachemischen Prozesse erhöht werden. Dazu werden zunächst die elektrische Feldverteilung und das Gasmanagement in der Plasmabrenner-Geometrie mit Hilfe der numerischen Simulationssoftware COMSOL Multiphysics^{TM}modelliert.

Der Brenner besteht aus einem mikrowellentransparenten Rohr, in dem das Plasma betrieben wird. Für ein Zünden des Plasmas sorgt ein koaxialer Resonator, der eine schmalbandige Ankopplung hoher Güte aufweist. Ein breitbandiger zylindrischer Resonator gewährleistet eine optimale Mikrowellenankopplung und somit einen stabilen Plasmabetrieb.

Vorgestellt werden die Feldverteilungen in unterschiedlichen Resonatorgeometrien und deren Ankopplung an das Hohlleitersystem. Um das Zusammenspiel von Zünd- und Brennverhalten zu ermitteln, werden zudem Kombinationen unterschiedlicher Geometrien betrachtet. Eine aus diesen Ergebnissen resultierende optimierte Brenner-Geometrie dient als Grundlage für Simulationen der Gasströmungen. Ziel ist es hierbei, eine hohe Stabilität des Plasmas sowie eine optimale Durchmischung der Gasströmungen zu erreichen.

P 19.14 Do 14:00 Poster EG

Investigation of power spreading in a tokamak divertor using numerical tools — •Felix Hoppe, Andrea Scarabosio, Marco

Wischmeier, and ASDEX Upgrade Team — Max-Planck Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching, Germany

Divertors are widely used in today's fusion devices in order to reduce plasma core impurities and improve energy confinement. As the divertor targets are exposed to the largest part of the particle and heat loads reaching the wall, these loads must be reduced to prevent material damage. An enhancement of the plasma-wetted area on the targets is one approach. In low density plasmas, the plasma-wetted area is mainly given by the width of the scrap-off-layer (SOL) plasma at the divertor entrance, modified by heat diffusion into the private flux region (PFR) in the divertor. The heat diffusion broadens the heat flux profile at the targets. This can be approximated by a convolution of the upstream profile with a Gaussian of width S. The SOLPS5.0 code package is used to study the influence of divertor geometry and neutral pressure on S. The code is then validated by comparing the numerical results to the experimental findings in the ASDEX Upgrade tokamak.

P 19.15 Do 14:00 Poster EG

Nonlinear Evolution of the Mode Structure of ELMs in Realistic ASDEX Upgrade Geometry — •Isabel Krebs, Matthias Hölzl, Karl Lackner, Sibylle Günter, and The ASDEX Upgrade Team — Max-Planck-Institut für Plasmaphysik, EURATOM Association, Boltzmannstr. 2, Garching, Germany

Edge-localized modes (ELMs) are edge instabilities in H-mode plasmas, which eject particles and energy. The suitability of the H-mode for future fusion reactors depends crucially on the exact ELM dynamics as they can damage plasma facing components if too large.

We have simulated ELMs in ASDEX Upgrade geometry using the nonlinear MHD code JOREK. Emphasis was put on the mode structure evolution in the early ELM phase which is characterized by the exponential growth of the unstable toroidal Fourier harmonics followed by a phase of saturation. In the linear phase, toroidal harmonics grow independently, whereas at larger amplitudes, the nonlinear interaction between the toroidal harmonics influences their growth and structure.

Prior to mode saturation, the evolution of the mode structure can be reproduced well by a simple quadratic mode-interaction model, which yields a possible explanation for the strong n=1 component of type-I ELMs observed in ASDEX Upgrade. In the linear phase of the simulations, intermediate toroidal mode numbers (n˜6-14) are most unstable as predicted by the peeling-ballooning model. But non-linearly, the n=1 component becomes important due to an energy transfer from pairs of linearly dominant toroidal harmonics with neighboring mode numbers to the n=1. The latter thereby changes its spatial structure.

P 19.16 Do 14:00 Poster EG

Berechnung von Transportkoeffizienten in nichtidealen Plasmen — •Michael Endres, Claudia-Veronika Meister und Dieter H. H. Hoffmann — Institut für Kernphysik, TU Darmstadt, Schlossgartenstraße 9, 64289 Darmstadt, Germany

Die elektrische Leitfähigkeit des vollständig ionisierten dichten Wasserstoffplasmas wird als Beispiel für Transporteigenschaften eines Plasmas untersucht. Dabei wird für die nichtidealen Plasma eine Näherung verwendet, die für wesentlich größere Plasmaparameter als die Spitzer-Theorie gültig ist. Es wird ein Ausdruck für die Leitfähigkeit vorgestellt, der mit Hilfe der Methode der Linear Response hergeleitet wurde. Dieser ist abhängig von Korrelationsfunktionen, die in sogenannter T-Matrix Näherung berechnet werden. Hierzu ist es nötig, die Streuphasen der jeweiligen Wechselwirkungspotentiale zu bestimmen. Die erhaltenen theoretischen Resultate für die elektrische Leitfähigkeit werden mit experimentellen Werten verglichen.

P 19.17 Do 14:00 Poster EG

Modeling and simulating high-harmonic generation with lasers at plasma surfaces — •Nils Fahrenkamp, Tatyana Liseykina, and Dieter Bauer — Institut für Physik, Universität Rostock, 18051 Rostock

When a linearly polarized laser pulse interacts with a dense plasma surface, the Lorentz force drives longitudinal oscillations at the surface, which hence is expected to behave as an oscillating mirror reflecting the incident light in the specular direction. The widely used oscillation mirror model (OMM) [1] accounts for high-harmonic generation (HHG) by treating the electron density profile as a rigid step-function. The motion of such a "mirror" depends on the plasma density, the laser polarization, the angle of incidence, and the intensity of the laser pulse (see [2,3] and references therein). We present results from one-dimensional particle-in-cell simulations and compare them with both the OMM and a further simplified model where the plasma response is included phenomenologically by inserting a harmonic recoil force into the equation of motion for the plasma-mirror.

[1] S. Bulanov, N. Naumova, F. Pegoraro, Phys. Plasmas 1, 745 (1994).
[2] U. Teubner, P. Gibbon, Rev. Mod. Physics. 81, 45 (2009).
[3] A. Macchi, *A Superintense Laser-Plasma Interaction Theory Primer*, (Springer, Heidelberg, 2013).

P 19.18 Do 14:00 Poster EG

Configuration path integral Monte Carlo simulation of correlated fermions — •Tim Schoof, Simon Groth, David Hochstuhl, Alex Filinov, and Michael Bonitz — Institut für Theoretische Physik und Astrophysik, Christian- Albrechts Universität zu Kiel, Germany

The configuration path integral Monte Carlo (CPIMC) approach for correlated many-particle systems with arbitrary pair interactions in a continuous space at finite temperatures is presented [1,2]. It is based on a representation of the N-particle density operator in a basis of (anti-)symmetrized N-particle states (configurations of occupation numbers). The method is applied to degenerate, correlated fermions in a two dimensional trap. A Restricted Active Space approach is used to reach stronger couplings ($\lambda \leq 4$) and larger particle numbers ($N \leq 10$). The efficiency of the method (fermion sign problem) is investigated and compared to standard Direct fermionic path integral Monte Carlo and an exact diagonalization method.

[1] T. Schoof, M. Bonitz, A. Filinov, D. Hochstuhl, and J. Dufty, Contrib. Plasma Phys. 51, 687 (2011)

[2] T. Schoof, Thermodynamische Eigenschaften entarteter, korrelierter Fermionen, Diplomarbeit, Universität Kiel (2011)

P 19.19 Do 14:00 Poster EG

Cluster virial expansion for partially ionized plasmas — •Niels-Uwe Bastian, Heidi Reinholz, and Gerd Röpke — Universität Rostock

The chemical picture serves as an intuitive concept to treat the low-density limit of many-particle systems forming clusters (bound states). Systematic quantum statistical approaches allow to combine the mass action law with mean-field concepts. Within a generalized Beth-Uhlenbeck approach, the quasiparticle virial expansion and the suppression of correlations due to screening and Pauli blocking is formulated. This approach is generalized to include arbitrary clusters, where special attention must be paid to avoid inconsistencies such as double counting. The contribution of the continuum to the virial coefficients can be reduced considering separately excited states and quasiparticle energies. The cluster-virial expansion connects known benchmarks at low densities as well as at high densities. In detail the electron, proton and atom system is considered.

P 19.20 Do 14:00 Poster EG

Transverse effects during the ultra-short relativistic laser pulse amplifications via Raman and Brillouin processes — •Friedrich Schluck, Götz Lehmann, and Karl-Heinz Spatschek — Heinrich-Heine Universität, 40225 Düsseldorf

Plasma-based amplification stages are a key element in the plans for the next generation of high-intensity ultra-short pulse laser amplifiers (www.int-zest.com). Energy transfer from a long pump pulse to a short seed pulse can be achieved via stimulated Raman or Brillouin scattering. To achieve high efficiency, it seems favorable to operate at high plasma densities. To keep the local energy density non- or weakly relativistic, large transversal beam diameters are currently discussed. This opens up the possibility of transversal instabilities.

We study the influence of transversal instabilities on Raman and Brillouin amplification to identify parameter regimes that allow for stable operation. Starting from simplified three-wave interaction models we motivate optimal choices for plasma density and pulse parameters. The predictions are then checked by numerical simulations.

P 19.21 Do 14:00 Poster EG

Linear response of strongly correlated confined plasmas — •Hanno Kählert[1], Gabor J. Kalman[1], and Michael Bonitz[2] — [1]Boston College, Department of Physics, Chestnut Hill, USA — [2]Christian-Albrechts-Universität zu Kiel, Institut für Theoretische Physik und Astrophysik

The quasi-localized charge approximation is based on the caging effect in strongly coupled liquids and has been widely applied to homogeneous systems in the past [1]. Here, we investigate the linear response

of confined strongly coupled plasmas by applying the theory to inhomogeneous systems in traps. The results should be important for confined dusty plasmas, laser-cooled ions, or ultracold neutral plasmas in the strongly correlated limit. Similar to previous calculations [2], we derive an equation for the fluid displacement field, which requires the density profile and the static pair correlation function of the confined plasma as input parameters. This adds correlation effects to the cold-fluid equations, which we previously used to study the collective modes of a confined Yukawa plasma [3]. We further discuss a possible extension to a kinetic theory based on an extended STLS scheme [4].
[1] K. I. Golden and G. J. Kalman, Phys. Plasmas **7**, 14 (2000)
[2] C.-J. Lee and G. J. Kalman, J. Korean Phys. Soc. **58**, 448 (2011)
[3] H. Kählert and M. Bonitz, Phys. Rev. E **82**, 036407 (2010)
[4] K. S. Singwi *et al.*, Phys. Rev. **176**, 589 (1968)
Supported by the DAAD via a postdoctoral fellowship and the DFG via SFB TR24.

P 19.22 Do 14:00 Poster EG

Investigation of nonlinear dynamics in capacitively coupled radio frequency discharges — •Schabnam Naggary, Abd elfattah Elgendy, Thomas Mussenbrock, and Ralf Peter Brinkmann — The Institute for theoretical electrical engineering, Ruhr university Bochum, Germany

Capacitively coupled radio frequency plasmas (CCP-RF) are widely used in material processing. Considering of the complicated analysis of the dynamic behavior of CCP-RF discharges, global models provide a simple understanding of these dynamics with relatively little effort.

Based on the matrix sheath model approach and description of the nonlinear charge-voltage characteristics of the sheath by a quadratic approximation, the global model yields a reasonable approximation of the RF current through the discharge. However, a more accurate description of the dynamics of CCP-RF discharges needed by the most plasma technologies can be obtained by applying a more exact sheath model realized by a cubic charge-voltage characteristic. This work shows that a small variation in the cubic charge-voltage characteristic compared to the quadratic approximation leads to considerably modification of the RF current which in turn has a significant influence on the power dissipation in the plasma.

P 19.23 Do 14:00 Poster EG

Dielectric wave model for the stratified ionospheric E-layer — •Claudia-Veronika Meister, Henrike Erhard, and Dieter H. H. Hoffmann — Institut für Kernphysik, TU Darmstadt, Schlossgartenstraße 9, 64289 - Darmstadt, Germany

A dielectric model for waves of the Earth's ionosphere caused by acoustic-type waves is developed. In doing so, in comparison to the well-known dielectric wave model by R.O. Dendy for homogeneous systems, the stratification of the atmosphere is taken into account. Moreover, within the frame of many-fluid magnetohydrodynamics also the momentum transfer between the charged and neutral particles is considered. The acoustic-type waves in the warm, weakly-collisional E-layer are introduced in the magnetohydrodynamic system by a fluctuating neutral-particle component. Models of the altitudinal scales of the plasma parameters and the electromagnetic wave field are derived. In case of the electric wave field, a method is given to calculate the altitudinal scale based on the Poisson equation for the electric field and the magnetohydrodynamic description of the particles. Further, an expression is derived to estimate the temperatur changes in the E-layer because of the propagation of acoustic-type wave modes.

P 19.24 Do 14:00 Poster EG

Simulationen zur Gasdynamik in Sputterprozessen — •J. Trieschmann[1,2], R.P. Brinkmann[1], T. Mussenbrock[1], S. Bienholz[1], P. Awakowicz[1], R.H. Brugnara[2], N. Bagcivan[2] und K. Bobzin[2] — [1]Ruhr-Universität Bochum, Bochum, Deutschland — [2]RWTH Aachen, Aachen, Deutschland

Magnetron Sputtering (DC-MS und HPPMS) ist für viele PVD-Prozesse zur Erzeugung von Korrosions- und Abnutzungsschutzschichten von großer Bedeutung; insbesondere die Kenntnis über die gasdynamischen Vorgänge innerhalb der benutzten Reaktorkammer.

In komplexen Reaktorgeometrien ist die Beschreibung der räumlichen Verteilung von Teilchen nur mittels numerischer Modelle möglich. Abhängig von der Geometrie des Reaktors und dem Prozessdruck (vgl. Knudsen-Zahl Kn) können Kontinuums- oder kinetische Modelle, wie die Direct Simulation Monte Carlo (DSMC) Methode, benutzt werden.

In dieser Arbeit werden DSMC-Simulationen verschiedener Magnetron Sputteranlage diskutiert. Die Simulationen basieren auf der frei verfügbaren Software OpenFOAM. In den untersuchten Reaktoren ist die Strömung mit einer Knudsen-Zahl von $Kn \approx 1$ im Übergangsbereich. Es werden Simulationsergebnisse zur Gasdynamik (Argon und Stickstoff) innerhalb der Reaktoren, sowie zum Sputter-, beziehungsweise Abscheideprozess von Aluminium und Chrom diskutiert und analysiert. Des Weiteren werden diese Ergebnisse unterstützt durch experimentelle Untersuchungen bzgl. der Druckverteilung, sowie des den Prozess treibenden Plasmas. (Die Arbeit wird gefördert durch die DFG im Rahmen des Sonderforschungsbereichs TRR87.)