P 5: Laserplasmen und Quantenplasmen

Zeit: Montag 16:30–18:45 Raum: HS 3

Hauptvortrag P 5.1 Mo 16:30 HS 3

Erzeugung intensiver Neutronenstrahlen aus Laserplasmen unter der Verwendung relativistischer Transparenz — •Markus Roth — Technische Universität Darmstadt, Institut für Kernphysik, 64289 Darmstadt, Germany

Neutronen bieten eine einzigartige Möglichkeit Materialeigenschaften zu untersuchen und zu beeinflussen. Daher rührt ein wachsender Bedarf an intensiven, gepulsten Quellen für schnelle oder thermische Neutronen. Beschleunigerbasierte Spallationsquellen bieten höchste Neutronenflüsse, könnten aber durch neue, kompakte Quellen mit höherer Spitzenleistung ergänzt werden. Laser bieten die Möglichkeit sehr kompakte Neutronenquellen zu treiben, die sich einfach an bestehende Einrichtungen koppeln lassen. Durch den Einsatz eines Hochenergie-Kurzpulslasersystems mit extrem hoher Strahlqualität kann die effiziente Beschleunigung von Ionen, hier besonders Deuteronen erreicht werden, deren Konversion in Neutronen extrem hohe Pulsleistungen erlaubt. Hierbei wird ein neuer Teilchenbeschleunigungsmechanismus erstmals verwendet, welcher auf relativistisch induzierter Transparenz von Festkörpern beruht. Es konnten damit erstmals ausreichend Neutronen erzeugt werden um Anwendungen in der Radiographie zu verwirklichen. Das erzeugte Neutronenspektrum reicht dabei bis zu Energien von 200 MeV und weist eine deutlich gerichtete Strahlcharakteristik auf. Diese neuen experimentellen Resultate könnten den Weg ebnen um Anwendungen der Neutronenuntersuchung in Bereichen der Medizin, Materialwissenschaft oder Archäologie zu erlauben die bislang nur an Großforschungsanlagen verfügbar waren.

P 5.2 Mo 17:00 HS 3

Radiation Pressure Assisted Ion acceleration from multi-component targets — •Stephan Kuschel[1,2], Christian Rödel[1,2], Bastian Aurand[2,3], Oliver Jäckel[1,2], Gerhard G. Paulus[1,2], Matthew Zepf[2], Malte Kaluza[1,2], and Thomas Kühl[2,3,4] — [1]Institute of Optics and Quantum Electronics, Jena, Germany — [2]Helmholtz Institute Jena, Jena, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [4]University of Mainz, Mainz, Germany

Monoenergetic ion acceleration using the radiation pressure of high intensity lasers has attracted a strong interest in recent years and holds promise for numerous applications. Laser particle simulations have shown that radiation pressure acceleration (RPA) is the dominant acceleration mechanism leading up to GeV proton energies for peak intensities of the order of 10^{23}W/cm^2. Using a peak intensity of $5 \cdot 10^{19}$W/cm^2, however, we have observed the onset of RPA at the "JETI" laser system. This has been achieved using multi-component foil targets matching the density and thickness conditions for efficient RPA.

P 5.3 Mo 17:15 HS 3

Seed pulse optimization for ultra-short relativistic laser pulse generation via stimulated scattering in plasmas — •Götz Lehmann[1], Granville Sewell[2], and Karl-Heinz Spatschek[1] — [1]Heinrich-Heine Universität, 40225 Düsseldorf — [2]University of Texas El Paso, El Paso, USA

Laser amplification schemes like chirped pulse amplification or optical parametric amplification are limited in intensity due to damage-threshold issues. Using underdense plasmas as amplifying medium is a promising way to circumvent these problems. Raman and Brillouin backscattering processes receive renewed interest in the context of generating ultra-intense and ultra-short laser pulses up to the exawatt-zetawatt regime. The IZEST initiative (www.int-zest.com) identified a plasma amplification stage as key technology for the next generation high-power lasers. In the proposed scenarios energy of a ps probe pulse is transferred to a fs seed pulse by scattering the pump off a plasma wave, driven by the beating of pump and seed pulse. The plasma wave can either be an electron wave (Raman scattering) or an ion wave (Brillouin scattering). While Raman and Brillouin back-scattering are well understood for monochromatic waves, the situation is less known when it comes to short pulses. This is in particular true when other effects like wave-breaking occur at the same time. Here it will be discussed how pulse forms influence the Raman and Brillouin processes, both in the linear as well as in the nonlinear regime. Results from simplified analytical models will be compared to numerical solutions obtained from general relativistic Maxwell-Vlasov simulations.

P 5.4 Mo 17:30 HS 3

Amplification of a surface electromagnetic wave by running over plasma surface ultrarelativistic electron bunch as a new scheme for generation of Terahertz radiation — •Saltanat P. Sadykova[1], Anri A. Rukhadze[2], T. G. Samkharadze[2], and Konstantin V. Khishchenko[3] — [1]Max-Born Institut fuer Nichtlineare Optik und Kurzzeitspektroskopie im Forschungsverbund Berlin e.V., DESY Hamburg — [2]Prokhorov General Physics Institute, Russian Academy of Sciences, Vavilov Str., 38., Moscow, 119991, Russia — [3]Joint Institute for High Temperatures RAS, Izhorskaya 13 bldg 2, Moscow 125412, Russia

The amplification of a surface electromagnetic wave by means of ultrarelativistic monoenergetic electron bunch running over the flat plasma surface in absence of a magnetic field is studied theoretically. It is shown that when the ratio of electron bunch number density to plasma electron number density multiplied by a powered to 5 relativity factor is much higher than 1, i.e $\gamma^5 n_b/n_p >> 1$, the saturation field of the surface electromagnetic wave induced by trapping of bunch electrons gains the magnitude: $E_x = B_y \approx \frac{\omega_p m c \gamma^{5/7}}{e}(\frac{2n_b}{n_p})^{1/7} \approx 10^{11}$ V/m, hence, the energy density flux (Poyinting vector) $|P| = c/4\pi(E_x^2) \simeq 6 \cdot 10^{15}$ W/cm^{-2} and does not approache the surface electromagnetic wave front breakdown threshold in plasma [1]. [1] A. A. Rukhadze, S. P. Sadykova, T. G. Samkharadze, K. V. Khishchenko, arXiv:1210.0610 (2012)

Hauptvortrag P 5.5 Mo 17:45 HS 3

Excitation spectrum of nonideal quantum systems from first-principle thermodynamic simulations — •Alexey Filinov[1,2] and Michael Bonitz[1] — [1]Institut für Theoretische Physik und Astrophysik, D-24098 Kiel, Germany — [2]Joint Institute for High Temperatures RAS, 125412 Moscow, Russia

In our talk we review the numerical schemes to extract information about real-time dynamics of quantum many-body systems from the imaginary-time correlation functions available from quantum Monte Carlo simulations. We discuss reconstruction of the dynamic structure factor $S(q, \omega)$ related with the collective density excitations, and the one-particle spectral function extracted from the one-particle Matsubara Green's function. The performance of the methods is demonstrated on several physical examples, which include superfluid ^{4}He [1], quasi-two dimensional dipolar Bose gases [2] and quantum electron-hole bilayers. The used approach allows one to analyze damping and hybridization of the excitation spectra from first principles, and to study temperature-density dependencies. Prospects for degenerate quantum plasmas are discussed.

[1] M. Rossi and et al., Phys. Rev. B 85, 014525 (2012); [2] A. Filinov and M. Bonitz, Phys. Rev. A 86, 043628 (2012).

P 5.6 Mo 18:15 HS 3

Effect of screening by external charges on the atomic orbitals and photoinduced processes within the Hartree-Fock-Slater atom — •Robert Thiele[1], Sang-Kil Son[1], Beata Ziaja[1,2], and Robin Santra[1,3] — [1]Center for Free-Electron Laser Science, DESY, 22607 Hamburg, Germany — [2]Institute of Nuclear Physics, Polish Academy of Sciences, Radzikowskiego 152, 31-342 Kraków, Poland — [3]Department of Physics, University of Hamburg, 20355 Hamburg, Germany

X-ray free-electron lasers (XFELs) are a promising tool for the structural determination of macro- and biomolecules, using coherent diffractive imaging. During imaging, the intense XFEL pulses also efficiently ionize the molecules, so it is important to estimate how the charged environment within the molecule modifies atomic properties, in comparison to the case of an isolated atom. Here, we apply the XATOM toolkit to obtain predictions on the modified ionization thresholds and rates of some photoinduced processes in carbon. The Hartree-Fock-Slater model is extended to include the electron screening and ion correlation effects, induced by external charges. With this extended model, we obtain predictions on modifications of orbital energies, photoabsorption cross sections, Auger decay rates, fluorescence emission rates, and atomic scattering factors as a function of the density and temperature of the surrounding charges. Our results have implications for the studies of dynamics within XFEL irradiated samples, in particular for those dedicated to coherent diffraction imaging.

P 5.7 Mo 18:30 HS 3

Testing the Shukla-Eliasson attractive force between protons in dense hydrogen — •Michael Bonitz, Eckhard Pehlke, and Tim Schoof — Institut für Theoretische Physik und Astrophysik, CAU Kiel, Leibnizstr. 15

In a recent letter [1] the discovery of a new attractive force between protons in a dense hydrogen plasma was reported that - according to the authors - would be responsible for the formation of molecules and of a proton lattice. Here we show, based on ab initio density functional calculations and general considerations, that these predictions have no factual basis and are caused by using linearized quantum hydrodynamics beyond the limits of its applicability [2].

[1] P.K. Shukla and B. Eliasson, Phys. Rev. Lett. 108, 165007 (2012), Erratum: Phys. Rev. Lett. 108, 219902 (2012); Erratum: Phys. Rev. Lett. 109, 019901 (2012)

[2] M. Bonitz, E. Pehlke, T. Schoof, Phys. Rev. E, accepted (2012), arxiv: 1205.4922