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Plasma-based amplification and manipulation of high-power laser pulses

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In the last decade the increasing availability of Tera- and Petawatt class lasers with ps to fs pulse duration has intensified the interest in the relativistic interaction between laser radiation and matter. Today laser intensities up to 10^{22} W/cm^2 can be achieved. Most high intensity lasers today rely on amplification schemes that can only hardly be scaled to higher power levels due to material damage thresholds. An alternative approach that allows circumventing these issues is the use of plasma as an amplification medium. Langmuir or ion waves may be used as optical components, scattering the energy from a long pump pulse into a short seed pulse [1,2]. Damage thresholds of solid-state materials are not only limiting the generation of high power laser light, but also its subsequent manipulation. Again, plasma can provide an alternative approach to light manipulation. We recently proposed the concept of transient plasma photonic crystals, which aims at transferring and extending the concept of photonic crystals to the realm of plasma physics in the range of optical frequencies [3]. In my presentation I will discuss Brillouin type plasma-based laser amplifiers and show that the ion plasma waves, driven by the two laser pulses, eventually form photonic crystals [4]. The properties and possible future applications of these plasma photonic crystals as efficient Bragg type mirrors or polarizers will be discussed. [1] V. Malkin, G. Shvets, and N. J. Fisch, Phys. Rev. Lett. 82, 4448 (1999) [2] A.A. Andreev, C. Riconda, V. T. Tikhonchuk, and S. Weber, Phys. Plasmas 13, 053110 (2006) [3] G. Lehmann and K.H. Spatschek, Phys. Rev. Lett. 166, 225002 (2016) [4] G. Lehmann and K.H. Spatschek, Phys. Plasmas 23, 023107 (2016)