Novel Mechanism to Generate Suprathermal Electrons by Anti-Stokes Langmuir Decay Instability Cascade

Q. S. Feng[1], R. Aboushelbaya[1], M. W. Mayr[1], B. T. Spiers[1], R. W. Paddock[1], I. Ouatu[1], R. Timmis[1], R. H. W. Wang[1], L. H. Cao[2], Z. J. Liu[2], C. Y. Zheng[2], X. T. He[2], and P. A. Norreys[1,3,4]
[1] Department of Physics, Atomic and Laser Physics sub-Department, University of Oxford, UK
[2] Institute of Applied Physics and Computational Mathematics, Beijing, China
[3] Central Laser Facility, UKRI-STFC Rutherford Appleton Laboratory, UK
[4] John Adams Institute, Denys Wilkinson Building, Oxford, United Kingdom
e-mail (speaker): qingsong.feng@physics.ox.ac.uk

The study of parametric instabilities has played a key role in the understanding energy transfer to plasmas and, with that, the development of key applications such as inertial confinement fusion, plasma wakefield accelerators and novel X-ray sources. Wave-wave interactions that cascade energy away from the focal region provide a very rich source of study that is yet to be fully explored and understood.

Here, a new mechanism for electron acceleration by anti-Stokes Langmuir decay instability cascade of forward stimulated Raman scattering is proposed. The problem is divided into three regions. When the electron temperature is Te = 2.5 keV, the first region is between densities of ne < 0.108 nc (Region I). Here, the backward stimulated Raman scattering of forward stimulated Raman scattering and corresponding Langmuir decay instability accelerate the electrons to high energy. The second region is when the densities are between 0.108 nc < ne < 0.138 nc (Region II). Here, anomalous hot electrons with kinetic energies above 100 keV are also generated. This process cannot be explained by traditional acceleration mechanisms. Evidence is presented to show that these hot electrons arise from anti-Stokes process of Langmuir decay instability cascade of forward stimulated Raman scattering. Finally, the third region is ne > 0.138 nc (Region III), where the electrons trapped by backward stimulated Raman scattering induced Langmuir wave are accelerated by the forward stimulated Raman scattering induced Langmuir wave directly. This new mechanism not only explains anomalous energetic electron generation in indirectly driven inertial confinement fusion experiments and the significant energy losses on the inner cones of beams for the first time (compensated by cross-beam energy transfer at the laser entrance holes of the holhraum targets), but also provides a new way of accelerating the electrons to higher energy in the laser-driven wakefield accelerator research.

This research was supported by the Oxford-ShanghaiTech collaboration project, the National Natural Science Foundation of China (Grant Nos. 12005021, 11875091 and 11875093).

References

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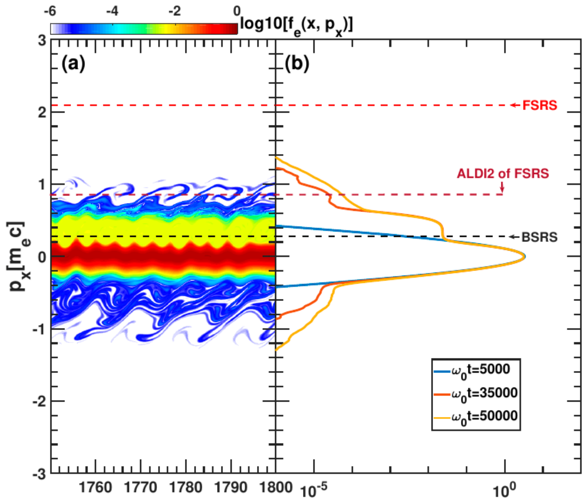

Figure 1. (a) The phase picture of electrons and (b) the corresponding electron distribution function.