2nd Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

Stimulated Raman and Brillouin scattering instabilities in a relativistic plasma

A. P. Misra, Debjani Chatterjee

Department of Mathematics, Visva-Bharati University, Santiniketan
e-mail (speaker): chatterjee.debjani10@gmail.com

The nonlinear self-interactions of finite amplitude intense electromagnetic waves (EMWs) and relativistic/nonrelativistic plasmas have received a significant research attention in recent years (see, e.g., Refs. [1]-[4]). Such high-frequency (hf) EMWs are used for plasma heating, e.g., in inertial fusion plasmas [5], as well as for plasma diagnostics [6], e.g., in solid density plasmas that are created by intense laser and charged particle beams. Furthermore, laser-plasma interaction provides a rich source of nonlinear phenomena including the formation of coherent structures as localized bursts of *x* rays and *gamma* rays [7] from compact astrophysical objects, fast ignition, particle acceleration, generation of different kinds of waves and instabilities [8].

In this work, we study the stimulated scattering instabilities of an intense linearly polarized electromagnetic wave (EMW) in a relativistic plasma with degenerate electrons. Starting from a relativistic hydrodynamic model and the Maxwell's equations, we derive coupled nonlinear equations for low-frequency electron and ion plasma oscillations that are driven by the EMW's ponderomotive force. The nonlinear dispersion relations are then obtained from the coupled nonlinear equations which reveal stimulated Raman scattering (SRS), stimulated Brillouin scattering (SBS), and modulational instabilities (MIs) of EMWs. It is shown that the thermal pressure of ions and the relativistic degenerate pressure of electrons significantly modify the characteristics of SRS, SBS, and MIs.

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