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RELATIVISTIC EFFECTS ON STIMULATED BRILLOUIN SCATTERING OF SELF-FOCUSED q-GAUSSIAN LASER BEAMS IN PLASMAS WITH AXIAL DENSITY RAMP

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Abstract

We investigate the phenomenon of stimulated Brillouin scattering (SBS) of q-Gaussian laser beams nonlinearly-interacting with underdense plasmas. When an intense laser beam with frequency ω_0 propagates through plasma, due to relativistic mass nonlinearity of plasma electrons, it gets coupled to a preexisting-ion acoustic wave (IAW) at frequency ω_{ia}. The nonlinear interaction of pump beam with IAW produces a back-scattered wave at frequency $\omega_s = \omega_0 - \omega_{ia}$. In view of the variational theory, we obtain semi-analytical solutions of the coupled nonlinear wave equations for the three waves (pump, IAW, and scattered wave) under the Wentzel-Kramers-Brillouin (WKB) approximation. We show that the scattered-wave power is significantly affected by the self-focusing effect of the pump beam.

Keywords: q-Gaussian beam, density pump, relativistic plasma, stimulated Brillouin scattering, self-focusing.

1. Introduction

Ever since the proposal of initiating nuclear fusion by intense laser beams (ICF) for viable energy production [1] without producing any harm to global climate, there was a considerable interest in the nonlinear interaction of intense laser beams with plasmas. In laser-driven fusion, the goal is to deposit the laser energy at a particular density in the plasma in order to derive the compression and subsequent heating of the fuel pellet. If the pellet is sufficiently compressed, it may undergo fusion, with the release of a large amount of energy. However, the laser may interact with the plasma at a density different to that which is intended, leading to myriad undesirable effects [2–5] and preventing the effective implosion of the target.

Due to their remarkable properties of quasineutrality and collective behavior, plasmas possess a number of natural modes of oscillations [6–8]. This includes high-frequency electron plasma waves (EPWs) and low-frequency ion acoustic waves (IAWs); the latter ones correspond to acoustical phonons, as do the

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