Contribution ID: **14** Type: **not specified**

Harmonic Generation In Magnetized Quantum Plasma with Separate Spin-up and Spin-down Evolution of Degenerated Electrons

Wednesday, 21 June 2017 16:00 (1h 45m)

The generation of harmonic radiation is significant in terms of laser-plasma interaction and has brought interesting notice due to the diversity of its applications. It has been remarked that second harmonic generation takes place in the presence of density gradient [1,2] which gives rise to perturbation in the electron density at the laser frequency. Second harmonic generation has also been related with filamentation [3,4]. In this case, second harmonic radiation was shown to be emitted in a direction perpendicular to the laser beam from filamentary structures in the under dense target corona.

In dense plasmas, when the de Broglie wavelength of the charge carriers becomes comparable to the spatial scale of plasma system, the quantum effects start playing a crucial role on the dynamics of plasma particles and their study becomes important. The quantum plasma has received much attention in recent years due to its important applications in astrophysics to modern technology [5-11]. Most of the studies in quantum plasma has been performed using the quantum hydrodynamic (QHD) model describing all particles of a species independent of their spin direction. These models do not distinguish between spin-up and spin-down states of electrons and ignore the spin-spin interaction. Recently a new approach has been reported considering two different spin states (spin-up and spin-down) as two different species of particles [12].

In the present paper, we present a study of second harmonic generation when a linearly polarized laser beam propagates through a homogeneous high density quantum plasma in the presence of a magnetic field. The effects of quantum Bohm potential, Fermi pressure and the electron spin have taken in the account. The linear, nonlinear current densities and dispersion for the second harmonic has been obtained. The spin-up and spin-down electrons has been taken as two different species of particles. The high magnetic field disturbs the equilibrium and a difference in concentration of spin-up and spin-down electrons is introduced. This results in the generation of a new wave at the second harmonic of laser frequency.

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Session Classification: Poster Session with Coffee break