Seminar

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Institute for Plasma Research

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Title: Nonlinear Laser Interaction with Nanoparticles, Nanotubes and Plasmas

Speaker: Dr. Mamta Rao
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Venue: Join the online meeting
https://meet.ipr.res.in/join/8088208287?be_auth=NTczMTc0
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Abstract

My research comprises analytical and numerical studies of nonlinear phenomena encountered in high power laser plasma interaction. The plasmas considered are embedded with nanotubes and nanoparticles or may contain a density ripple. I have studied nonlinear absorption, harmonic generation, parametric instabilities and charged particle acceleration.

An analytical formalism has been developed to study the nonlinear absorption and harmonic generation of laser impinged on an array of CNTs mounted on a planar surface, including the effects of thermal conduction. The nanotubes give rise to nonlinear effects at relatively lower laser intensities, as compared to smooth surfaces. Surface plasmon resonance plays a vital role in it. The second and third harmonic generation conversion efficiency has been calculated and found to be of the order of 1.4×10^{-2}, and 0.9×10^{-2} respectively.

The nonlinear absorption of a short laser on metal surfaces embedded with metallic nanoparticles and nanotubes has been studied. Both the cases of expanding and nonexpanding nanoparticles and nanotubes have been discussed. The absorption is found to be resonantly enhance at surface plasmon resonance when the laser frequency becomes comparable to the frequency of surface charge oscillations. The absorption coefficient increases with the angle of incidence at all frequencies. Heat conduction inside the metal limits the rise in electron temperature. Surface plasmon resonance in expanding nanoparticles occurs for a narrow duration. For bigger nanoparticles, the resonance is delayed due to the slow expansion rate. However, electron temperature attains higher value. This leads to large absorption in the bigger nanoparticles.

The Parametric instability of Stimulated Raman Scattering (SRS) of a laser pump has been studied in CNT embedded plasmas. The anisotropic behavior of CNTs significantly modifies the electrostatic and electromagnetic modes. For Raman backscattering, the growth rate increases due to the presence of CNTs. The enhancement is strong when frequency of the pump or one of the decay waves is near the surface plasmon resonance. For the normalized laser amplitude a0 = 0.01 at 1.06-micron wavelength, the growth time is typically in the sub-picosecond range. The effect of linear damping on growth rate has been found to be more pronounced for the plasmas with CNTs as compared to plasma without CNTs.

The scheme of guided acceleration of laser-irradiated deuterium nanoparticles interspersed between two gold parallel nanorods has been proposed. The laser pulse of intensity exceeding 10^{18} W/cm^{-2} at 1 μm wavelength and pulse duration ~30 fs causes full ionization of nanoparticles and high state ionization of gold atoms and pushes out the free electrons via the ponderomotive force. The charged nanorods have an electric field that has transverse component towards the axis of symmetry and axial field outwards. Thus, 2 the nanoparticles are accelerated axially while confined transversely. Deuterium beam of a few MeV energy can be produced by this technique.