Seminar

Institute for Plasma Research

Title : Ultra-short laser pulse interaction with atomic clusters

Speaker: Dr. Prachi Venkat
BITS, Pilani, Jaipur

Date : 21st September 2020 (Monday)

Time : 03:30 PM

Venue : Online - Join the talk: https://meet.ipr.res.in/Dr.PrachiVenkat_PDFtalk

Abstract :

When highly intense laser beams interact with atomic clusters, the constituent atoms get ionized, producing high energy electrons and ions in a small region. These ions and electrons collectively behave as hot plasma which is a very promising source of energetic ions, electrons, a whole spectrum of intense radiation and also, an environment for fusion to occur. An important advantage of using a cluster over a solid or gaseous target is the high local density in an otherwise gaseous medium, due to which the energy is not easily redistributed. Laser-cluster interaction finds application in a number of fields such as lithography, energetic ion production, higher order harmonics generation, source of XUV pulses, energetic electron production, neutron production in Deuterium clusters, etc.

With these applications in mind, a detailed computational study of laser-cluster interaction has been done which can be divided into three broad categories: sub-cycle pulsed beam interaction with clusters to produce energetic ions, high energy electron generation using mutually perpendicularly polarized laser pulses and non-linear Thomson scattering in clusters which gives rise to higher order harmonics generation.

Using a molecular dynamics model, interaction of intense, sub-cycle pulses of femtosecond duration with noble gas clusters has been studied. The extremely high energy pulse of such short duration ionizes the cluster almost instantly, followed by the stripping of electrons from the cluster and coulomb expansion of the ionic cloud, which ultimately yields emission of high energy ions. The electrons produced during ionization also carry extremely high energy and such a high energy electron source can be used as a prerequisite to laser wakefield acceleration. To produce such high energy electrons a model of two mutually perpendicularly polarized laser beams has been used to irradiate the cluster and produce high energy electrons, which are also decoupled from the dying energy of the pulse. Radiation emitted by electrons from an ionized cluster due to the relativistic non-linear Thomson scattering has also been studied, which predominantly occurs when the pulse intensity is $>\sim 10^{18}$ W/cm^2. The radiation spectrum emitted during this process has higher order harmonics which are emitted in different directions. We have attempted to find the optimal conditions for emission of these harmonics and also use the angle at which maximum power is emitted as a laser pulse diagnostic tool to directly measure the laser intensity, which otherwise relies on indirect means of measurement.