Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally, Ranga Reddy Dist., Hyderabad – 500 046

Seminar

Tailored Droplets Enhance Parametric Instabilities in Intense laser Interactions: A Symphony Amidst the Cacophony

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TIFR, Hyderabad

The interaction of intense (10^{12} -10^{16} W/cm^2) ultrashort (25 fs) laser pulses with matter at different length scales manifests intriguing behaviour even while having fundamental congruity. Intense ultrashort pulses impinging on matter are absorbed to start with by single particle response to the field like multi-photon ionization, tunnel ionization or over-the-barrier ionization. At the level of atoms, molecules, clusters Nano-tips, these interactions have been studied at TIFR Hyderabad for the past decade.

In our latest work with free-standing particles ranging from 2-70 μm at intensities of 10^{15} -10^{16} W/cm^2 plasma-driven processes such as parametric instabilities transfer a significant amount of laser energy to electrons beyond those predicted by conventional scaling relations. In this talk, I will present evidence of the generation of relativistic electrons (temperature >200 keV, maximum energies >1 MeV) at intensities that are two orders of magnitude lower than the relativistic intensity threshold. A pre-pulse with 1-5% of the intensity of the main pulse, arriving 4 ns early, is critical for hot electron generation. In addition to this unprecedented energy enhancement, we also characterise the dependence of X-ray spectra on the background gas of the particles. Intriguingly, the easier the gas is to ionise, the greater the number of hot electrons observed, while the electron temperature remains the same.

2-D Radiation hydrodynamics and Particle-in-cell (PIC) simulations explain both the experimentally observed electron emission and the role of the low-density plasma in yield enhancement. The pre-pulse sets the stage in tailoring the plasma profile for enhanced interaction of the main pulse with a long-density gradient plasma. A resonant parametric process known as Two-Plasmon Decay drives nonlinear plasma waves that break to release high-energy electrons. Here, I will chart out these prominent results from the TIFR Hyderabad lab and the applications of the laser plasma source.

Tuesday, Sep 3rd 2024

16:00 Hrs (Tea / Coffee 15:45 Hrs)

Auditorium, TIFR-H