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A study of Intense Lasers and Plasma Interaction

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Laser plasma interaction always remains an interesting and enriched field to carry out research investigations of several physical phenomena involved herein. Laser plasma interaction facilitates the phenomenon namely inertial confinement fusion, particle and radiation sources, laser plasma accelerators, ion acceleration, coherent light sources and parametric instabilities. To investigate the underlying mechanism, highly intense lasers are required so that they can propagation through the plasma with least defocussing. Earlier days Giga watt laser systems were available but nowadays laser powers are enhanced significantly. This power amplification of lasers is further enhances with shortening of the laser pulse. Now femtosecond to attosecond ultra-short pulses are readily available. Development of high power lasers of intensity ranging terawatt to petawatt lasers opens up the new doors to the research of ultra-intense laser plasma interaction. When a short duration ultra-intense laser pulse propagates through the under-dense plasma, the plasma species comes under the influence. It is assumed that being heavier in mass, the ions almost remain unaffected whereas electrons are the main actors playing role in laser dynamics. Nonlinear electron redistributions are setup in the plasma in the wake of laser propagation which results excitation of wakefield as well as excitation of nonlinear plasma currents. The former case prevails when laser pulse length is of the order of plasma wavelength whereas in the latter case nonlinear currents are excited resonantly when plasma frequency matches with laser frequency or beat frequency in case of two lasers. In either case the radiation fields are emitted out of the plasma which may have several applications based on their characteristics in terms of field amplitude and frequency. These applications involve material characterization, ICF fusion, Security and surveillance, food technology, accelerators and medical diagnostics etc. Thus, it becomes imperative to study laser plasma interaction because of their extensive applications.

Development of terahertz (THz) radiation sources is also a distinguished application of laser plasma interaction. We have employed different shape profile lasers to obtain controlled amplitude, frequency, polarization tunable THz radiation sources based on the beating of laser pulses in the under-dense plasma. Resonant emission of THz radiation is achieved with employment of rippled density plasma. We further extend this scheme by application of external periodic electrostatic field where we obtain another parameter to control and tune amplitude and frequency of emitted THz radiation. This mechanism is termed as external field induced terahertz radiation emission i.e. EFIT.

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