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Abstract

In the last two decades, the terahertz (THz) radiation that belong to the part of electromagnetic spectrum lying between low frequency infra red (IR) and high frequency microwave regions, has woken tremendous interest and has become an important area of research in both fundamental and applied sciences. Due to its non-ionising and non-invasive features, THz radiation finds numerous applications in the field of tomography, security screening, time domain spectroscopy, medical diagnostic and material characterization. Researchers all over the world are working to find a promising way to generate and tune THz radiations to achieve high power, amplitude and efficiency with reasonable cost and size.

Since these radiations demarcate the regions of two very fascinating fields i.e. electronics and photonics, both optical and electronic techniques can be utilised for the generation and detection of terahertz radiations. Several experimental and theoretical techniques have been employed to generate terahertz radiations such as THz quantum cascade laser, photo-conductive antenna, electro-optic crystals and optical rectification. But these conventional terahertz generation techniques suffer from various disadvantages such as low conversion efficiency, low damage threshold and narrow bandwidth. Plasma is also utilised as a nonlinear medium to generate efficient THz radiations as it is able to withstand laser intensities that are higher than the damage threshold of nonlinear crystals or PCAs. Researchers have proposed several laser-plasma interaction-based schemes for generating high power THz radiation sources.

In this thesis, we worked on development of new plasma-based THz radiation generation schemes. Our work focuses on terahertz radiation generation by nonlinear frequency of two laser beams in hot/cold and magnetized/ unmagnetized plasma. In particular, focus is laid on tunable and efficient terahertz radiation generation for which various laser profiles such as *Hermite cosh Gaussian* (HchG) and *hollow sinh super Gaussian* are examined analytically and numerically. We proposed to use the resultant field of two superposing lasers having an initial phase difference δ in modulated density collisional gas plasma. Based on initial phase difference between lasers δ and different field amplitudes of the laser, we realised the optimum field for the THz radiation. We talked about the importance of density ripples and their periodicity for efficient THz radiation generation. The importance of decentered parameter, mode index, indices of *hollow sinh super Gaussian* and initial phase difference between two lasers is also discussed.

In order to achieve the resonance condition easily, we proposed to use an external magnetic field in the direction perpendicular to both the polarization and direction of propagation of lasers. Based on this, we could tune the frequency and power of THz radiation and also enhance the efficiency of conversion. The effect of collision frequency on resonance condition and terahertz field amplitude is also investigated. We have also examined the combined effect of electron temperature (electron thermal velocity) and laser polarisation on terahertz field amplitude and conversion efficiency by propagating two radially polarized lasers beams in hot, collisional gas/air plasma. Thus, we believe that proposed schemes are very useful to generate radially/linearly polarized, frequency and field profile tunable and high power/intensity THz radiations, which have numerous applications in medical diagnostic, security scanning etc.

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