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Terahertz radiation produced by ultraintense laser-solid interactions

A current challenge in terahertz (THz) science [1] is to produce broadband THz pulses with mJ-level energies, which can be achieved by irradiating solid targets at relativistic laser intensities. In this regime, coherent transition radiation from electron bunches exiting the rear plasma boundary of fully ionized matter may lead to intense THz emissions characterized by a mJ-to-Joule energy yield [2].
In this talk, using multi-dimensional particle-in-cell simulations we will investigate the mechanisms of terahertz emissions in sub-micrometer-thick solid foils driven by ultraintense (10^{20} W/cm^2), ultrashort (30 fs) laser pulses at normal incidence for various target thicknesses. Our analysis will reveal that, within the first picosecond after the interaction, successive THz emissions occur as a result of coherent transition radiation by the recirculating hot electrons and antenna-type emission by the shielding electron currents traveling along the fast-expanding target surfaces [3].
We will then elaborate on a semi-analytical model describing the coherent transition radiation due to electrons crossing the plasma-vacuum interface and the synchrotron radiation due to their deflection and deceleration in the sheath field set up near the target backside. The same sheath field rapidly sets into motion the surface ions and may contribute to the THz yield as well. We shall describe the THz emission from these accelerated ions by means of a plasma expansion model and show that the THz radiation from the expanding plasma is much less energetic than that due to the early dynamics of the fast electrons [4].

References

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