Burst of Ultraintense, Coherent Radiation from Colliding Laser Pulses in a Plasma

Min Sup Hur*

Department of Physics, Ulsan National Institute of Science and Technology, Ulsan 44910, Korea
**mshur@unist.ac.kr*

While it is widely accepted that the plasma oscillation is an underlying mechanism of coherent radio-burst in space, there has been a controversy on the radiation at the plasma frequency in laser-plasma interaction in laboratory. Commonly accepted framework is that since the plasma oscillation is electrostatic, its electric field is curl-free, prohibiting any electromagnetic radiation. On the other hand, numerous theoretical, experimental, simulation data suggests a possibility of the radiation burst by the plasma oscillation. However, all the previous reports of radiation by the plasma oscillation have shown broadband spectrum, making it dubious if it is really from the self-oscillation of the plasma with wp. In this presentation, for the first time we show theoretical and simulation results of radiation burst with a narrowband spectrum at the plasma frequency. The mechanism is colliding two detuned laser pulses in a plasma. In the overlapped region of the laser pulse, the electrons are trapped in the ponderomotive potential train associated with the beat of the laser pulses. Because the overlapped region is spatially limited to a few microns, a finite-sized electron block composed of multiple microbunches trapped in the ponderomotive buckets are displaced in-phase. After the pulse collision is finished, the displaced electron block commence the plasma oscillation, named plasma dipole oscillation (PDO). As the PDO is located close to the plasma-vacuum boundary, it emits strong THz burst into the vacuum side, exhibiting a narrowband spectrum at the plasma frequency and GV/cm-order peak electric field. Emitted energy of the burst reaches mJ, with efficiency of order 10-3. We observe that non-zero curl of the electric field is generated over the collisional position of the laser pulses, which is quite opposite to conventional belief that laser-induced plasma oscillation is purely electrostatic, or contains at most a very negligible electromagnetic, coherent component.