THZ GENERATION IN PLASMAS USING TWO-COLOR LASER PULSES*

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We analyze the generation of THz radiation when an intense, short laser pulse is mixed with its frequency-doubled counterpart in plasma[1]. The nonlinear coupling of the fundamental and the frequency-doubled laser pulses in plasma is shown to be characterized by a third order susceptibility which has a time dependence characteristic of the laser pulse durations. The THz generation process depends on the relative polarizations of the lasers and the THz frequency is $\omega \sim 1/\tau_L$, where τ_L is the laser pulse duration. Since the laser pulse duration is typically in the pico-second or sub-pico-second regime the resulting radiation is in the THz or multi-THz regime. To obtain the third order susceptibility we solve the plasma fluid equations correct to third order in the laser fields, including both the relativistic and ponderomotive force terms. The relativistic and ponderomotive contributions to the susceptibility nearly cancel in the absence of electron collisions. Therefore, in this THz generation mechanism collisional effects play a critical role. Consistent with recent experimental observations, our model shows that 1) the THz field amplitude is proportional to $I_1(I_2)^{1/2}$, where I_1 and I_2 are the intensities of the fundamental and second harmonic laser pulses, respectively, 2) the THz emission is maximized when the polarization of the laser beams and the THz are aligned, 3) for typical experimental parameters, the emitted THz field amplitude is on the order of tens of kilovolts/cm with duration comparable to that of the drive laser pulses, and 4) the direction of THz emission depends sensitively on experimental parameters.

1. J. Peñano, P. Sprangle, B. Hafizi, D. Gordon, P. Serafim, "THz Generation in Plasmas using Two-Color Laser Pulses," to appear in Physical Review E.

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