Short Pulse Interaction with Droplet Generated Microplasmas

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Interaction of non relativistic femtosecond(fs) pulses with spatially confined plasmas, generated from microdroplets, have recently been used to generate energetic electrons. [1], [2]The production of hot electrons conventionally requires long duration (ps-ns) and high energy pulses(J-kJ) to create an extended region of inhomogeneous plasma and sufficient time for instabilities due to two plasmon decay (TPD) and stimulated Raman scattering (SRS) to grow which can accelerated electrons to high energies[3–7]. If these conditions are achieved using fs duration, mJ energy, kHz repetition rate pulses then hot electron production may be achieved using table top facilities. The understanding of the production of hot electrons possessing energy of the order of 100keV with mJ, non-relativistic fs pulses with micro-plasma remains elusive. TPD mechanism has been proposed due to detection of 3/2 harmonic of laser frequency.[2], [8]

Our work here is aimed at understanding the underlying normal modes and parametric processes which may arise in the context of such finite plasmas. Thus, we have chosen a simple set-up of a microdroplet interacting with fs laser for our study. Numerical simulations were performed using 2D Particle in Cell (PIC) code EPOCH.[9] The simulation domain consisted of 50 × 50 μm^2 and had 3000 × 3000 cells with 8 macro particles per cell. The micro plasma was of 30 μm dia. In the plasma, $n_e = 10n_c$ for $r < 13\mu m$, $n_e = 10n_c \cos((r - 13\mu m)/4\mu m)$ for $13\mu m < r < 15\mu m$ and $n_e = 0$ for r>15 μm (r is the radius of microplasma centered at 25 μm,25 μm) and A Gaussian laser propagating along X axis with beam waist of 20 μm dia., with full width half maximum (FWHM) pulse duration 25 fs, having peak intensity of 5.28 × 10^{17} W/cm^2 and corresponding a_0= 0.5 was made to interact with such a micro plasma.

Figure 1.a presents the electron number density after the interaction of laser pulse with target plasma. It shows electrons emerging symmetrically at an angle of about 22^o from the beam axis. In Figure 1.b. the electron energy has been depicted. The maximum energy is shown to be around ~380keV. An understanding of the observations will be provided.

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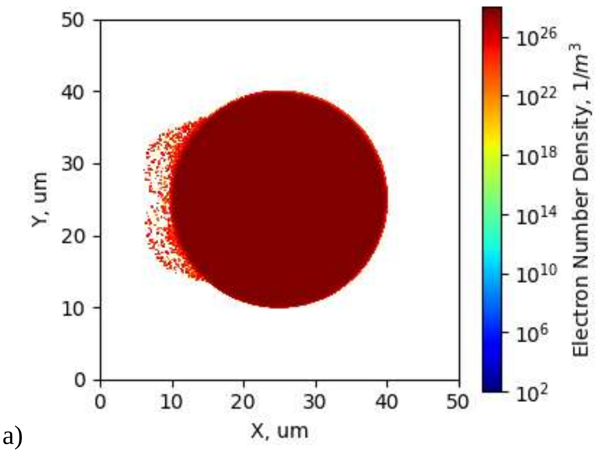
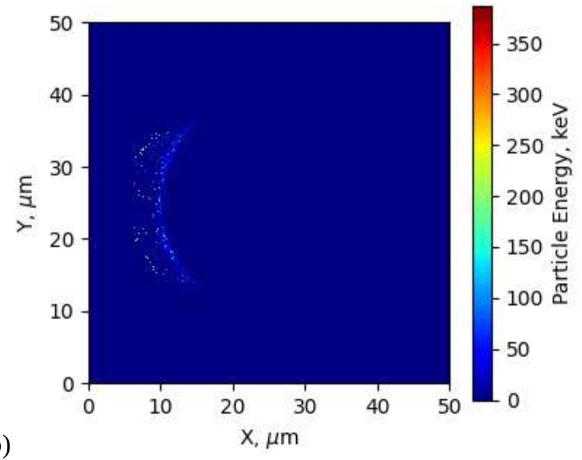


a)



b)

Figure 1. The a) number density of electrons and b) mean particle energy at t=80fs.The bunching of electrons is seen at symmetrical locations in the backward scattering direction (Y=25μm). Highest energy reached is ~380 keV