MINOR II

PYL 879: High Power Laser Matter Interaction

October 8, 2015, Time 1 hr, M. Marks 15

Attempt 4 problems.

1A) A CW laser exerts a force of $10^{16} N/m^2$ on a stationary foil. When the foil moves, the force due to the laser at certain instant is $10^{15} N/m^2$. Obtain the velocity of the foil at that instant. (2)

1B) A laser of $1 \mu m$ wavelength, and certain power and radius, propagates through a plasma without convergence or divergence. What would happen if plasma density were reduced to half? Give reason. (2)

1C) A deuterium cluster undergoes ion Coulomb explosion producing maximum ion energy of 10 KeV. If the cluster had C^{6+} ions of same ion density and same radius, how much maximum ion energy would you get? (2)

2) A thin foil of diamond like carbon (C^{6+}) of ion density n_0, ion mass m_i and thickness l undergoes radiation pressure acceleration by a Gaussian laser pulse of intensity $I_0 = I_{00}\exp(-t^2/\tau_L^2)$. Estimate the energy gained by the ions at the end of the pulse. Ignore relativistic effects. (3)

3) Two lasers propagate through a plasma with fields

$$\vec{E}_1 = \hat{y}A_1 e^{-i(\omega_1 t - k_1 z)}, \vec{E}_2 = \hat{y}A_2 e^{-i(\omega_2 t - k_2 \cos\theta z - k_2 \sin\theta x)}.$$

Obtain the sum and difference frequency ponderomotive force. Determine the phase velocity of the plasma wave excited by the lasers when $\omega_1 = 4\omega_p, \omega_2 = 3\omega_p, \theta = \pi/3$. (3)

4 A) The potential of a large amplitude plasma wave is $\phi = A\cos\psi, \psi = (\omega t - kz)$. Plot the force experienced by an electron of charge $-e$ by it as a function of z and indicate at where would you place electron to gain maximum energy and why? (1)

4 B) Deduce the $\gamma - \psi$ relation for an electron in the field of the plasma wave given above, (2)

OR

4) Deduce the optimum thickness of a foil, having carbon and hydrogen of atomic density n_0 each and irradiated by a laser of intensity I_0, for radiation pressure acceleration. What effect would you expect had the laser been having Gaussian distribution of intensity along the wavefront? (3)