

## Efficient electron energy by radial polarization of laser and obliquely incident magnetic field

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### **Abstract**

*In this investigation, we have examined laser-induced electron acceleration process during ionisation in less denser gases by a radially polarised (RP) laser with obliquely incident magnetic field ( $B_s$ ). The longitudinal field of RP laser is quite striking for the particle acceleration applications, whereas, the transverse component is not as dominating and strong. As the laser imparts its longitudinal force on electron, the gain in electron-energy enhances, then after, electron loses its energy as the deviation from resonance condition. So, to attain and maintain higher electron energy, external magnetic field is applied.*

### **Introduction:**

Laser-based processes are of high importance from last few decades [1-3]. Conventionally, huge structures are necessary to accelerate particles, but after advancement in the laser technology and the table top lasers, the research in the field of particle acceleration due to laser-electron interaction in vacuum/plasma has achieved a new level. For effective particle acceleration, many techniques have been employed with the passage of time like plasma-wakefield accelerator, laser wakefield accelerator and laser beat wave accelerator [4-6]. Due to the challenges in vacuum based electron acceleration such as existence of complex electric field distribution and the unsuitable interaction length, the electron loses its energy and net final energy is very small. The above said difficulties can be surmounted by employing RP laser beam as in this type of polarization; the electric field vector lies in the plane of cross-section; generating a more strong longitudinal electric-field than the other laser polarizations. The application of magnetic field in electron acceleration has turned out to be fascinating in laser plasma physics and continues to remain a hot topic and waiting to be explored [7-11]. Due to resonance, the electron receives an extra energy in the presence of external magnetic field applied obliquely in transverse direction to that of propagation direction and excited to higher energies of order GeV.

In the present communication, we examine the role of obliquely incident magnetic field on the electron acceleration. A noticeable rise in electron energy is observed along with laser's strong longitudinal field which accelerate the electron axially. We have numerically calculated equations of electron motion. The momentum and energy equations are as given:

$$E_{rad} = E_0 r_n \sin(\varphi) e^{(-r_n/F^2)}$$

$$E_{long} = 2E_0/f^2 K_0 r_0 \left[ \cos(\varphi) - \cos(\varphi) r_n^2 / F^2 - R^2 / r_0^2 F^2 \sin(\varphi) \right] e^{[-r_n^2/F^2]}$$

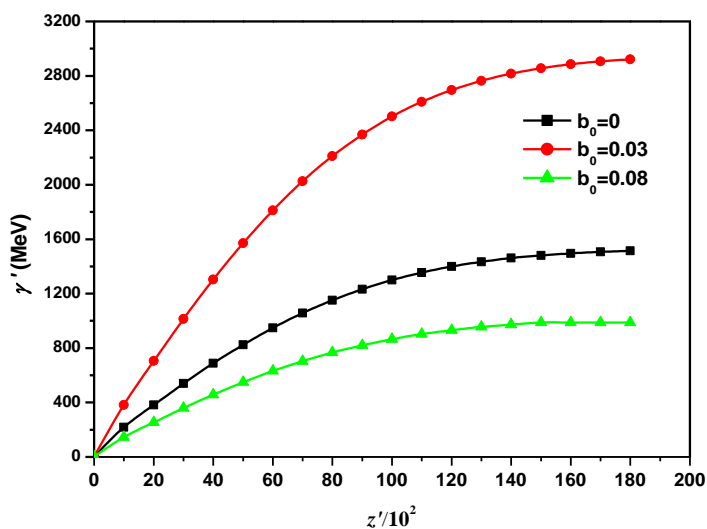
where,  $\varphi = K_0 z + z r_n r / R_d F^2 - \Omega t - 2 \tan^{-1}[z / R_d] + \varphi_0$

$F^2 = 1 + (z/R_d)^2$ ,  $r_n = r/r_0$ ,  $r_0$  is the minimum spot size,  $\Omega_0$  is laser frequency and  $F$  is beam width parameter of the laser. Externally applied obliquely incident magnetic field given by  $B_s = B_0(-\hat{r} \sin \theta + \hat{z} \cos \theta)$ . Also, the magnetic field linked with laser pulse is given as  $B_L = (k \times E) / \omega$

So from Newton-Lorentz equations, the equation for electron energy gain can be calculated as

$$2\gamma(m_0 c)^2 d\gamma/dt = 2p_r dp_r/dt + 2p_z dp_z/dt$$

We study the variation of electron energy with  $z'$  by varying magnetic field. Other parameters are  $a_0 = 10, r_0 = 200$ . A significant rise in electron energy in the presence of magnetic field than in its absence due to resonance.



**Figure:** Variation of normalized electron energy  $\gamma'$  with  $z'$  by varying magnetic field. Other parameters are  $a_0 = 10, r_0 = 200$ .

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