Magnetic Field Generation at Extreme Laser Intensities*

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Some of the most energetic astrophysical bodies are theorized to have extreme magnetic field strengths defined by a large magnetization parameter $\sigma_{cold} = B^2/\mu_0 n_e m_e c^2$. In the laboratory, the highest energy laser-driven experiment studying magnetic reconnection was able to reach the ``semi-relativistic" regime where $\sigma_{cold} \approx 1$ for electrons and $\sigma_{cold} \ll 1$ for ions [1]. This experiment was performed using a laser intensity of $\sim 10^{19}$ W/cm^2, much less than $>10^{23}$ W/cm^2 expected to be reached by the next generation of multi-petawatt power laser systems e.g. ELI, ZEUS. At these extreme intensities, quantum electrodynamic (QED) effects such as radiation reaction may become important. Using the QED module in the OSIRIS particle-in-cell code, we perform simulations to study magnetic field generation in this regime to understand how the field strength scales with laser intensity. The implications of this scaling for studying relativistic magnetic reconnection in the laboratory will be discussed.

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References

[1] A. E. Raymond *et al.*, PRE **98**, 043207 (2018).