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Twisiting high intensity lasers to produce extreme magnetic fields

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Recently, orbital angular momentum (OAM) beams have demonstrated at relativistic intensities at several high-power laser facilities around the world using off-axis spiral phase mirrors. The additional angular momentum carried by OAM beams, even when linearly polarized, introduces a new control parameter in laser plasma interactions and has shown promise to introduce new and exciting phenomena not possible with a standard Gaussian beam.
Of particular interest is the relativistic inverse Faraday effect where laser angular momentum is absorbed by a plasma generating large axial magnetic fields colinear with the laser k vector. Our recent work has demonstrated that magnetic fields on the order of 100's of Tesla, extending 100's of microns, and lasting on the order of 10 picoseconds can be generated with laser powers less than 5 terawatts. In this work we will explore this phenomenon through theory, simulations, and present results from a recent campaign at the COMET laser at Lawrence Livermore National Laboratory in which we used a linearly polarized Laguerre Gaussian laser to drive magnetic fields for the first time in the laboratory. Experimental results will be compared and validated against theory and simulations.

Keyword-1

Orbital Angular Momentum Laser

Keyword-2

Kilo Tesla Magnetic Fields

Keyword-3

Inverse Faraday Effect

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