Effects of Kilotesla-Level Applied Magnetic Fields on Relativistic Laser-Plasma Interaction

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Ongoing advances in experimental techniques for generating magnetic fields will enable access to previously unexplored regimes in magnetized high-energy-density physics. Strong static magnetic fields, for instance, fundamentally alter the interaction of a relativistically intense laser with a plasma. In this talk, I will present particle-in-cell simulations of a number of common laser-plasma configurations in which diverse and potentially beneficial changes to the plasma dynamics become evident at or below the kilotesla level. In this near-term experimentally realizable regime, the magnetic field acts primarily through the magnetization of hot electrons, which impacts processes such as ion acceleration, direct laser acceleration, and magnetic-field amplification. These findings suggest that applied magnetic fields could improve applications of relativistic laser–plasma interactions, delivering, for example, focusing, high-energy ion beams for isochoric heating, dramatic electron heating for x-ray generation, and astrophysically relevant, megatesla-level magnetic fields. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0003856, the DOE Office of Science under Grant No. DESC0018312, and the DOE Computational Science Graduate Fellowship under Grant No. DE-FG02-97ER25308. Particle-in-cell simulations were performed using EPOCH, developed under UK EPSRC Grant Nos. EP/G054940, EP/G055165, and EP/G056803. This work used HPC resources of the Texas Advanced Computing Center (TACC) at the University of Texas at Austin, the Extreme Science and Engineering Discovery Environment (XSEDE), which is supported by National Science Foundation grant number ACI-1548562, and the National Energy Research Scientific Computing Center (NERSC), a U.S. Department of Energy Office of Science User Facility operated under Contract No. DE-AC02-05CH11231.