Magnetic reconnection as a fundamental plasma process in which the opposite directed magnetic-field lines passing plasma undergoes dramatic rearrangement, often happens in the solar plasmas, magnetosphere et al. Laser driven high beta (>4) magnetic reconnection (LDMR) is constructed with self-generated magnetic fields has been experimentally and theoretically studied extensively, where very strong Mega-Gausses magnetic fields are spontaneously generated in high-power laser-plasma interactions, which located on the target surface and produced by Biermann battery effect due to non-parallel temperature and density gradients in expanding plasmas. A well-scaled laboratory reconnection experiment has reproduced the physics of solar flares in a controlled setting, despite orders of magnitude differences in spatial and temporal scales. Relativistic electrons of energy up to MeV with a power law distribution are detected roughly in the direction along the magnetic separatrices that bound the reconnection outflow. We also notice that the electrons that are accelerated in the electromagnetic (EM) field with a guide field could get more energy than those accelerated in an environment without guide field. The numerical experiments performed in the same EM configurations reproduce these results. The experimental results are in line with simulations, and confirm that the energetic electrons are produced in the reconnecting region where the temperature are high and the accelerating process is impulsive.

Magnetic reconnection can be triggered in either high or low beta plasmas, especially in solar atmosphere plasmas, where the resulting $\beta$ variation with height. We demonstrate a novel plasma device for magnetic reconnection, driven by Gekko XII lasers irradiating a double-turn Helmholtz capacitor-coil target. Optical probing revealed an accumulated plasma plume near the magnetic reconnection outflow. The background electron density and magnetic field were measured to be approximately $10^{18}$ cm$^{-3}$ and 60 T by using Nomarski interferometry and the Faraday effect, respectively. In contrast with experiments on magnetic reconnection constructed by the Biermann battery effect, which produced high beta values, our beta value was much lower than one, which greatly extends the parameter regime of laser-driven magnetic reconnection and reveals its potential in astrophysical plasma applications.

References
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