Study of driven magnetic reconnection in high-power laser-produced plasma

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Magnetic reconnection in collisionless plasma is considered to play a key role in global change of magnetic field topology and rapid energy conversion from magnetic fields to plasmas[1]. The reconnection physics could be regarded as a combination of microscopic plasma dissipation at the reconnection region and macroscopic advection of surrounding magnetized plasmas. Previous numerical studies (kinetic or fluid simulations) and observations (magnetosphere or solar corona) have approached these two mechanisms rather separately. Laser experiment with various optical measurements provides a new approach to explore such multi-hierarchy plasma physics. Recently, a laser experiment for magnetic reconnection have suggested that the reconnection rate can be very large ~100% of the Alfvénic rate with high compression by supersonic inflows[2].

We have performed experimental demonstration of magnetic reconnection with Gekko-XII laser. In the present experiment, we investigate the reconnection process dynamically coupled with the relaxation of global magnetic field configurations. Global plasma structure is measured and combined with local measurements of plasma conditions. A quasi-stable anti-parallel magnetic field of ~0.1 T was generated by pulse-powered circuit. Two-dimensional self-emission measurement shows laser-ablation plasma structures as inflows for typical reconnection setting, and Thomson scattering measurement shows the plasma temperature, density and flow velocity in the outflow region. We performed some laser shots with anti-parallel and parallel magnetic field structures and without the magnetic field.

[1] E. G. Zweibel et al, *Annual Review of Astronomy and Astrophysics* **47**, 291 (2009).
[2] G. Fiksel et al, *Physical Review Letters* **113**, 105003 (2014).