Turbulence magnetic reconnection experiments driven by intense lasers

Yongli Ping[1,2], Jiayong Zhong[1,2]
[1]*Department of Astronomy, Beijing Normal University, China,* [2]*Institute for Frontiers in Astronomy and Astrophysics, Beijing Normal University, China*

Turbulent magnetic reconnection is believed to occur in astrophysical plasmas, and it has been suggested to be a trigger of solar flares. It often occurs in long stretched and fragmented current sheets. Recent observations agree with signatures expected from turbulent reconnection. However, the underlying mechanisms remain unclear, including how magnetic energy stored in the Sun's magnetic field is dissipated. We demonstrate turbulent magnetic reconnection in laser-generated plasmas created when irradiating solid targets. Turbulence is generated by strongly driven magnetic reconnection, which fragments the current sheet, and we also observe the formation of multiple magnetic islands and flux tubes. Our findings reproduce key features of solar flare observations. Supported by kinetic simulations, we reveal the mechanism underlying the electron acceleration in turbulent magnetic reconnection dominated by the parallel electric field. In contrast, the betatron mechanism is cooling, and Fermi acceleration is negligible. As the conditions in our laboratory experiments are scalable to those of astrophysical plasmas, our results apply to the study of solar flares.