Relativistic magnetic reconnection driven by a laser interacting with a micro-scale plasma slab

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Magnetic reconnection is a fundamental plasma process associated with conversion of embedded magnetic field energy into kinetic and thermal plasma energy, via bulk acceleration and Ohmic dissipation. In many high-energy astrophysical events, magnetic reconnection operating in the relativistic regime, i.e. with magnetic energy per particle exceeds the rest mass energy, is usually invoked to explain the non-thermal signatures. However, due to the difficulty in making direct measurements in remote high-energy astrophysical systems and/or achieving the extreme energy density conditions that are necessary to observe relativistic reconnection in laboratory environments, the process by which field energy is transferred to the plasma to power the observed emission are still not properly understood. In this work[1], we propose a novel scenario where the relativistic reconnection is accessed via the interaction of a readily available (TW-mJ-class) laser with micro-scale plasma slab. By means of fully-kinetic 3D particle-in-cell simulations, we show that when the electron beams excited on both sides of the slab approaches the end of the plasma structure, ultra-fast relativistic reconnection occurs in a magnetically-dominated (low-β) plasma. As the field topology changes, the explosive release of magnetic energy results in the emission of relativistic electron jets with cut-off energy ~ 12 MeV. In the meantime, various signatures of magnetic reconnection are observed, including a hard power-law electron energy distribution (with index p ~ 1.8), out-of-plane quadrupole fields pattern, and quantified agyrotropy peaks in the reconnection site. The proposed scenario can be straightforwardly implemented in experiments, and the significant field dissipation process (0.1-TW-class) makes it a promising platform to study the non-thermal signatures and energy conversion in the relativistic regime of reconnection.

[1] L. Q. Yi, B. F. Shen, A. Pukhov, and T. Fülöp, *Relativistic magnetic reconnection driven by a laser interacting with a micro-scale plasma slab*, under consideration in Nat. Commun. (2017) https://arxiv.org/abs/1708.07676