QED-PIC relativistic magnetic reconnection with radiation and pair production

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Magnetic reconnection is a fundamental plasma process involving a rapid change of magnetic topology and often leading to a violent release of magnetic energy. Most of the reconnection research has so far been driven to understand magnetic dissipation in space, solar, and laboratory plasmas. These environments are rather tenuous and hence are adequately described by traditional, low-energy-density plasma physics. However, magnetic reconnection is now also being increasingly recognized as an important physical process in numerous astrophysical contexts beyond the solar system, especially in high-energy astrophysics (pulsar magnetospheres, black-hole coronae and jets, magnetar flares) [1]. We will discuss some astrophysical examples of high-energy-density reconnection and identify the key physical processes that distinguish them from traditional reconnection. Among the most important processes are: special-relativistic effects, radiative effects and at the most extreme, QED effects, including pair creation.

Due to the complexity of the system, we rely on QED-PIC OSIRIS in order to model from first-principles magnetic reconnection in these environments where the magnetic field approaches the critical quantum field. The QED module, that has been used to model QED cascades [2], includes photon emission by electrons and positrons and single photon decay into pairs (Breit-Wheeler). We aim to address through this numerical study various fundamental questions such as (i) how effective is reconnection in the presence of pair creation in an ultra-intense magnetic field? (ii) what are the effects of radiative losses and pair creation on reconnection rate, on particle acceleration and on the observational appearance of the reconnection layer?

References
