Kinetic Ohm’s law in relativistic magnetic reconnection

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Magnetic reconnection draws recent attention in relativistic astrophysics, in particular after the discovery of Crab gamma-ray flares. Owning to this, kinetic modeling of relativistic reconnection has now become an active topic of research. From the physics viewpoint, relativistic reconnection is an ideal material to test the traditional theories.

In nonrelativistic kinetic reconnection, it is widely accepted that the reconnection electric field at the X-line is balanced by the divergence of the pressure tensor in the electron Ohm’s law. This term, the local diffusion of the electron momentum, is sometimes referred to as the thermal inertial effects. This pressure-tensor paradigm was recently questioned by a numerical work on asymmetric reconnection, which reported that the bulk inertial term is a major player at the X-line.

In this contribution, we examine a relativistic Ohm’s law in kinetic magnetic reconnection. With some help from radiation physics, we decompose the relativistic stress-energy tensor to derive the kinetic Ohm’s law. Then we evaluate the the composition of the Ohm’s law in particle-in-cell (PIC) simulation. It was found that a new inertial term plays a role at the X-line in the relativistic regime. We discuss our physical interpretation, by using these results.