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PIC Simulations of Particle Acceleration in Magnetized Relativistic Shocks

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Relativistic magnetized shocks are ubiquitous in the universe. High energy astrophysical objects such as active galactic nuclei, gamma ray burst, and pulsar wind nebula are usually associated with the shocks as a consequence of the interaction between relativistic plasma outflow and interstellar medium. The nonthermal emission from these objects are generally modeled as synchrotron radiation and inverse Compton scattering of relativistic electrons, which are believed to be generated in relativistic magnetized shocks. Relativistic magnetized shocks are assumed to be an efficient particle accelerator and are often invoked for the source of ultra-high-energy cosmic rays. However, the detailed acceleration mechanism is far from understood.
Particle-in-cell (PIC) method is a first-principles model of collisionless plasmas and a central tool to simulate relativistic maetized shocks. Numerous PIC simulations of relativistic magnetized shocks are so far conducted to explore particle acceleration. They demonstrate that many kinetic plasma instabilities such as Weibel instability, synchrotron maser instability, and parametric decay instability can develop depending on physical parameters and these instabilities plays a significant role for particle acceleration. In this talk, we will review the recent progress in PIC simulations of magnetized relativistic shocks and discuss our new particle acceleration mechanism.

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