

Electron acceleration at supernova remnants

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Supernova remnants (SNRs) are believed to produce the most part of the galactic cosmic rays (CRs). SNRs harbor non-relativistic collisionless shocks responsible for acceleration of CRs via diffusive shock acceleration (DSA), in which particles gain their energies in repetitive interactions with the shock front. As the DSA theory involves pre-existing mildly energetic particles, a means of pre-acceleration is required, especially for electrons. Electron injection remains one of the most troublesome and still unresolved issues and our physical understanding of it is essential to fully comprehend the physics of SNRs. To study any electron-scale phenomena responsible for pre-acceleration, we require a method capable of resolving these small kinetic scales and Particle-in-cell (PIC) simulations fulfill this criterion. Here I report about the latest achievements on kinetic simulations of non-relativistic high Mach number shocks. I discuss how the physics of SNR shocks depends on the shock parameters (e.g., the shock obliquity, Mach numbers, the ion-to-electron mass ratio), which processes are responsible for the electron pre-acceleration and how these shocks can be studied using in-situ satellite measurements. Finally, I outline future perspectives of the electron injection problem and other complementary ways to solve it.

Author: BOHDAN, Artem (Deutsches Elektronen-Synchrotron DESY)

Presenter: BOHDAN, Artem (Deutsches Elektronen-Synchrotron DESY)

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