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Spatial Evolution of Nonresonant Instabilities in the Precursors of Young Supernova Remnant Shocks

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The nonresonant cosmic-ray-current-driven instability that operates in the precursors of shocks in young supernova remnants may be responsible for magnetic-field amplification, quasithermal plasma heating, and hydrodynamical turbulence, all of which have impact on the shock properties and particle-acceleration processes. The temporal and spatial development of the instability is investigated here with Particle-In-Cell (PIC) simulations. Earlier PIC simulations used computational boxes with periodic boundary conditions which do not account for mass conservation in decelerating flows. Our current study for the first time uses a more realistic setup with open boundaries that permit inflow of plasma on one side of the simulation box and outflow at the other end. We demonstrate magnetic-field amplification as expected on the grounds of our earlier results. The effects of backreaction on CRs that slow down the initial relative drift velocity, limit further growth of the turbulence and lead to its saturation are also re-confirmed. We discuss a spatio-temporal structure of the shock precursor, including the evolution of CR distribution and the details of the saturation processes.

Collaboration

– not specified –

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Author: Prof. NIEMIEC, Jacek (Institute of Nuclear Physics PAN, Krakow, Poland)

Co-author: Prof. POHL, Martin (DESY)

Presenter: Prof. NIEMIEC, Jacek (Institute of Nuclear Physics PAN, Krakow, Poland)

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