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Particle acceleration by sound waves generated in the shock downstream region

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Diffusive shock acceleration (DSA) in supernova remnants is widely accepted as a plausible mechanism to produce galactic cosmic rays. However, several problems are pointed out to this picture and some modifications are needed to understand cosmic ray acceleration in SNRs. In our previous work (Yokoyama & Ohira, 2020), we considered a shock wave propagating to an inhomogeneous medium, although the conventional DSA assumed the shock upstream medium to be uniform. It was revealed that sound waves generated by the interaction between the inhomogeneous upstream medium and the shock wave can accelerate particles even in the shock downstream region and modify the energy spectrum of cosmic rays.
However, because our simulations used linear solutions for the description of background plasma, nonlinear behaviors of sound waves are not included. In this talk, we introduce our recent simulations which solve particle diffusion and fluid equations simultaneously. The results show that weak shock waves formed by steepening of downstream sound waves can rapidly accelerate particles before they dissipate. We will discuss the spectral modification and the difference with the results of our previous simulations.

Keywords

Particle acceleration; shocks; supernova remnants

Collaboration

other Collaboration

Subcategory

Theoretical Results

Primary authors: YOKOYAMA, Shota (The University of Tokyo); Dr OHIRA, Yutaka (The University of Tokyo)

Presenter: YOKOYAMA, Shota (The University of Tokyo)

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