Non-linear diffusion of cosmic rays escaping from supernova remnants

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Abstract

The escape mechanism of cosmic rays (CR) from supernova remnants and their propagation around their sources remain an open issue. In fact the problem is highly nonlinear, since CRs excite the magnetic turbulence that confines them close to their sources. We study CR propagation accounting for amplification of magnetic turbulence via streaming instability. Since the environment determines the relevant mechanisms for wave damping, different results are found in different phases of the interstellar medium. In the warm phases, ion-neutral friction causes a severe wave damping, while in the hot phase the nonlinear Landau and turbulent dampings are the most effective. It is found that streaming instability affects the propagation of CRs in all phases. In the warm phases, the diffusion coefficient can be suppressed by more than a factor of 2 up to few tens of pc around the remnant. The propagation of _˜ 10 GeV particles is affected for several tens of kiloyears after escape, while _˜ 1 TeV particles are affected for few kiloyears. Those values are generally 2-3 times larger in the hot phase. All this might have a great impact on the interpretation of gamma-ray observations of molecular clouds near supernova remnants.

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