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Self-confinement of low-energy cosmic rays around supernova remnants

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Supernova Remnants have long been considered as promising candidate sources for cosmic rays. However, modelling the transport around these sources is difficult due to its nonlinear nature. The strong overdensity in the near source region leads to the production of plasma turbulence, upon which the particles scatter. To calculate this mechanism, called self-confinement, requires the numerical solution of two coupled differential equations describing the transport of particles and waves, most often done in the flux tube approximation. Here, this formalism is extended to energies below 10 GeV, where energy losses become relevant. Particles around 100 MeV are found to be confined for in between 300 kyr and 1 Myr, depending on the interstellar medium. The diffusion coefficient is initially suppressed by up to two orders of magnitude. Interestingly, the spectrum outside the supernova flattens below 1 GeV at later times, similar to the spectral behavior observed by Voyager. Furthermore, the grammage accumulated in the near source region is found to be non-negligible, which could be important for precision fitting cosmic ray spectra.

Summary

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