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The inefficiency of the first-order Fermi process in UHECR production at relativistic shocks

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Abstract content

The question of the origin of ultra-high-energy cosmic rays at relativistic shock waves is discussed in the light of results of recent Monte Carlo studies of the first-order Fermi particle acceleration (Niemiec & Ostrowski 2006; Niemiec, Ostrowski & Pohl 2006). The models of the turbulent magnetic field near the shock considered in these simulations include realistic features of the perturbed magnetic field structures at the shock, which allow us to study all the field and particle motion characteristics that are important for cosmic-ray acceleration. Our results show that turbulent conditions near the shock, that are consistent with the shock jump conditions, lead to substantial modifications of the acceleration process with respect to the simplified models, that produce wide-range power-law energy distributions, often with the “universal” spectral index. Relativistic shocks are essentially always superluminal, and thus they preferentially generate steep particle spectra with cutoffs well below the maximum scattering energy, often not exceeding the energy of the compressed background plasma ions. Thus, cosmic-ray acceleration to very high energies at relativistic shock waves is inefficient, and such shocks are not expected to be the sources of ultra-high-energy particles.

If this papers is presented for a collaboration, please specify the collaboration

Summary

Reference

Proceedings of the 30th International Cosmic Ray Conference; Rogelio Caballero, Juan Carlos D’Olivo, Gustavo Medina-Tanco, Lukas Nellen, Federico A. Sánchez, José F. Valdés-Galicia (eds.); Universidad Nacional Autónoma de México, Mexico City, Mexico, 2008; Vol. 2 (OG part 1), pages 283-286

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