Contribution ID : **1047** Type : **Oral**

Magnetic turbulence production by streaming cosmic rays upstream of SNR shocks

Thursday, 5 July 2007 13:05 (0:12)

Abstract content

We present preliminary results of Particle-In-Cell simulations of magnetic turbulence production by isotropic cosmic ray nucleons streaming upstream of supernova remnant shocks. The studies aim at testing the MHD predictions by Bell (2004, 2005) of a strong amplification of short-wavelength nonresonant wave modes and at studying the the subsequent evolution of the magnetic turbulence and its backreaction on cosmic ray trajectories. The detailed knowledge of the upstream turbulence properties is crucial to ascertain all aspects of the shock acceleration process - the transport properties of cosmic rays, the shock structure, thermal particle injection and heating processes. An amplification of magnetic field would also facilitate the acceleration of particles beyond the "knee" in the cosmic-ray spectrum. Our kinetic approach is particularly suited to address the backreaction on the cosmic rays, and it allows us to test Bell's prediction of the eventual formation of extended filamentary structure in the cosmic-ray distribution and also to arrive at a reliable estimate of the total saturation magnetic-field level. The parameters chosen for the simulations are favorable for the rapid excitation of purely growing modes. However, no significant magnetic turbulence build-up is observed. This suggests that the growth of the turbulent magnetic field is slower than estimated using the MHD approach. We compare these results with a model in which a beam of cosmic-ray nuleons is streaming in the upstream plasma, in which case we observe the production of strong magnetic turbulence in the plane perpendicular to the streaming direction. Quantitative differences between both scenarios are discussed.

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 279-282

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Session Classification : OG 1.4

Track Classification : OG.1.4