X-ray Polarization Probes of Turbulence and Cosmic Ray Diffusion in Supernova Remnants

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Abstract

The ability of shocks in the outer shells of supernova remnants to accelerate cosmic rays up to the knee above 1 PeV is strongly dependent on the nature of the turbulence in the shock environs. The paradigm of field enhancement through current-driven instabilities has promoted high levels of turbulence, seeding diffusion near the Bohm limit. Radio observations corresponding to GeV electrons suggest lower levels of turbulence. With the prospect of spatially-resolved X-ray polarimetry for supernova remnants (SNRs) on the horizon, ushered in by IXPE, eXTP and XIPE, probes of turbulence using synchrotron signals from 10-100 TeV electrons will soon be possible. This paper explores this possibility, presenting models of X-ray polarization signatures from prescribed turbulence in SNR shocks, and how these couple to MHD turbulence variances. The coupling between polarization and diffusion characteristics is then inferred, providing input for determinations of acceleration times for cosmic ray electrons and ions of similarly rigidities.

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