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Anisotropic Cosmic Ray Diffusion and its Implications for Gamma-Ray Astronomy

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Analyses of TeV-PeV cosmic ray (CR) diffusion around their sources usually assume either isotropic diffusion, or anisotropic diffusion due to the regular Galactic magnetic field in the spiral arms of our Galaxy. We show that none of these descriptions is adequate on distances smaller than a few coherence lengths (~ 10 pc) of the turbulent interstellar magnetic field.

As a result, we predict anisotropic gamma-ray emissions around CR proton and electron sources (even for uniform densities of target gas). The centers of extended emission regions may have non-negligible offsets from their sources, leading to risks of misidentifications. Gamma-rays from CR filaments have steeper energy spectra than those from surrounding regions.

We show that gamma-ray telescopes can notably be used in the future as a new way to probe the still poorly known interstellar magnetic fields.

Finally, we discuss the impact of CR-driven instabilities on the above results, and on the magnetic fields around CR sources.

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