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Reverse Direct Detection: Cosmic Ray Tests of Light Dark Matter Elastic Scattering

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Many dark matter studies have considered indirect detection ($\chi\chi \rightarrow f\bar{f}$), direct detection ($\chi f \rightarrow \chi f$), and collider searches ($f\bar{f} \rightarrow \chi\chi$). We propose a new strategy in searching for dark matter elastic cross section by considering cosmic-ray propagation in the galactic dark matter halo. We find that cosmic rays can lose significant fraction of their energy through scattering with dark matter ($f\chi \rightarrow f\chi$). Using existing cosmic-ray data and a simple cosmic-ray propagation model, we study the qualitative effects of dark matter scattering on cosmic-ray propagation and obtain new constraints of dark matter elastic cross sections on light dark matter (keV–GeV), a regime that is difficult for traditional direct detection experiments to probe.

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