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Celestial-Body Focused Dark Matter Annihilation Throughout the Galaxy

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Indirect detection experiments typically measure the flux of annihilating dark matter (DM) particles propagating freely through galactic halos. We consider a new scenario where celestial bodies “focus” DM annihilation events, increasing the efficiency of halo annihilation. In this setup, DM is first captured by celestial bodies, such as neutron stars or brown dwarfs, and then annihilates within them. If DM annihilates to sufficiently long-lived particles, they can escape and subsequently decay into detectable radiation. This produces a distinctive annihilation morphology, which scales as the product of the DM and celestial body densities, rather than as DM density squared. We show that this signal can dominate over the halo annihilation rate in γ-ray observations in both the Milky Way Galactic center and globular clusters. We use \textit{Fermi} and H.E.S.S. data to constrain the DM-nucleon scattering cross section, setting powerful new limits down to ~10ˆ{−39} cm2 for sub-GeV DM using brown dwarfs, which is up to nine orders of magnitude stronger than existing limits. We demonstrate that neutron stars can set limits for TeV-scale DM down to about 10ˆ{−47} cm2

Summary

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