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Velocity-dependent J-factors in FIRE simulations of Milky-Way size galaxies for indirect detection experiments

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I present dark matter indirect detection predictions (J-factors) for the Galactic-center using 12 highly-resolved, hydrodynamic FIRE-2 zoom cosmological simulations of Milky Way size galaxies. In addition to velocity-independent (s-wave) annihilation cross-sections ⟨σv⟩, we also calculate effective J-factors for velocity-dependent models, where the annihilation cross-section is either p-wave ($\propto v^2/c^2$) or d-wave ($\propto v^4/c^4$). Compared to dark-matter-only (DMO) counterparts, the FIRE runs produce central dark matter velocity dispersions that are systematically larger than in DMO runs by factors of ˜2.5-4. They also have a larger range of central (˜400 pc) dark matter densities than the DMO runs ($\rho_{\rm FIRE}/\rho_{\rm DMO}$ ⊠ 0.5-3). At 3 deg from the Galactic Center, FIRE J-factors are 3-60 (p-wave) and 10-500 (d-wave) times higher than in the DMO runs. The change in s-wave signal at 3 deg is more modest and can be higher or lower (˜0.3-7), though the shape of the emission profile is flatter (less peaked towards the Galactic Centre) and more circular on the sky in FIRE runs. Given that p-wave J-factors that are significantly enhanced compared to most past estimates, contrary to previous expectations, such models may be in the range of detection in the not too distant future.

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