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A Solar System Test of Self-Interacting Dark Matter

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Dark matter (DM) self-interactions affect the gravitational capture of DM in the Sun and Earth differently as a simple consequence of the differing kinematics of collisions within the two potential wells: the dominant effect of self-interactions in the Sun is to provide an additional channel for capture, while the dominant effect in the Earth is to eject previously captured DM. I will discuss how this simple observation can be used to deduce the existence of DM self-interactions by comparing the annihilation rates of DM gravitationally bound within the Sun and Earth. I will present the computation of the Sun and Earth annihilation fluxes for DM with spin-independent nuclear cross-sections and thermal annihilation cross-sections and demonstrate that, for cross-sections allowed by direct detection, self-interactions can easily suppress the expected Earth flux by multiple orders of magnitude. This suppression is potentially significant even for self-interaction cross-sections orders of magnitude below the Bullet Cluster bounds, making this solar system comparison a leading test of dark matter self-interactions.

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