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Complementary Test of the Dark Matter Self-Interaction by Direct and Indirect Detections

The halo dark matter (DM) can be gravitationally captured by the Sun. For self-interacting DM (SIDM), we show that the number of DM trapped inside the Sun remains unsuppressed even if the DM-nucleon cross section is negligible. We consider a SIDM model where $U(1)$ gauge symmetry is introduced to account for the DM self-interaction. Such a model naturally leads to isospin violation for DM-nucleon interaction, although isospin symmetry is still allowed as a special case.We show that the indirect detection of DM-induced neutrinos from the Sun can probe those SIDM parameter ranges not reachable by direct detections. Those parameter ranges are either the region with a very small m_χ or the region opened up due to isospin violations.

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