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A halo-independent lower bound on the dark matter capture rate in the Sun from a direct detection signal

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We show that a positive signal in a dark matter (DM) direct detection experiment can be used to place a lower bound on the DM capture rate in the Sun, independent of the DM halo. For a given particle physics model and DM mass we obtain a lower bound on the capture rate independent of the local DM density, velocity distribution, galactic escape velocity, as well as the scattering cross section. We illustrate this lower bound on the capture rate by assuming that upcoming direct detection experiments will soon obtain a significant signal. When comparing the lower bound on the capture rate with limits on the high-energy neutrino flux from the Sun from neutrino telescopes, we can place upper limits on the branching fraction of DM annihilation channels leading to neutrinos. With current data from IceCube and Super-Kamiokande non-trivial limits can be obtained for spin-dependent interactions and direct annihilations into neutrinos. In some cases also annihilations into $\tau\tau$ or $b\bar{b}$ start getting constrained. For spin-independent interactions current constraints are weak, but they may become interesting for data from future neutrino telescopes.

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