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Halo-independent bounds on the WIMP-nucleon couplings of long-range interactions from direct detection and neutrino observations

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I discuss the bounds on WIMP-proton and WIMP-neutron couplings of spin-independent and spin-dependent long-range interactions via massless mediator. I update the bounds in the Standard Halo Model for direct detection and the neutrino signal from WIMP annihilation in the Sun, and set halo-independent bounds using the single-stream method.

In the case of a massless mediator the capture rate in the Sun diverges and is regularized by removing the contribution of WIMPs locked into orbits that extend beyond the Sun-Jupiter distance. I discuss the dependence of the SHM bounds on the Jupiter cut showing that it can be sizable for a WIMP-proton coupling of a spin-dependent long-range interaction and a WIMP mass exceeding 1 TeV.

I show that the halo-independent analysis shows that mostly the relaxation of the bounds compared to the SHM is of the same order of that for contact interactions, relatively moderate in the low and high WIMP mass regimes and large for intermediate WIMP mass range. However, in the case of a WIMP-proton coupling of a spin-dependent long-range interaction, the relaxation of the bounds becomes not reliable at large WIMP mass range due to the sensitivity of the SHM capture rate in the Sun to low incoming WIMP speeds. In contrast, the halo–independent bounds are robust against the details of the velocity distribution including the Jupiter cut and the local escape speed.

Collaboration(s)

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