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Dark matter self-interactions from a general spin-0 mediator

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Dark matter particles interacting via the exchange of very light spin-0 mediators can have large self-interaction rates and obtain their relic abundance from thermal freeze-out. At the same time, these models face strong bounds from direct and indirect probes of dark matter as well as a number of constraints on the properties of the mediator. We investigate whether these constraints can be consistent with having observable effects from dark matter self-interactions in astrophysical systems. For the case of a mediator with purely scalar couplings we point out the highly relevant impact of low-threshold direct detection experiments like CRESST-II, which essentially rule out the simplest realization of this model. These constraints can be significantly relaxed if the mediator has CP-violating couplings, but then the model faces strong constraints from CMB measurements, which can only be avoided in special regions of parameter space.

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