

# General Pseudo Scalar Dark Matter and Direct Detection

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In the WIMP framework, the Higgs portal has a relatively small Higgs–nucleon interaction compared to other mechanisms, and, since the mediator is the Higgs boson, it is subject to fewer theoretical constraints. However, recent improvements in the precision of direct detection experiments have placed increasing pressure on Higgs-portal dark matter models. In simple models, the preferred DM mass is typically pushed into the TeV range. O. Lebedev et al. propose a simple Higgs-portal model with softly broken symmetry ( $S^2+h.c.$ ) in which the direct-detection amplitude is automatically canceled. This mechanism demonstrates that an electroweak-scale WIMP can satisfy all constraints without fine-tuning. However, in Cartesian coordinates, the cancellation mechanism is not apparent. We therefore formulate the theory in polar coordinates to make the mechanism explicit. Extending their setup, we consider a more general breaking term of the form ( $S^n+h.c.$ ) and investigate the cancellation condition in this broader context.

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