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Impact of nuclear structure on nuclear responses to WIMP elastic scattering

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Experimentalists strive to better analyse signals of dark matter direct detection at detectors. Thus, improved theoretical models are being developed to describe WIMP-nucleus elastic scattering. Notably, the work of Fitzpatrick et al [1,2] utilises an extended list of non-relativistic effective field theory (EFT) nuclear operators. We build on this work by investigating the sensitivity of said nuclear responses to nuclear structure, using nuclear shell model interactions which differ from those used in [1,2] and comparing both sets of results.

To facilitate this comparison, we perform state-of-the-art nuclear shell model calculations for isotopes relevant to direct detection experiments: ^{19}F, ^{23}Na, $^{28,29,30}Si$, ^{40}Ar, ^{127}I, $^{70,72,73,74,76}Ge$ and $^{128,129,130,131,132,134,136}Xe$. Our integrated nuclear response values sometimes exhibit large (up to orders-of-magnitude) factor differences compared to those in [1,2] for certain WIMP-nucleus interaction channels and their associated isotopes. We highlight the potential uncertainties that may arise from the nuclear components of WIMP-nucleus scattering amplitudes due to nuclear structure theory and modeling. This enables us to deduce the effect of these uncertainties on the scattering cross-section.

[1] A. Liam Fitzpatrick et al. "The effective field theory of dark matter direct detection". In: Journal of Cosmology and Astroparticle Physics (2013). issn: 14757516. doi: 10.1088/1475-7516/2013/02/004.
[2] Nikhil Anand, A. Liam Fitzpatrick, and W. C. Haxton. "Model-independent WIMP Scattering Responses and Event Rates: A Mathematica Package for Experimental Analysis". In: (2013). doi: 10.1103/PhysRevC.89.065501. url: http://arxiv.org/abs/1308.6288

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