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Prospects for the detection of Dark Matter with Long-lived Mediators in the Sun using the Southern Wide-field Gamma-ray Observatory

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The search for dark matter is advancing into a new era with the development of next-generation gamma-ray observatories, which will significantly enhance detection capabilities. These instruments will extend the limits of detection, offering new opportunities to investigate one of the most elusive components of the universe. Among them, the Southern Wide-field Gamma-ray Observatory, SWGO, stands out for its potential to detect gamma-ray signals originating from dark matter particles trapped within the Sun. This work focuses on hidden sector models, particularly secluded scenarios, where dark matter particles annihilate into long-lived mediators. Unlike standard annihilation channels occurring deep within the Sun's core, in these scenarios, dark matter annihilates into these mediators that escape the dense solar environment before decaying into detectable gamma rays. The detection of these decay products by SWGO could provide valuable insights into dark matter interactions. Our analysis indicates that SWGO will reach a high level of sensitivity, probing spin-dependent cross-sections as low as 10^{-46} cm^2 for dark matter masses below 5 TeV. This represents a substantial improvement over current detection capabilities, improving current indirect detection constraints by over an order of magnitude. Such advancements will not only strengthen the search for dark matter but also contribute to a deeper understanding of its fundamental properties.

Collaboration(s)

Southern Wide-field Gamma-ray Observatory (SWGO)

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