Optimising the SWGO Array Configuration for Dark Matter Searches

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1 Introduction

Because of many new evidences for dark matter (DM), coming from gravitational and cosmological observations the search for DM has increased exponentially in different areas of physics, one of them being astroparticle physics. We try to indirectly detect it with the help of gamma-ray experiments. One of the leading future experiments will be the Southern Wide-field Gamma-ray Observatory (SWGO).

2 Indirect DM searches

For the indirect detection of DM the objective is to constraint some specific parameters, most of the time these parameters are the cross section and mass of the DM particle. To do this, the target of observation needs to be established first. It is required to be a region with sufficient DM density, such as the galactic centre, dwarf galaxies or galaxy clusters. With the target selected we look for a gamma-ray signal coming from a DM interaction and try to determine the signal statistical significance over the background. For present experiments this leads to cross section constraints while for future experiments, like SWGO, this will lead to sensitivity predictions for DM detection.

3 SWGO

SWGO is a future particle detector array that uses WCD and will be built in South America [1]. SWGO will scrutinize nearby extended sources of dark matter for evidence of gamma rays produced in annihilation or decay processes. Weakly interacting massive particles (WIMPs) that were once in thermal equilibrium in the early universe remain one of the most promising and explored explanations for dark matter. Thermal WIMPs with masses between 2 TeV and 100 TeV are largely still viable [2], and only astrophysical experiments similar to SWGO can probe heavy DM (>1 TeV) indirectly. SWGO, along with current and future gamma-ray experiments, will be able to probe nearly the full thermal WIMP mass range by extending the sensitivity up to 100 TeV. Also, both SWGO and CTA will be sensitive to thermal WIMPs for masses from about 1 to 10 TeV. If there is a gamma-ray signal in that mass range, both experiments should see it, leading to independent confirmation of the signal. In the case of total exclusion of WIMP dark matter, SWGO can still prove itself to be extremely competent in investigating different particle models that may still not be probed by current generation detectors.

4 Methodology and prospects

Given that the SWGO experiment is still in its early design stages, this study will aim to evaluate the performance of candidate array configurations w.r.t. their capabilities of constraining common DM models. The plan for this proposal is to develop the reconstruction and instrument response functions for different detector configurations and to calculate DM constraints from the resulting configuration dependent sensitivity.

[1] `https://arxiv.org/pdf/1907.07737.pdf`
[2] `https://arxiv.org/pdf/1906.03353`