Snowmass2021 - Letter of Interest

Phystat-DM - Statistical Methods for Dark Matter Direct Detection

Topical Group(s): (check all that apply by copying/pasting ☐/☑)

☑ (CF1) Dark Matter: Particle Like
☐ (CF2) Dark Matter: Wavelike
☐ (CF3) Dark Matter: Cosmic Probes
☐ (CF4) Dark Energy and Cosmic Acceleration: The Modern Universe
☐ (CF5) Dark Energy and Cosmic Acceleration: Cosmic Dawn and Before
☐ (CF6) Dark Energy and Cosmic Acceleration: Complementarity of Probes and New Facilities
☐ (CF7) Cosmic Probes of Fundamental Physics
☐ (Other) *[Please specify frontier/topical group]*

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Abstract: (maximum 200 words)
This LOI describes an effort among dark matter direct detection experiments to find agreement on methods for calculation and display of dark matter sensitivities.

In going from data to final dark matter results, direct detection collaborations make a series of choices, ranging from how to model the dark matter halo in the Milky Way to which test statistic to use if using a Profile Likelihood Ratio analysis. Different approaches can lead to significant differences in the interpretation of a result even if the underlying data is the same. Dating back to the paper of Lewin and Smith [1], most dark matter collaborations have used the same assumptions about the density and distribution of dark matter in the local galaxy in presenting results, but the community has not converged on a similar consensus regarding how to make statistical inferences from direct detection data. To address this lack, members of the community organized a Phystat-DM workshop in Stockholm, Sweden in August 2019 [2]. An extension of the successful Phystat conference series to the field of direct detection of dark matter, this workshop led to the formation of a "Phystat-DM" committee with members from several dark matter collaborations.

This is a letter of intent of the Phystat DM group to produce a white paper or series of white papers laying out recommendations for the field on how dark matter collaborations should calculate and publish their sensitivity to dark matter after performing an experiment. The Phystat DM group has also discussed whether and how to update the model and parameters of the "Standard Halo Model" as well as certain aspects of backgrounds that are common to all experiments, such as solar and atmospheric neutrino fluxes. The initial white paper will focus on issues particularly relevant for liquid xenon time projection chambers, but many of the proposed methods are directly transferable to other experiments. We hope the work of this group will lead to the establishment of a standard treatment of these issues that can be applied across the direct detection community.

References: (hyperlinks welcome)

1. J.D. Lewin and P.F. Smith, *Review of mathematics, numerical factors, and corrections for dark matter experiments based on elastic nuclear recoil*, Astroparticle Physics 6:87-112 (1996), DOI:10.1016
2. Phystat-DM workshop: https://indico.cern.ch/event/769726/overview

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