Contribution ID: **122** Type: **Argonne open session**

CYGNUS: New Physics Capabilities from Recoil Imaging

Thursday, 23 March 2023 14:05 (5 minutes)

A Snowmass working group of 167 experimental and theoretical physicists straddling the neutrino, cosmic, and instrumentation frontiers started to map out the physics case for a modular, low-energy, "recoil imaging" experiment, which we call CYGNUS.

The ultimate goal is to build a large detector that can count and localize — in the optimal case — individual electrons of ionization in a very large volume of gas. This uniquely enables the topological and directional reconstruction of nuclear and electronic recoils, and much more. We have a proposal for a 30+-year program of experiments where the technology is fully optimized while gradually scaling up the size of detectors.

A portfolio of gas-target detectors would strongly complement ongoing solid-state-based experiments yet are under-represented in the US program. While gas-target detectors have comparatively low target density, the consequently large detector volume and room-temperature operation result in operational advantages and unique physics reach. Three very broad and general examples are 1) detection of complex, multi-particle final states that cannot be resolved in other detectors 2) detection of BSM physics models where the sensitivity scales with detector volume, rather than mass, and 3) low-energy neutrino spectroscopy.

For every factor of ten increase in detector volume, interesting new measurements become possible. Liter-scale gas detectors are already being constructed to measure the Migdal effect, which other experiments implicitly rely on, but cannot probe. Cubic-meter scale detectors could be used to demonstrate directional sensitivity to Coherent Elastic Neutrino-Nucleus Scattering (CEvNS), for example at the Spallation Neutron Source (SNS) at Oak Ridge National Lab, and to search for BSM mediator particles contributing to the neutral-current interaction. Detectors at this scale could also search for low-mass dark matter, heavy sterile neutrinos, and axion-like particles. 10-m^3-scale detectors could produce the strongest spin-dependent WIMP-proton cross section limits of any experiment across all WIMP masses. 1000-m^3-scale detectors could perform solar neutrino physics. Larger volumes would bring sensitivity to neutrinos from an even wider range of sources, including galactic supernovae, nuclear reactors, and geological processes. An ambitious DUNE-scale detector, but operating at room temperature and atmospheric pressure, could have non-directional WIMP sensitivity in excess of any proposed experiment, and use directionality to penetrate deep into the neutrino floor.

Finally, if a dark matter signal is observed, this would mark the beginning of a new era in physics. A large directional detector as envisioned here would then hold the key to first establishing the galactic origin of the signal, and to subsequently map the local WIMP velocity distribution and explore the particle phenomenology of dark matter.

For further information, see https://arxiv.org/abs/2203.05914

Please select if remarks will be in person or on zoom

On zoom

Do you describe your self as early career?

no

Please add details of experiment/project that this abstract corresponds to?

CYGNUS experiment

Primary author: VAHSEN, Sven (University of Hawaii)

Presenter: VAHSEN, Sven (University of Hawaii)

Session Classification: Open Session for remarks