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The CYGNUS Directional Recoil Observatory

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Gas Time Projection Chambers (TPCs) with highly segmented readouts based on micropattern gaseous detectors (MPGDs) are capable of measuring the detailed topology and direction of low-energy nuclear recoils and electron recoils, in real time. This unique capability enables new measurements, and is also highly desirable for probing below the neutrino floor by distinguishing between dark matter (DM) and neutrino scattering. The CYGNUS collaboration aims to deploy a modular network of detectors in multiple underground labs (including in the southern hemisphere), which will be expanded over time. I will outline the physics program enabled by this scheme in the next two decades. Current and near-term, mˆ3-scale detectors can be used for precision studies of final state topology, such as measurements of the Migdal effect, and searches for beyond the Standard Model (BSM) physics at beam dumps and neutrino beams. Next generation, 10 mˆ3 detectors should allow measurements of CNO solar neutrinos via coherent elastic scattering, and produce improved limits on spin-dependent DM scattering. A ton-scale observatory would probe unexplored DM parameter space, including below the neutrino floor, and can be used to confirm the galactic origin of a dark matter signal. I will discuss recent developments in the CYGNUS collaboration, including construction of new detectors, gas and performance optimization studies, and novel algorithm development in support of the physics program.

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