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Neutrino-Nucleus Scattering from analog Electromagnetic Reactions[1]

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Despite their weakly-interacting character, neutrinos have a significant impact on the most spectacular astronomical events known, such as supernovae and neutron-star mergers. Furthermore, they carry information about these events to Earth almost unaffected by the interstellar medium. Unfortunately, the low interaction probability with matter implies that their detection is challenging. For the same reason, basic properties of neutrinos such as their mass or the character of their antiparticles remain unknown, and many large-scale experiments are dedicated to their study on a worldwide scale. Since the direct detection of neutrinos relies on scattering and absorption processes, a precise knowledge of neutrino-nuclear cross sections is crucial to understand the nature of the neutrinos themselves as well as of the astrophysical processes generating them. This contribution will give a brief overview of the efforts to detect neutrinos directly, with a focus on experiments at the Triangle Universities Nuclear Laboratory (TUNL). After that, it will be shown how the close relationship between the weak and the electromagnetic (EM) interaction can be used to infer neutrino-nucleus scattering cross sections from photonuclear reactions. As an example, a nuclear resonance fluorescence experiment on ^{40}Ar – a promising isotope for next-generation neutrino detectors – will be discussed. At TUNL's High-Intensity Gamma-Ray source, the magnetic dipole strength of this nucleus was studied. This strength is closely related to the so-called Gamow-Teller strength that makes up a significant part of the neutrino-nucleus cross section at energies relevant for astrophysics. It will be demonstrated that uncertainties in this type of measurement are dominated by systematic effects in the data and by the nuclear theory required to connect the EM and weak sectors.

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