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The NUCLEUS and CRAB experiments: Low-energy signal detection with cryogenic calorimeters

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Coherent elastic neutrino-nucleus scattering (CEvNS) occurs within the Standard Model of particle physics when a neutrino interacts with a nucleus as a whole. The coherence condition, which is fulfilled for neutrino energies below 50 MeV, leads to a large interaction cross section, making CEvNS an excellent precision probe of the Standard Model.

The NUCLEUS experiment aims to detect CEvNS using gram-scale CaWO4 and Al2O3 cryogenic calorimeters. The experiment will be deployed this year at the commercial nuclear power plant in Chooz, France, at distances of 70 m and 102 m from the reactor cores. The excellent energy resolution of a few eV, and the resulting low noise threshold, enable the detection of nuclear recoils induced by MeV-scale neutrinos for the first time, allowing a detailed study of the CEvNS interaction.

In this talk, I will outline the physics potential of CEvNS and describe the current status of the NUCLEUS experiment, including the performance benchmarks achieved during commissioning at the Technical University of Munich prior to deployment at the reactor site.

A prerequisite for a precision measurement of CEvNS is an accurate calibration of the nuclear recoil energy scale in the 100 eV range. This can be achieved with CRAB (Calibrated nuclear Recoils for Accurate Bolometry). The CRAB experiment is located at the TRIGA research reactor in Vienna. Nuclear recoils produced by the capture of thermal neutrons from the reactor beam line are detected using cryogenic calorimeters of a design similar to those employed in NUCLEUS. I will present the current status of the experiment and discuss the first physics results that demonstrate the precision potential of the method.

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