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Searching for neutrinoless double beta decay

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In the Standard Model of particle physics (SM), the lepton sector is composed of massive charged particles (electron, muon and tau) and neutral particles, neutrinos, which are massless by construction.
Nevertheless, observations of neutrino oscillations indicate that neutrinos are massive particles.
Given their neutral character, neutrinos can be either Dirac or Majorana particles.
Should neutrinos be Majorana particles, their mass term leads to lepton number violation (LNV) with $\Delta L = 2$, forbidden in the SM.
The best known process able to probe LNV is neutrinoless double beta decay ($0\nu\beta\beta$) proposed in 1939 by W.H. Furry.
This process is beyond the SM and is allowed if neutrinos are Majorana particles, and so far, it has never been observed.
The observation of $0\nu\beta\beta$ could explain the smallness of neutrino masses by the see-saw mechanism, as well as the observed current asymmetry between matter and antimatter via leptogenesis.
The SuperNEMO experiment, in installation at LSM (Laboratoire Souterrain de Modane) is one of the experiment trying to observe such a rare decay.
By coupling a tracker to a calorimeter, SuperNEMO is the unique experiment able to track particles in the detector and to measure the deposited energy when a decay occurs.
But even if neutrinos are Majorana particles, $0\nu\beta\beta$ remains an extremely rare process.
As a consequence, SuperNEMO is built to be an ultra-low background detector.
SuperNEMO could observe the neutrinoless double beta decay of ^{82}Se nuclei, with an available mass of around 7 kg and an acquisition time of 2.5 years, with a half-life sensitivity expected to be $\tau_{1/2}^{0\nu\beta\beta} > 6,5.10^{24}$ years.

Auteur principal: M. GIRARD-CARILLO, Cloé

Orateur: M. GIRARD-CARILLO, Cloé

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