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Basic Applications in Fundamental Research - Neutrino Physics

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Rastislav Hodak

Institute of Experimental and Applied Physics, Czech Technical University in Prague, Czech Republic

Abstract

Scintillators are indispensable tools in fundamental research, particularly in neutrino physics. Neutrinos are the most mysterious of the known particles playing an important role from the birth of the Universe until nowadays. Numerous unanswered questions about neutrinos necessitate both theoretical exploration and experimental investigation. Experimental neutrino physics focuses on measuring key properties of neutrinos, such as their absolute mass scale, their nature (whether they are Majorana or Dirac particles), and the violation of lepton number, each with profound implications for understanding cosmic evolution and their relationships with other elementary particles. The search for neutrinoless double beta decay (DBD) is a key approach to address aforementioned fundamental questions.

The prime candidate for the experimental study rare DBD processes is the SuperNEMO experiment. The approach is based on the so-called "tracker-calorimeter" method where not only the energy spectrum (crucial to distinguish neutrinoless DBD from two-neutrino DBD) is measured, but also the outgoing particles' trajectories are reconstructed. This method offers significant advantages, including substantial reduction of radioactive background and the capability to investigate multiple DBD sources. The SuperNEMO demonstrator is located in the Modane Underground Laboratory (Laboratoire Souterrain de Modane - LSM), at the French-Italian border in the middle of the Fréjus highway tunnel.

This lecture will provide an overview of the fundamental applications of scintillators in this field, along with an introduction to the Modane Underground Laboratory and the SuperNEMO experiment. Through this exploration, attendees will gain insight into the critical role that scintillators play in probing the fundamental aspects of particle physics.

Presenter: Dr HODAK, Rastislav (Czech Technical University in Prague (CZ))