PhD opportunity in LUX-ZEPLIN at LIP

Project: Probing the nature of the neutrino: Studies of neutrinoless double beta decay in Xe isotopes

Neutrinoless double-beta decay (0νββ) is one of the most important topics in modern particle physics, offering a unique opportunity to discover physics beyond the Standard Model. In this decay a nucleus emits two electrons but no accompanying neutrinos. This is not allowed in the Standard Model as it violates the conservation of the lepton number, hinting that leptons play a part in the observed Universe matter/antimatter asymmetry. It would also probe the Majorana nature of neutrinos, *i.e.* if neutrinos are their own antiparticles, and provide information about the neutrino mass hierarchy and effective mass. As such, the observation of this process would be a breakthrough in modern physics. Xe-136, which comprises 9% of natural xenon, is one of the few isotopes that are expected to undergo this decay. Xe-134 is another Xe isotope that is also expected to exhibit 0νββ decay. This makes xenon detectors designed to search for dark matter extremely competitive in the search for this process, given their large masses and extremely low backgrounds, reaching sensitivities similar to dedicated experiments.

LUX-ZEPLIN (LZ), installed 1470 m underground in the SURF laboratory (Lead, USA), employs 10 tonnes of liquid xenon with a total of 630 kg of Xe-136 in its sensitive region. A preliminary study showed that it can reach a sensitivity of 1.06×10^{26} ys, similar to current best results. For Xe-134, LZ will allow to exclude values of the half-life up to 7.3×10^{24} years.

The Laboratory of instrumentation and Experimental Particle Physics (LIP) was a founding member of LZ and is the main LZ group studying 0νββ in Xe-136 and Xe-134. The LIP team is composed by 6 researchers and 7 (PhD and Master) students.

The studentship will focus on data analysis regarding the search of neutrinoless double beta decay in Xe-136. It comprises the characterization of the backgrounds using real data, to explore the use of machine learning techniques to event identification, perform the required data analysis and develop a statistical framework using a profile likelihood ratio method.

In alternative, the studentship can be focused in exploring the combination of the PLR method with ML techniques to facilitate the usage of higher dimensionality Probability Distribution Functions (PDFs) which otherwise drive the PLR calculation into computational limitations. The development of such tools will find application in other rare event searches (e.g dark matter detection).

The student will be a member of the LZ team at LIP, and through frequent meetings will be interacting with the whole collaboration that counts with about 250 members from about 36 institutions from USA, UK, Portugal, Russia and South Korea (https://lz.lbl.gov/) . The student is also expected to participate in data taking and calibration shifts of the LZ experiment at SURF.

The work will take place mainly at LIP, Coimbra, Portugal.

The studentship is 4 years long and is funded by the Portuguese Foundation for Science and Technology.

The successful candidate will be enrolled in the PhD Physics Program at University of Coimbra. The grant covers the tuition fees.

The candidates should have the master's degree in physics or related area by September 30, 2022. The grant starts on October 2022.

Interested candidates should contact Prof. Isabel Lopes (Isabel.lopes@uc.pt).