TECHNISCHE UNIVERSITÄT DRESDEN

INSTITUT FÜR KERN- UND TEILCHENPHYSIK

Fakultät Physik / Institut für Kern- und Teilchenphysik

Bachelor Thesis Announcement: Investigating Neutrinoless Double Electron Capture in Enriched ^{152}Gd

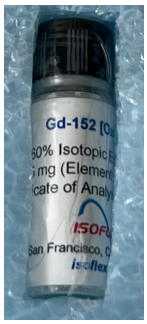
(Deutsche Version auf separatem Blatt)

Introduction and Significance:

Neutrinoless double electron capture (NDEC) is a hypothesized, exceedingly rare nuclear decay process that, if observed, could yield critical insights into the fundamental properties of neutrinos, particularly their Majorana nature and absolute mass scale. Recent investigations, such as those described in the study "Search for neutrinoless double electron capture of Gd-152" (https://arxiv.org/abs/2302.06131), using natural gadolinium samples, have established a solid foundation for advanced research. This thesis aims to exploit a unique sample of enriched Gd-152, which contains more than 100 times the concentration of the target isotope compared to earlier efforts, to further this pioneering exploration.

Objectives and Methodology:

The primary objective of this thesis will be to plan and execute a preliminary measurement of NDEC using the enriched Gd-152 sample. The student will begin by identifying the most appropriate low-background germanium detector at the Felsenkeller Laboratory, suitable for measuring the x-ray signature around 40 keV. Subsequent preparation of the sample will focus on optimizing its geometry to enhance detection efficiency. Following this, the student will conduct a series of preliminary measurements to establish baseline data and refine the detection techniques. Data analysis will concentrate on effectively distinguishing genuine signal events from background noise, using advanced analytical methods.



Enriched Gd_2O_3 powder

Future Work and Impact:

Should time allow, the student will draft a comprehensive plan for a future long-term measurement that could evolve into a master's thesis. This plan shall outline a detailed strategy for expanding the experiment, including potential enhancements to detector shielding and the integration of more sophisticated data analysis methodologies. Completing this bachelor thesis will not only pave the way for future publishable research but will also refine the student's abilities in experimental design, data analysis, and scientific communication. This project represents a distinctive opportunity for hands-on experience with advanced low-background detector technology, which could fundamentally alter our understanding of the particles and forces that govern the universe.

Please jointly contact Prof. Kai Zuber (kai.zuber@tu-dresden.de) and Dr. Björn Lehnert (bjoern.lehnert@tu-dresden.de) for further information and discussion.