Contribution ID: **54** Type: **Contributed Oral**

βNMR Spectroscopy of Ta films for the BeEST Sterile Neutrino Search

Saturday, 14 February 2026 19:00 (15 minutes)

The BeEST experiment (Beryllium Electron-capture in Superconducting Tunnel-junctions (STJs)) is a world-leading search for beyond the standard model (or "new") neutrino physics and investigating quantum properties of weak decay using radioactive beryllium atoms embedded into thin-film superconducting quantum sensors. These sensors provide a unique tool for eV-scale measurements of the recoiling atom that accompany the emitted neutrino. The nuclear recoils are encoded with the fundamental quantum information of the decay process and carry unique signatures of new physics, if they exist! One puzzling observation in the ^{7}Li recoil spectra is the fact that the peaks widths are significantly broader than the ~2eV width of the laser peaks set by the energy resolution of the STJ's. This isn't currently understood, thus is a limitation to the progression of the BeEST experimentation through the sensitivity, which is crucial for the observation of small sterile neutrino masses which are especially interesting for warm dark matter candidates. A possible investigation to provide clarity in where this broadening could have come from, involves looking deeper into the material properties of STJ's themselves, especially in the low temperature range. While tantalum has been used for a long time in the fabrication of STJ's, its material behaviours in this environment remain unresearched. With this in consideration, beta-NMR was utilised to analyse the material effects of Ta foils. This experiment consisted of the film being implanted with a ^{8}Li probe, used for its similar properties to the recoil daughter nucleus from the BeEST experiment. This technique allows the ability to infer the probes landing site in the Ta lattice after implantation at 25keV. This presentation will discuss the results from these experiments and indicate probable implantation sites combining experimental data and density functional theory analysis.

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Session Classification: Neutrino Physics

Track Classification: Neutrino properties