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The missing proton emitter –the case of 125Pm

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The phenomenon of proton radioactivity, where the atomic nucleus is energetically unstable to the spontaneous emission of a proton is a crucial source of nuclear structure and mass- landscape information at, and beyond, the proton drip line. In addition, in contrast to alpha decay where the formation of an alpha particle close to the nuclear surface must be considered, the pre-existence of protons within the nucleus allows for a cleaner theoretical treatment. This phenomenon has been observed in the most neutron-deficient isotopes of all odd-Z nuclides with atomic numbers between 53 and 83, with promethium (Z=61) being the only exception. Previous searches for proton emission from 125Pm have been unsuccessful likely due to either a smaller than expected cross section or a short half-life for decay. However, recent theoretical calculations of proton emission, utilizing a non-adiabatic quasiparticle model, have indicated that observing the decay of 125Pm should be within the limits of state-of-the- art experimental setups utilizing digital electronics that allow for the analysis of pile-up waveforms with sophisticated analysis techniques. The observation of proton emission from 125Pm will be an important benchmark for both theories of proton decay, given the large, predicted deformation and the important role of the Coriolis interaction, and of mass models. Here, we report on a recent experimental search using the Fragment Mass Analyzer (FMA) at Argonne National Laboratory's ATLAS facility. Evidence for possible proton emission from 125Pm will be presented and the important role of fine structure in the decay discussed. In addition, perspectives will be presented for future observation of even more exotic nuclear decays.

Presenter: DOHERTY, Dan (University of Surrey)

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