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Differential Plunger Lifetime measurements of Proton-Unbound Nuclear States (DPUNS).

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A new differential-plunger device, DPUNS, has been commissioned to measure the lifetimes of excited states beyond the proton drip line. DPUNS has been coupled to the Jurogam II and RITU spectrometers at the University of Jyvaskyla using proton tagging and to isolate the weakly populated nuclei of interest. Recoil-Distance-Doppler-Shift measurements have been employed to measure the lifetimes of exited nuclear states in these exotic nuclei. So far, our new experiments have measuring the lifetimes and extracting deformations for states in the near-spherical proton emitters, 109I and 151Lu. However, even for these somewhat easier to understand near-spherical proton emitters, the theoretical situation is somewhat complex. Current calculations based on the CD-Bonn potential tend to underestimate the spectroscopic factors and overestimate the B(E2) reduced transition probabilities for the unbound states in 109I, whereas, the opposite situation is found in 151Lu. As part of this work, our collaboration is developing a non-adiabatic model which has the ability to self-consistently calculate energy levels, electromagnetic transition rates and proton decay tunnelling rates within a common theoretical framework. Prior to this work, theoretical tunnelling calculations have relied on deformations which were inferred from the alignment properties of the states built upon the proton decaying state. With these new lifetime measurements, the extracted deformations should be more reliable.
In summary, this talk will review the new experimental and theoretical knowledge obtained from our measurements in this region of exotic nuclear states and will close with a discussion of potential future experiments and additional knowledge that can be gained from a study of deformed proton emitters.

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