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Developing a charge plunger method for lifetime measurements in the heavy elements

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The Recoil Distance Doppler-Shift (RDDS) method for measuring the lifetime of excited nuclear states relies on the detection of gamma rays. In cases where the internal conversion coefficient (ICC) becomes large, e.g. for low energy transitions in heavy nuclei, the intensity of γ-ray emissions may be small and the RDDS method becomes impractical. To overcome this difficulty, a charge plunger technique has been previously employed by G. Ulfert et al.

The charge plunger technique relies on two effects that change the charge state of an ion. Firstly, the large increase of an ionic charge state due to a cascade of Auger electrons that follow the internal conversion of a transition depopulating an excited nuclear state. Secondly, when an ion passes through a thin foil it will pick up electrons causing the charge state to reset to a lower value. In a plunger setting this results in high and low charge components in the ionic charge state distribution (CSD) with intensities that depend on the flight time of the ions between the target and charge reset foil, the ICC of the transition and the lifetime of the excited state. Therefore, an analysis of high and low charge components can be used for lifetime measurements.

The charge plunger method has recently been used at the University of Jyväskylä Accelerator Laboratory, Finland, to perform lifetime measurements of yrast states in ^{178,180}Pt. The Differential Plunger for Unbound Nuclear States (DPUNS) was employed together with the vacuum separator MARA to observe the intensities of different charge states. The Jurogam 3 array was used to detect prompt γ-ray emission. The results for ^{178}Pt are presented here, along with two planned experiments on ^{222}Th and ^{254}No which have been approved to run at the University of Jyväskylä.

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