Recoil Beta Tagging: Application to the study of odd-odd near proton drip line nuclei, ^{74}Rb and ^{78}Y

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In recent years, Recoil decay tagging has been at the forefront of the study of excited states of heavy nuclei at the limits of stability [1]. In particular, Recoil-alpha tagging has been used for the study of nuclei with cross sections as low as 25 nb extracted from total production cross sections of 1 b [2]. Other tagging methods such as tagging with electron cascades, isomeric states, and protons have allowed state of the art research to be performed with very low fusion cross sections. However, tagging with electrons (positrons) from the β-decay, Recoil-beta tagging (RBT), at the focal plane of a recoil separator has not been successfully pursued. The difficulty can be attributed to the fact that the β-decay is a three body process, implying no characteristic β-particle energy to tag with. Furthermore, beta decays usually involve much longer lifetimes compared to those of alpha and proton decays from nuclei near the proton drip line. There is however a distinct subset of nuclei, namely those odd-odd N = Z nuclei with $J^{\pi} = 0^{+}$ ground states, which decay almost entirely by the process of Fermi super-allowed beta decay. Such nuclei (particularly, in the mass 70 region) are suitable for study via the RBT technique due to their conveniently short β-decay lifetimes and high end point energies.

A proof of technique experiment was carried out successfully to study the known nucleus ^{74}Rb [3] at University of Jyväskylä using the GREAT spectrometer at the focal plane of the RITU separator [4,5]. The JUROGAM γ-detector array at the target position detected the prompt γ-rays. The combination of a Double-sided silicon strip detector (DSSD) and a planar Ge detector served as an effective ΔE-E telescope for high energy positrons. Correlations over long time periods were possible due to the total data read out method, where each event is time stamped using a 100 MHz global clock and all data channels were read independently. Results from this experiment will be discussed to demonstrate that a clean identification of a reaction channel with cross section $<< 1\,\%$ of the total reaction cross seciton can be achieved. The role of the present technique in opening up the possibilities to study various physics issues related to N $\approx$ Z nuclei will be discussed. Finally, new results on the T = 1 states in ^{74}Rb and the application of the technique to carry out the first identification of non-isomeric excited states in the odd-odd N = Z nucleus, ^{78}Y will be presented.

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