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Comparison of Tz=-2 beta decays with their mirror process on Tz=2 nuclei and search for isospin suppressed gamma and proton transitions

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Isospin symmetry is based on the almost identical 'behavior' of proton and neutron in terms of the strong interaction. However, due to isospin breaking interactions, including electro-magnetic interaction, slight asymmetry is associated with the nuclear structure of mirror nuclei.

We have been studying Tz=\pm 1->0, Tz=\pm 3/2->\pm 1/2, and Tz=\pm 2->\pm 1 mirror Gamow-Teller (GT) transitions as a tool to study the nuclear structure of relevant nuclei in connection with isospin symmetry and isospin selection rules. The Tz=+1->0, +3/2->+1/2, and +2->+1 GT- transitions have been studied by high-resolution (about 30 keV) \beta- like (3He,t) reactions performed at RCNP, Osaka, while mirror GT+ transitions, in particular for lower Z, pf-shell nuclei, by the \beta+ decays of proton rich unstable nuclei performed at GANIL, Caen and GSI, Darmstadt.

Note that the production rate of the negative Tz nuclei in the Z > 30 region is the largest at BigRIPS @RIKEN. Since these nuclei are situated on the path of rapid-proton (rp) process, decay study of them are also of astro-physical interest.

Eurica setup in combination with BigRIPS was used to study the GT transitions (and also Fermi transitions) by the \beta decay of Tz= -1, -3/2, and -2 nuclei in the higher Z, pf-shell region (Z=30 - 36). The initial 345 MeV/nucleon 78Kr beam with an intensity up to 300 pnA on the Be target was used for the production of fragments.

It is expected that these near-drip-line nuclei decay with various decay modes due to large decay Q-values. They can be delayed-\gamma, delayed-proton, and even delayed-\gamma-proton. Therefore, measurements of particle decay as well as gamma decay are important.

Produced unstable nuclei were implanted in active stopper, i.e., WAS3ABi setup, for the measurement of \beta rays and delayedprotons. The setup consists of three 1mm thick double-sided Si strip detectors (DSSSD) with each of them having an active area of 60 x 40 mm2 segmented into 60 vertical by 40 horizontal strips. The WAS3ABi setup was surrounded by the EURICA setup consisting of 12 HPGe CLUSTER-detectors of Euroball type for the efficient measurement of \gamma rays.

Owing to the large productive power of unstable nuclei at BigRIPS,

we could observe Tz=-1 nuclei 58Zn, 60Ga, 62Ge, 64As, 66Se, and 70Kr, Tz=-3/2 nuclei 57Zn, 61Ge, 65Se, and 69Kr, Tz=-2 nuclei 60Ge and 64Se. It is decided that all of them will analyzed inside our collaboration.

After performing particle identifications, we started to have precise half-life values. For some of the nuclei, the error-bars have reduced by one-order-of-magnitude due to the good statistics. Reconstruction of \gamma-decay scheme has also started recently.

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