Probing the Structure of Exotic Nuclei by Advanced Time-Delayed Methods; Studies of μs Isomers at LISE in GANIL and RMS at HRIBF

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We have applied a novel time-delayed technique in order to determine lifetimes of the levels γ-fed from the exotic (and thus weakly populated) μs isomers. The measurements were performed at the LISE spectrometer in GANIL following fragmentation of the ^{76}Ge 60 MeV/u beam on a ^{9}Be target. An array of four BaF_2 detectors, which time response was precisely calibrated at the OSIRIS separator at Studsvik, was employed to search for level lifetimes from ~20 ns down to ~10 ps. The aim of the measurement was to verify theoretical structure interpretation of a few nuclei in a close vicinity of ^{70}Ni, via a strong pairing of $g_{9/2}$ neutrons. Several level lifetimes have been measured with high precision in ^{67,69,70}Ni and ^{71,72}Cu. Moreover, positions of gamma rays in the decay schemes have been also firmly assigned. The absolute transition rates provide a new level of information and more strict verification of the theoretical predictions. A preliminary result for the 694.1 keV level in ^{67}Ni is illustrated in Fig.1. A successful application of the BaF_2 array opens new possibilities for measurements of dynamic moments (via ps-lifetimes) in very exotic nuclei produced with very low intensity.

The N=Z=33 proton drip-line nucleus of ^{66}As represents one of the most interesting cases of μs isomers. Yet numerous experimental ambiguities in the knowledge of ^{66}As prevent a meaningful comparison with theoretical calculations. The time-delayed measurements, descibed above, could remove much of the existing ambiguities related to the postion of the γ rays in the decay scheme, level energies, spin/parities and the nature of the observed γ rays below the isomers. This should clarify the relative position of the low-lying T=0 and T=1 states crucial for the shell model interpretation of heavy N=Z nuclei. At present the most favourable conditions to perform the ATD measurements on ^{66}As exist at HRIBF at the Recoil Mass Separator (RMS).

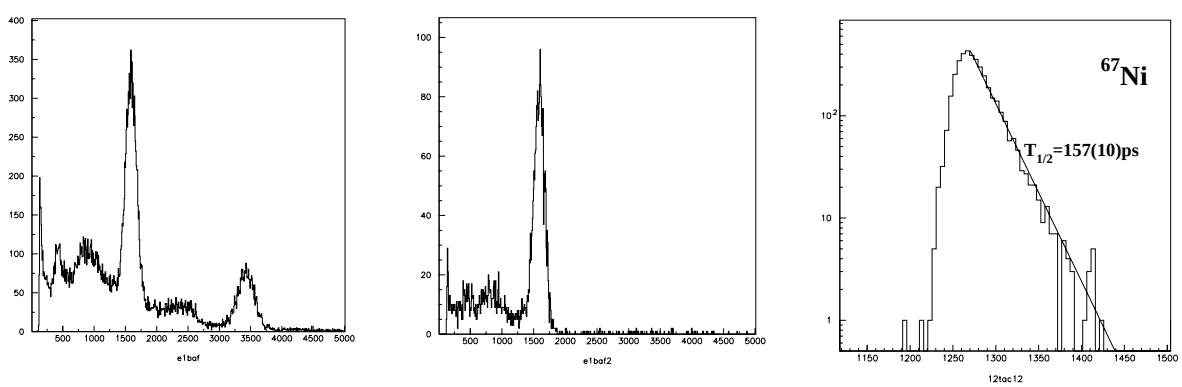
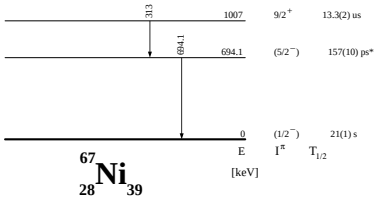
FIG.1. Left:The energy spectrum in BaF_2(det-1) showing the 313 (ch~ 1530) and 694 keV γ peaks (ch~3400). Middle: The coincident energy spectrum in BaF_2 (det-2) gated by the 694-keV γ-ray in BaF_2(det-1). The gate was set on the 694-keV full energy peak. Right: A time-delayed spectrum due to the 694-keV level in ^{67}Ni gated by the 313-keV (start) and 694-keV γ-rays (stop). Gates were set only on the full energy peaks.