

# From RISING to HISPEC/DESPEC - $\gamma$ spectroscopy at GSI and FAIR

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Nuclear spectroscopy using radioactive isotope beams requires dedicated set-ups. State-of-the-art Ge arrays recently started to provide valuable  $\gamma$  spectroscopic data. At the SIS/FRS facility at GSI exotic beams at relativistic energies were employed for Coulomb excitation and secondary fragmentation experiments with the fast beam RISING set-up. Shell evolution far off stability, pn-pairing, symmetries and nuclear shapes were studied in nuclei ranging from  $^{36}\text{Ca}$  to  $^{136}\text{Nd}$ . In another Ge-detector configuration a series of g-factor experiments was performed. Recently the compact detector arrangement of RISING -providing about 15% full energy efficiency- went into operation. Seniority isomers in medium heavy nuclei at the proton drip line have been investigated as well as new isomers found in neutron rich nuclei, e.g.  $^{204}\text{Pt}$ . Most recently the decay properties of  $^{100}\text{Sn}$  were investigated successfully. The observation of a  $I = 27 \hbar$  state demonstrated that high spin states can be obtained in massive fragmentation reactions. This and the large sensitivity of both relativistic in-beam as well as stopped decay experiments open a rich ground for advanced nuclear structure studies.

At future FAIR/GSI the Super-FRS facility within the NUSTAR project will provide an enormously enlarged variety of exotic beams. To fully exploit these beams lasting detection deficiencies have to be solved. They result from still limited beam intensity, particularly for the most exotic nuclei, a wide range of beam velocities (from stopped to  $v/c \sim 0.5$ ), high  $\gamma$  ray and particle background and  $\gamma$  ray multiplicities up to  $M \leq 30$ , which are typical characteristics of the reactions. The HISPEC/DESPEC project aims to develop, build and operate optimized experimental set-ups. Based on the experience with RISING novel particle identification and tracking detectors will be employed. For in-beam  $\gamma$  detection AGATA detectors are foreseen as well as a dedicated compact Ge tracking and imaging array for decay experiments. In addition, a suite of ancillary detectors is planned to complete the experimental set-ups. To bridge the gap between RISING and HISPEC/DESPEC, from this year on detectors developed for HISPEC/DESPEC will be commissioned and employed for experimental campaigns at the FRS facility at GSI as they become available. This evolutionary approach with continuously improving experimental possibilities allows exploring increasingly remote areas of the nuclear landscape and enables more and more detailed structure studies of less exotic nuclei.