

PreSPEC-AGATA Experiments at the Frontier of Nuclear Structure

*P. Boutachkov^{*1}, N. Pietralla¹, J. Gerl² for the PreSPEC-AGATA collaboration*

¹TU, Darmstadt, Germany; ²GSI, Darmstadt, Germany

In 2012, Coulomb excitation and secondary fragmentation experiments using radioactive ion beams at relativistic energies have been performed for the first time with the new PreSPEC-AGATA setup.

PreSPEC-AGATA is a unique combination of the FRagment Separator (FRS) [1], used for providing and selecting specific radioactive ion beams, the Lund-York-Cologne CALorimeter (LYCCA) [2], which discriminates heavy ions produced in nuclear reactions taking place at the secondary target, the HECTOR [3] array and 10 LaBr₃ detectors used for detection of high-energy γ -rays and the Advanced Gamma Tracking Array (AGATA) [4], for the precise measurement of γ -ray energies. PreSPEC-AGATA is based on the very successful RISING campaign [5]. The major improvements are the ability of LYCCA to determine the mass of the reaction products and the accurate determination of the first γ -ray interaction point in the AGATA array. The latter leads to a higher γ -efficiency ($\sim 10\%$) keeping the γ -ray energy resolution at about 1%, after Doppler correction, as AGATA can be positioned closer to the PreSPEC-AGATA target. These improvements together with the higher beam intensity provided by the SIS-UNILAC accelerators, yield a factor of 10 higher sensitivity compared to RISING. A picture of the setup is shown in Figure 1.

In 2012, four experiments were performed with the new setup. They investigated how the collectivity is build-up from single particle excitations and how it evolves away from magic nuclei.

Excitation probabilities of the first excited states in nuclei south-west of ²⁰⁸Pb were measured, including heavy Pb, Hg and Pt isotopes. The level scheme of the ⁵²Fe nucleus which is only two valence proton and neutron holes away from the doubly magic ⁵⁶Ni, shows rotational behavior for the low spin states. In the primary FRS production target ⁵²Fe nuclei were not only populated in their ground state but also in the 12⁺ isomeric state, which was Coulomb excited using a gold target at the PreSPEC-AGATA setup. For ⁶⁴Fe the Pygmy dipole resonance was studied, which probes the properties of neutron skin. Finally, neutron rich Zr isotopes were excited to determine their shape evolution.

A γ -spectrum taken during the commissioning is shown in Figure 2. The fragments identification with LYCCA is discussed in Reference [6], while the trigger configuration used for the experiments is described in Reference [7].

In 2013, the PreSPEC-AGATA experiments will be extended to life-time measurements as well as scattering on a liquid hydrogen target.

^{*}This work was supported by NAVI, Helmholtz Association Nuclear Astrophysics Virtual Institute.

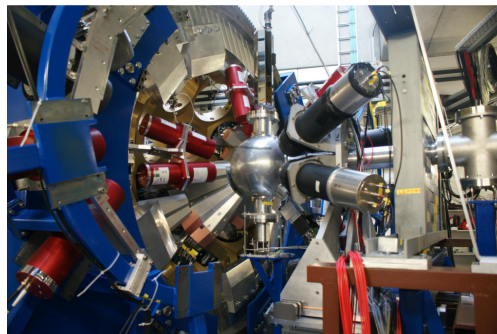


Figure 1: A photograph of the PreSPEC-AGATA setup. The beam from the FRS comes from the right. HECTOR detectors in black, chamber with target manipulators, LaBr₃ detectors in red, the AGATA detectors are mounted on the large metal ring, a beam tube connects the target chamber to the LYCCA array.

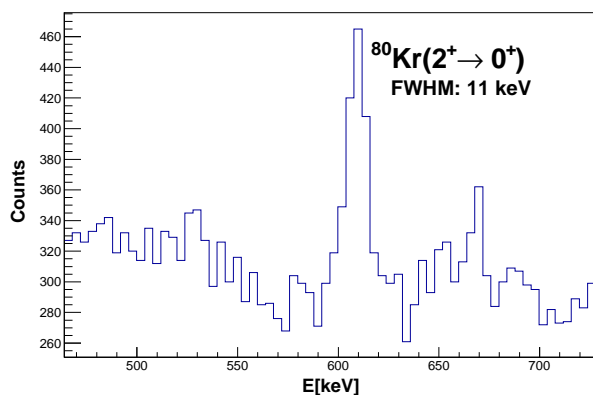


Figure 2: γ -ray spectrum from Coulomb excitation of ⁸⁰Kr on a gold target at the PreSPEC-AGATA setup. The γ -transition from the first 2⁺ excited state to the ground state of ⁸⁰Kr is marked.

References

- [1] H. Geissel *et al.*, Nucl. Instr. and Meth. **B70** (1992) 286.
- [2] http://www.nuclear.lu.se/english/research/basic_nuclear_physics/nustar/lycca/
- [3] A. Maj *et al.*, Nucl. Phys. **A571** (1994) 185.
- [4] S. Akkoyun *et al.*, Nucl. Phys. **A668** (2012) 26.
- [5] H.J. Wollersheim *et al.*, Nucl. Phys. **A537** (2005) 637.
- [6] P.P. Singh *et al.*, "LYCCA Performance During the PreSPEC-AGATA Campaign", GSI Scientific Report 2012.
- [7] D. Ralet *et al.*, "Trigger Configuration for the PreSPEC-AGATA Campaign at GSI", GSI Scientific Report 2012.