

Relativistic 1n Knockout in $^{48,50}\text{Ca}$ and ^{56}Ti \diamond

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The structure of neutron-rich nuclei is in the focus of current theoretical and experimental investigations. Due to the influence of the residual interaction between valence orbitals the shell structure is expected to change locally. For Calcium isotopes, a new shell closure for neutron number $N=34$ is predicted [1]. Knockout experiments are a tool to probe the single particle structure of nuclei and therefore to test theoretical predictions.

At the GSI SIS facility (Darmstadt), a 500 AMeV ^{86}Kr primary beam was fragmented using a 1625 mg/cm^2 ^9Be production target. The first two dipole stages of the fragment separator (FRS) equipped with additional TOF and energy loss measurements allowed for event by event mass and charge identification of the primary fragments at the central focus of the spectrometer. The knockout reactions of interest were induced in a secondary target (1760 mg/cm^2 ^9Be) there. Eight clusters of the MINIBALL gamma-ray spectrometer surrounding this target were used to tag exited states in the residual nucleus. The second half of the FRS provided the identification of the secondary fragments after the reaction and a precise measurement of their longitudinal momentum. From this momentum distributions the angular momentum of the knocked out nucleons can be determined [2]. With a ^{48}Ca primary beam and the reaction $^{48}\text{Ca} \rightarrow ^{47}\text{Ca}$ the properties of the setup and the methods of analysis have been adjusted with good event statistics (see Fig. 1).

One important aspect of the analysis so far was related to the MINIBALL detectors. Due to the high velocity of the fragments ($\beta \approx 0.7$), a good energy and position calibration is essential for the Doppler correction of the measured γ -rays. For an offline pulse shape analysis (PSA), the preamplifier signals of all 168 channels of the MINIBALL array were digitized with 40 Mhz and 40 samples were stored on tape. Fig. 1 shows the measured gamma spectrum of the $^{48}\text{Ca} \rightarrow ^{47}\text{Ca}$ reaction. Using the developed PSA algorithm [3], a resolution of 38 keV (FWHM) was achieved for the known transitions at 565 keV and 586 keV and 96 keV (FWHM) for the 2013 keV transition respectively.

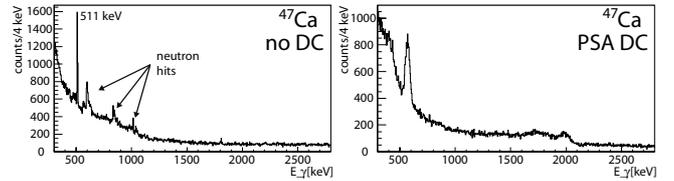


Fig. 1: Gamma spectrum from ^{47}Ca gamma after knockout. Without DC (left) background from scattered neutrons and β -decay dominates. After DC using PSA Doppler (right), the transitions in ^{47}Ca are clearly separated from background.

13 days of beamtime focused on several different nuclei in the vicinity of ^{54}Ca . Figure (2) shows γ -spectra taken in coincidence with fully identified reaction products. In case of ^{55}Ti there is a strong indication for a new γ transition at $E_\gamma \approx 950\text{ keV}$. In ^{49}Ca there is indication for a new transition at $E_\gamma \approx 3500\text{ keV}$.

Next steps of the analysis will extract momentum distributions and cross sections of the different reaction channels to identify angular momenta and spectroscopic factors of the populated states.

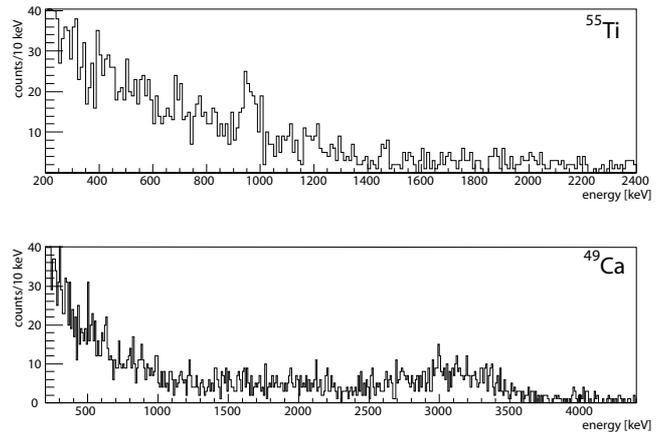


Fig. 2: Gamma spectra of ^{55}Ti (upper spectrum) and ^{50}Ca (lower spectrum), Doppler correction using only detector geometry

References

- [1] M. Honma *et al.*, Phys. Rev. **C65** (2002) 061301
- [2] D. Cortina-Gil *et al.*, Phys.Rev.Lett **93** (2004) 062501
- [3] K. Eppinger, diploma thesis, TU München, 2006, and this report, p. 86