TERMINATION OF sd-SHELL MODEL STATES IN ^{24}Mg, STUDIED BY TRIPLE-α ANGULAR CORRELATION STUDIES

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The high–spin states of the nucleus ^{24}Mg have long attracted the interest of experimentalists and theorists alike, based on the observation of structures ranging from the superdeformed prolate ground state to well-defined resonances in the system ^{12}C + ^{12}C . These excited resonances have been described as quasi–molecular states, statistical fluctuations or simply as excited rotational bands in the nucleus ^{24}Mg. The lower-lying excitations were very successfully described by the shell model, as excitations within the sd-shell. These orbitals create a maximum angular momentum of 12^+ in ^{24}Mg, states, which had so far not been observed. One prevailing problem has been the inability to tie the unbound resonances to the bound states because of the negligible γ–ray branching and unclear, often conflicting spin assignments.

We performed an experiment at the FSU superconducting accelerator laboratory, using a new multistrip Silicon-detector array. Our technique for spin determination is based on measuring complete events, where the quantum numbers of the ^{24}Mg wave function is imprinted on the multi-particle correlations of the decay cascade. The applied method is a further development and generalization of a previous work using $\alpha\gamma\gamma$ angular correlations [1], which established the Yrast 10^+ state in ^{24}Mg. The sought-after states approaching angular momentum 12 lie at higher excitation energies and predominantly decay by cascades of two α–particles, populating the ^{16}O ground state.

By analyzing the triple angular correlations, we established the spin and parity of several unbound resonances between 22 and 30 MeV of excitation energy. The results of our experiment test the validity of the shell-model at the limits of angular momentum coupling. The sensitivity of the experimental and data analysis technique will finally allow the gap between the unbound resonances and bound states to be closed experimentally and their relationship to be identified. A complete data set of bound and unbound structures in the same system will enhance our ability to predict the structure of nuclei at the proton– and neutron drip lines.

[1] I. Wiedenhöver, A. H. Wuosmaa, R. V. F. Janssens, C. J. Lister, M. P. Carpenter, H. Amro, P. Bhattacharyya, B. A. Brown, J. Caggiano, M. Devlin, A. Heinz, F. G. Kondev, T. Lauritsen, D. G. Sarantites, S. Siem, L. G. Sobotka, A. Sonzogni: *Identification of the $I^\pi = 10^+$ Yrast Rotational State in ^{24}Mg*, Phys. Rev. Lett. **87**, 142502 (2001)