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Enhanced α-Transfer population of the 2^+_{ms} mixed-symmetry state in ^{52}Ti

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The residual nucleon-nucleon interaction plays a crucial role in nuclear structure physics. In spherical even-even nuclei the quadrupole interaction leads to characteristic low-lying 2+ states of proton-neutron mixed symmetry character, decaying via M1 transitions to the proton-neutron symmetric states. We have calculated the associated M1 transition strengths in the ^{52}Ti nucleus within the ab initio valence-space in-medium similarity renormalization group based on NN and 3N forces from chiral effective field theory. In this framework we also construct an effective valence-space M1 operator, which captures nonperturbatively many-body excitations outside the valence space. Our calculations well describe the established mixed-symmetry state in ^{52}Ti nucleus. Thus, ab-initio calculations are able to describe fundamental low-lying collective excitaitons in nuclei.\\

In order to investigate the microscopic structure of the mixedsymmetry state in ^{52}Ti nucleus even further, we run an experiment on the ^{52}Ti nucleus, populated via the alpha transfer reaction ^{48}Ca(^{12}C,^{8}Be)^{52}Ti using a ^{48}Ca beam from the Maier-Leibnitz-Laboratory in Munich. Gamma rays of populated states were detected with the high-granularity MINIBALL array of HPGe detectors, and charged particles were detected using a highly segmented DSSD silicon detector, allowing to select the channel of interest via a multiplicity coincidence condition. In first order, ^{52}Ti can be described as the coupling of a ^{4}He nucleus to the doubly-magic ^{4}8Ca core. In the frame work of the interacting boson model 2 (IBM-2), Alonso *et al.*[1] have shown that the population of the MS 2^+_{ms} state is strictly forbidden. This prediction is also confirmed in our new shell model calculation using the full fp space and effective interactions. Alpha transfer spectroscopic factors were evaluated with a cluster model using the oxbash shell model code. In contrast to the theoretical predictions, we experimentally find an exceptionally strong population of the well-established 2^+_{ms} mixed-symmetry state in ^{52}Ti relative to the population of the 2^+_1 state. We discuss the impact of our findings to our microscopic understanding of the proton-neutron interaction and shell structure in this interesting region of the nuclear chart.

References

[1] C.E. Alonso and J.M. Arias, Phys. Rev. C 78, 017301 (2008).

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