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Investigating the strength of the $N = 34$ subshell closure in ^{54}Ca

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Over the past few decades nuclear structure studies have focused intensively on the evolution of the traditional magic numbers away from the valley of β stability. In the neutron-rich fp shell, for example, the discovery of a new subshell closure at $N = 32$ became evident from experimental measurements of $E(2_1^+)$ and $B(E2)$ reduced transition probabilities along the Ca [1], Ti [2, 3] and Cr [4, 5] isotopic chains, a characteristic that is reproduced rather well by the spherical shell model with effective interactions such as GXPF1 [6] and KB3G [7]. Another important manifestation of the GXPF1 interaction is the prediction of a significant subshell closure at $N = 34$ in Ca and Ti isotopes, however, this was found to be in contrast with experimental results for ^{56}Ti [3, 8], leading to the development of the modified interaction GXPF1A [9] and the most recent version, GXPF1B. Importantly, the predicted strength of the $N = 34$ subshell closure in ^{54}Ca remains relatively large in the GXPF1-based interactions, while some other models indicate a much weaker shell closure. Clearly, experimental input on the matter is essential to help resolve the situation.

In order to address this issue, the structures of ^{53}Ca and ^{54}Ca were investigated using in-beam γ-ray spectroscopy at the Radioactive Isotope Beam Factory, operated by RIKEN Nishina Center and Center for Nuclear Study, University of Tokyo. A radioactive beam containing ^{55}Sc and ^{56}Ti was employed to populate excited states in neutron-rich Ca isotopes via nucleon knockout reactions, and the structures of the reaction products were deduced by measuring $\gamma\gamma$ coincidences. Several new γ-ray lines have been assigned, including a strong candidate for the $2_1^+ \rightarrow 0_1^+$ transition in ^{54}Ca. The results will be discussed in terms of the energy systematics along the Ca isotopic chain, and modifications to shell-model effective interactions based on the new findings will be presented.

[1] A. Gade et al., Phys. Rev. C **74**, 021302(R) (2006);
[2] R. V. F. Janssens et al., Phys. Lett. B **546**, 55 (2002);
[3] D.-C. Dinca et al., Phys. Rev. C **71**, 041302(R) (2005);
[4] J. I. Prisciandaro et al., Phys. Lett. B **510**, 17 (2001);
[5] A. Bürger et al., Phys. Lett. B **622**, 29 (2005);
[6] M. Honma et al., Phys. Rev. C **65**, 061301(R) (2005);
[7] A. Poves et al., Nucl. Phys. A **694**, 157 (2001);
[8] S. N. Liddick et al., Phys. Rev. Lett. **92**, 072502 (2004);
[9] M. Honma et al., Eur. Phys. J. A **25**, 499 (2005).