

Two-Phonon Octupole Excitation in ^{146}Gd

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Since the identification of the 3^- first excited state in ^{208}Pb , and its interpretation as a collective octupole phonon, numerous attempts have been made to identify the members of the anticipated even-parity 0, 2, 4, 6 two-phonon octupole quartet. But until now the knowledge is still incomplete, and in particular it was not possible to identify the aligned $(3^- \times 3^-)6^+$ quartet member. The experimental situation is somewhat more favorable in ^{146}Gd , the only other nuclide known so far with a 3^- first excited state. This nucleus can be excited in the $^{144}\text{Sm}(\alpha, 2n)$ fusion-evaporation reaction, and an experiment in 1986 [1] has identified two closely spaced 6^+ states (3456 and 3485 keV) interpreted as the double-octupole quartet member and the nearby expected $(\pi d^{-1}_{5/2}, \pi g^{-1}_{7/2})$ two-proton hole level, but the data could not distinguish conclusively between the two assignments. We have now re-investigated ^{146}Gd through the $^{144}\text{Sm}(\alpha, 2n\gamma)$ reaction at the Cologne Tandem accelerator using modern high-efficiency multi-detector γ -arrays. The detector sensitivity was about ten times greater than in the previous work [1]. We have, in general, confirmed previous results and in only a few cases modified them. However, we have observed many new states, and equally importantly, we have identified new decay branches from previously observed levels, thus allowing us to make firmer spin and parity assignments. Among the newly observed levels, new candidates for particle-hole multiplets and two-phonon excitations have been identified. In particular, we have clearly characterized the upper 6^+ state (3485 keV) as the two-phonon octupole quartet member through observation of a new $(E3)$ decay branch to the 1579 keV 3^- one-phonon octupole excitation, and in addition an $(E1)$ decay branch to the lowest 7^- level (2982 keV), which further solidifies the 6^+ character for the 3485 keV state. Finally, we will also present new results pertinent for the above mentioned state at 3456 keV. We note that our results present the first observation of a $6^+ \rightarrow 3^- \rightarrow 0^+$ double $E3$ cascade in decay of a two-phonon octupole state in a doubly closed shell nucleus.

[1] S. W. Yates et al., Z. Phys. A324 (1986) 417.