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Shifted Identical Bands: A New Phenomenon*

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Abstract—The levels in ^{162}Gd were identified in spontaneous fission studies. Its transition energies are remarkably similar to those in ^{160}Gd. From that work, an analysis of yrast bands in even–even proton to neutron-rich Ba to Pb nuclei led to the discovery of a new phenomenon, shifted identical bands (SIB). SIBs are yrast bands in neighboring nuclei (a, b) with moments of inertia which are identical when shifted by a constant amount κ, so $J_{1a}(1 + \kappa) = J_{1b}$, from 2^+ to 8^+ and higher to 16^+. Out of over 700 comparisons, 55 SIBs were found from stable to the most neutron-rich Ce–W nuclei with $|\bar{\kappa}|$ between 1.5% and 13%, where the spread in κ is less than $\pm 1\%$, and only four identical bands ($\bar{\kappa} \cong 0$). As examples, we found for ^{158}Sm–^{160}Gd, $\bar{\kappa} = (-3.2^{+0.1}_{-0.2})\%$ (where the $\pm$ is the total spread in κ from -3.1 to -3.4); ^{156}Nd–^{160}Gd, $(-10.6^{+0.4}_{-0.2})\%$; ^{158}Sm–^{160}Sm, $(3.4^{+0.5}_{-0.3})\%$. The J_1 values were fitted to a variable moment of inertia model with parameters J_0 and C whose values correlate with the SIB J_1 values. The SIBs are not correlated either with deformation or with the N_pN_n product of the IBA model. © *2001 MAIK "Nauka/Interperiodica".*

1. INTRODUCTION

The discovery of identical bands (IB) in both superdeformed and normal deformed bands was a major highlight of nuclear structure research in the 1990s [1]. Bands in two neighboring nuclei with essentially equal transition energies and moments of inertia for every spin state in the band are classified as identical bands. As noted [1], IBs test our theoretical understanding of large amplitude collective motion, demanding more precise microscopic approaches to calculating moments of inertia. Almost all IBs involve even–even and even–odd neighbors in proton-rich nuclei [1]. A series of nearly "IBs" was reported for the α chain ^{156}Dy to ^{172}W compared to ^{180}Os [2]. There, energy similarities were somewhat correlated with N_pN_n. Two IBs have been reported in neutron-rich nuclei, $^{98,\,100}$Sr and $^{108-110}$Ru [3].

While investigating the structure of neutron-rich nuclei in prompt γ–γ–γ coincidence studies in the spontaneous fission of ^{252}Cf, we discovered a new phenomenon, which we call shifted identical bands (SIB). We identified levels in ^{160}Sm and ^{162}Gd [3, 4] and new high spin states in the heavy partners in neutron-rich Ba to Gd nuclei [3]. The new ^{162}Gd yrast transition energies were so similar to ^{160}Gd that this initiated a comparison of the moments of inertia of neighboring even–even nuclei in the $A = 140$–162 region. We classified shifted identical bands as occurring when two yrast cascades in nuclei separated by two to eight nucleons have their transition energies and moments of inertia become identical when E_γ and J_1 for one nucleus are shifted by a constant amount with less than $\pm 1\%$ total spread in the constant κ, where $J_{1a}(1 + \kappa) = J_{1b}$ for every state from 2^+ to 8^+ and higher to 16^+. We extended this analysis to even–even nuclei from Ba to Pb, from proton- to neutron-rich nuclei, and to some excited superdeformed bands. The SIBs are grouped in stable to the most neutron-rich Sm to Yb nuclei known, while SIBs are not seen in their lighter mass nuclei nor in Ba, Ce, or Os nuclei, except

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