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Anomalous transitions in ^{144}Nd and ^{146}Nd in "2-keV" (n, γ) measurements

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CONF-810920--11

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Abstract. In "2-keV" (n, γ) measurements, anomalously strong E1 transitions have been observed to known 2^+ levels in ^{144}Nd and ^{146}Nd .

We have carried out average resonance neutron capture measurements on ^{143}Nd and ^{145}Nd at the Brookhaven High Flux Beam Reactor. The measurements utilized 100 g each of 91.7% ^{143}Nd and 89.7% ^{145}Nd in the oxide form. A Sc filtered neutron beam (Greenwood and Chrien 1976) characterized by a flux of $\approx 7 \times 10^6 \text{ n/cm}^2 \cdot \text{sec}$, a full width at half maximum of $\approx 0.9 \text{ keV}$, and a centroid of $\approx 2 \text{ keV}$ was employed. The resulting γ -ray spectra represented an average over ≈ 28 resonances in ^{143}Nd and over ≈ 47 resonances in ^{145}Nd . The ground states of both target nuclei are $7/2^-$. Since capture at 2-keV proceeds mainly via s-wave, the capturing states are 3^- and 4^- in the ratio $\approx 7:9$. The γ -ray spectra were obtained with a pair spectrometer having a central $55 \text{ cm}^3 \text{ Ge(Li)}$ detector and two $25 \text{ cm} \times 18 \text{ cm} \text{ NaI(Tl)}$ detectors. The E1 transitions to the 3^+ and 4^+ levels in ^{144}Nd and ^{146}Nd are expected to be ≈ 2.3 times more intense than E1 transitions to 2^+ levels.

The results are shown in Fig. 1. The most striking feature is the enhancement in the intensities of transitions leading to the 1560 keV level in ^{144}Nd and the 1778 keV level in ^{146}Nd . The 1560 keV level is known to be a definite 2^+ level (Behar, Grabowski and Raman 1974). The 1773 keV level is most probably also a 2^+ level (Berant, Tenenbaum and Moreh 1977). If one relied only on average capture measurements, one would have erroneously concluded that these were 3^+ or 4^+ levels. The intensity enhancements are especially interesting because they are also present in average-resonance capture measurements (Bushnell, Tassotto and Smither 1976) with "reactor neutrons", where averaging takes place over approximately similar number of resonances.

In the case of ^{144}Nd , there are strong reasons, based on systematics and shell model calculations (Raman et al 1973), to suppose that the 1560 keV level is predominantly a "two-proton" 2^+ excitation. Even so, it is surprising that the γ -ray intensity, averaged over so many resonances, shows sensitivity to such nuclear structure details. In the same vein, an anticorrelation has been reported (Weigmann, Rohr and Heske 1972) between the strengths of transitions from 3^+ resonances to "one- and two-phonon final states" in ^{144}Nd .

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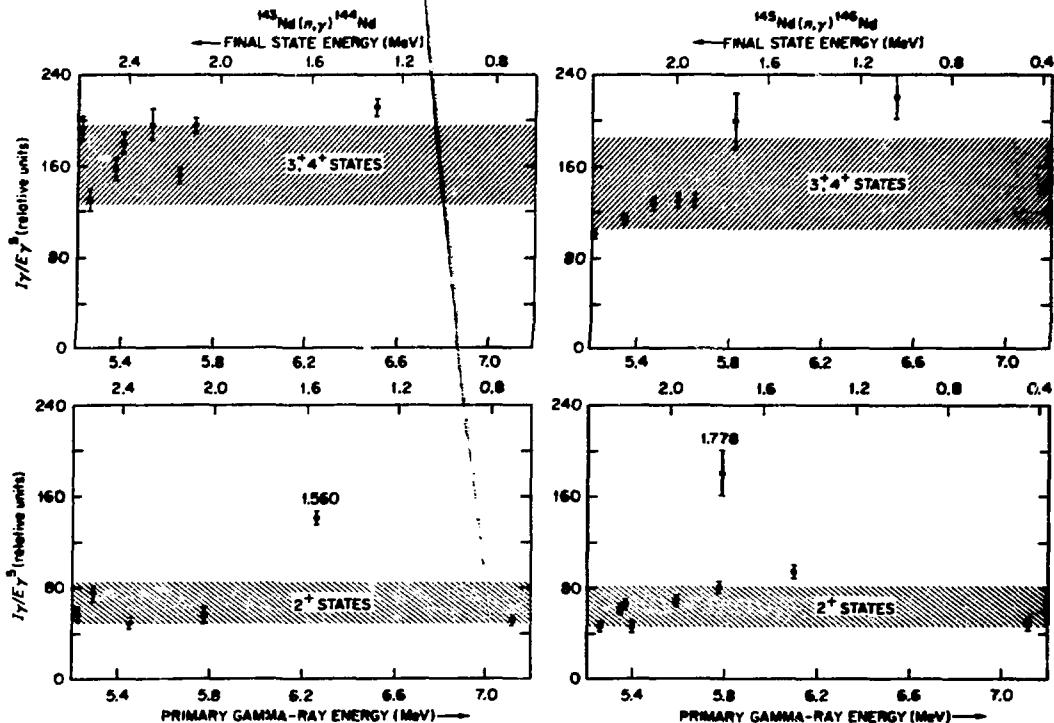


Fig. 1. Summary of average capture results

The hospitality and assistance provided by the Brookhaven National Laboratory (n, γ) group are gratefully acknowledged.

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[#]Research sponsored by the U S Department of Energy under contract W-7405-eng-26 with the Union Carbide Corporation (ORNL) and under contract DE-AC02-76CH00016 with the Associated Universities, Inc (BNL)

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