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THE ALPHA DECAY SCHEME OF 152 YEAR Am^{242m}

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ABSTRACT

Detailed nuclear spectroscopy studies on the alpha decay of Am^{242m} show many low-lying energy levels which have been interpreted in terms of a few rotational bands. The predominant alpha decay is of the unhindered type observed in the even-even and odd-mass nuclides. The rotational bands can be interpreted in terms of the Nilsson orbitals associated with odd-mass nuclides as can the moments of inertia, and the interband alpha and gamma-ray transition probabilities. There is also evidence of an appreciable Coriolis interaction between different rotational bands having the same Nilsson orbital assignments (one of which is $K = 1/2$).

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A preliminary investigation[1] of the alpha decay of Am^{242m} indicated further detailed studies could contribute substantially to the understanding of the energy levels of strongly deformed odd-odd nuclei. The most highly enriched samples of Am^{242m} made by conventional neutron bombardment of Am^{241} however, contain only ~1.5 x 10^{-2} percent Am^{242m} by alpha activity, and the predominant Am^{241} activity masks to a large extent the Am^{242m} alpha decay radiations. Therefore suitable samples for alpha, electron, and gamma ray spectroscopic measurements were prepared with the aid of the excellent mass separator at the Institute for Theoretical Physics in Copenhagen, Denmark.

The alpha spectra measurements showed groups of 5.404 (~1.6), 5.360 (~1.6), 5.308 (0.8), 5.28 (0.4)?, 5.244 (0.6), 5.201 (88), 5.136 (5.7±0.2), 5.082 (0.30±0.06) and 5.061 Mev (0.25±0.06 percent). The main group of Am^{241} at 5.482 Mev was used as an energy standard for these measurements.

The electron spectra indicated only an 87-kev M1 transition which could be assigned to the Am^{242m} alpha decay.

The main gamma ray studies consisted of delay measurements and coincidence studies of the L x-ray and gamma ray spectra occuring before and after two metastable states. The results of these experiments are shown in the decay scheme in Fig. 1. The dashed quantities, those in parentheses, and the relative positions of the 48 and 87 kev gamma rays are considered somewhat uncertain.

* Work done under the auspices of the U.S. Atomic Energy Commission.

The assignment of spins and parities to the various Np^{238} levels depends considerably on the values assigned to the 337-kev level. The partial alpha half-life for the decay of this level is essentially unhindered. In the even-even and odd-mass nuclides the unhindered (or favored) type of decay populates states in the daughter nucleus having the same configuration as the parent. As K, π, and I had been assigned 5-5 for Am^{242m},[2] we calculated the expected relative alpha intensities[3] to the rotational members of a similar 5-5 band in Np^{238}. As is seen in Table I the agreement is very good; even with respect to the energy spacings, which will be discussed later.

Table I. Am^{242m} Favored Alpha Decay to 5- Band

K π I	Energy spacings (kev)		Calc. abundances (percent)				Exp. abundances (percent)
	Calc.	Exp.	L=0	L=2	L=4	Sum	
5 - 5	----	----	65.2	22.8	0.023	88.0	88
5 - 6	66.0	65.7	----	5.6	0.021	5.6	5.66(±0.17)
5 - 7	143.0	142	----	0.33	0.006	0.34	0.25(±0.06)

In Fig. 1 the assigned rotational bands of Np^{238} are classified in terms of the adjacent odd-mass Nilsson orbitals. These orbitals are listed as A, B, etc. according to their increasing excited state energy in the appropriate odd-mass nuclides. All of the observed alpha and gamma ray transitions shown in Fig. 1 can be interpreted as taking place between levels having at least one common Nilsson orbital. In five instances where comparisons could be made, the reduced gamma-ray and alpha-particle transition probabilities were within a factor of four of the values for the corresponding odd-mass transitions in Cm^{243} and Am^{243} alpha decay. This served as a basis for the assignment made to the 462 kev level.

The rotational energy spacings were calculated from the moments of inertia of the corresponding levels in Np^{237} modified by the difference between the even-even and the corresponding odd-neutron moments of inertia. The agreement was good for the bands BB(5-) and BA(3-) but the calculated spacings for the AA(2+) band were about 15% too small.

A peculiar ratio of intensities for the E1 gamma rays populating the AA(2+) band can be explained qualitatively by a Coriolis interaction between AA(2+) and AA(3+), and BA(3-) and BA(2-) (unobserved).

REFERENCES

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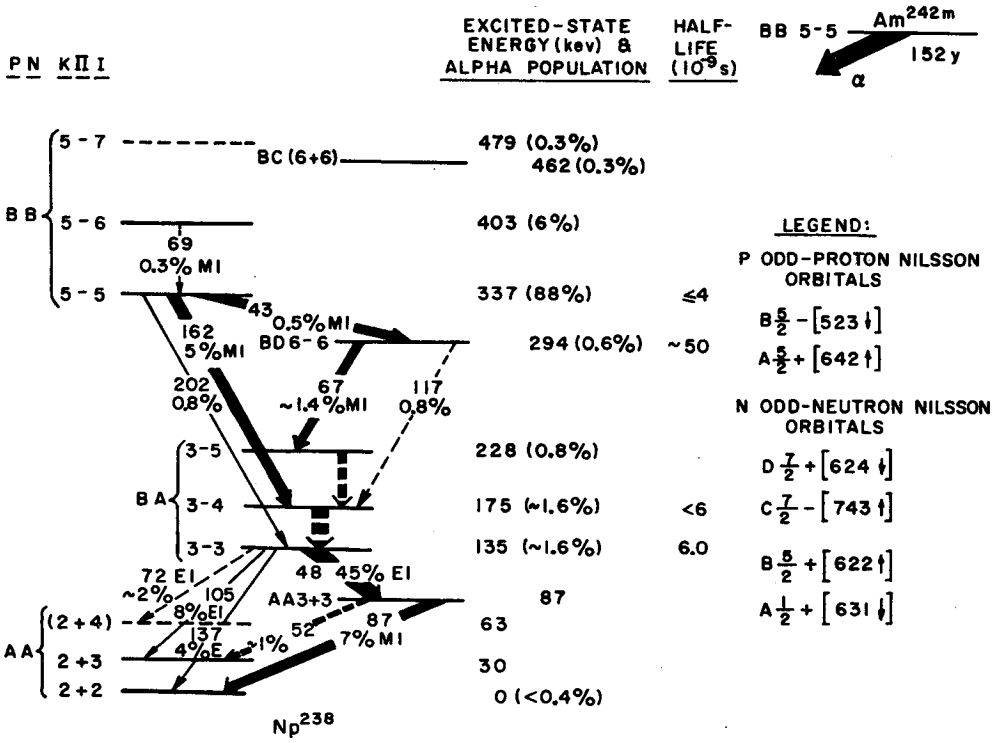

Fig. 1. The alpha decay scheme of Am^{242m}.