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Short Note

Structure of the odd-odd-nucleus ^{84}Nb

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Abstract. The nucleus ^{84}Nb has been studied with the ^{58}Ni(^{28}Si,pnγ) reaction at 90 MeV. Several rotational structures are established and connected to an irregular low-energy level scheme which includes one isomeric level whose decay was observed before.

PACS. 21.10.-k Properties of nuclei – 27.50.+e $59 \leq A \leq 89$

The nucleus ^{84}Nb belongs to the transitional region in the immediate vicinity of the N≈Z deformed nuclei with A≈80 [1], therefore its detailed study is interesting as it may clarify aspects related to the neutron-proton pairing interactions.

Two band structures presumably with high spin states, of a few transitions each, have been assigned to this nucleus by Gross et al. [2]. Apart from this, other information concern the $J^\pi = 3^+$ assignment to the ground state from its beta decay properties [3], and the existence of an isomeric level with $\tau = 150(70)$ ns [4] decaying by five γ-rays (not placed into a level scheme).

It is the purpose of this note to report a more complete level scheme of ^{84}Nb, which includes both several high-spin bands and their connection to the low-energy level scheme. The nucleus has been populated in the reaction ^{58}Ni(^{28}Si,pn) at 90 MeV, in a 'thin' target experiment. The target consisted of a stack of two 0.5 mg/cm^2 ^{58}Ni foils. Gamma-rays and charged particles were detected with the GASP array (40 CS HPGe detectors and an 80 BGO inner ball) and the ISIS ball (40 ΔE-E Si telescopes), respectively. Events have been collected if the multiplicities were a minimum of two in the Ge detectors and a minimum of three in the BGO ball. A total of 10^9 events have been collected and off-line sorted in matrices gated by charged particles and a γ-γ-γ cube. Standard double and triple coincidence analysis has been made starting from the known γ-rays assigned to ^{84}Nb [2].

The level scheme resulted from this analysis is shown in Fig. 1. We note the following points. (i) The band structures A and B, generally agree with those from [2] and have been prolonged to high spins; in addition, they were anchored to the low-excitation level structure evidence in the present work. The low-energy portions of other three band structures (one of them with both signatures) are also found. (ii) A complex level scheme has been established at low energies, very likely ending with the ground state; (iii) The coincidence data establish a level at 48.0 keV excitation; since the 48 keV transition was not observed, it is possible either that this level is an isomer (with lifetime larger than a few hundred ns) or that its transition is highly converted. (iv) The established low-energy level scheme includes the isomeric state found in ref. [4]; the γ-rays with energies 175.2, 132.6, 114.5, 205.0 and 140.0 keV, assigned in [4] to the decay of the isomer, and, in addition, a transition of 65.0 keV were seen in our coincident spectra with reduced intensities. The excitation energy of the isomer is established at 338.0 keV (Fig. 1). (v) A set of levels which feed one of the signatures of band A in a remarkable way, via high energy transitions (Fig. 1) is also observed.

DCO ratios have been determined for most of the transitions; they generally agree with those of ref. [2] and support the multipolarities shown in Fig. 1 in bands A and B, which are the most strongly populated. Their J^π values in Fig. 1 were tentatively assigned on the basis of systematics of similar bands in ^{82}Y [5], ^{84}Y [6] and ^{86}Nb [7]. Band A has a signature splitting characteristic of the $\gamma g_{9/2} \otimes \pi g_{9/2}$ structures, whereas band B that of the $\nu g_{9/2} \otimes \pi f_{5/2}$ structures [5–7]. Such configuration are also supported by blocking arguments [2]. The DCO ratios of the 585.8, 358.1 and 228.1 keV transitions support

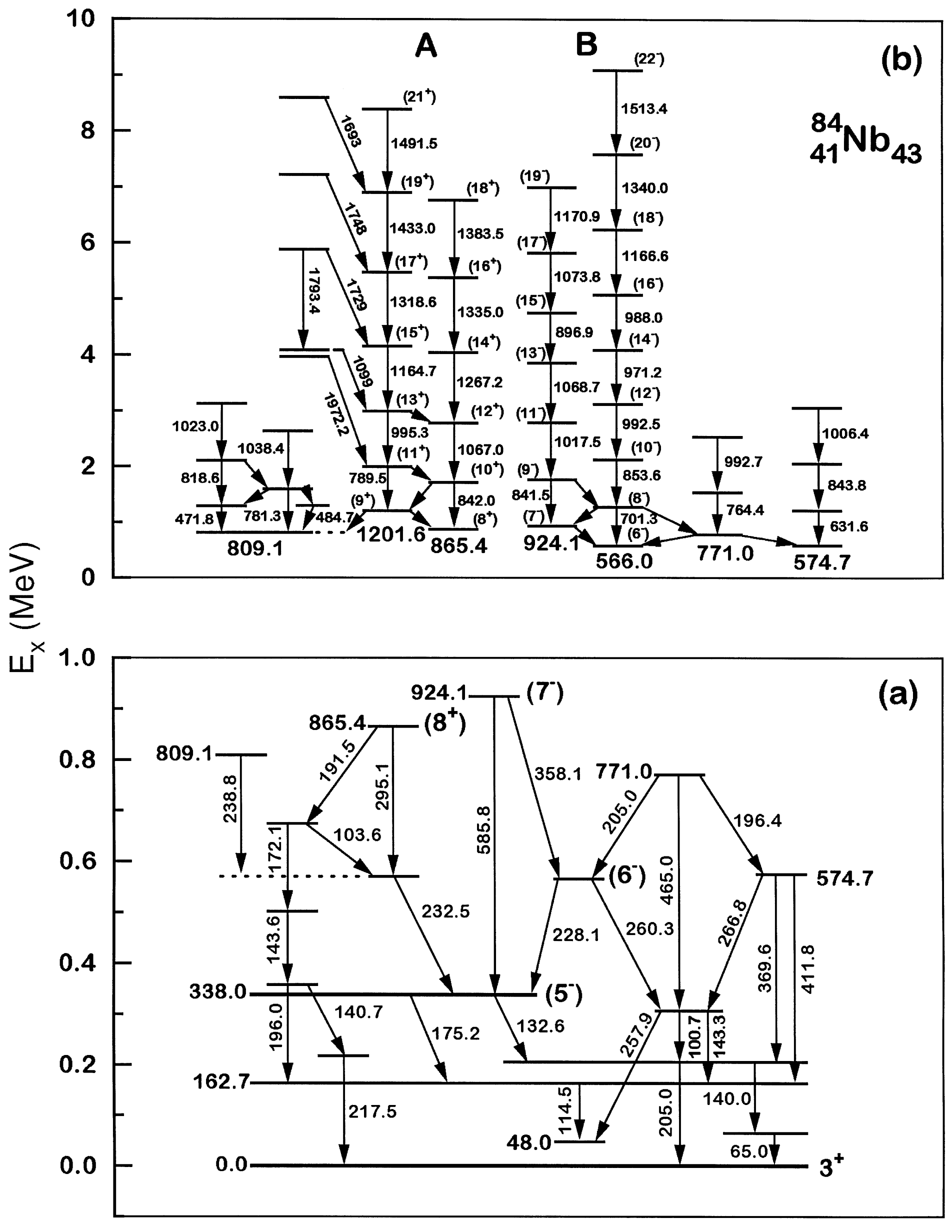

Fig. 1. Level scheme of ^{84}Nb established in the present work: (a) low-energy portion; (b) high-energy portion

a $J^\pi = (5^-)$ assignment for the 338 keV isomer, which is consistent with the lifetime and the observed decay path to the 3^+ ground state. The 132.6 and 175.2 keV isomeric transitions could be of the E1, M1 or E2 type, M2 being ruled out by unacceptably large strengths (larger than 40 W.u.). Low-lying negative-parity isomers are present in the neighbouring odd-odd nuclei, and deexcite by strongly hindered E1 transitions [5,6]. this would suggest E1 multipolarity for the 132.6 and 175.2 keV transitions, their hindrances being similar to the known ones [5,6]. Unambiguous spin-parity assignments for the low-lying states in Fig. 1(a) are, however, difficult to make at present.

Further comments on the observed structures will be made in forthcoming publication.

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