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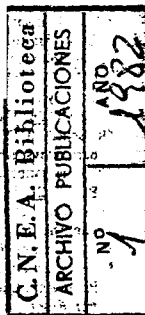
Collective states in the doubly odd ^{72}Br nucleusG. García Bermúdez,^{*} C. Baktash,[†] and O. Kistner

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Lifetimes of states of ^{72}Br produced by the reaction $^{58}\text{Ni}(^{16}\text{O}, np)$ have been measured by the recoil-distance Doppler-shift method. The transition rates deduced for the 353.3, 323.2, and 270.0 keV transitions are 66(15), 125(40), and 79(35) single particle units, respectively. The identification of the levels, deexcited by these transitions, as member of the $\pi g_{7/2} \otimes \nu g_{7/2}$ structure is discussed.

NUCLEAR REACTIONS $^{58}\text{Ni}(^{16}\text{O}, np)$ $E = 50$ MeV; measured Doppler shift, deduced, $T_{1/2}$.



A recent study of the doubly odd nucleus, ^{72}Br , established a γ -ray cascade of quadrupole transitions. The decay properties of this cascade suggest that these γ rays deexcite positive parity states. Positive parity $\Delta I = 1$ bands had been found in $^{74,76}\text{Br}$ (Refs. 2 and 3). The band in ^{76}Br has been described assuming two noninteracting quasiparticles of $g_{7/2}$ parentage, coupled to a rigid rotor.⁴ From the linear relationship between the level energy and $I(I+1)$ which shows an effective moment of inertia similar to that of $^{74,76}\text{Br}$ (see Fig. 5, Ref. 1), it can be suggested that the ^{72}Br cascade could likewise be associated with the high spin intrinsic $\pi g_{7/2} \otimes \nu g_{7/2}$ configuration. The purpose of this work is to explore further these similarities by measuring the lifetimes of the levels of interest in order to determine the degree of collectivity involved.

Lifetimes were measured by the recoil-distance Doppler-shift technique. The nuclei were produced by the $^{58}\text{Ni}(^{16}\text{O}, np)$ reaction, provided by the Brookhaven National Laboratory tandem accelerator. The target was a stretched ^{58}Ni foil (99.9%) of 0.4 mg/cm² thickness and a thick piece of ^{209}Pb was used to stop the recoiling nuclei and the beam. The target-stopper distance was varied from 1–10 000 μm . γ rays were measured with a Ge(Li) detector placed at 0° relative to the beam direction. The average recoil velocity (V/c) of the ^{72}Br nuclei as determined from the energy shift between the fully Doppler-shifted and unshifted γ ray was 1.58(5)%. An automated plunger device was used for these measurements which provided the capability of repeatedly cycling through a predetermined set of recoil distances, changing position every few minutes. In this way, systematic errors arising from drifts in the electronics and changes in the condition of the target due to the action of the beam were minimized. The cycling time was determined by γ -ray counts derived from windows set on the 774.7 and 862.0 keV transi-

tions, which deexcite levels of ^{72}Se . Several sets of measurements covering different flight distance intervals were performed. Due to background and interfering effect from other γ rays, most of the transitions were analyzed measuring the intensity of the unshifted peak with the exception of the 353.3 keV transition where measurements of the shifted peak were more favorable. The area of the unshifted transitions were corrected for solid angle, normalizing the data with the intensity of the Pb x ray observed from the moving stopper. A preliminary analysis of the data indicated that the lifetimes of the 1448.0, 1344.7, 991.4, and 668.2 keV levels ranged from 40 to 200 ps. Similarity in lifetimes, among these levels, made it necessary to analyze each level considering the influence of delayed feeding from the higher levels as well as side feeding. For this purpose, the code MASTER,⁵ which describes the time evolution of the deexcitation process between many nuclear levels, was used. This analysis shows that the 1448.0 keV level, deexcited by the 103.3 keV transition, has a composite decay where the lifetimes of the unknown feeding component are similar to that of the 1448.0 level itself, which resulted in 40(25) ps. This corresponds to a transition rate for the 103.3 keV dipole transition in Weisskopf units [$S(x) = B(x)_{\text{exp}}/B(x)_W$] of $S(E_1) = 1.2(7) \times 10^{-2}$ W.u. and $S(M_1) = 0.7(4)$ W.u. These strengths agree with the recommended upper limits obtained from Endt⁶; $S(E_1) = 10^{-2}$ W.u. $S(M_1) = 3$ W.u. for this mass region. The analysis of the remaining levels yields lifetimes for the side feeding components of less than 2 ps. An upper limit of 5 ps was obtained for the lifetime of the 842.3 keV transition. In Table I the experimental transition probabilities for the 353.3, 323.2, and 270.0 keV quadrupole transitions are reported. They show a strength ranging from 66 to 125 single particle units. This enhancement clearly indicates that these levels are highly collective and supports the previously not-

TABLE 1. Lifetimes and transition probabilities in ^{72}Br .

State (keV)	I	E_γ (keV)	$I_i \rightarrow I_f$	Branch (%)	τ (ps)	$B(E2)_{exp}$ ($10 e^2 \text{fm}^4$)	$\frac{B(E2)_{exp}}{B(E2)_w}$
1344.7	(8)	353.3	(8) \rightarrow (6)	100	126(28)	117(26)	66(15)
911.4	(6)	323.2	(6) \rightarrow (4)	100	104(31)	222(70)	125(40)
668.2	(4)				206(80)		
		270.0	(4) \rightarrow (2)	51	404(180)	140(60)	79(35)
		289.1	(4) \rightarrow (2)	22	936(420)	43(20)	24(11)

ed similarities with the band structure found in the heavier isotopes $^{74,76}\text{Br}$.

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³G. García Bermúdez, C. Baktash, A. J. Kreiner, and M. A. J. Mariscotti, Phys. Rev. C **25**, 1396 (1982).

⁴G. García Bermúdez, A. Filevich, A. J. Kreiner, M. A. J. Mariscotti, C. Baktash, E. der Mateosian, and P. Thieberger, Phys. Rev. C **23**, 2024 (1981).

⁵M. Behar, A. Filevich, G. García Bermúdez, and M. A. J. Mariscotti, Nucl. Phys. **A282**, 331 (1977); A. J. Kreiner, G. García Bermúdez, M. A. J. Mariscotti, and P. Thieberger, Phys. Lett. **83B**, 31 (1979).

⁶A. J. Kreiner and M. A. J. Mariscotti, Phys. Rev. Lett. **43**, 1150 (1979).

⁷H. Emling, Gesellschaft für Schwerionenforschung, Darmstadt (private communication).

⁸P. M. Endt, At. Data Nucl. Data Tables **23**, 547 (1979).