EXCITATION SPECTRA OF EVEN-EVEN NUCLEI OF NON-DEFORMED REGION

R. V. RAMAMOHAN

DEPARTMENT OF PHYSICS, UNIVERSITY OF AGRICULTURAL SCIENCES, BANGALORE, INDIA,

(*Received August* 29, 1967)

Augular correlation studies of three even-even radioactive nuclei, namely Fe^{58}, Te^{124} and Ba^{134}, which come under the non-deformed region of mass $40 \leqslant A \leqslant 154$ where undertaken by Rama Mohan *et al* (1965 and 1967). in order to assign the spins of the excited states and the characteristics of transitions, by using a slow-fast triple coincidence scintillation spectrometer. These experimental results are now analysed with those predicted theoretically on the basis of various existing models by Bohr and Mottelson (1953), Davydov and Fillipov (1958, 1960), Mallaman (1961), Raz(1959), Schraff G-Goldhaber *et al* (1958) and Wilets and Jean (1956).

The general characteristics observed by the experimental studies of Ramamohan *et al*, are 0^+, 2^+ spins for the ground and first excited (1965, 1867) states for all the three even-even nuclei, with quadrupole multipolarities in the transition from the first excited state to the ground state.

The spin of the second excited state of Te^{124} is characterised by spin 4 where as those of the remaining two nuclei by the spin 2. These characteristics of Te^{124} confirm the Bohr-Mottelson's model, for even-even nuclei with the ground state rotational bands with 0^+, 2^+, 4^+ values. There is, however, an exception to the regularities observed in the even- even nuclei in the region $40 \leqslant A \leqslant 154$. The ground state rotational band in even-even nuclei are characterised by consecutive states with ΔI being 2 and the transition proceeds by a cascade of pure $E2$.

According to Scharff- Goldhaber and Weneser, the following characteristics are observed in the region of $66 \leqslant A \leqslant 154$. The ratio of the energy of the second excited state to that of the first excited state ranges between 2 and 2.5. The low lying states usually have the spin sequence 0^+, 2^+ and 2^+ and the E2 cross over transition occurs with greater probability than the upper transition. The cross over transition $2^+ \rightarrow 0^+$ proceeds by E2 while the upper transition is predominantly E2 with a small admixture of M1. Coulomb excitation data also indicate that the probability for a transition from the first excited state to the ground state is higher than that which would be expected on the basis of a single particle model. This fact reveals that the large E2 transition probabilities in case of lighter elements are due to collective excitations of individual nucleons. Besides, it is also noted that the energy of the first excited state increases as the number of neutrons or protons approaches to the completion of the shell and shows a prominent peak at the filled shell. These facts predicted theoretically by nuclear models are noticed in the level characteristics of Fe^{58} and Ba^{134} arrived by the experimental investigations of Ramamohan *et al*, (1965, 1967).

The spin sequence of the ground, first and second excited states of Fe^{58} and Ba^{134} are obtained as 0, 2 and 2. The ratio between the energies of the second excited state to the first one is respectively 2 and 1.93. Further the transition from the second to the first excited state is characterised by E2+M1 multipolarities. This result confirms the validity of the theoretical predictions of Mallaman (1961). The 0^+, 2^+ and 2^+ pattern in the low lying excited states is mainly due to collective vibrations of individual nucleons.

The slight decrease in the value of the ratio between the energies of the second excited state to that of the first for Ba^{134} is due to the fact that the neutron number 78 of that isotope is in the vicinity of the magic number 82.

The harmonic pattern of energy levels of Ba^{134} at energies 605 keV. 1168 KeV and 1845 keV with the spins 0, 2 and 4 and with the dipole radiation in $4 \rightarrow 2$ transition is in agreement with the Bohr-Mottelson's predictions of weak to moderate coupling model.

The 0, 2 and 2 spin levels with energies 0 keV, 800 keV and 1600 keV, observed in the studies of Fe^{58} by the same investigators Ramamohan *et al*,, form the harmonic pattern supporting the theoretical predictions of Bohr-Mottelson model in the region of strong coupling with unstable potential.

Hence, it is concluded that the nuclear excitation spectra arrived by experimental studies is in good agreement with that predicted by theoretical methods, using the various nuclear models.

REFERENCES

Bohr, A. and Mottelson, B., 1953, *Mat. Fys. Medd. Dan. Vid. Selsk*, **27**, No. 16.

Davydov., A. and Fillipov. G., 1958, *Nucl. Phy.*, **8**, 237.

———, 1960, *Nucl. Phy.* **20**, 499.

Mallaman, G., 1961, *Nucl. Phy.* **24**, 535.

Ramamohan, R. V., Venkata Reddy. K., Venkatapathi Raju and S. Jnanananda, 1966. *Ind. Jr. Pure and App. Phy.*, **4**, 420.

——— –, 1965, *Indian J. Phy.*, **39**, 521.

———, 1967, *Indian J. Phy.*, **41**, 30.

Raz, B., 1959, *Phys. Rev.*, **114**, 1116.

Scharff. *G*-Goldhaber and Weneser, 1958, *Phys. Rev.*, **98**, 212.

Wilets, L. and Jean, M., 1956, *Phys. Rev.*, **102**, 788.