New estimates of quadrupole deformation β of some nearly spherical even Mo Nuclei

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The deformation parameter β and γ of the collective model of Bohr and Mottelson are basic descriptors of the nuclear equilibrium shape and structure [1]. In recent past the sets of deformation parameters (*β, γ*) have been extracted from both level energies and E2 transition rates in even Xe, Ba and Ce nuclei [2] and Hf, W, Os, Pt and Hg nuclei [3] using rigid triaxial rotor model of Davydov – Filippov [4]. Researchers have found that the values of *β* obtained separately from energy and transition rate though, are found almost equal in nuclei possessing small asymmetry $(0 < \gamma < 20)$but, not so in nuclei having large asymmetry $(\gamma > 20)$. This observation puts a question mark whether the *β* dependence of moment of inertia in hydrodynamic model is reliable [2, 3].

The Mo nuclei chain has typical character since the deformation parameter $\beta A^{2/3}$ for $^{90-98}$Mo found to be less than 4 and more than 7 for ^{102}Mo, ^{106}Mo nuclei only. However, the value of $\beta A^{2/3}$ for ^{100}Mo nucleus lies between 4 and 7. Thus, the isotopic chain of Mo nuclei under consideration has vibrational, triaxial and well deformed shapes. We calculate the moment of inertia I_0 from the relation $I_0 = \frac{\varepsilon 2_1}{E2_1}$ for all the considered nuclei. The systematic between N_pN_n and I_0 or β have been found similar. It has been observed that there is nearly linear relationship between β and I_0 fig.1 [5].

The β - I_0 systematics has been used to estimate β knowing the values of I_0 for $^{84-108}$Mo nuclei.

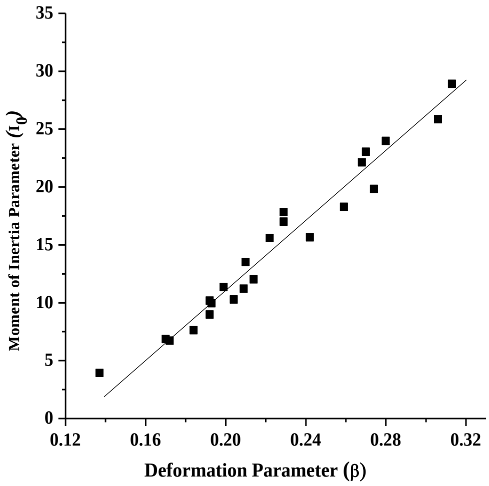

Fig.1

The product of valance proton and valance neutron N_pN_n, asymmetric parameter γ_e calculated from energy, moment of inertia I_0, quadrupole deformation β experimental and predicted from our systematic are listed in table 1 for $^{84-108}$Mo nuclei along with the corrected values of β for nearly spherical nuclei.

Table 1

Nucleus	N_pN_n	γ_e(in deg.)	I_0	β(exp)*	β(pred.)	β(revised)
^{84}Mo	64	24	12.5	-	0.202	-
^{86}Mo	48	25	10.0	-	0.183	-
^{88}Mo	32	26	7.8	-	0.164	0.156
^{90}Mo	16	27	6.2	-	0.153	0.143
^{92}Mo	0	28	3.9	0.106	0.146	0.097
^{94}Mo	16	27	6.1	0.151	0.166	0.135
^{96}Mo	32	28	7.6	0.172	0.172	-
^{98}Mo	48	29	6.8	0.168	0.167	-
^{100}Mo	64	30	11.2	0.231	0.197	-
^{102}Mo	80	23	18.3	0.311	0.311	-
^{104}Mo	96	19	25.8	0.362	0.299	-
^{106}Mo	112	19	28.9	0.354	0.321	-
^{108}Mo	128	18	25.2	0.380	0.380	-

data have been taken from ref. [7].

It is clear from table 1 that the values of β and I_0 are minimum at N_pN_n = 0 for ^{92}Mo nucleus. The values of these parameters are increasing in both sides upwards as well as downwards, since N_pN_n is increasing. ^{98}Mo is only exception where the value of β is less than value of preceding nucleus ^{96}Mo.

In this work, a different rotational formula has been employed valid for nearly spherical nuclei. The standard rotational formula works only for strongly deformed nuclei where β~ 0.15 and breakdown when the deformation is less. Such nuclei have non-negligible amplitude in the wave function and their contribution to the transition rates needs to be handled with care. Robledo and Bertsch have proposed an interpolation formula which describes the transition strength in nearly spherical nuclei [6]. We have revised the values of β in $^{88-96}$Mo and are written in last column of table 1. It is observed that the value of β_{exp} and β_{revised} in ^{92}Mo have become closed where N_pN_n = 0. In addition to this the increasing trend in values of β in nuclei beyond ^{92}Mo became uniform.

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