JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN VOL. 34, SUPPLEMENT, 1973
PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON NUCLEAR MOMENTS AND NUCLEAR STRUCTURE, 1972

VII-4 Change in Mean Square Radius between Ground and Excited States in Deformed Nuclei

M. SANO and M. WAKAI

Department of Physics, Osaka University, Toyonaka, Osaka

Nuclear rotational motion gives a few influences on the structure of nucleus.[1-2] One of them is the so called centrifugal stretching effect and the other is the antipairing effect. An intuitive interpretation of the former effect is that the centrifugal force stretches a nucleus and nuclear shapes change with angular momentum. Previously[1] we calculated the difference of the quadrupole deformation of 2^+ and 0^+ states in the ground band $\delta\beta_2$ taking account of the antipairing effect. In that work only the quadrupole deformation β_2 was considered and the hexadecapole deformation β_4 was ignored. The results of our calculation showed that the sign of $\delta\beta_2$ is positive and supported the intuitive interpretation. Recently the difference of the monopole moment of 2^+ and 0^+ ground band states $\delta\langle r^2\rangle/\langle r^2\rangle$, the isomer shift, was systematically measured for rare-earth nuclei by using the Mössbauer effect and muonic atoms.[3] An interesting fact is that the sign of $\delta\langle r^2\rangle/\langle r^2\rangle$ is not always positive and is negative for nuclei in the latter half of the rare-earth region. The relation between $\delta\beta_2$, $\delta\beta_4$ and $\delta\langle r^2\rangle/\langle r^2\rangle$ is given as follows:

$$\delta\langle r^2\rangle/\langle r^2\rangle = \frac{5}{2\pi}\left\{\left(\beta_2 + \frac{15}{\sqrt{98\pi}}\beta_2\beta_4\right)\delta\beta_2 + \left(\beta_4 + \frac{15}{7\sqrt{4\pi}}\beta_2^2\right)\delta\beta_4 + \cdots \right. \quad (1)$$

Here, $\delta\beta_2$ and $\delta\beta_4$ are the differences between the deformation parameters which give the energy minimum for the ground 0^+ and first 2^+ states. As the second term in the right hand side is small, the sign of $\delta\langle r^2\rangle/\langle r^2\rangle$ is almost determined by the first term only. In some cases $\delta\beta_2$ becomes negative. This improves the results in our previous work so as to fit the experiments. We recalculated $\delta\langle r^2\rangle/\langle r^2\rangle$ taking account of both the quadrupole and hexadecapole deformations. The used parameters defining single particle level spectra are those of Gustafson *et al.*[4] The values of the deformation parameters β_2 and β_4 in the ground state coincide with those obtained by Möller.[5] The results are plotted on Fig. 1 with experimental values as a function of atomic mass number. We can see from Fig. 1 that the introduction of the hexadecapole deformation explains qualitatively the experimental tendency of the isomer shift.

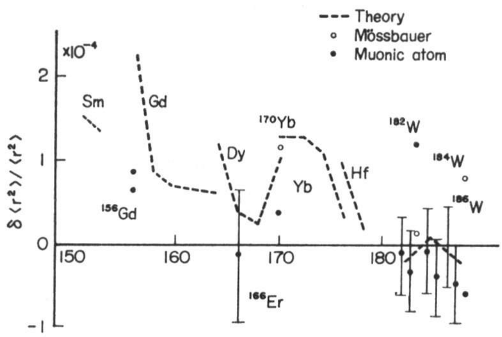

Fig. 1

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