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V–3 Excited Deformation in Odd Mass Indium Isotopes

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Possibility[1] of quadrupole deformation in the odd mass In isotopes is investigated by a microscopic theory. We use the wave functions projected from an intrinsic wave function, *i.e.* a Slater determinant. Our model space is composed of $1g_{7/2}$, $2d_{5/2}$, $2d_{3/2}$ and $3s_{1/2}$ levels for particles and a $1g_{9/2}$ level for holes; all the lower *j*-levels are fully occupied. Therefore the surface region on the nuclei is deformable. The proton intrinsic state is the one-particle two-hole state which is formed by exciting a proton from the $1g_{9/2}$ state to the Nilsson state $1/2^+$ [431]. The $N_{eff} = N - 50 - \alpha$ neutrons occupy the lower Nilsson levels in our model space, where α is introduced in order to take into account the occupation in the higher major shell. We use the Yukawa interaction of strength 50 MeV and range 2.1 fm with a Rosenfeld mixture.

For $N_{eff} = 12$, the dependence on a deformation parameter β for the total kinetic energy and proton-neutron (P-N) interaction is shown in Fig. 1; the β-dependence of the latter is attributed mainly to the interaction between the proton in the Nilsson state $1/2^+$ [431] and twelve neutrons. Our results indicate that between $\beta = 0.1$ and $\beta = 0.2$, the fall of P-N interaction energy is almost equal to the gain of kinetic energy. Therefore we can conclude by adding P-P and N-N interactions that the minimum of the energy curve appears at around $\beta = 0.2$. In fact the equilibrium deformation $\beta \simeq 0.15$ is obtained from Fig. 1, *i.e.* P-N interaction and kinetic energy. The excitation energy of this $K = 1/2$ rotational band is about 500 keV. However, P-N interaction cannot give the negative decoupling parameter,[1] but gives the spin sequence $5/2^+$ (lowest), $1/2^+$, $3/2^+$, $7/2^+$ for this rotational band. For $N_{eff} = 14$ and 16 the neutrons occupy the Nilsson states $5/2^+$ [402] and $7/2^+$ [404], and then because of shell effect the β-dependence of P-N interaction energy becomes smaller than that for $N_{eff} = 12$. This means that the states with $N_{eff} \gtrsim 14$ are not favourable to deformation.

As the numerical values of magnetic moment $\mu_{3/2^+}$ for the deformed $3/2^+$ state, 0.96 n.m. at $\beta = 0.1$ and 0.56 n.m. at $\beta = 0.2$ are obtained by using our wave function and $g_s = 1/2\ (g_s)_{free}$. The expectation values of s_z and l_z for proton are respectively -0.24 and 1.23 at $\beta = 0.2$; for neutron the values of $\langle \Sigma s_z \rangle$ and $\langle \Sigma l_z \rangle$ are -0.0032 and 0.52. If $\delta g_l = -0.1\tau_3$[2] is used, the above numerical values of $\mu_{3/2^+}$ increase by 0.07 n.m. at $\beta = 0.2$ and 0.24 n.m. at $\beta = 0.1$. The calculated values with δg_l are in better agreement with the observed value.[3]

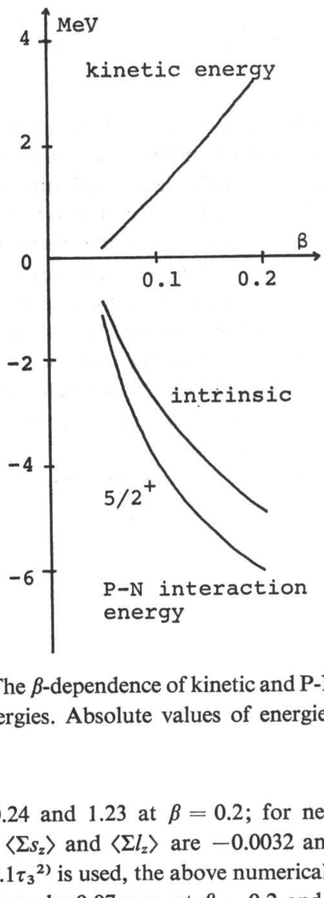

Fig. 1. The β-dependence of kinetic and P-N interaction energies. Absolute values of energies are not shown.

Our wave function gives -0.63 barn ($\beta = 0.2$) as the value of quadrupole moment for the $3/2^+$ state if we use $\delta e_{eff} = 1.0$.

References

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