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New ground-state band energy formula for transitional nuclei

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In the work done by Brentano et al.[1], a two parameter formula for yrast energies in soft rotors or transitional nuclei was proposed, that is $E=\frac{1}{\Im_0(1+\alpha I+\beta E)}$I(I+1), where the moment of inertia depends linearly on spin I and excitation energy E, but it was not pointed out by them how it was deduced, we tend to believe that their formula lacks a clear physical significance, so in the present work a new formula for soft rotors or transitional nuclei is tried to derive. In the variable-moment-of-inertia (VMI) model[2], the following expression for the energy of the state with spin I is yielded:

E$_I=\frac{I(I+1)}{2\Im_I}[1+\frac{I(I+1)}{4C\Im_I^3}]$ (1)

In the limit of very soft nuclei, Eq. (1) then becomes

E$_I(\sigma\to\infty)=\frac{3}{4}\frac{I(I+1)}{\Im_I}=\frac{1}{\frac{4}{3}\sigma^{\frac{1}{3}}[I(I+1)]^{\frac{1}{3}}\Im_0}I(I+1)$ (2)

where $\sigma=\frac{1}{2C\Im_0^3}$. On the other hand, when discussing the rotation-vibration coupling energy spectrum in the rotation-vibration model (RVM), an approximate expression for the effective moment of inertia has ever been obtained as follows:

$\Im_{eff}=C_1+C_2E_I$ (3)

Experimental data on many large deformed nuclei indicate that the linear relationship between the effective moment of inertia and the excitation energy is fairly well established. For transitional nuclei between spherical and deformed limits where neither the vibrator nor rotor limit is very apt. In the present work, a new formula is thus proposed which is tried to fit the level energies of ground-state bands in this kind of nuclei[3]. The basis of this expression is simple: it is the ideal rotor expression

E=$\frac{1}{\Im(I,E)}$I(I+1)(4) but where the moment of inertia depends linearly on expression $(I(I+1))^{\frac{1}{3}}$ of spin I and excitation energy E. That is

$\Im(I,E)=\Im_0(1+\alpha(I(I+1))^{\frac{1}{3}}+\beta E)$ (5)

where α and β are adjustable parameters and $\Im_0$ sets the overall scale. This moment of inertia is the linear superposition of Eq. (2) and Eq. (3).

References

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Abstract Type

Talk

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