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GAMMA-VIBRATIONAL BANDS IN I820s AND I82*Os

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ABSTRACT

The systematics of the gamma-vibrational bands in even Os nuclei ($A = 182 \sim 192$) has been obtained from the study of gamma rays in $^{185,187}\text{Re}(p,2n)^{184,186}\text{Os}$ and $^{185,187}\text{Re}(p,4n)^{182,184}\text{Os}$ reactions. The gamma-vibrational energies obtained are 892 keV in ^{182}Os and 942 keV in ^{184}Os . The present results reveal a unique correlation of $\hbar\omega_\gamma$ with the moment of inertia.

[†]Work performed under the auspices of the U. S. Atomic Energy Commission.

The gamma-vibrational bands in neutron-deficient even Os nuclei have been studied by observing interband gamma rays in $^{185,187}\text{Re}(p,2n)^{184,186}\text{Os}$ and $^{185,187}\text{Re}(p,4n)^{182,184}\text{Os}$ reactions. The previously known gamma-vibrational band of ^{186}Os , which was studied by Emery et al.¹ from the decay of ^{186}Ir , is considerably populated up to the 5^+ level in $^{187}\text{Re}(p,2n)^{186}\text{Os}$ reaction (see the spectrum in Fig. 1(a)). This information was utilized to assign gamma rays in $^{185}\text{Re}(p,2n)^{184}\text{Os}$ reaction (Fig. 1(b)). The assignment given in Fig. 1(b) seems to be suspicious, because in the strong-coupling limit the $2_{\gamma} \rightarrow 2_g$ line and $2_{\gamma} \rightarrow 0_g$ lines should agree with the $4_{\gamma} \rightarrow 4_g$ and $3_{\gamma} \rightarrow 2_g$ lines, respectively. If we regard the 840 keV peak as the $2_{\gamma} \rightarrow 2_g$, $4_{\gamma} \rightarrow 4_g$ doublet and the 936-keV peak as the $2_{\gamma} \rightarrow 0_g$, $3_{\gamma} \rightarrow 2_g$ doublet, then the 822 keV and 942 keV lines must be associated with another level at 942 keV. However, if they were so, such a level should also be populated in ^{186}Os as well as the gamma vibrational levels. Therefore we have made the assignments as shown in the Fig. 1(b), although they are still doubtful.

After having established the gamma-vibrational band in ^{184}Os , the population of the same states was examined in $^{187}\text{Re}(p,4n)^{184}\text{Os}$ reaction at $E_p = 35$ MeV, which showed lower population of the gamma-vibrational band compared with the ground band and relatively higher population of higher-spin gamma-vibrational states. Subsequently this information was utilized to identify gamma rays in $^{185}\text{Re}(p,4n)^{182}\text{Os}$ reaction.

The systematics of the ground and the gamma-vibrational bands has been obtained, as shown in Fig. 2. Remarkable facts are

- 1) The energy of gamma vibration is uniquely correlated with the moment of inertia. As the neutron number decreases, the moment of inertia

and the gamma-vibrational energy increase until they reach maxima at $A = 184$ ($N = 108$), then both start decreasing.

2) There is appreciable difference in the moment of inertia between the ground band and the gamma-vibrational band. The level spacing $\Delta_{32}^{\gamma} \equiv E(3_{\gamma}) - E(2_{\gamma})$ should be equal to $\Delta_{20}^g \equiv E(2_g)$ in the strong-coupling limit. The differences are presented in Table 1. The quantity, $\Delta_{32}^{\gamma} - \Delta_{20}^g$, is negative in ^{164}Er , ^{168}Yb , and ^{180}W according to a recent experiment by Graetzer et al.,² while in Os nuclei it is always positive. This quantity is roughly evaluated by perturbation as follows:

$$\frac{\Delta_{32}^{\gamma} - \Delta_{20}^g}{\Delta_{20}^g} = -\frac{4}{3} \left(\frac{E(2_g)}{E_{\beta}} \right)^2 + \frac{4}{9} \left(\frac{E(2_g)}{E_{\gamma}} \right)^2$$

The first term arises from the beta-vibration-rotation interaction. As far as only the interaction between the ground band and the $K = 2$ gamma-vibrational band, is taken in account, the second term should vanish. This is why in the Davydov-Chaban model this quantity is always negative. The second term appears when the interaction between the $K = 2$ gamma-vibrational state and the $K = 0$ (two-phonon) gamma-vibrational state is taken into account. Therefore the fact mentioned above may infer the presence of the two-phonon gamma-vibrational band which plays an important role in the Os region.

REFERENCES

1. G. T. Emery, et al., Phys. Rev. 129, 2597 (1963).
2. Graetzer, et al., Nucl. Phys. 76, 1 (1966).

Table I.

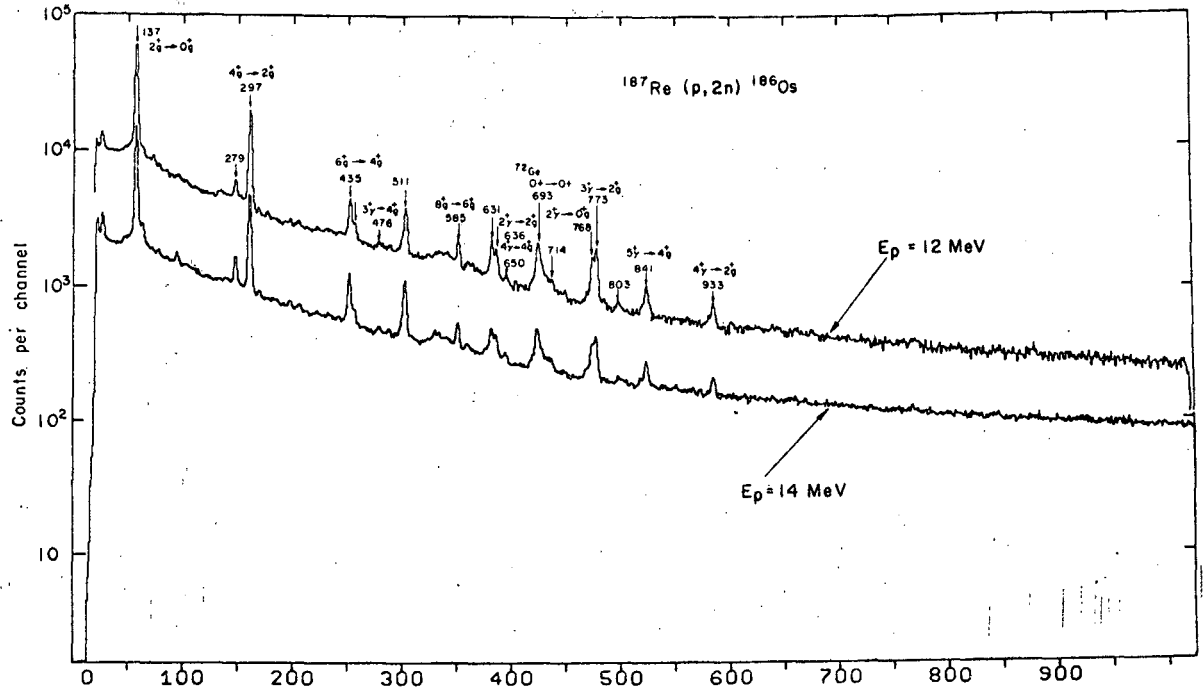
Nucleus	$E(2_g)$ (keV)	$E(2_\gamma)$ (keV)	$(\Delta_{32}^\gamma - \Delta_{20}^g) / \Delta_{20}^g$ (%)	$(\Delta_{42}^\gamma - \Delta_{42}^g) / \Delta_{42}^g$ (%)
^{182}Os	128	892	14.9	9.7
^{184}Os	122	942	17.2	7.6
^{186}Os	137	768	3.7	1.7
^{188}Os	155	633	1.3	2.8
^{190}Os	187	557	6.4	10.2
^{192}Os	206	489	-1.9	
^{158}Dy	98.7	945	1.3	1.0
^{164}Er	91.3	858	-3.6	-4.8
^{168}Yb	87.9	986	-4.4	-5.5
^{180}W	103.6	828	-9.3	-11.1

FIGURE CAPTIONS

Fig. 1(a). Gamma ray spectra in $^{187}\text{(p,2n)}^{186}\text{Os}$ reaction.

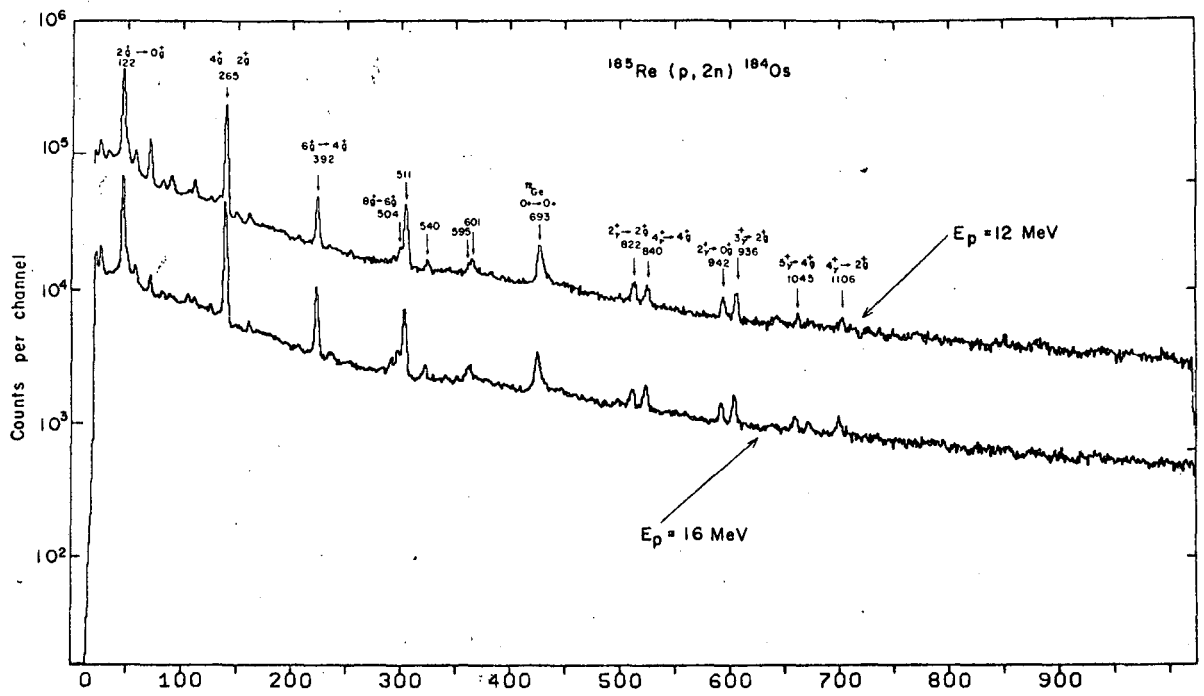
Fig. 1(b). Gamma ray spectra in $^{185}\text{(p,2n)}^{184}\text{Os}$ reaction.

Fig. 2. Systematics of the ground band and the gamma-vibrational bands in even Os nuclei.



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Fig. 1(a)



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Fig. 1(b)

Ground and gamma-vibrational bands in even Os nuclei

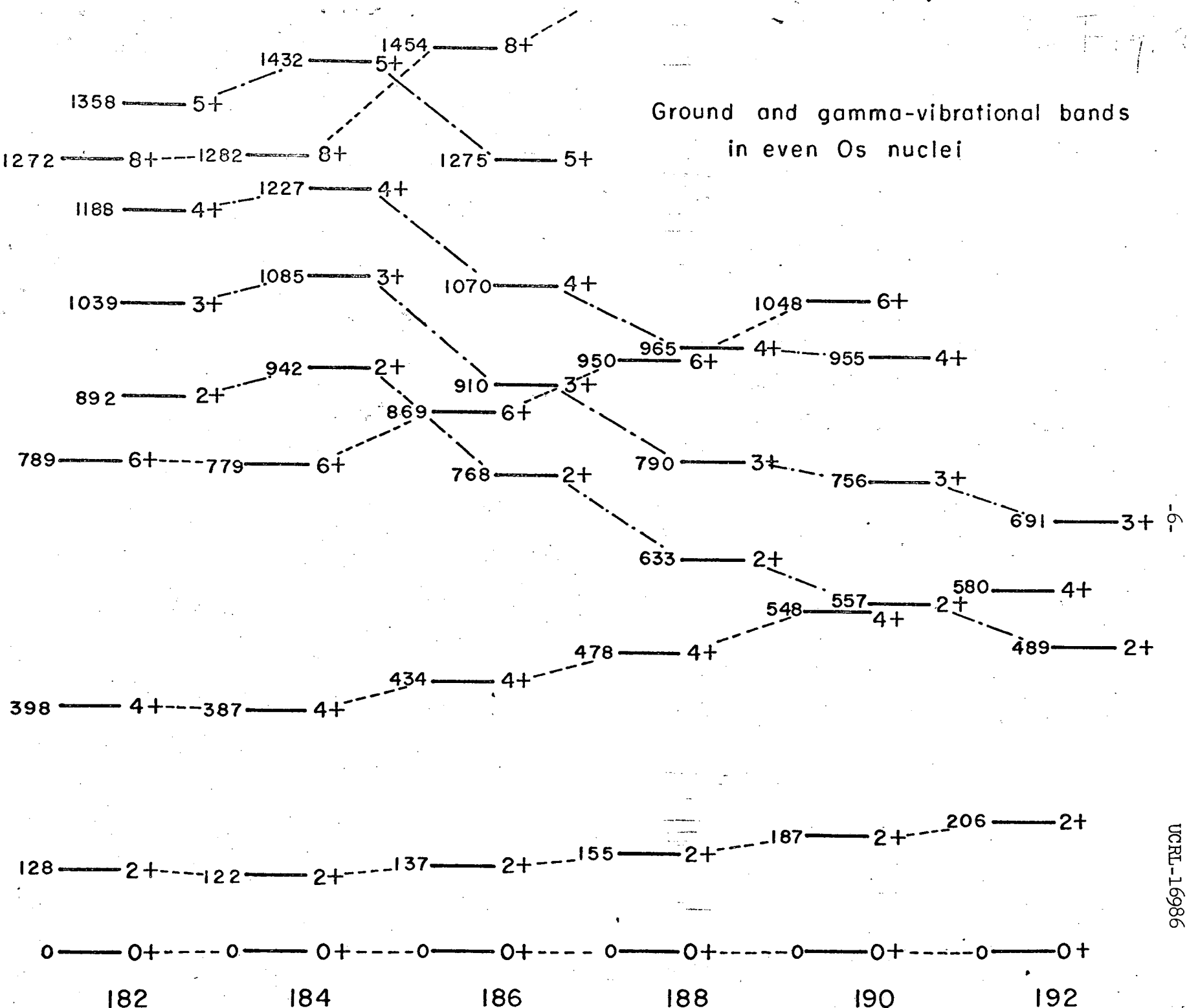


Fig. 2

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