Nuclear Structure of $^{180\text{-}186}$Os Isotopes

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The heavier Os nuclei N=112-116, A=188-192 were studied by Krishna Kumar [1] and Sahu et al. [2] using the microscopic theory in the pairing plus quadrupole (PPQ) model. Here we extend this study, to lighter Os nuclei N=104-110, A=180-186. The complete description will be in the fourth coming paper [3]. Here we present only the empirical aspects of these nuclei. It includes the level energies, energy ratios, power index 'b' and the B(E2; 0_1^+ - 2_1^+).

The Os isotopes having atomic number *Z*=76 and neutron number *N* varies from 86 to 122. These isotopes contains various bands i.e. ground state band, K=0 β-band, K=2 γ-band, K=4 band which are dependent on the combination of *N* and *Z*. Recently A. Harter et al. [4] studied the lifetimes measurements in low yrast states in ^{182}Os as a collective signatures and transitional phenomena.

Empirical Feature of ground band in Os

We see the variation in the energy [5] of spin I=2 $E(2_1^+)$ from N = 86 to 108 having values 706.7 keV to 119.8 keV. After that again, $E(2_1^+)$ rises as N increases from 108 to 122. Here the shape transitional phenomena both sides of N=108.

The systemetics of energy ratio $R_{4/2}$ for $^{162\text{-}198}$Os is shown in Fig. 1. At N=86, ^{162}Os the energy ratio $R_{4/2}$ is equal to 2.0 corresponding to U(5) symmetry. At N=88, ^{164}Os the energy ratio is 2.2 corresponding to E(5) symmetry and for N=92, ^{168}Os the $R_{4/2}$ ratio is 2.5 corresponding to O(6) symmetry. At N=100, ^{176}Os, the $R_{4/2}$ ratio is 2.9 corresponding to X(5) symmetry. At N=108, ^{184}Os nucleus, the energy ratio $R_{4/2}$ is 3.20 corresponding to nearly SU(3) symmetry. Beyond that, for N>108, energy ratio $R_{4/2}$ starts decreasing, the shape changes from SU(3) to E(5) symmetry. Here we study the shape change both side of ^{184}Os nucleus.

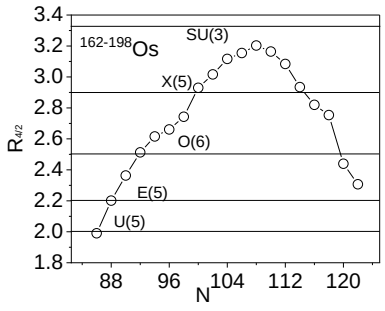

Fig. 1. The plot of the energy ratio $R_{4/2}$ with neutron number N for $^{162\text{-}198}$Os.

The variation of deformation is also studied by the power index formula $E(I) = aI^b$ suggested by Gupta et al. [6]. The power index 'b' is varies between 1.0 and 2.0 for vibrational to rotational nuclei. The coefficient 'a' corresponds to the inverse of moments of inertia. The variation of power index 'b' with spin indicates the shape changes of the nucleus with spin I.

Below and above N=108, the power index is less. The variation of index 'b' in these isotopes with spin I is also different. e.g. at N=104, it is maximum at spin I=6, and decreases sharply with increasing spin.

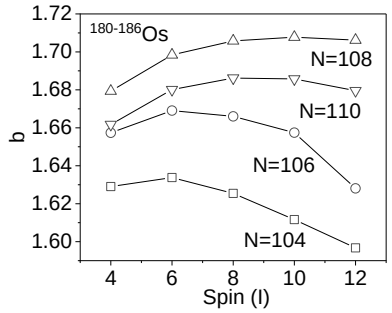

Fig. 2. Systematics of power index 'b' with spin (I) for $^{180-186}$Os.

At N=106, the variation in the index 'b' with spin is relatively slower. At N=108, the index 'b' is almost constant at higher spins. On the other hand at N=110 as a whole, the index 'b' is less with some variation with spin I.

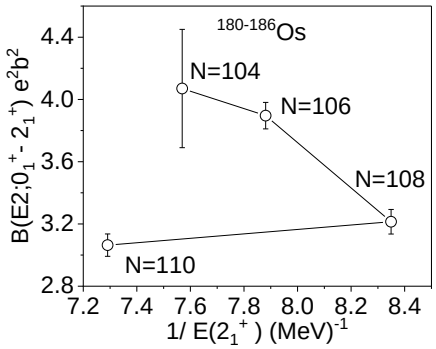

Fig. 3. The plot of B(E2; 0_1^+ - 2_1^+) with 1/ E(2_1^+) for $^{180-186}$Os.

Here the plot of B(E2; 0_1^+ - 2_1^+) [7] in e^2b^2 with 1/ E(2_1^+) (MeV)$^{-1}$ for $^{180-186}$Os is shown in Fig. 3. For N=104 to N=108, the energy E(2_1^+) for spin I=2 decreases, its inverse increases and this inverse plotted with electromagnetic transition B(E2) from spin I = 0 to 2, the B(E2) value decreases from N=104 to N=108. For N=110, the B(E2) value is small and inverse of energy E(2_1^+) lies lower and shows different slope in the fig. 3. Here for N< 108 and N> 108, the Os isotopes show different shape transition.

Result: Here we see the shape changes in Os nuclei, both below and above of N=108 the most deformed, with energy of spin I=2 E(2_1^+), energy ratios $R_{4/2}$, power index 'b' and B(E2; 0_1^+ - 2_1^+) with 1/ E(2_1^+). It is apparent that light Os isotopes are relatively axially symmetric in being different than the heavier N=112 to 116 Os isotopes, studied in [1, 2].

Reference:

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