The nuclear structure of $^{182\text{-}186}$W in IBM-1

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In W, the energy of 2_1^+ rises from 100 keV to 122 keV for N=108 to 112, but the energy ratio $R_{4/2}$ varies little, 3.29 to 3.24 only. That is the MoI decreases but the deformation is almost the same. The β- and γ-bands overlap and both bands move downwards with decreasing neutron hole-pairs, (9 to 7 in N=108-112). Also the γ-band falls faster than the β-band, so that the separation of the two vibrational bands increases with increasing N. This affects the β-γ-band mixing very much, which is larger in ^{182}W. This varying character of the band structure provides a good testing ground for the collective models.

In their pioneering work with the Pairing plus quadrupole model, BK [1] predicted the shape changes in W-Os-Pt nuclei with variation in N. Wu et al. [2] pointed out that the large band mixing predicted in W in [1] disagrees with experiment. Using the DDM, Vescovic et al. [3] obtained the requisite band mixing in $^{182\text{-}186}$W. However, with improved method of calculation in DPPQ model and with careful choice of quadrupole strength, we obtained the required small band mixing in these W isotopes [4]. To further elucidate the dependence of the band mixing here, we report the results of the Interacting Boson Model (IBM-1) [5] calculation.

The parameters of H_{IBM} for the empirical fit are listed in Table 1.

$$H_{IBM} = \varepsilon\, n_d + kQ.Q + k'L.L + k''P.P$$

Here PAIR=k"/2, ELL=2k', QQ=2k.The value of EPS=ε and k decrease with increasing N, while k' and k" increase with N. The increasing k" signifies the increasing asymmetry angle γ. The resulting empirical fit of level energies is quiet good (Table 2). The absolute B(E2) values (Table 3) for the three 2+ states are well given with constant charge parameter E2SD and E2DD of 0.135 e.b., -0.12. The sign and magnitude of the quadrupole moments Q(2+) (negative for K=0 states and positive for K=2 state) is reproduced (Table 4). The ^{182}W at N=108 is a shape transitional nucleus [7] due to the closure of $i_{13/2}$ subshell and the value of k" greater than a critical value is required for obtaining the 2' and 2" in proper order, since they are close in energy. Finally we present a few B(E2) ratios for transitions from the K=2 gamma band to ground band and K=0 to g-band (Table 5).

Table 1. Parameters used in IBM-1 in keV.

	EPS	PAIR	ELL	QQ
182	300	8.8	15.9	-28.5
184	200.4	17.2	23.3	-21.3
186	125.4	15.2	28.5	-20.4

Table 2 The level energies in keV.

Isotope	182W		184W		186W	
Spin	EX	IBM	EX	IBM	EX	IBM
2+	100	97	111	106	122	116
4+	329	324	364	355	396	386
6+	681	679	748	743	809	810
2'	1221	1214	903	872	738	776
3	1331	1319	1006	984	862	895
4'	1443	1449	1134	1130	1031	1052
5	1624	1628	1295	1316		1251
6'	1757	1813	1477	1531		1484
0"	1136	1137	1003	996	882	868
2"	1257	1255	1121	1115	1007	993
4"	1510	1503	1360	1385	1318	1278

Table 3. Absolute B(E2) values in $^{182\text{-}186}$W in $e^2.b^2$.

	A=182	184	186
0-2	EX[a] 4.21 7	3.81 6	3.50 6
	IBM 4.34	3.73	3.20
0-2'	EX 0.124 6	0.123 6	0.15 1
	IBM 0.135	0.131	0.11
0-2"	EX 0.023 2	0.010 2	0.006 1
	IBM 0.008	0.0015	0.0002

a) Ref. [2, 3, 8].

Table 4 Quadrupole moments in e.b.

	A=182	184	186
Q(2)	EX[a] -2.00 6	-1.98	-1.75(2)
	EX[b] -1.85 2	-1.74 2	-1.68 2
	IBM -1.88	-1.74	-1.61
Q(2')	EX[a] +1.94 7	2.36 9	1.3 3
	IBM +1.70	1.59	1.46
Q(2")EX			
	IBM -1.60	-1.47	-1.35

The EX[a] data is from WU et al. [2] and EX[b] from [9].

Table 5. The B(E2) ratios. Upper row for Expt. [6, 8]. Lower row from IBM.

I_i	I_f/ $I_{f'}$	A=182	184	186
		Alaga	EX / IBM	
2'-0/2	0.7	0.52 1	0.55 2	0.44 5
		0.58	0.60	0.61
2'-4/2	0.05	0.005 1	0.05 1	0.16 1
		0.04	0.07	0.07
3-2/4	2.5	2.03 8	1.56 16	1.6 4
		1.8	1.72	1.75
4'-2/4	0.34	0.26 2	0.21 3	0.23 10
		0.33	0.22	0.24
2"-0/2	0.7	1.23 10	0.17 3	1.1 2
		8	1.5	0/0
4/2	1.8	2.34 21	3.0 4	1.1 2
		12	4.0	0/0
4"-2/4	1.1	0.21 3		
		0.6	0.22	0.24

The deviations from the Alaga values are fairly reproduced for K=2 band. For example the weak 2'- 4 transition is obtained here. However, the transitions from the $K^{\pi}=0_2$ band to the g-band are too weak and in theory also they are weak, so that the E2 branching ratios are not obtained properly.

+ Associated with.

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