Low Lying two-quasiparticle structures in odd-odd $^{182}_{75}Re_{107}$

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The latest evaluation of the odd-odd nucleus ^{182}Re found in the Nuclear Data Sheets (NDS2015) [1] lists 16 energy levels below 500 keV. These levels were adopted in NDS2015 following reports on investigations in the ϵ-decay of ^{182}Os [2,3] and other reaction studies [4,5]. It is observed that only two levels among these are identified bandheads with configurations assigned. While the ground state in ^{182}Re is established as the 7^+ triplet of $\pi 5/2[402] \otimes \nu 9/2[624]$ configuration, the singlet 2^+ member of this GM doublet is not assigned to any level, even though it is expected to be low-lying. Similarly, except for the triplet $9^-$from the $\pi 9/2[514] \otimes \nu 9/2[624]$ configuration which is tentatively placed at around 445 keV, no other configurations expected with $E_x \leq 500$ keV are assigned to the observed low lying levels.

Spin-parity assignments for most of the observed levels are uncertain. For example, the (5^+) level observed in the reaction studies of ^{181}Ta$(\alpha, 3n\gamma)$ and ^{182}W(p,nγ)at around 285 keV [4,5] could also have other possible spin parity assignments based on the observation from the authors of the report.

In our present work, we have taken up the evaluation of the low-lying bandhead energies arising from possible 2qp configurations by using a simple phenomenological model [6]. The model uses a simple formula given by:

$$E(K:\Omega_p,\Omega_n) = E_p(\Omega_p) + E_n(\Omega_n) + E_{rot} - \left(\frac{1}{2} - \delta_{\Sigma,0}\right)\Delta E_{GM} + \delta_{K,0}(-)^I E_N$$

The proton single particle energies are taken from the neighboring Re isotopes with $A = 181$ and 183, while the single particle neutron energies are obtained from ^{181}W and ^{183}Os in line with the observation made in a recent report [7] on Re nuclei falling in the transitional region. The data used for evaluating the bandhead energies is presented in Table 1.

Table 1: Expected low-lying ($E_x \leq 525$keV) 2qp GM doublets in ^{182}Re that arise out of coupling of single particle Nilsson orbitals from respective (A±1) isotopes (proton orbitals) and isotones (neutron orbitals). Out of these orbitals (E_p+E_n) ≤ 525keV are considered.

p_i → / n_j ↓	p_0: 0.00 $5/2^+[402]$	p_1: 385 $9/2^-[514]$	p_2: 525 $1/2^-[541]$
n_0: 0.00 $9/2^+[624]$	7^+ 2^+	9^- 0^- E_N=1.2KeV	4^- 5^-
n_1:300 $1/2^-[521]$	2^- 3^-		
n_2:365 $5/2^-[512]$	5^- 0^- E_N= 40 KeV		
n_3:426 $1/2^-[510]$	3^- 2^-		
n_4:480 $7/2^-[514]$	1^- 6^-		

The results of our evaluation are presented in Figure 1 where we have compared our results with the relevant adopted data in NDS2015.

While our analysis agrees with the triplet 7^+ (p_0, n_0)assignment to the ground state in ^{182}Re, we obtain the energy of the singlet 2^+ of this combination as 65 keV. We hence identify the 2^+

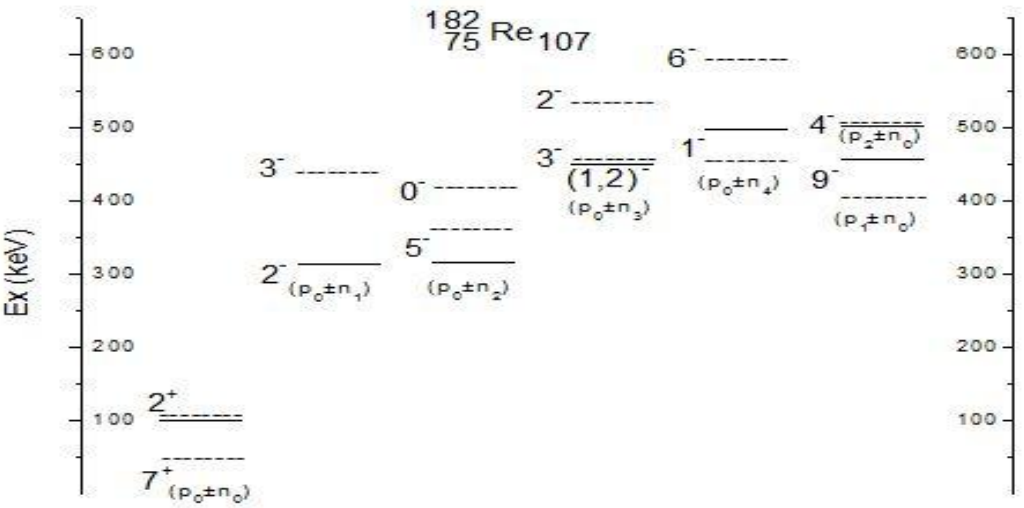

Figure 1: Low –lying 2qp states evaluated for ^{182}Re. The model calculated bandheads (in dotted lines) are compared to corresponding experimental data (Solid line), where available, in NDS2015.

level in NDS2015 occurring at $'0.00+x'$ ('x being the offset having a value between 50 and 60 keV) with the singlet 2+ (p_0,n_0) state. The triplet 2$^-$$(p_0,n_1)$is evaluated by us to lie around 290 keV. This could probably correspond to the $'235.73+x'$ energy level with a tentative (2$^-$) assignment adopted in the NDS2015.

The energy level at $'227.51+x'$ is tentatively assigned (5$^+$) by NDS2015 based on the strong 95.7 γ decaying to the lower lying 4$^+$ level at $'131.90+x'$ observed in ^{181}Ta$(\alpha,3n\gamma)$ and ^{182}W(p,nγ) [4,5]. While the authors of this work unambiguously assign the transition $\Delta J=1$ based on their $\gamma(\theta)$ measurements, they add that intensity balance measurements could give this gamma either an M1 or E1multipolarity. NDS2015 considers an M1 character and adopts (5$^+$) for this level, making it a rotational band member of the lower lying 2$^+$ level at 65 keV. Instead, we propose that if E1 multipolarity is adopted for the 95.7 γ from this level, then a spin parity of 5$^-$ becomes admissible, thus identifying this level with the triplet 5$^-$$(p_0,n_2)$.The NDS2015 level at $(379.22+x)$ keV is tentatively assigned (1,2)$^-$ based on a high intensity 379.22 keV E1(+M2) γ to the lower 2$^+$ level at $(0.00+x)$ keV. Another high intensity gamma of 115.92 keV with M1(+E2) character was also found to decay to the 1$^-$ level at $(263.278+x)$ keV level in ^{182}Re. This information, coupled with the considerably high E2 admixture in the115.92 keV gamma (as suggested by the mixing ratio of $\delta<1.4$) enables us to suggest that the $(379.22+x)$ keV is the triplet 3$^-$$(p_0,n_3)$. The unassigned (9$^-$) level at 443.15 keV in NDS 2015 comes close to the triplet 9$^-$$(p_1,n_0)$ in our evaluation. The NDS 2015 1$^-$ level at $(438.28+x)$ keV is identified by us to be the possible triplet 1$^-$$(p_0,n_4)$. Finally, the previously configuration unassigned level at $(461.3+x)$ keV with a tentative spin parity of (4$^-$) is determined in our evaluation as the likely triplet 4$^-$$(p_2,n_0)$.

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