Lifetime measurements in the non-yrast bands in ^{177}Re

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Introduction

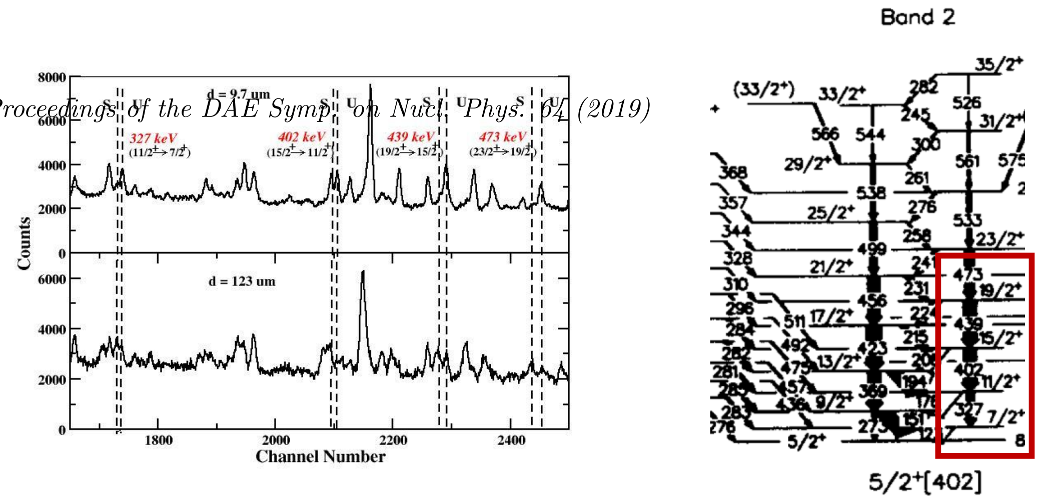
The nuclei with Z ~ 75 and A ~ 175 fall in the transitional region between the strongly deformed rare earth nuclei and the spherical lead isotopes. These nuclei exhibit softness in their nuclear potential and hence are also known as '*gamma-soft nuclei*'. For these nuclei the proton Fermi level is close to the highly down sloping low Ω, high-j orbital's like $\pi h_{9/2}[541]1/2^-$orbital intruding from above the Z = 82 shell closure. The presence of highly intruding orbital's makes the nuclear structure studies more interesting in this mass region. For odd proton nucleus such as $_{75}$Re, the high-*K* $(9/2^-)h_{11/2}$ and $(5/2^+)d_{5/2}$ bands are upsloping in the Nilsson diagram and therefore have positive slope as a function of deformation, so have a tendency to drive the nucleus to smaller deformations. As the deformation affects the energy of the entire band, the band crossing frequencies corresponding to the alignment of the $i_{13/2}$ neutron pair also observe a shift to higher or lower values, depending upon the type of orbital occupied by the odd particle. For high-*K* orbital's like $h_{11/2}[514]9/2^-$ and $d_{5/2}[402]5/2^+$ configurations, a gradual alignment gain is observed which has been understood as due to βstretching [1-4]. Thus the $\nu i_{13/2}$ crossing for high-*K* orbital's is shifted to lower rotational frequencies relative to the crossing frequency for the $\pi h_{9/2}$ $(K =1/2^-)$ configuration [5]. The shift of the band crossing frequency due to the alignment of a pair of $i_{13/2}$ neutrons for different quasi-proton configurations is a sensitive test of the single quasi-particle basis of the nuclear shape. For the ^{177}Re nucleus, the neutron number is close to the mid-shell gap N =104, so it is interesting to see the effect of the relative location of the quasi-proton orbital's with respect to the Fermi level on the shift of neutron band crossing frequency. With this motivation, the lifetime measurements in different quasi-proton bands in ^{177}Re nucleus have been done with recoil distance Doppler Shift technique [6] using the plunger setup available at the Inter University Accelerator (IUAC), Delhi.

Experimental Details

In the experiment the high spin states of the ^{177}Re isotope was populated using the heavy ion fusion reaction ^{165}Ho (^{16}O, 4n) at beam energy of 84 MeV, provided the 15UD Pelletron accelerator facility at the IUAC, Delhi. In the experiment, the self-supporting foil of ^{165}Ho of thickness ~ 780 μg/cm^{2}as target and thick a Gold foil of thickness ~ 8 mg/cm^{2}as stopper was used. To detect the de-exciting gamma rays the GDA setup, consisting of 12 HPGe detectors, was used. The data in singles mode was taken at 22 target-stopper distances ranging from 10 – 10,000 μm.

Data Analysis and results

The data analysis has been done using LIFETIME code [7, 8]. The preliminary results obtained from the data analysis do indeed indicate the shape driving nature of various quasi-particle orbital's in ^{177}Re. The quality of data obtained with detectors at the backward angle (144^0 with the beam direction) in the experiment is shown in Figure 1. In the figure, the shifted (S) and unshifted (U) energy peaks at two different target –stopper distances (D_{T-S}) for gamma transitions of interest have been clearly marked. The details of the data analysis and more improved results of the analysis will be presented at in the conference.



(a) **(b)**

Figure 1: (a) The shifted (S) and unshifted (U) energy peaks for few γ -ray transisitions of interest at two different target-stopper distance (D_{t-s}) at angle 144^0 with respect to beam direction. (b) Partial level scheme of $\pi d_{5/2}$ orbital in ^{177}Re.

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