NEWBY SHIFTS IN ODD-ODD TRANSITIONAL NUCLEI AT A~190

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Introduction

Correct accounting for residual NN-interaction between valence particles is of utmost importance for structure interpretation of deformed odd-odd nuclei. This interaction manifests itself in such effects as the Gallagher-Moszkowski (GM) energy splitting of two-quasiparticle doublets, the Newby shift of odd-even spin value levels in K=0 rotational bands, as well as the ΔK=0 mixing of rotational bands due to non-diagonal matrix elements when wave function components of both valence particles exchange.

In two-particle plus rotor model calculations, one usually uses the residual NN-interaction potential parameter values obtained via a fit to empirical matrix elements derived from a wide range of well-deformed odd-odd nuclei (see, e.g., [1-3]). However, it is hard to perform similar studies for transitional nuclei due to a lack of confident experimental data about complete doublets.

Detailed experimental nuclear structure studies performed recently for 160,162Re and 164,166Ir [4-6] allowed to obtain empirical values for a number of residual NN-interaction matrix elements responsible for Newby shifts in transitional deformation region at A~190. These empirical values have been used to fit the parameters of the finite-range residual proton-neutron interaction potential including both the short, and the long range central forces with spin polarization, as well as the tensor interaction terms.

Unified model of deformed odd-even nuclei

\[
H = H_{core} + H_{sp} + H_{res} + H_{sp-core}
\]

Model basis functions

\[
\psi(j,M,K,\Omega_1,\Omega_2) = \sum_{j'\ell n} C_{n\ell j'} \chi_{n\ell j'}(r) \chi_{n\ell j'}(r') \Omega_1 (\ell j') \Omega_2 (\ell j')
\]

Single particle Hamiltonian – modified h.o. potential [1]

Residual NN-interaction between valence particles

\[
V_{vp} = (u_{ij} + u_{ij} \sigma_i \sigma_j) V(r) + (V_{pp} + \frac{1}{2} \ell \sigma_i \ell \sigma_j) V(r) + \frac{1}{3} \sigma_i \sigma_j)
\]

a) Gallagher-Moszkowski (GM) splitting of the two-quasiparticle doublet; 

\[
E_{GM} = A_{even} - A_{odd} \left( -1 \right)^{\frac{\ell + 1}{2}} \frac{1}{2} + \frac{1}{2} \sigma_i \sigma_j
\]

b) Newby shift of odd-even spin value levels in K=0 bands;

\[
B_{new} = \left( \chi_{n\ell j'} \chi_{n\ell j'} \right)^2 \chi_{n\ell j'}(r) \chi_{n\ell j'}(r') \Omega_1 (\ell j') \Omega_2 (\ell j')
\]

Table 1. Empirical Newby energy values \(E_n\) of K=0 bands in odd-odd 160,162Re and 164,166Ir [1] derived from energies of lowest spin value levels (\(n=0,1,2\)) using formula \(E=E_0+A_0n(n+1)+H_0\)

<table>
<thead>
<tr>
<th>Nucleides</th>
<th>Configuration</th>
<th>(E_{2n}) (keV)</th>
<th>Number of levels</th>
<th>(A_0) (keV)</th>
<th>(H_0) (keV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>160Re</td>
<td>(n=9) : (255)</td>
<td>271.4</td>
<td>3 (0; 1; 2)</td>
<td>14.85</td>
<td>-57.18</td>
</tr>
<tr>
<td>162Re</td>
<td>(n=9) : (255)</td>
<td>271.4</td>
<td>3 (0; 1; 2)</td>
<td>14.85</td>
<td>-57.18</td>
</tr>
<tr>
<td>164Ir</td>
<td>(n=11) : (255)</td>
<td>271.4</td>
<td>3 (0; 1; 2)</td>
<td>20.55</td>
<td>3.85</td>
</tr>
</tbody>
</table>

References
