Survey of Spectroscopic factors for Z=3-24 isotopes

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Excluding deformed Ne, F and Ti isotopes, ground state neutron spectroscopic factors for Z=3-24 nuclei extracted using the simple DWBA reaction theory agree with the independent particle models for nuclei with spherical cores (e.g. $^{40}$Ca to $^{48}$Ca isotopes). Most discrepancies arise from nuclear or core correlations can be accounted for in modern day shell model.

**Conclusions**

- Adopt fixed parameters in DWBA calculations for the entire range of nuclei investigated.
- Digitize ~400 angular distributions from (d,p) and (p,d) reactions measured in the past 40 years to extract the SF values for 79 nuclei from Li to Cr.
- Perform Shell Model calculations for 59 nuclei from p to 1 f $7/2$ shells.

**Definitions**

\[ S = n \quad \text{n even} \]
\[ S = 1 - \frac{n-1}{2j+1} \quad \text{n odd} \]

**Theoretical spectroscopic factor**

Take A(d,p)A+1 stripping reaction as an example:

\[ \Psi_\alpha = \sum \psi_\alpha (r_\alpha) \psi_{\bar{\alpha}} \]

\( \psi_\alpha (r_\alpha) \) is the overlap function defined as:

\[ \psi_\alpha (r_\alpha) = \Psi_\alpha^\dagger \Psi_{\bar{\alpha}} \]

The theoretical spectroscopic factor \( S_\alpha \) is given by

\[ S_\alpha = \left| \frac{\psi_\alpha (r_\alpha)}{\psi_\alpha (r_\alpha)} \right|^2 \]

 Demonstrates the use of spectroscopic factors to study nuclear structure.

**Comparison with Independent Particle Model**

SF’s of $^{40}$Ca-$^{48}$Ca isotopes agree very well with IPM. $^{40}$Ca SF value is lower than predicted. The 1f$4/2$ valence neutrons in Ca isotopes are good single particles with spherical cores.

**Comparison with Shell Model (Oxbash)**

Good agreement with most isotopes within 20%.

**Spectroscopic Factors**

- Measure the orbital configuration of the valence nucleons.

**Within the Independent Particle Model (Austern):**

The values of the spectroscopic factors depend on the number of valence nucleons.

**Summary of the input parameters used in TWOFNR**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Target r.m.s radius/density</td>
<td>Shell model</td>
</tr>
<tr>
<td>Deuteron potential</td>
<td>Daehnick [45]</td>
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<tr>
<td>Parameters for the DWBA reaction mode calculations.</td>
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