Structure overlaps

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1 Cluster overlaps

Reactions involving the transfer of a cluster can either be treated as the movement of a single 'particle', or more microscopically as a combination of simultaneous and sequential transfers.

The bound states of clusters treated as one particle are commonly found in a Saxon-Woods potential with the same geometry parameters as are found for low-energy scattering of the same nuclei. The number of radial nodes is chosen by means of a shell-model counting of oscillator quanta, to accommodate the Pauli exclusion principle, as follows.

Suppose that the valence nucleon shell has $\mathcal{N}_i = 2n_i + \ell_i$ quanta, that is $\mathcal{N} = 1$ for the p-shell, 2 for the sd-shell, etc. If the transferred valence cluster is taken as composed of v such nucleons, then the total energy of the cluster nucleons will be $v\mathcal{N}_i\hbar\omega$. If the *internal* cluster configuration has $\mathcal{N}_{\rm int} = 2n_{\rm int}+\ell_{\rm int}$ quanta (0 for s-shell clusters), then the cluster-core motion in partial wave L has N nodes where

$$2N + L + \mathcal{N}_{\rm int} = v\mathcal{N}_i. \tag{1}$$

Usually L is fixed by the spin of the composite state, so N may be determined. Note that $N = 0, 1, \ldots$ is the number of nodes *excluding* the origin.[1]

Section 5.3.3 from 'Nuclear Reactions for Astrophysics',
`http://www.fresco.org.uk/book/reactions.htm`

[1]The `NN` parameter for FRESCO bound states includes the origin, so $\texttt{NN} = N + 1 \geq 1$.