

GROUND-STATE ALPHA-CLUSTER CORRELATION IN SD-SHELL NUCLEI

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ABSTRACT

Alpha-spectroscopic factors for all ground-state to ground-state transitions in sd-shell nuclei have been calculated in the full $d_{5/2}^- s_{1/2}^- d_{3/2}^-$ model space. Comparison is made with presently available experimental data.

Wave-functions for ground-states of sd-shell nuclei have been generated in the full $d_{5/2}^- s_{1/2}^- d_{3/2}^-$ shell-model basis in the $j-j$ coupling scheme using the empirical "particle" and "hole" interactions of Chung and Wildenthal¹⁾. From this set of wave-functions, alpha-spectroscopic factors have been calculated for ground-state to ground-state transitions between $T=0$, $T=1/2$ and $T=1$ sd-shell nuclei using the method described by Bennett²⁾. The alpha-spectroscopic factors (S -factors) are defined as in Ref.3. The 4 nucleons transferred are assumed to be in an unexcited $(0s)^4$ internal state; and within the harmonic oscillator framework, the harmonic oscillator frequency parameter of the transferred particles is assumed to be the same in the projectile and the target or residual nucleus. The 4-nucleon shell-model wave function is then described with space symmetry $[4]$ and SU_3 quantum numbers $(\lambda, \mu) = (8, 0)$.

In Fig.1 S -factors for ground-state to ground-state transitions in sd-shell nuclei for odd- A and even- A are plotted separately. The S -factors are normalized relative to 1.0 for the ^{16}O - ^{20}Ne transitions, except for the (p, α) and $(\alpha, 2\alpha)$ S -factors which are normalized relative to the theoretical ^{24}Mg - ^{28}Si S -factor. The $A_>$ denotes the residual nucleus for a stripping-like reaction, or the target nucleus for a pick-up-like reaction. For the odd- A transitions, where the transition can go by more than one L -transfer, $L_<$ denotes the lower and $L_>$ the higher of the two L -transfers. The $(^6Li, d)$, $(d, ^6Li)$, $(^3He, ^7Be)$, (p, α) and $(\alpha, 2\alpha)$ S -factors are from References 4, 5, 6, 7 and 8, respectively.

For the odd- A transitions, the theoretical S -factors agree very well with the experimental $(^6Li, d)$ S -factors, specifically the weak ^{19}F - ^{23}Na , ^{21}Ne - ^{25}Mg and ^{23}Na - ^{27}Al transitions are very well reproduced. For the even- A transitions, although uncertainties associated with the experimental S -factors have to be taken into consideration, the available S -factors from different reactions are in poor agree-

ment with each other. The theoretical S-factors agree very well with the $(\alpha, 2\alpha)$ S-factors. The theory may overpredict and underpredict the S-factors at the lower and upper end of the sd-shell, respectively, because of the restriction in the model space. However, more accurate experimental S-factors would be desirable.

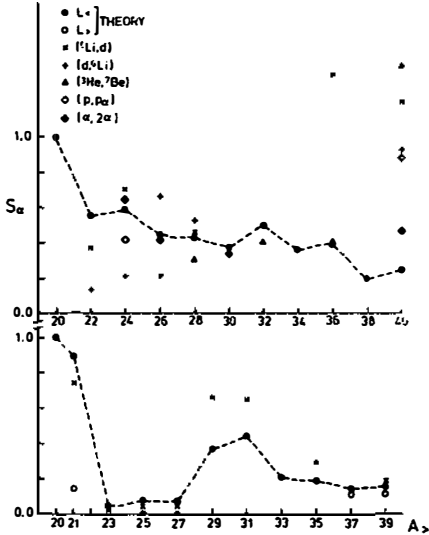


Figure 1. Relative alpha-spectroscopic factors for sd-shell nuclei.

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