A DESCRIPTION OF ^{7}Li IN A MODEL FOR COUPLING TWO–CLUSTER STRUCTURES

M.V. Mihailović and M. Poljšak

J.Stefan Institute, University of Ljubljana, Ljubljana, Yugoslavia

ABSTRACT

States of ^{7}Li(^{7}Be) are described by the wave functions of the generator coordinate type which are superpositions of components corresponding to two clusters (^{4}He+^{3}H)and (^{6}Li + n). The ^{6}Li cluster is described as a shell model state of lp configurations. The energies of states of ^{7}Li are influenced by coupling of these cluster structure as much as doing the GCM calculation with single two–cluster configuration. The influence of the coupling to the shape of ^{7}L is even more pronounced.

Studies of the structure of light nuclei revealed the existance of the groups of states which have the structure different that those predicted by the usual shall model description.

A model was proposed [1] recently in which the model space is derived from the two–centre GC basis of Slater determinants of the two–cluster structures

$$\Phi_{1\kappa}(\vec{x},\vec{S}_{(He,H)}) = A\{\Phi_{4_{He}}(\vec{x}_1,\dots\vec{x}_4,\vec{S}_{He})\,\Phi_{3_H}(\vec{x}_5,\dots,\vec{x}_7,\vec{S}_H)\}, \quad \kappa = 1,2,\ \vec{x}\equiv(\vec{x}_1,\dots\vec{x}_7) \qquad (1)$$

and

$$\Phi_{2\kappa}(\vec{x},\vec{S}_{(Li,n)}) = A\{\Phi_{6_{Li,k_1}}(\vec{x}_1,\dots,\vec{x}_6,\vec{S}_{Li})\Phi_{n,\kappa_2}(\vec{x}_7,\vec{S}_n)\}, \qquad (2)$$

$$\kappa \equiv (\kappa_1,\kappa_2) = (n_p,\sigma_p,n_n,\sigma_n,\kappa_2) = 1,\dots 72.$$

$\vec{S}_{(He,H)} = \vec{S}_{He} - \vec{S}_H$ and $\vec{S}_{(Li,n)} = \vec{S}_{Li} - \vec{S}_n$ are the generator coordinates. The GC two-centre basis is obtained by projecting the functions (1) and (2) onto the eigenspace of the angular momentum and parity.

The Hamiltonian used in this calculation contains the two body Coulomb potential and the effective nuclear two body central potential with the radial parts same as those of Volkov [2].

Following calculations were performed:

1. For both single cluster structures (1) and (2) expectation value of the Hamiltonian is calculated [3], as function of the separation.
2. For several fixed separations the mixing of shell model configurations ^{6}Li has been performed (two-centre shell model).
3. The energy surfaces $E(S_{(He,^3H)}, S_{(Li,n)})$ were calculated. The position of minima in the ground state ($S_{(He,^3H)}$ = 4.0 fm and $S_{(Li\,n)}$ = 2.2 fm) are approximately same as those for the excited state $J\pi = \frac{5-}{2}, \frac{7-}{2}$.
4. Two–parametric Hill–Wheeler equation has been solved. The ground state energy is −37.86 MeV when Volkov potential V1 is used and −35.83 MeV for the potential V2. This value is for 1.30 MeV lower than that in the PHF calculation[4],in which 1s, 1p, 1d, 1f shells were included.

REFERENCES

1. M.V. Mihailović and M. Poljšak, to be submitted to Nucl. Phys.
2. A.B. Volkov, Nucl. Phys. 74, 33 (1964).
3. M.V. Mihailović, M. Poljšak, Phys. Lett. 66B, 209 (1977).
4. M. Bouten and P. van Leuven, Nucl. Phys. A100, 90 (1967).