Microscopic Description of the Alpha-Clustering Phenomenon in (2s-1d)-Shell Nuclei

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As it is shown in [1], the generalized Elliott model based on the microscopic (i. e. expressed in terms of nucleon variables) Hamiltonian of the broken *SU(3)* symmetry is a valuable research tool in studying of various clustering phenomena. In the present work the multi-alpha-particle states of the (2s-1d)-shell nuclei are studied by these means.
The discussed Hamiltonian can be presented in the form:

$$\hat{H}=\hat{H}_{osc}+F\,(L^2,\, p,\, \hat{g}_2,\, \hat{g}_3,\, \Omega), \qquad (1)$$

where $\hat{H}_{osc}$ is the oscillator Hamiltonian, p is the operator of parity, L is the angular momentum operator, $\hat{g}_2$ and $\hat{g}_3$ are Casimir operators of the *SU(3)* group, Ω is Bargman operator and F is an arbitrary function of the arguments. The use of the Hamiltonian makes it possible to classify of alpha-particle states of the discussed nuclei and to calculate very complicated spectra. For example dense spectrum of alpha-cluster states in ^{32}S nucleus containing more than 80 levels with identified spin, which is experimentally studied in [2], is calculated using six-parameter linear Hamiltonian (1).

The results of the calculations are in a rather good agreement with the experimental data. In the energy regions where, according to [2], the levels with certain value of the spin J^π are observed (the widths of these regions are about 2 – 3 MeV) theoretical calculations result in trifle over numbers of such levels which may be unobservable because of limited resolution power of the experimental set. The sole exclusion is related to 6^+ levels – 11 levels are observed whereas there are 9 theoretical ones in the respective region. The energies of lower-lying levels are slightly overestimated by the calculations.

The alpha-particle spectra of other N=Z-even nuclei are studied. A lot of α-particle states of these nuclei are predicted.

[1] I.A. Gnilozub, S.D. Kurgalin, Yu.M. Tchuvil'sky, Phys. At. Nucl. **69**, 1014. (2006).
[2] K.–M. Kallman, M. Brenner, V. Z. Goldberg *et.al*., Eur. Phys. J. **A 16**, 159 (2003).