

CLASSIFICATION OF CLUSTER STATES IN ACCORDANCE WITH YOUNG SCHEMES

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Over the three latest decades there has been published a relatively large number of works dedicated to investigation of interactions of light nuclear systems like $^2\text{H}^4\text{He}$, $^3\text{H}^4\text{He}$, $^3\text{He}^3\text{H}$, $^4\text{He}^4\text{He}$ and N^4He on the basis of potentials with forbidden states (FS) [1, 2]. Potentials with FS in systems $^2\text{H}^4\text{He}$, $^3\text{H}^4\text{He}$ and others enable not only to give a correct energy description of phase shifts of scattering and elastic cross sections, but also to reproduce some characteristics of $^6,^7\text{Li}$ and ^8Be nuclei in cluster models on the basis of the same parameters. This is due to high clusterization probability of these nuclei, as well as due to the fact that only one allowed orbital Young scheme corresponds to both states (bound state (BS), scattering state) in every system.

At the same time for lighter clusters like N^2H , N^3H etc. the orbital states in the channel with the minimal spin are «mixed» in accordance with Young schemes for scattering states, but the ground states depend only on one orbital scheme. Thus, the potentials extracted from the

⁴He nuclei in cluster models.

The phase shifts of scattering in this case can be represented as a half-sum of phase shifts which are «pure» in accordance with Young schemes. One of them can be taken from the scattering in the channel with the maximal spin and «pure» in accordance with the orbital schemes. Thus, if we have a «mixed» experimental phase shift and one of «pure» phase shifts, we can find another «pure» phase shift of the scattering process in the channel with the minimal spin and use this phase shift for parametrization of intercluster potential, which then can be used for description of bound states in the cluster system [3].

The classification of orbital states in accordance with Young schemes for all cluster systems up to N=5 is given below in the Table, and it is easy to see which of them are «pure» and which are «mixed» in states with the minimal spin. The states can be «mixed» not only in lightest cluster nuclei, but also in heavier N⁶Li, ²H⁶Li systems. Moreover, in all cases only the states with the minimal spin are “mixed” in accordance with Young schemes, while the other states are “pure”.

Table – Classification of allowed states (AS) and forbidden states (FS) in light cluster systems. T, S – isospin and spin of particle system, {f}_T, {f}_S – isospin and spin parts of Young schemes, {f}_{ST} – spin-isospin component of Young schemes, L – orbital moment of particle system, {f}_L – orbital component of Young schemes, {f}_{AS} – Young scheme for AS, {f}_{FS} – Young scheme for FS.

System	T	S	{f} _T	{f} _S	{f} _{ST}	{f} _L	L	{f} _{AS}	{f} _{FS}
1	2	3	4	5	6	7	8	9	10
N ² H	1/2	1/2	{21}	{21}	{111} + {21} + {3}	{3}	0	{3}	-
		3/2	{21}	{3}	{21}	{21}	1	{21}	-
n ³ He p ³ H	0	0	{22}	{22}	{4} + {22} + {1111}	{4}	0	{4}	-
		1	{22}	{31}	{31} + {211}	{31}	1	-	{31}
p ³ He n ³ H n ³ He p ³ H	1	0	{31}	{22}	{31} + {211}	{4}	0	-	{4}
		1	{31}	{31}	{4} + {31} + {22} + {211}	{31}	1	{31}	-
² H ² H	0	0	{22}	{22}	{4} + {22} + {1111}	{4}	0	{4}	-
		1	{22}	{31}	{31} + {211}	{31}	1	-	{31}
		2	{22}	{4}	{22}	{22}	0,2	{22}	-

${}^2\text{H}^3\text{He}$	1/2	1/2	{32}	{32}	{5} + {41} + {32} + {311} + {221} + {2111}	{5} {41} {32}	0 1 0,2	- {41} {32}	{5} - -
${}^2\text{H}^3\text{H}$		3/2	{32}	{41}	{41} + {32} + {311} + {221}	{5} {41} {32}	0 1 0,2	- - {32}	{5} {41} -
p^4He n^4He	1/2	1/2	{32}	{32}	{5} + {41} + {32} + {311} + {221} + {2111}	{5} {41}	0 1	- {41}	{5} -

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