Three-Cluster Equation Using the Two-Cluster RGM Kernel

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The recent QCD-inspired SU_6 quark model for the baryon-baryon interaction, proposed by the Kyoto-Niigata group, is a unified model for the complete baryon octet, which has achieved very accurate descriptions of the NN and YN interactions. [1,2] These quark-model interactions can be used for realistic calculations of few-baryon systems and various types of baryonic matter through the Faddeev formalism and G-matrix calculations. We first formulate a three-cluster equation which explicitly uses two-cluster resonating-group-method (RGM) kernels. [3] This equation eliminates 3-cluster redundant components by the orthogonality of the total wave function to two-cluster Pauli-forbidden states. The explicit energy dependence ε inherent in the exchange RGM kernel is self-consistently determined. This equation is straightforwardly transformed into the Faddeev equation, which uses a modified singularity-free T-matrix constructed from the two-cluster RGM kernel. To illustrate the present formalism, we calculate the ground states of three di-neutron ($3d'$) and 3α systems, using the Faddeev formalism and a variational method with the translationally invariant harmonic-oscillator basis. The 3α Faddeev equation involves redundant components whose contribution to the total wave function entirely vanishes. [4] We propose a practical method to eliminate the admixture of such components. The equivalence of the present Faddeev approach and the variational approach was numerically demonstrated as shown in the table. In the 3α calculation, the shielded Coulomb force with $R_C = 6$ fm^{-1} is included. $c_{(04)}$ is the amplitude of the shell-model (04) component. $n_{\max}$ is the number of the basis states or the discretization points (Faddeev).

method	$n_{\max}$	$E_{3d'}$ (MeV)	$n_{\max}$	ε (MeV)	$E_{3\alpha}$ (MeV)	$c_{(04)}$
variation	4,197	-0.4343	1,602	9.3504	-6.1210	0.7861
Faddeev	7,875	-0.4378	12,000	9.3490	-6.1217	0.7860
difference		0.0035		-0.0014	0.0007	0.0001

References

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