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# Number of three-particle bound states and structure of essential spectra of the energy operator of two-magnon systems in a isotropic ferromagnetic impurity non-Heisenberg model with arbitrary spin value S

In this work, we consider the energy operator of two-magnon systems in an isotropic non-Heisenberg ferromagnetic impurity model with an arbitrary spin value s and with a coupling between nearest neighbors. We investigated the structure of essential spectrum and number of three-particle bound states in the $\nu-$ dimensional lattice $Z^\nu$. The considering systems is consists of three body systems; two magnons and one impurity spins. The Hamiltonian of the system in question has the form

$$H = -\sum_{m,\tau}\sum_{n=1}^{2s} J_n(\overrightarrow{S}_m \overrightarrow{S}_{m+\tau})^n - \sum_{\tau}\sum_{n=1}^{2s}(J_n^0 - J_n)(\overrightarrow{S}_0 \overrightarrow{S}_\tau)^n, \tag{1}$$

where $\overrightarrow{S}_m$ is the atomic spin operator for the spin $s$ at the lattice site $m$, $J_n > 0, n = 1, 2, ..., 2s$; are the parameters of the multipole exchange interaction between the nearest-neighbor atoms in the lattice, $J_n^0$ are the atom-impurity multipole exchange interaction parameters, the summation over $\tau$ ranges the nearest-neighbors.

Spectra of the this three-particle system is a tightly bound to spectra of one-magnon subsystems. In [1], the case of a $\nu-$ dimensional lattice was considered the energy operator of one-magnon systems in an isotropic non-Heisenberg ferromagnetic impurity model with an arbitrary spin value $s$, and it was proved that there are at most three types of LISs (not counting the degeneracy multipliticities of their energy levels) in the $\nu-$ dimensional case. It was shown that the number of types of LISs in the system changes with varying parameters of the Hamiltonian, and the LIS domains were found. In this case , it turns out that the three types of LISs in the system are respectively nondegenerate, $\nu-$ fold degenerate, and $(\nu-1)-$ fold degenerate. We show the essential spectra of two-magnon system is consists of unification no more than four segments and we find the lower and upper appraisal for the number of three-particle bound states of the considering system.

Let $\nu = 1$ and $p(s) = -2\sum_{k=1}^{2s}(-2s)^k J_k, q(s) = -2\sum_{k=1}^{2s}(-2s)^k(J_k^0 - J_k)$, and $\widetilde{\mathcal{H}}_2$ is the two-magnon invariant subspace of the Hamiltonian $H$, and $\widetilde{H}_2 = H/_{\widetilde{\mathcal{H}}_2}$, and $N-$ number of three-particle bound states of Hamiltonian (1).

Theorem 1. If $p(s) > 0, q(s) > -p(s)$, then the essential spectrum of the operator $\tilde{H}_2$ consists of unification of three segments: $\sigma_{ess.}(\tilde{H}_2) = [0; 2p(s)]\bigcap\bigcup[z_1; 2p(s) + z_1]\bigcup[z_2; 2p(s) + z_2]$ and for number $N$ has such relation: $3 \le N \le 15$.

Theorem 2.If $p(s) < 0, q(s) > p(s)$, then the essential spectrum of the operator $\tilde{H}_2$ consists of unification of three segments: $\sigma_{ess.}(\tilde{H}_2) = [2p(s); 0]\bigcap\bigcup[2p(s) + z_1; z_1]\bigcup[2p(s) + z_2; z_2]$ and for number $N$ has such relation: $3 \le N \le 15$.

[1] Tashpulatov S. M.//Theoretical and Mathematical Physics. — Moscow: Nauka. — 2005. — **142**, N 1. PP.83-92.