Phase diagram of spin-1 condensate with quadrupole degrees of freedom in a magnetic field

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We obtain and justify a many-body Hamiltonian of pairwise interacting spin-1 atoms, which includes eight generators of the SU(3) group associated with spin and quadrupole degrees of freedom. It is shown that this Hamiltonian is valid for nonlocal interaction potential, whereas for local interaction specified by s-wave scattering length, the Hamiltonian should be bilinear in spin operators only (of the Heisenberg type). We apply the obtained Hamiltonian to study the ground-state properties and single-particle excitations of a weakly interacting gas of spin-1 atoms with Bose-Einstein condensate taking into account the quadrupole degrees of freedom [1]. It is shown that the system under consideration can be in ferromagnetic, quadrupolar, and paramagnetic phases. The corresponding phase diagram is constructed. The main characteristics such as the density of the grand thermodynamic potential, condensate density, and single-particle excitation spectra modified by quadrupole degrees of freedom are determined for different phases.

References:

[1] M.S. Bulakhov, A.S. Peletminskii, S.V. Peletminskii, and Yu.V. Slyusarenko, J. Phys. A (accepted, doi:10.1088/1751-8121/abed16)

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