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Green's function method for the two-dimensional frustrated spin-1/2 Heisenberg magnetic lattice

The Green Function (GF) technique can be a good candidate for the study of the strongly coherent behavior and the magnetic structure factor of real materials, and in particular to address the case of long-range coupling. We present a new approach to solve a finite $S = 1/2$, two-dimensional (2D) frustrated $J_1 - J_2$ quantum Heisenberg Model (QHM) within the GF scheme. The magnon Hedin's equations for the QHM are derived, via the Schwinger functional derivative technique, and solved self-consistently within a scheme beyond the Random Phase Approximation. The spin correlations functions and the magnetic structure factor are calculated for a finite 2D cluster system, for both the ferromagnetic and antiferromagnetic cases. We also benchmark our approach against exact numerical solutions, and find that it provides fairly good accuracy with relatively low computational cost. Most importantly, and more in general, our results suggest that the new method presented here offers a practical and computationally advantageous route to investigate long-range interactions in the QHM.

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