Dynamics of the Two-Dimensional Heisenberg Model: Experiment, Computation and Theory

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The excitations of the 2D Heisenberg antiferromagnet, Rb_2MnF_4, have been studied using neutron scattering techniques with the MAPS spectrometer at the ISIS facility of RAL. Measurements were made of the magnetic excitations over the whole of the 2D Brillouin zone at 4 temperatures below the ordering temperature of 38K and 6 temperatures above. It was found that the excitations were well defined if their wave vectors were larger than the inverse correlation length and were overdamped if the wave vectors of the excitations were smaller than the inverse correlation length. In more detail we have compared our experimental results with the results of classical simulations and the calculations gave a very adequate description of the experimental results except at the lowest temperature where the form of the dispersion relation was correct but the energies of the excitations were in error. Nevertheless, classical simulations do provide an efficient and easily implemented methodology for modelling the excitations in Heisenberg magnets. Random phase calculations gave a good description of the energy of the excitations at low temperatures. The damping of the excitations was experimentally found to follow a T^2 behaviour over all wave vector and energy scales. This is in agreement with the classical simulations but inconsistent with analytic theories of the damping for the 2D Heisenberg model and in particular does not agree with hydrodynamic behaviour or dynamic scaling. The result is similar to that found in 3D Heisenberg systems and suggests that more analytic theory is needed to explain the experimental results. For both 2D and 3D Heisenberg magnets.