Experimental Observations of Magnetic Bose Glass

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The turn of millennia marked a milestone in quantum many-body physics with first reports of Bose-Einstein condensation in quantum magnets[1]. A natural question to ask is: what happens to the phase transition in the presence of magnetic disorder? Theory predicts that disorder may disrupt the formation of condensate at the phase boundary and lead to an intermediate Bose Glass (BG) phase before entering the BEC state. Recently, experimental evidence of a magnon Bose Glass have been reported for several materials, including IPA-$CuCl_{(1-x)}Br_x)_3$ and $Tl_{1-x}K_xCuCl_3$. In the present work we compare those results with new experiments on the disordered spin gap systems $(C_4H_{12}N_2)Cu_2(Cl_{1-x}Br_x)_6$ and Sul-$Cu_2(Cl_{1-x}Br_x)_4$. Indeed, we find that even weak disorder has a profound effect on the magnon BEC phenomenon. However, to date there is no clear evidence that the BEC phase persists at high fields, as predicted by BG theory. In its place one observes a gradual spin freezing, and probably a glassy short-range-ordered phase at high fields. Does this call for re-evaluation of BG physics for quantum magnets?

[1] T. Giamarchi, Ch. Rüegg and O. Tchernyshyov, Nature Physics 4, 198 - 204 (2008)