Exotic Phase Diagram of Multilayered Triangular Ising Model

Cristian D. Batista*

Theoretical Division of Los Alamos National Laboratory, 87545 Los Alamos, USA

I will introduce the thermodynamic phase diagram of a multilayered triangular lattice Ising model (MLTIM) with a finite number N of vertically stacked layers. We will see that above a critical N there is a low temperature reentrance of one or two Berezinskii-Kosterlitz-Thouless (BKT) transitions, which results in an extended pseudo-critical disordered regime ($\langle \sigma_{i,n}\sigma_{i+r,n}\rangle \sim r^{-\eta(T)}e^{-r/\xi}$) down to zero temperature. This low-temperature disordered regime has peculiar properties such as a negative value of $d\eta/dT$ (short-range spin-spin correlations increase with temperature). I will explain these results by analyzing the RG flow of a low energy effective dimer theory that quantitatively describes the low temperature physics of the MLTIM. I will also derive qualitative features of the global phase diagram by mapping the classical spin model into the single-layer quantum Ising model.

In the 3D limit ($N \to \infty$), the two upper BKT transitions collapse into a single 3D-XY critical point that signals the transition into a partially disordered antiferromagnetic state that breaks a Z_2xZ_3 symmetry. This transition and the normal to superfluid transition of a neutral system, like ^{4}He, are in the same universality class. Onsager and Feynman envisioned long time ago that the superfluid to normal transition can be understood as a proliferation of U(1) vortex loops. We will see that the proliferation of Z_6 vortex loops that has been recently observed in $RMNO_3$ compounds is a direct manifestation of this phenomenon in systems that have lower symmetry (Z_6).

*Work done in collaboration with Yoshitomo Kamiya, Shizeng Lin and Gia Wei Chern