Tricriticality, BKT multicriticality and proximate deconfined quantum criticality in fully frustrated quantum antiferromagnets

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Fully frustrated quantum antiferromagnetic models exhibit a wealth of novel phenomena, including strongly bound multiparticle excitations whose proliferation assures anomalous thermodynamic properties [1, 2 and references therein]. A common feature of these models is a first-order quantum phase transition, which persists to finite temperatures before terminating at a thermal critical point [1, 2]. Major advances in numerical techniques, including quantum Monte Carlo (QMC) in arbitrary bases [1, 2] and finite-temperature tensor-network methods [3], have provided unprecedented insight into the physics of these models.

The Shastry-Sutherland model provides one paradigm for a fully frustrated system that is realised quite faithfully in the material $SrCu_2(BO_3)_2$ (SCBO). It was shown recently by specific-heat measurements and tensor-network modelling [3] that the pressure-temperature phase diagram of SCBO is dominated by a thermal critical point, occurring at approximately 19 kbar and 3.2 K, which extends with little alteration to finite magnetic fields.

Here we report further theoretical and experimental progress. By QMC simulations of the fully frustrated bilayer model [1] in an applied magnetic field, we show that the line of thermal critical points between the dimer-singlet (DS) and -triplet antiferromagnetic (DTAF) phases becomes a line of finite-temperature tricritical points once the DS phase is replaced by a field-induced checkerboard triplon-crystal (TC) state [4]. The tricritical TC-DTAF line displays emergent Z_4 symmetry, delimits the BKT regime of the DTAF state and terminates at a quantum critical endpoint. By nuclear magnetic resonance (NMR) measurements in the plaquette phase of SCBO, we demonstrate that the field-induced transition to the AF phase occurring around 6 T is a "weakly first-order" bicritical point with matching critical exponents, a gapless spin excitation and an emergent O(3) symmetry [5]. These results provide strong experimental evidence for close proximity to a deconfined quantum critical point in SCBO [6].

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