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Dimensionality and Quantum Criticality: the case of the spin-dimer system $BaCuSi_2O_6$

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Physical properties in the vicinity of a quantum critical point (QCP) are intimately related to system dimensionality. In heavy fermion systems, for instance, the origin of emergent superconductivity and non Fermi liquid behaviour at a pressure-tuned QCP has been suggested to be a consequence of reduced dimensionality. In this talk, I discuss the field-tuned Bose Einstein condensation (BEC) QCP in the spin-dimer system $BaCuSi_2O_6$ - also known as Han Purple. Long-range anti-ferromagnetic order in this system appears above a critical magnetic field $H_{c1} \sim 23.5$ T due to the closure of the spin gap to triplon excitations. While the divergence of critical fluctuations tends to destabilise any reduction of dimensions at a fermionic QCP, contrary behaviour is demonstrated at the field-tuned bosonic QCP in $BaCuSi_2O_6$. The suppression of amplitude fluctuations at the BEC QCP in this system contributes to the effectiveness of geometrical frustration in reducing the effective dimensionality at the QCP. Experimental thermodynamic signatures are presented as evidence for a 2D BEC QCP in $BaCuSi_2O_6$.

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[1] S. E. Sebastian et al., "Dimensional reduction at a quantum critical point," Nature 441, 617-620 (2006)