Hidden quantum critical point in $SrCo_2V_2O_8$

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$SrCo_2V_2O_8$ is composed of weakly coupled Co^{2+} chains along the crystallographic *c* axis. Each of these chains realizes the renowned spin-1/2 XXZ model in the Heisenberg-Ising regime. This model predicts a gapped Néel ground state at zero-temperature and a novel magnetic-field-induced (**B** // chain) Néel to Tomonaga-Luttinger liquid (TLL) quantum phase transition (QPT) at B_c, where the gap closes [1-2]. Due to the nonnegligible interchain interactions, all these states are experimentally accessible in $SrCo_2V_2O_8$ (sometimes in a slightly modified fashion), making it an ideal system to explore the exotic quantum spin states in one-dimension, e.g. spinons, psinons, antipsinons and Bethe strings [3-5].

The XXZ model is exactly solvable. Only two parameters are required to capture the magnetic properties; they are the spin anisotropy Δ and intrachain exchange J. In theory, Δ and J can be analytically obtained by measuring B_c and the saturation field B_{sat}, where a fully field-polarized ferromagnetic state is realized [6]. Consequently, a valid set of Δ and J must satisfy the experimentally evaluated B_c and B_{sat} values. In the literature, B_c is commonly assigned as the melting point B_m ($T \to 0$) = 3.9 T of the finite-temperature Néel order in this compound and the Δ and J have been determined accordingly [4, 5]. Nevertheless, no gap closure has been identified along the B_m (T) line.

In this talk, we will present experimental evidence for the spinon gap closure and TLL emergence in $SrCo_2V_2O_8$ at 2.0 T < B^* ($T \to 0$) < 2.5 T. First of all, we discuss the inelastic neutron scattering (INS) signature for spinon-spinon bound states with the quantum spin numbers $S = \pm 1$ and marginal spectral weights around 0.80 meV. Secondly, we demonstrate the neutron diffraction results which reveal the partial suppression of the bulk Néel order and emergence of a finite staggered magnetic moment along the chain at B^*. Last but not the least, we will show the INS spectra recorded between B^* ($T \to 0$) and B_m ($T \to 0$), which feature paired quasi-particle excitations of spinon-spinon (confined) and psinon-antipsinon; the latter directly supports the existence of a TLL in this region.

We determine a new set of Δ and J values by assuming $B_c = B^*$ ($T \to 0$). Using the Bethe ansatz, we find that the theoretical magnetization versus magnetic field curve excellently reproduces the experimentally measured one. Our results reveal a first-order-like Néel to TLL QPT around B^*. Other important aspects, including the nature of the B_m (T) line and nontrivial interchain interactions, will also be addressed in this talk.

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