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Bound states and triplet excitations at very high magnetic fields in the Shastry-Sutherland compound, $\text{SrCu}_2(\text{BO}_3)_2$

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Chasing new states of quantum matter is a central element in condensed matter physics, motivated both by fundamental curiosity but also by the need for a better understanding of many-body quantum effects for future technologies. Of particular interest are frustrated systems such as the Shastry-Sutherland (SS) model consisting of spin pairs (dimers) embedded in a square lattice. The model has an exact dimer product ground state when the ratio, J'/J , between the inter-dimer coupling, J , and intra-dimer coupling, J' , is less than 0.675 [1]. The network of Cu^{2+} ions in $\text{SrCu}_2(\text{BO}_3)_2$ (SCBO) is topologically equivalent to the SS lattice and with $J'/J \sim 0.6$ close to the critical point, this compound presents unique experimental testing grounds for the model. Upon applying a magnetic field, SCBO exhibits a series of phase transitions [3,4] and we study the magnetic excitations upon approaching the first transition at 27T to the 1/8 magnetization plateau using inelastic neutron scattering. At field values much below the transition a novel and unexpected mode shows up. We use state-of-the-art model calculations to identify the nature of this mode: Is it a bound state or a triplet excitation? And why does it appear before the transition?

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[2] S. Miyahara and K. Ueda, Phys. Rev. Lett. 82, 3701 (1999)

[3] M. Takigawa et al., Phys. Rev. Lett. 110, 067210 (2013)

[4] P. Corboz and F. Mila, Phys. Rev. Lett. 112, 147203 (2014)

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