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Bound states and triplet excitations at very high magnetic fields in the Shastry-Sutherland compound, $SrCu_2(BO_3)_2$

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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 $SrCu_2(BO_3)_2$ (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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