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Exploring the Shastry-Sutherland compound, Sr2Cu(BO3)2, by using inelastic neutron scattering with high pressures and high magnetic fields

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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 magnets where competing interactions may lead to exotic magnetic states and an external parameter such as magnetic field or pressure can be used to tune the system from one quantum state to another. The Shastry-Sutherland lattice is such a frustrated system. It consists of spin pairs (dimers) embedded in a square lattice. It has an exact dimer product ground state when the ratio between the inter and intra-dimer couplings is sufficiently low [1]. Upon increasing this ratio, the system goes through a quantum phase transition to a plaquette singlet state followed by an antiferromagnetic phase [2]. Sr2Cu(BO3)2 is a unique material since it is topologically equivalent to the Shastry-Sutherland lattice [3] and it is close to the critical point to the plaquette phase. Sr2Cu(BO3)2 therefore presents remarkable experimental testing grounds for the Shastry-Sutherland model where the couplings may be altered by applying pressure to obtain a phase diagram which resembles the one theoretically predicted [4]. As a frustrated magnetic system, Sr2Cu(BO3)2 also exhibits a series of transitions upon applying a magnetic field with the first one occurring at 27T [5] . The transition field may be tuned to a range achievable in neutron scattering experiments by applying pressure [6]. I will thus present our recent experimental effort to characterize the first magnetization plateau of Sr2Cu(BO3)2 by carrying out neutron scattering experiments with high pressure, high magnetic field and low temperatures, all simultaneously. I will also show you results from inelastic neutron scattering experiments performed with the aim to explore the plaquette and antiferromagnetic phases and where even higher pressures were needed.

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