Revisiting magnetization plateaus in $SrCu_2(BO_3)_2$ by high-field NMR

Mladen HORVATIĆ
Laboratoire National des Champs Magnétiques Intenses, LNCMI-CNRS (UPR3228), EMFL, Univ. Grenoble Alpes, Univ. Toulouse, INSA-T, 38042 Grenoble Cedex 9, France
mladen.horvatic@lncmi.cnrs.fr

Investigation of magnetization plateaus in the Shastry-Sutherland compound $SrCu_2(BO_3)_2$ by high-field NMR at LNCMI-Grenoble now spans 25 years, during which these experiments marked some of crucial technical advances of the laboratory. The first ever ultra-high-field NMR measurement carried out in a dilution refrigerator [1] brought the experimental confirmation for the nature of the plateaus: the ^{63,65}Cu NMR spectrum recorded at 27.6 T and 35 mK evidenced the commensurate spin superstructure demonstrating the Wigner crystallization of magnetic excitations, taken to be the extended triplets at that time. As the field of 34 T became available, the first experiment carried out up to this field value was the ^{11}B NMR spectroscopy, establishing the precise sequence of the low-magnetization plateaus, at 1/8, 2/15, 1/6 and 1/4 of the saturation magnetization [2]. In the meantime, using advanced tensor-network numerical methods, theorists proposed that constituting elements of the 1/8, 2/15 and 1/6 plateaus are not the spin-1 extended triplets but the spin-2 bound triplet pairs forming a pinwheel pattern [3]. In 2025, by one of the two first experiments carried out in the new hybrid magnet of LNCMI, providing up to 42 T, we could compare the ^{63,65}Cu NMR spectrum in the 1/3 plateau at 41.9 T to the spectra in 27.6 T and 29.0 T, respectively in the 1/8 and 2/15 plateau. Confronting the spectra to the updated theoretical prediction for the spin superstructures, we proved that, as expected, the 1/3 plateau is based on the extended triplets and the 1/8 and 2/15 plateaus on the pinwheel-shaped spin-2 elements [4]. To our knowledge, this is the first ever real-space imaging of a complex, bound triplet pair excitation, demonstrating remarkable power of the NMR technique. Our results add the formation of Wigner crystals of *bound states* as a new paradigm in the theory of magnetization plateaus.

References:
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