Robust intralayer antiferromagnetism and tricriticality in VBr_3

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We will report on magnetic states and phase transitions in the van der Waals antiferromagnet VBr_3. The magnetization behavior resembles Ising antiferromagnets with magnetic moments kept in the out-of-plane direction by strong uniaxial magnetocrystalline anisotropy. The out-of-plane magnetic field induces a spin-flip metamagnetic transition, which is of first-order type at low temperatures while at higher temperatures the transition becomes continuous (second order type). The two segmemts of magnetic phase transition lines in the B-T phase diagram are separated by a tricritical point at 12 K. The magnetization response to the in-plane field manifests a continuous spin-flop like transition, which at 2 K terminates at a field $\mu_0 H_c \approx 27$ T that can serve as an estimate of the anisotropy field in VBr_3. The magnetization curves above the metamagnetic transition saturate at the same value of magnetic moment $\mu_{sat} = 1.2\ \mu_B$/f.u., which is much smaller than the expected spin-only (S = 1) moment of the V^{3+} ion. The reduced moment can be explained by the existence of a significant orbital magnetic moment antiparallel to the spin. The exact energy evaluation of possible magnetic orders unambiguously shows that the magnetic ground state of VBr_3 is the intralayer zigzag antiferromagnetic order that renders the antiferromagnetic ground state significantly more stable against the spin-flip transition than the other options. The calculations also predict that a minimal distortion of the Br ion sublattice causes a radical change of the orbital occupation in the ground state, connected with the formation of the orbital moment and the stability of magnetic order.[1]

References

Dávid Hovančík, Marie Kratochvílová, Tetiana Haidamak, Petr Doležal, Karel Carva, Anežka Bendová, Jan Prokleška, Petr Proschek, Martin Míšek, Denis I. Gorbunov, Jan Kotek, Vladimír Sechovský and Jiří Pospíšil, in review process in Physical Review B (2023)

Figures

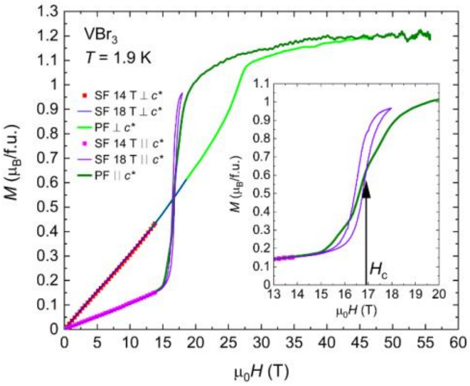

Figure 1: The magnetization isotherms of VBr_3 measured at 2 K in static fields (SF) up to 18 T and pulsed fields (PF) *H* ll *c** and *H* ⊥ *c** up to 58 T. Inset: The detail of the plots for *H* ll *c** between 13 and 20 T. The arrow points to the critical field H_c.