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Ordering and Excitations in the Field-Induced Magnetic Phase of $Cs_3Cr_2Br_9$

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$Cs_3Cr_2Br_9$ is an interesting example of interacting spin-dimer system. As in other isotropic antiferromagnets such as Haldane or alternating chains and ladders, the ground state in zero field is a total spin singlet separated from the excited triplet by an energy gap. In a magnetic field H, a phase transition occurs at a critical field H_{c1}, where the gap to the lowest component of the Zeeman-split triplet closes. Above H_{c1}, field-induced magnetic order (FIMO) for spin components perpendicular to H is induced by inter-dimer or inter-chain couplings. The FIMO transition may be considered as a Bose-Einstein Condensation. $Cs_3Cr_2Br_9$ differs from other dimer systems currently studied (*e.g.* PHCC, $TlCuCl_3$) in two main ways: each Cr^{3+} ion of the dimer has spin 3/2 rather than 1/2 for Cu-based systems and the arrangement of the dimers is hexagonal. This gives rise to anisotropy and frustration in a 3D lattice, respectively. The possibility of studying the magnetic ordering and the spin dynamics in a FIMO with sufficient detail to bring out features of frustration and anisotropy motivated the present neutron scattering study in $Cs_3Cr_2Br_9$*. Two field orientations have been exploited, perpendicular and parallel to the easy axis **c** (direction of the dimers). First, I present the diffraction study: the FIMO displays large hysteresis incommensurability, showing the importance of frustration. The impact of anisotropy is seen in the magnetic structure, whose nature strongly depends on the field direction. Second, I focus on spin dynamics: it quantifies the presence of anisotropy and shows its crucial role on the energy gap at H_{c1}, which is measurably open or not, depending on whether H is perpendicular or parallel to **c**. Third, an explanation is proposed for the large value of the gap at higher field: it involves the mixing of higher order states (*extended*-FIMO), reflected by the absence of magnetization plateaus. Comparison with the sister $Cs_3Cr_2Cl_9$ compound provides a test of this hypothesis. *B. Grenier *et al.,* Phys. Rev. Lett. **92**, 177202 (2004)