High-field magnetization and antiferromagnetic resonance in novel frustrated magnetic materials

Using high-field magnetization and anitiferromagnetic resonance measurements we investigated two novel frustrated magnetic compounds, β-$TeVO_4$ and Cu_2OCl_2. In β-$TeVO_4$, at 1.5 K, a clear field-induced transition is found at 5 and 10 T when field is in the *ab* plane and along *c*, respectively. On the other hand, filed dependences of antiferromagnetic resonance imply a zero-field gap of ~150 GHz and ~300 GHz. In Cu_2OCl_2, we found no field induced transitions, while a zero-field gap is very clear and amounts ~100 GHz.

Frustrated magnetic systems, i.e., systems with competing magnetic interactions, often exhibit complex magnetic ground states, which are very sensitive to external perturbations. This effect becomes even more pronounced in low-dimensional systems and may lead to fascinating new phenomena, e.g. magnetoelectric coupling, and rich magnetic phase diagrams.

To pursue such intriguing effects, we undertook high-magnetic-field study of two novel magnetic compounds, β-$TeVO_4$ and Cu_2OCl_2, respectively. The former is a chain compound with dominant exchange interaction J ~ 21.4 K and potentially significant competing next-nearest exchange interactions [1]. The latter, however, has a highly frustrated pyrochlore lattice with the exchange constant estimated to J ~ 110 K [2]. At low temperatures, β-$TeVO_4$ exhibits three consecutive magnetic phases transitions, at 4.65, 3.28 and 2.28 K, which according to the neutron diffraction most likely correspond to three incommensurate magnetic phases. On the other hand, magnetic ordering temperature in Cu_2OCl_2 is T ~ 70 K, while the ground state is still unknown.

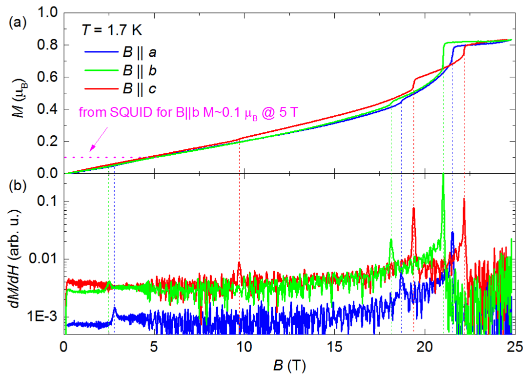

Fig. 1 Magnetization and its derivative in β-$TeVO_4$.

Our results for β-$TeVO_4$ reveal that at 1.5 K, a field induced transition occurs that strongly depends on the field direction, i.e., when field is in the *ab* plane the transition is found at 5 T, while for the perpendicular orientation it occurs at 10 T. Further, we found at least two magnetic excitation branches with zero-field gaps of ~150 and ~300 GHz, which dramatically change in the high-field phase.

In Cu_2OCl_2 the antferromagnetic resonance at 1.5 K, i.e., well below magnetic transition, has a broad powder-like (box-shaped) spectrum. The broad feature extends for 3 to 8 T, at low and high frequencies, respectively. The spectral feature is touching the ordinate axis (0 T) at ~100 GHz, and herby reveal the size of the zero-field gap in the excitation spectrum. With increasing frequency, a linear shift to higher frequencies is found, as typically encountered in antiferromagnetic systems.

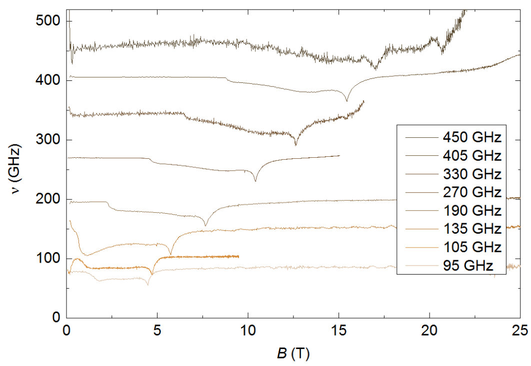

Fig. 2 Antiferromagnetic resonance in Cu_2OCl_2.

References

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[2] M. Nishiyama et al., J. Phys.: Conference Series 320 012030 (2011).

Keywords: high magnetic field, electron spin resonance, magnetnic properties
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