Anomalously field-susceptible spin clusters emerging in an electric-dipole liquid candidate κ-$(BEDT\text{-}TTF)_2Hg(SCN)_2Br$

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The family of layered organic conductors κ-$(BEDT\text{-}TTF)_2X$ where X is monovalent anion species have been studied as model systems exhibiting the Mott metal-insulator transition. The strongly dimerized BEDT-TTF molecules allow us to consider the crystal structure as the simple anisotropic triangular lattice hosting one hole with spin-half on each lattice point. This simplification is a basis for understanding the various magnetic states in κ-$(BEDT\text{-}TTF)_2X$, including the antiferromagnetic long-range order and possible spin liquid states.

Recently, the title compound κ-$(BEDT\text{-}TTF)_2Hg(SCN)_2Br$ with the relatively weak BEDT-TTF dimerization has been reported to host a quantum electric-dipole liquid state where electric dipole degrees of freedom on BEDT-TTF dimer sites remain fluctuating down to low temperatures [1]. From the Raman vibrational spectroscopy, the time scale of charge fluctuations is estimated to be ~1 THz [1], which is of the same order as the antiferromagnetic spin exchange frequency; therefore, the charge fluctuations could have a significant influence on the spin state in the system resulting in exotic magnetic properties.

In the presentation, we report the results of ^{1}H NMR as well as dc and ac magnetization measurements. The ^{1}H NMR spectra and dc magnetization measured in various magnetic fields indicate that large and inhomogeneous staggered magnetic moments with weak-ferromagnetic components are induced by external magnetic fields. The dc and ac susceptibilities have no indications of a long-range spin ordering or spin freezing down to 2 K; nevertheless, sizable staggered moments are induced by the external field below 20 K; the moments reach as large as 0.5–1μ_B per dimer at a field of 6 T. Furthermore, the analysis of the NMR relaxation rate reveals that the dynamics slows down to submegahertz at low temperatures. We discuss these unique magnetic properties in terms of inhomogeneous spin clustering not leading to ordering or freezing due to frustration [2].

References

[1] N. Hassan et al., *Science* **360**, 1101 (2018).
[2] M. Urai et al., arXiv:2201.04857 (2022).