Geometrically frustrated $CuFeO_2$

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Complex magnetic oxides exhibit a rich variety of intriguing phenomena arising from the interplay between multiple coupled degrees of freedom, with the latter eventually determining their macroscopic behaviour. A particularly interesting class of materials in this respect are the geometrically frustrated spin systems, with the multiferroic two dimensional delafossite system ($CuFeO_2$) as one of the more intriguing examples. This material exhibits a staircase of metamagnetic phase transitions, originating from competing spin-spin, spin-phonon, spin-orbit, and spin-field interactions. The physical origin of this fascinating behavior has been unraveled by a variety of experimental and theoretical approaches, including magnetization, nuclear forward scattering and x-ray absorption experiments, as well as band structure calculations and semiclassical magnetic modeling. Apart from obtaining a detailed insight in the nature of the various ground states and the observation of a reversed spin-Peierls transition at high magnetic fields, one of the eye-opening findings is the existence of a finite $3d$ spin density on the nominally $3d^{10}$ Cu^+ site. This spin density is shown to play a pivotal role in the low temperature magnetism potentially also in the field induced multiferroic state of this material.