Bond randomness in the frustrated spin ladder Sul-$Cu_2(Cl_{1-x}Br_x)_4$

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We study the effect of bond randomness on the magnetic and thermodynamic properties of a geometrically frustrated $S = 1/2$ quantum spin ladder Sul-Cu_2Cl_4. The pure system is a gapped quantum spin liquid that in a magnetic field $H_c = 3.75$ T experiences a quantum phase transition to an ordered helimagnetic state [1]. Bond disorder is implemented by substituting chlorine for bromine on the non-magnetic halogen site in Sul-$Cu_2(Cl_{1-x}Br_x)_4$. Materials with $x < 0.1$ retain the original crystal structure but show quite different properties in applied fields. The main result is that for x as low as $x = 0.0025$, the field-induced long-range ordering is disrupted. Instead, at H_c one observes a crossover to a short-range ordered state. A new regime or phase is detected at $T > 0$, just below H_c. The extreme sensitivity to disorder is linked to the incommensurate nature of field-induced magnetic order in the parent compound. A novel mechanism for disorder in weakly-coupled one dimensional incommensurate systems is proposed.

[1] V. O. Garlea *et. al.*, Phys. Rev. B **79**, 060404(R) (2009).