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Fractional spin textures in the frustrated magnet SCGO

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Spin liquids are remarkable states of matter that do not order magnetically even at very low temperatures and show collective phenomena like emergent gauge fields and topological order. Impurities can potentially reveal the underlying correlations in such states that appear deceptively featureless in their ground state properties. We consider the archetypal frustrated antiferromagnet $SrCr_{9p}Ga_{12-9p}O_{19}$ (SCGO) in which Ga ions act as non-magnetic impurities in the magnetic lattice composed of Cr^{3+} S=3/2 spins for disordered $p < 1$ samples. We demonstrate that a spin in direct proximity to a pair of vacancies is cloaked by a spatially extended spin texture that encodes the correlations of the parent spin liquid. In this spin liquid regime, our analytic theory predicts that the combined object has a magnetic response identical to a classical spin of length S/2=3/4, which dominates over the small intrinsic susceptibility of the pure system. We calculate the full texture on the lattice in the spin liquid regime and check that it agrees well with Monte-Carlo simulations. This fractional-spin texture leaves an unmistakable imprint on the measured ^{71}Ga nuclear magnetic resonance (NMR) lineshapes, which we compute using Monte-Carlo simulations and compare with experimental data. We also study the long-ranged interactions between these spin textures at low temperatures to gain a better understanding of the case of finite dilution in the parent spin liquid.