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Spiral spin-liquid and a vortex-like state in $MnSc_2S_4$

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Spirals and helices are common motifs of long-range order in magnetic solids, and they may also be organized into more complex emergent structures such as magnetic skyrmions and vortices. A new type of spiral state, the spiral spin-liquid, in which spins fluctuate collectively as spirals, has recently been predicted to exist [1]. Here, using neutron scattering techniques, we experimentally prove the existence of a spiral spin-liquid in MnSc2S4 by directly observing the 'spiral surface' (a continuous surface of spiral propagation vectors in reciprocal space) [2]. We elucidate the multi-step ordering behavior of the spiral spin-liquid, and discover a vortex-like triple-q phase on application of a magnetic field. Our results prove the effectiveness of the J1-J2 Hamiltonian on the diamond lattice as a model for the spiral spin-liquid state in MnSc2S4, and also demonstrate a new way to realize a magnetic vortex lattice through frustrated interactions.

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