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Frustration and kinetic magnetism in a Fermi-Hubbard Simulator

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Geometrical frustration in strongly correlated systems can give rise to intriguing ordered states such as quantum spin liquids. In this work, we report on recent experimental progress in Fermi gas microscopy demonstrating emergent magnetic states in a Hubbard model with controllable frustration and doping. Using an optical lattice continuously tunable from a square to a triangular geometry, we observe how geometrical frustration transforms a Néel antiferromagnet at half-filling into a short-range 120◦ spiral state. Away from half-filling, antiferromagnetic correlations in the triangular lattice are strengthened by hole dopants but surprisingly reverse to ferromagnetic when adding particle dopants. Through measurements of three-point dopant-spin-spin correlations, we reveal how these particle dopants are embedded into extended ferromagnetic bubbles resulting from the local interplay between coherent dopant motion and spin exchange. Such ferromagnetic polarons represent the first cold-atom observation of Nagaoka ferromagnetism, a paradigmatic model of itinerant magnetism with strong Hubbard interactions. Our work provides a microscopic picture of kinetic magnetism that has recently been observed in twisted TMD bilayers, and opens the way to investigating dopant pairing mediated by frustration.

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