Spectroscopy of magnetic polarons in geometrically frustrated systems

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The emergence of quasiparticles that differ qualitatively from their constituent particles is a hallmark of strongly correlated quantum many-body states. In doped ferromagnetic insulators, a paradigmatic example of such an emergent quasiparticle is a bound state of a mobile charge carrier and a magnon. This is a special kind of magnetic polaron that carries charge $Q = 1$ and spin $S = 3/2$. These composite objects underlie several critical phenomena in geometrically frustrated systems, including magnetization plateaus and superconductivity. While experiments with moire electron systems, ultracold atoms in optical lattices, and Rydberg arrays have recently provided evidence of the existence of these magnetic polarons, measurements of the single-particle spectral function - which provides crucial information on binding energy and dispersion-have been lacking. In this talk, we will discuss a novel spectroscopic protocol that enables the measurement of spectral functions in Rydberg arrays. This method can be configured to measure spectral functions in momentum space, analogous to ARPES, or locally in real space, similar to STM experiments in solids. We will review experimental measurements of single-particle spectral functions in frustrated $t - J$ Hamiltonians using a Rydberg tweezer array. Leveraging single-atom resolution, these experiments go beyond canonical spectroscopic measurements to directly visualize photoexcited states, confirming their magnetic character, spatial localization, and composite nature.