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Atomic spin chains as testing ground for quantum magnetism[1]

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The field of quantum magnetism aims to capture the rich emergent physics that arises when multiple spins interact, in terms of elementary models such as the spin $\frac{1}{2}$ Heisenberg chain. Experimental platforms to verify these models are rare and generally do not provide the possibility to detect spin correlations locally. In my lab we use low-temperature scanning tunneling microscopy to design and build artificial spin lattices with atomic precision. Inelastic electron tunneling spectroscopy enables us to identify the ground state and probe spin excitations as a function of system size, location inside the lattice and coupling parameter values. Two types of collective excitations that play a role in many dynamic magnetic processes are spin waves (magnons) and spinons. Our experiments enable us to study both types of excitations. First, we have been able to map the standing spin wave modes of a ferromagnetic bit of six atoms, and to determine their role in the collective reversal process of the bit (Spinelli *et al.*, Nature Materials 2014). More recently, we have crafted antiferromagnetic spin $\frac{1}{2}$ XXZ chains, which allow us to observe spinon excitations, as well as the stepwise transition to a fully aligned phase beyond the critical magnetic field (Toskovic *et al.*, in preparation). These findings create a promising experimental environment for putting quantum magnetic models to the test.

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