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Optical control over correlated magnetism in moiré materials

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Abstract

Understanding and controlling strongly correlated many-body spin systems is one of the key challenges in modern condensed matter physics. A groundbreaking platform for exploring this frontier has emerged with the advent of semiconducting moiré materials (SMMs), which uniquely bridge the gap between conventional quantum materials and cold-atom quantum simulators.

In this talk, I will review our recent ultra-low-temperature magneto-optical investigations of collective electronic magnetism in two different types of SMMs. In the first part, I will show an unusual type of electronic ferromagnetism in $MoSe_2/WS_2$ heterobilayers, which arises not from exchange interactions, but due to minimization of kinetic energy via elusive Nagaoka mechanism. In the second part, I will focus on twisted MoTe2 homobilayers, where strong interlayer hybridization gives rise to flat topological valence bands that support robust fractional and integer Chern insulators. I will demonstrate that the spin of these topological magnets can be optically oriented, paving the way for ultrafast control over the topological order parameter.