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**Quantum Simulation with 2D Arrays of Trapped Ions** PHILIP RICHERME, Indiana University — The computational difficulty of solving fully quantum many-body spin problems is a significant obstacle to understanding the behavior of strongly correlated quantum matter. This work proposes the design and construction of a 2D quantum spin simulator to investigate the physics of frustrated materials, highly entangled states, mechanisms potentially underpinning high-temperature superconductivity, and other topics inaccessible to current 1D systems. The effective quantum spins will be encoded within the well-isolated electronic levels of trapped ions, confined in a two-dimensional planar geometry, and made to interact using phonon-mediated optical dipole forces. The system will be scalable to 100+ quantum particles, far beyond the realm of classical intractability, while maintaining individual-ion control, long quantum coherence times, and site-resolved projective spin measurements. Once constructed, the two-dimensional quantum simulator will implement a broad range of spin models on a variety of reconfigurable lattices and characterize their behavior through measurements of spin-spin correlations and entanglement. This versatile tool will serve as an important experimental resource for exploring difficult quantum many-body problems in a regime where classical methods fail.

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