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**Synthesizing complex spin networks with spin-motion coupled neutral atoms in photonic crystals** YING DONG, IQC, University of Waterloo — We develop a toolbox for realizing "fully programmable" d-dimensional pairwise interacting lattice spin systems with spin-motion coupled neutral atoms in the vicinity of 1D photonic crystal waveguides. The enabling platform thereby allows to synthesize a wide range of strongly interacting quantum materials by way of vacuum-engineered interatomic kinetic interactions. We demonstrate the versatility of our assembly language approach towards arbitrary SU(2)-lattice spin models with explicit constructions of familiar Hamiltonians for perfect state transfer in 1D spin chains, lattice gauge theories, and topologicallyquantum spin liquids. We further construct Dzyaloshinski-Moriya interaction for the realization ofspin liquids and long-range random quantum magnets with spin-glass phase.

Ying Dong
IQC, University of Waterloo

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