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Hybrid quantum systems with ultracold spins and optomechanics[1] AIRLIA SHAFFER, YOGESH SHARAD PATIL, HIL F. H. CHEUNG, KE WANG, Cornell University, ADITYA DATE, KEITH SCHWAB, California Institute of Technology, PIERRE MEYSTRE, University of Arizona, MUKUND VENGALATTORE, Cornell University — Linear cavity optomechanics has enabled radiation pressure cooling and sensing of mechanical resonators at the quantum limits. However, exciting and unrealized avenues such as generating massive macroscopic nonclassical states, quantum signal transduction, and phonon-based manybody physics each require strong, nonlinear interactions. In our group, we are exploring three approaches to realizing strong optomechanical nonlinearities – i. using atomically thin graphene membranes, ii. coupling optomechanical systems with ultracold atomic spins, and iii. using microtoroidal optomechanical resonators strongly coupled to atoms trapped in their evanescent fields. We describe our progress in each of these efforts and discuss ongoing studies on various aspects of quantum enhanced metrology, nonequilibrium dynamics of open quantum systems and quantum transduction using these novel hybrid quantum systems.

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Yogesh Sharad Patil
Cornell University

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