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**Optical beams with embedded vortices: building blocks for atom optics and quantum information**[1] N. CHATTRAPIBAN, I. ARAKELYAN, Department of Physics, University of Maryland, S. MITRA, Institute for Physical Science and Technology, University of Maryland, W. T. HILL, III, Institute for Physical Science and Technology & Department of Physics, University of Maryland — Laser beams with embedded vortices, Bessel or Laguerre-Gaussian modes, provide a unique opportunity for creating elements for atom optics, entangling photons and, potentially, mediating novel quantum interconnects between photons and matter. High-order Bessel modes, for example, contain intensity voids and propagate nearly diffraction-free for tens of meters. These vortices can be exploited to produce dark channels oriented longitudinally (hollow beams) or transversely to the laser propagation direction. Such channels are ideal for generating networks or circuits to guide and manipulate cold neutral atoms, an essential requirement for realizing future applications associated with atom interferometry, atom lithography and even some neutral atom-based quantum computing architectures. Recently, we divided a thermal cloud of neutral atoms moving within a blue-detuned beam into two clouds with two different momenta by crossing two hollow beams. In this presentation, we will describe these results and discuss the prospects for extending the process to coherent ensembles of matter.

[1]ARO, OIDA - PTAP, NIST, NSF

Narupon Chattrapiban
Department of Physics, University of Maryland

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