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Time-of-flight expansion dynamics of a circulating ring BEC[1]
MARK EDWARDS, NOEL MURRAY, Georgia Southern University, KEVIN WRIGHT, GRETCHEN CAMPBELL, WILLIAM D. PHILLIPS, NIST and Joint Quantum Institute, CHARLES W. CLARK, Joint Quantum Institute — We have studied the effect of non–zero circulation on the time–of–flight expansion dynamics of a ring–shaped BEC, under conditions matching recent experiments at the Joint Quantum Institute/NIST in Maryland. We modeled the dynamics of the condensate by first solving the time–independent Gross–Pitaevskii equation (GPE) to obtain the initial condensate wavefunction, with the (quantized) circulation set by imprinting an azimuthal phase gradient. This state was then propagated using the time–dependent GPE in real time, with the trapping potential turned off. In the absence of circulation, the BEC expands and closes the central hole in a few milliseconds, eventually resulting in a density profile with a central peak surrounded by a pedestal modulated by weak concentric fringes. When the ring BEC is circulating, the central hole initially decreases in size but never closes due to the phase singularity. In the long–time limit, the size of the central hole scales nearly linearly with the winding number of the circulation state, in good agreement with the NIST experimental results.

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Mark Edwards
Georgia Southern University

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