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Atom Interferometric Holography and Arbitrary Pattern Nanolithography Using Bose-Einstein Condensates SELIM SHAHRIAR, MAY KIM, JONATHAN TROSSMAN, JOHN KETTERSON, MOHAMED FOUDA, RENPENG FANG, Northwestern University — We describe a technique where atomic interferometry along with light-shift induced, two dimensional phase imprinting with optical pulses are used to produced three dimensional holographic patterns of atoms, using a Bose-Einstein Condensate as a source. We also show how a variation of this technique can be used to realize arbitrary pattern nanolithography with a feature size as small as 2 nm. We have used the Gross-Pitaevskii equations to model the evolution of the condensate order parameter through free space as well as during interaction with the optical fields, using typical values of scattering lengths, in the absence of Feshbach resonances. In our scheme, the condensate is first split into two components in different hyperfine states, using a Raman pulse. Detuned optical pulses are then used to imprint desired phase pofiles on one or both parts of the split components. For proper choice of pulses and phase patterns, the atoms form a three-dimensional hologram or a two-dimensional pattern, upon recombination of the two parts using additional Raman pulses. These techniques could be used for nanolithography by transfering the pattern to coinage metals, or to produce various topological patterns of condensates for fundamental studies.

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