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Einstein-Podolsky-Rosen correlations using dissociation of a molecular Bose-Einstein condensate KAREN KHERUNTSYAN, Australian Centre for Quantum-Atom Optics, University of Queensland, MURRAY OLSEN, PETER DRUMMOND — We combine two of Einstein's contributions to twentieth century physics, Bose-Einstein condensation and the Einstein-Podolsky-Rosen (EPR) paradox, to propose a test of local realism with mesoscopic numbers of massive particles. Using dissociation of a Bose-Eistein condensate of homonuclear diatomic molecules into the constituent bosonic atoms, we demonstrate that strongly entangled output atomic beams may be produced which possess nonlocal EPR correlations in particular field quadratures [1]. These are directly analogous to the position and momentum correlations originally considered by EPR, and to the quadrature correlations for massless photons demonstrated experimentally using optical parametric down-conversion. We show that for realistic non-uniform condensate models, the proposed matter-wave quadrature measuments have to rely on mode-matched local oscillators. Our model takes into account molecular condensate depletion, s-wave scattering interaction and possible one-body losses of atoms and molecules. An experimental realization of this proposal, which can in principle be achieved via optical Raman transitions or using a magnetic Feshbach resonance, would be a test of fundamental quantum mechanics with massive particles in a mesoscopic regime. [1] K. V. Kheruntsyan, M. K. Olsen, and P. D. Drummond, cond-mat/0407363.

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