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Particle-Hole Pair Coherence in Mott Insulator Quench Dynamics[1] EITE TIESINGA, NIST, KHAN MAHMUD, LEI JIANG, Joint Quantum Institute, PHILLIP JOHNSON, American University — We predict the existence of novel collapse and revival oscillations that are a distinctive signature of the short-range off-diagonal coherence associated with particle-hole pairs in Mott insulator states. Starting with an atomic Mott state in a one-dimensional optical lattice, suddenly raising the lattice depth freezes the particle-hole pairs in place and induces phase oscillations. The peak of the quasi-momentum distribution, revealed through time of flight interference, oscillates between a maximum occupation at zero quasi-momentum (the Γ point) and the edge of the Brillouin zone. We find that the population enhancements at the edge of the Brillouin zone is due to coherent particle-hole pairs, and we show similar effects for fermions and Bose-Fermi mixtures in a lattice. Our results open a new avenue for probing strongly correlated many-body states with short-range phase coherence that goes beyond the familiar collapse and revivals previously observed in the long-range coherent superfluid regime.

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