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**Reversible Transfer of Optical to Atomic States** ANDREEA BOCA, California Institute of Technology, ALLEN DAVID BOOZER, RUSSELL MILLER, TRACY NORTHUP, H. JEFF KIMBLE — Using a single atom strongly coupled to a high-finesse cavity, optical states can be reversibly transferred to superpositions of atomic internal states. We demonstrate this by transferring a weak coherent state to a superposition of  $F=3$  and  $F=4$  atomic ground states in a single trapped Cesium atom. To confirm that the process is reversible, we transfer the atomic superposition back to an optical state, which is shown to be phase coherent with the original coherent state.

Andreea Boca  
California Institute of Technology

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