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Measuring Correlations by Single Atom Detection in Quantum Degenerate Gases ANTON ÖTTL, STEPHAN RITTER, TOBIAS DONNER, THOMAS BOURDEL, MICHAEL KÖHL, TILMAN ESSLINGER, Institute for Quantum Electronics, ETH Zurich, Switzerland — We observe single atoms by means of cavity QED detection in a quantum degenerate gas. Starting from a magnetically trapped ^{87}Rb BEC of 5 million atoms we coherently output couple a continuous atom laser by means of a local radio-frequency induced spin-flip into a magnetically untrapped hyperfine state. These atoms propagate freely downward due to gravity and enter the detector which is placed 36 mm below the BEC. Our single atom detector consists of an ultra-high finesse ($\mathcal{F} = 3 \cdot 10^5$) optical cavity in the strong coupling limit of cavity QED. We record the transmission of a weak resonant probe laser through the cavity with a single photon counter and detect single atom transits by their significant reduction of transmission. We measured the second order correlation function of an atom laser beam in a Hanbury Brown & Twiss type experiment. Analyzing the correlations in the arrival time of individual atoms reveals the second order coherence of the atom laser. The high quantum efficiency and fast response time of our single atom detector enables us to extract the full counting statistic of atomic beams. We verified a poissonian distribution for the atom laser whereas a pseudo-thermal atomic beam showed a bunching behavior corresponding to a Bose-Einstein statistical distribution function.

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