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Observing Spin-Charge Separation in a 1D Fermi Gas[1] ANDREW MARCUM, ARIF MAWARDI ISMAIL, FRANCISCO FONTA, KENNETH O'HARA, The Pennsylvania State University — The low energy excitations of an interacting Fermi gas in one dimension are collective sound-like modes which independently govern spin transport and density transport in such systems. In general, these spin- and density-waves travel with different interaction-dependent sound velocities. In electronic systems, this phenomenon – referred to as spin-charge separation as density transport implies charge transport – has been observed indirectly in tunneling experiments. Here, we aim to directly observe spin-"charge" (i.e. density) separation in an ultracold two-component Fermi gas of atoms. Absorption imaging allows for the direct observation in real space of the dynamics of spin-density and "charge"-density waves excited in an ultracold gas of spin-1/2 fermions confined in an array of 1D optical waveguides (formed by a 2D optical lattice). To excite spin waves in a two-component mixture of ^{6}Li atoms with minimal heating we employ a two-photon Raman transition acting only on one of the internal states to either (1) excite a spin-dipole mode or (2) locally eject one spin state from the trap. In the first approach, spin-charge separation manifests as a strong dependence of the spin-dipole mode frequency on interaction strength in contrast to a weak dependence for the density-dipole and density-quadrupole mode frequencies. In the second approach, spin-density and "charge"-density wavepackets are excited directly and propagate at different velocities in the interacting system.

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