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Direct Observation of Spin- and Charge-Density Waves in a Luttinger Liquid[1] CHENGLIN CAO, ANDREW MARCUM, ARIF MAWARDI ISMAIL, FRANCISCO FONTA, KENNETH O'HARA, The Pennsylvania State University — At low energy, interacting fermions in one dimension (e.g. electrons in quantum wires or fermionic atoms in 1D waveguides) should behave as Luttinger liquids. In stark contrast to Fermi liquids, the low-energy elementary excitations in Luttinger liquids are collective sound-like modes that propagate independently as spin-density and/or charge-density (i.e. particle-density) waves with generally unequal, and interaction-dependent, velocities. Here we aim to unambiguously confirm this hallmark feature of the Luttinger liquid – the phenomenon of spin-charge separation – by directly observing in real space 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. Starting from a two-component mixture of ^{6}Li atoms harmonically confined along each of the 1D waveguides, we excite low lying normal modes of the trapped system – namely the spin dipole and density dipole and quadrupole modes – and measure their frequency as a function of interaction strength. Luttinger liquid theory predicts that the spin dipole frequency is strongly dependent on interaction strength whereas the density dipole and quadrupole mode frequencies are relatively insensitive. We will also discuss extending our approach to exciting localized spin density and particle density wavepackets which should propagate at different velocities.

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Kenneth O'Hara
The Pennsylvania State University

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