Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Observation of a hierarchy of modes in an interacting one-dimensional system CHRISTOPHER FORD, MARIA MORENO, YIQING JIN, WOOI KIAT TAN, JON GRIFFITHS, IAN FARRER, GEB JONES, University of Cambridge, ANNE ANTHORE, Universite Paris Diderot, DAVID RITCHIE, University of Cambridge, OLEKSANDR TSYPLYATYEV, ANDREW SCHOFIELD, University of Birmingham — Studying interacting fermions in 1D at high energy, we find a hierarchy in the spectral weights of the excitations theoretically and we observe evidence for second-level excitations experimentally. Diagonalising a model of fermions (without spin), we show that levels of the hierarchy are separated by powers of $\mathcal{R}^{\in}/\mathcal{L}^{\in}$, where $\mathcal{R}$ is a length-scale related to interactions and L is the system length. The first-level (strongest) excitations form a mode with parabolic dispersion, like that of a renormalised single particle. The second-level excitations produce a singular power-law line shape to the first-level mode and multiple power-laws at the spectral edge. We measure momentum-resolved tunneling of electrons (fermions with spin) from/to a wire formed within a GaAs heterostructure, which shows parabolic dispersion of the first-level mode and well-resolved spin-charge separation at low energy with appreciable interaction strength. We find structure resembling the second-level excitations, which dies away quite rapidly at high momentum.

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Date submitted: 14 Nov 2014 Electronic form version 1.4