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Theory of shock waves in a unitary Fermi gas ALEXANDER ABANOV, Stony Brook University, MANAS KULKARNI, Stony Brook University and Brookhaven National Laboratory, JAMES JOSEPH, JOHN THOMAS, Duke University — We present here evidence of shock wave formation during the collision of two clouds of a unitary Fermi gas. A unitary Fermi gas is an ideal test ground for extreme quantum hydrodynamics. By its very nature the system exhibits universality, i.e., the properties of the gas, constrained by an underlying scale invariance, depend entirely on the density and temperature. The nonlinear hydrodynamics exhibited in this experiment is understood by using a dimensionally reduced quasi- 1D form of the quantum hydrodynamic equations of motion. We found a near perfect agreement with the experiment. The evidence of shock wave formation is a hallmark of nonlinear physics in a universal quantum hydrodynamic system. The hydrodynamic approach works well deep in the nonlinear regime even at low density and for a system far from equilibrium.

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