Abstract Submitted
for the OSF10 Meeting of
The American Physical Society

Quantized Conductance in Mechanically Controlled Break Junctions for Undergraduate Labs ROBERT TOLLEY, DANIEL WENTZEL, ANTONY SILVIDI, KHALID EID, Miami University — We have constructed a system to demonstrate quantized conductance steps through mechanically controlled break junctions in gold wires [1]. This apparatus is designed to use simple and robust parts with the intention of making it conceptually accessible as an experiment in an undergraduate laboratory. Unlike more common methods of using piezo-electric crystals, our apparatus relies upon a stepper motor and simple reduction gears to achieve the necessary atomic level resolution. This experiment allows a clear and intuitive investigation of four distinct regimes of charge transport in physics. Starting at the macroscopic (i.e. diffusive transport regime), pulling the wire allows us to reproducibly probe transport in the mesoscopic, quantized conductance, and finally quantum tunneling regimes. Despite the very simple tabletop design, this device allows students to directly observe the transition between the classical world and the one dominated by quantum mechanics. We specifically developed this setup for use in the sophomore-level contemporary physics lab at Miami University.

[1] N. Agrait, A.L. Yeyati, J.M. Van Ruitenbeek. Physics Reports 377, 81 (2003)

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Date submitted: 09 Sep 2010 Electronic form version 1.4