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Observation of persistent currents in thirty metal rings, one at a time

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It is a central prediction of quantum mechanics that a thermodynamically stable or "persistent" current should exist in sufficiently small electronic structures, even if they have a finite resistance as semiconducting or metallic samples do. The magnitude and even the sign of this current should vary greatly from sample to sample, but it should always have a periodic dependence on the applied magnetic field in ring-shaped samples. Due to the extremely high sensitivity required to measure persistent currents in normal metals, only a handful of experiments exist, and most measure ensemble-averaged properties. I will present measurements of the magnetic response of 33 gold rings, measured one ring at a time with a sensitive scanning SQUID technique. We find that the amplitude distribution and temperature dependence of the h/e-periodic persistent current is in good agreement with theoretical predictions. This result is in disagreement with the only previous experiment [1] measuring individual metal rings, which found a much larger response than expected in the three measured rings. Our results confirm predictions for the typical, disorder-realization dependent h/e persistent current in diffusive rings at the single ring level, and thus address a major open question in mesoscopic physics.

[1] V. Chandrasekhar et al., PRL **67, 3578 (1991).**

[1]Work done at Stanford University.