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Persistent currents in superconducting rings well above their critical magnetic field[1]

ANIA BLESZYNSKI-JAYICH, Yale University

A striking manifestation of quantum mechanics is the existence of a dissipationless current in a non-superconducting metal ring. The persistent current is analogous to electrons orbiting the nucleus in an atom. The prediction that an atom-like persistent current could be observed in a micron size metal ring generated considerable interest. The persistent current is a signature of electronic phase coherence around the ring and offers insight into many issues in mesoscopic physics such as coherence and electron interactions in metals. The small magnitude of the current and the necessity of measuring it through its associated magnetic moment make persistent current experiments challenging. Few measurements have been reported and inconsistent results have left an unclear picture of the properties of persistent currents. In a novel approach to studying persistent currents we have developed a cantilever based torsional magnetometer capable of detecting a magnetic moment of 1 $\mu_B/Hz^{1/2}$and a force of 1.6 $aN/Hz^{1/2}$ at 300 mK. I present measurements of persistent currents in normal aluminum rings in the presence of large magnetic fields. We have measured single rings and arrays of rings. I discuss the temperature, ring size, and magnetic field dependence of the persistent current and compare it to theory and previous experiments.

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