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**Non-sinusoidal current-phase relations in SFS  $\pi$ -Josephson junctions<sup>1</sup>**

DALE J. VAN HARLINGEN, University of Illinois at Urbana-Champaign

We report the direct observation of a  $\sin(2\phi)$  component in the current-phase relation (CPR) of Superconductor-Ferromagnet-Superconductor (SFS) Josephson junctions. The deviation from a sinusoidal CPR is most evident near the crossover between the 0-junction to  $\pi$ -junction states reached by tuning the thickness of the ferromagnet barrier and the temperature. We measure the CPR in Nb-CuNi-Nb junctions using a phase-sensitive Josephson interferometer technique in which the junctions are incorporated into a superconducting loop coupled to a dc SQUID. We correlate the CPR data with measurements of subharmonic Shapiro steps and anomalous critical current diffraction patterns that have previously been cited as evidence for higher-order Josephson tunneling components. We will discuss possible origins and implications for the non-sinusoidal component. In collaboration with M.J.A. Stoutimore (University of Illinois at Urbana-Champaign) and A.Yu. Rusanov, V.A. Oboznov, V.V. Bolginov, A.N. Rossolenko, and V.V. Ryazanov (Institute of Solid State Physics, Russian Academy of Sciences, Chernogolovka, Russia).

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