sion. The pressure dependence of this ratio is given by

$$d\ln(I/\tfrac{1}{2}\Delta_0^2)/dP = 2(d\ln H_0/dP - d\ln\Delta_0/dP) - d\ln N(0)/dP. \quad (6)$$

We use $d\ln H_0/dP = -9.4\times10^{-6}$/bar, representing an average between the more recent measurements of Garfinkel and Mapother[3] and of White,[12] and $d\ln N(0)/dP = -8.2\times10^{-6}$/bar, Ref. 3. Combining this with our result, Eq. (3), we get

$$d\ln(I/\tfrac{1}{2}\Delta_0^2)/dP = +(9.6\pm3.4)\times10^{-6}/\text{bar}. \quad (7)$$

The indicated error includes the errors for $d\ln H_0/dP$ and $d\ln N(0)/dP$ quoted in Ref. 3. We find therefore again that increasing pressure changes the properties of Pb towards those of a BCS superconductor.

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QUANTUM PHASE FLUCTUATIONS IN SUPERCONDUCTING TIN

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We have directly observed quantum phase fluctuations at the onset of long-range quantum phase coherence in single-crystal bulk tin as it becomes superconducting.

Upon becoming superconducting a normal metal develops long-range quantum mechanical phase coherence.[1] Observable secondary effects at the onset of this macroscopic quantum state include the Meissner effect, vanishing electrical resistance, and a discontinuity in the specific heat. This Letter reports the first direct observation of the behavior of the quantum phase during the superconducting transition. We find that the superconductor passes through a regime of temperature-dependent quantum phase fluctuation at the superconducting transition.

A technique has been developed to establish a superconducting junction between a normal metal and a superconductor in which quantum phase coherence already exists. The resistance of a point contact junction between normal tin and superconducting niobium has been found to vanish at temperatures as high as 4.0°K, significantly above the 3.72°K superconducting transition of bulk tin.[2] Above the transition of bulk tin this junction exhibits superconducting characteristics typical of a weak link between two superconductors: (1) Current-voltage (I-V) characteristics possess a zero-voltage critical supercurrent, above which the junction is resistive. (2) Microwave radiation induces structure in the I-V characteristics similar to that observed in thin-film bridges or point contacts between two superconductors.[3] When used in a quantum interferometer[4] these junctions serve as probes to investigate the onset of quantum phase coherence in tin during the superconducting transition. Such an interferometer is shown schematically in Fig. 1(a). Interference is observed only when quantum phase coherence exists along a path within the bulk tin as well as in the niobium. In this experiment the temperature is lowered through the tin transition temperature and quantum phase fluctuations at the onset of quantum phase coherence are directly observed. In the usual quantum interferometer the temperature depen-