MPT operation

1. Using 3-eV photons from a Blu-ray diode

C and G Measurements

- A persistent current is trapped in the bias circuit above the $T_c$ of aluminum wirebonds that connect each sensor to its associated SQUID.
- As we cool or warm through the MoAu sensor’s superconducting transition, the inductance of the meander changes as the MoAu film expels or allows entry of flux, and we measure a current proportional to the sensor’s magnetic response.
- MPTs give us a unique avenue to probe superconducting effects in MoAu films.

M vs T

- Four different bias currents (806 uA, 903 uA, 952 uA, 1001 uA)

Theory

1. Free-energy difference between superconducting and normal states of MPT

- $f$ = fraction of meaner length for which MoAu enters a partly-normal intermediate state
- $g$ = fractional width of normal stripes in intermediate state region
- $\Delta$ = superconducting energy gap reduction in Ginzburg-Landau equation
- $\tr$ = find state with minimum free energy of MPT relative to fully normal state. Free energy contains inductive and condensation terms:

\[ G \sim G_0 + \frac{1}{2} \int (\frac{\Delta T}{\Delta N})^{2/3} \left( \frac{d\mu}{d\tau} \right)^2 + \frac{1}{2} \int \text{condensation terms} \]

2. Heat capacity from second derivative of free energy

3. Thermal conductance: quasiparticle recombination & electron-phonon cooling

Conclusions

- We measured the variation in heat capacity and thermal conductance of a molybdenum-gold Magnetic Penetration Thermometer (MPT) near its field dependent Meissner transition temperature.
- We did this by two methods: detection of pulses in response to absorption of one or more 3 eV photons, and equilibrium noise measurements.
- Observed $C$ & $G$ show peaks in approximate agreement with a Ginzburg-Landau model of the superconducting intermediate state of an MPT.

References