PROBLEM SET 7

November 8 Colloquium: “Domain coarsening in a pattern: how do stripes grow?”

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3:30 pm, 101 Rowland Hall

1. Name the topic of your report (try to be specific) and list the reference(s) you will use for your final report.

2. AC Josephson Effect. When a static DC voltage $V$ is applied across a Josephson junction, an AC current results. To see how this comes about, notice that an electron pair experiences a potential energy difference $qV$ on passing across the junction, where $q = -2e$. We can say that a pair on one side is at potential $-eV$ and a pair on the other side is at $+eV$. Thus the equations of motion become

$$i\hbar \frac{\partial \psi_1}{\partial t} = \hbar T \psi_2 - eV \psi_1 \quad i\hbar \frac{\partial \psi_2}{\partial t} = \hbar T \psi_1 + eV \psi_2$$

(1)

where $\psi_1$ is the superconducting order parameter on side 1:

$$\psi_1 = \sqrt{n_1} e^{i\theta_1}$$

(2)

$n_1$ is the density of superconducting pairs on side 1. Similarly

$$\psi_2 = \sqrt{n_2} e^{i\theta_2}$$

(3)

Assume that the superconductors are identical. Find the current density $J$ as a function of time and of the phase difference $\delta(0)$. $\delta(0) = \theta_2 - \theta_1$ is the phase difference at $V = 0$. What is the angular frequency $\omega$ at which the current oscillates when a voltage $V$ is applied?


5. Eisberg and Resnick Problem 13.30 (n-p-n transistor).