Effects of Heat Current on The Superfluid Transition In a Low-gravity Simulator

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Abstract

Liquid ^{4}He provides an ideal system for the study of phase transitions under non-equilibrium, dynamic experimental conditions. Under the influence of a heat current, Q, the physical properties become nonlinear and Q-dependent near the superfluid transition. For example, renormalization-group[1] and mean-field[2] theories predict an enhancement of the heat capacity due to an applied heat current, and these predictions have been experimentally verified.[3] Gravity induced pressure variations in the liquid may influence the character of the transition in addition to our ability to examine the transition experimentally.

As such, to examine the effects of gravity on the heat-current influenced superfluid transition in *liquid*-^{4}He, a low-gravity simulator facility has been developed at JPL.[4] One of the more attractive aspects of this experiment is that these data fill the void in results between 1g earth-based studies and proposed μg-experiments. The low-g simulator uses a superconducting magnet to supply the magnetic force profile $\chi B(dB/dz) \sim -22\ T^2/cm = \rho g$; to cancel gravitationally induced hydrostatic pressure variations in a helium sample over a range 0.01 to 1g. In this reduced gravity range, experiments have verified that the canceling B-field does not change the sample pressure. In this poster we describe the experimental work in progress to improve our experimental capabilities. These improvements include the implementation of SQUID-based mini-high-resolution-thermometers (mini-HRTs) onto a new cryostat probe. High permeability magnetic shields will be used to reduce the stray magnetic fields that adversely affect the performance of the SQUID sensors and mini-HRTs. Continuous cooling of the existing superconducting magnet to T = 2.2 K using a λ-plate refrigerator will also be incorporated into the design of the new facility.

References

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