Abstract Submitted
for the MAR96 Meeting of
The American Physical Society

Sorting Category: 9.c

Precision Density Measurements Near the Helium Lambda Transition Using High-Q Microwave Cavities D. M. STRAYER, Jet Propulsion Laboratory, Caltech, W, JIANG, N.-C. YEH, N. ASPLUND, Caltech — A new experimental approach for high-precision density measurements of liquid helium near the lambda transition is proposed, Using a high-Q Nb microwave cavity ($Q \sim 10^{10}$) and the high-resolution thermometry (HRT), the changes in the density of helium that fills the cavity can be detected to high precision by accurate measurements of the resonant frequency shift (Δf) as a function of the temperature, Since the frequency shift provides direct information for the changes in the dielectric constant, and since the dielectric constant is related to the density through the Clausius-Mossotti relation, the capability of high resolution frequency measurements (to one part in 10^{13}) will enable us to resolve density changes to one part in 10^{10}. Numerical calculations have been performed to demonstrate the feasibility of this approach for mapping out the density profile of liquid helium which couples to the TE modes of a microwave cavity. For temperatures very near the lambda transition, a superfluid-normal fluid interface develops inside the cavity. A numerical deconvolution technique is established to resolve the helium density profile in the cavity. Preliminary experimental data using a TMO1O niobium cavity and with microkelvin temperature resolutions will be presented.
● Supported by NASA contract and Packard Foundation.

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Date submitted: November 30, 1995 Electronic form version 1.1

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