1989

Observation of a doublet splitting of the squashing mode in superfluid ^{3}He-B

Z. Zhao
Northwestern University

Shireen Adenwalla
University of Nebraska-Lincoln, sadenwalla1@unl.edu

P. N. Brusov
Northwestern University

J. B. Ketterson
Northwestern University

B. K. Sarma
University of Wisconsin - Milwaukee

Observation of a doublet splitting of the squashing mode in superfluid ^{3}He-B

Z. Zhao, S. Adenwalla, P. N. Brusov, and J. B. KettersonB. K. Sarma

Citation: AIP Conference Proceedings **194**, 109 (1989); doi: 10.1063/1.38816
View online: http://dx.doi.org/10.1063/1.38816
View Table of Contents: http://aip.scitation.org/toc/apc/194/1
Published by the American Institute of Physics

OBSERVATION OF A DOUBLET SPLITTING OF THE SQUASHING MODE IN SUPERFLUID ^{3}He–B

Z. Zhao, S. Adenwalla, P.N. Brusov and J.B. Ketterson
Physics and Astronomy Department
Northwestern University
Evanston, Illinois 60208

B.K. Sarma
University of Wisconsin-Milwaukee
Milwaukee, Wisconsin 53201

EXPERIMENT

The squashing mode in ^{3}He - B has been studied using a single ended cw acoustic impedance technique.[1] The sound cell employed two 12.8 MHz x-cut quartz transducers separated by a pair of gold plated tungsten wires resulting in a round trip path length of 381 μm. The spacing was calibrated by measuring the change of the velocity with pressure and was consistent with the measured wire diameter.

The principal thermometer was the susceptibility of LCMN, which was calibrated against the superfluid transition temperature. The pressure was measured in situ with a capacitance gauge that was in turn calibrated (at 1K) against a Paro Scientific Pressure Gauge. The Helsinki temperature scale was adopted. The collective modes were probed in both pressure and temperature sweeps at frequencies of 115.8 MHz and 141.6 MHz. A doublet splitting of the sq-mode in zero field has been observed in both cases as shown in Fig. 1.

DISCUSSION

There are at least three explanations of the observed effect: (1) a dispersion induced splitting of the sq-mode; (2) a texture induced splitting of the J_z = 0 branch of the sq-mode and (3) the existence of some other phase near the boundary.

In the first case, a three-fold splitting should be observed as predicted in Ref. 2. However the splitting between the $|J_z|$ = 1 and $|J_z|$ = 2 branches is only one-quarter of that between the $|J_z|$ = 0 and $|J_z|$ = 2 branches, which would not be resolved in this experiment. The experimentally observed splitting is about four times larger than that predicted by weak-coupling collective mode theory.[2] A similar situation arose for the rsq-mode[1] and the discrepancy was greatly reduced by incorporating Fermi liquid corrections (FLC).

Two other explanations of the observed two-fold splitting are attractive. A picture similar to the case of the rsq-mode may apply,[1],[3] where a texture induced doublet splitting of the J_z = 0 central peak was observed in low magnetic fields. Similar phenomena may occur for the sq-mode in zero field because of textures created by the restricted geometry. (The theory of texture induced splitting of sq-mode needs further development.)

Another possibility is that the additional peak is associated with a collective mode in a boundary induced 2D-phase[4]: one peak would arise from the bulk B-phase sq-mode and the other from the super-flapping (sfl) mode in the 2D-phase. The spectrum of the collective modes in the 2D-phase has been calculated recently.[5] The results show that part of the spectrum in the 2D-phase is the same as in the A-phase (e.g. we have the cl-mode and the pb-mode). It is known that the sfl-mode only appears when strong coupling effects are included.[6] Estimates show that the difference between the sq-mode in ^3He - B and the sfl mode in the 2D-phase is of the order of a few tens of μK at $T/T_c = 0.7$ and is consistent with the observed splitting.

This work was supported by NSF grant DMR-86-02857 and ONR.

REFERENCES

1. B.S. Shivaram, M.W. Meisel, B.K. Sarma, D.B. Mast, W.P. Halperin and J.B. Ketterson, Phys. Rev. Lett. 49, 1646 (1982).
2. Y.A. Vdovin, Proc. of Moscow Engineering Physical Institute (MEPI), Moscow, 94, (1962). P.N. Brusov, V.N. Popov, Sov. Phys. JETP. 51, 1217 (1980).
3. R.S. Fishman, J.A. Sauls, Phys. Rev. Lett. 61, 2871 (1988).
4. T. Fujita, M. Nakahara, T. Ohmi and T. Tsuneto, Progr. Theor. Phys. 64, 396 (1980).
5. P.N. Brusov, M.V. Lomakov, to be published.
6. P.N. Brusov, V.N. Popov, Sov. Phys. JETP, 52, 945 (1980).

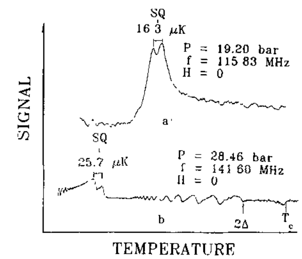

Fig. 1 Doublet splitting of the sq-mode in ^3He - B