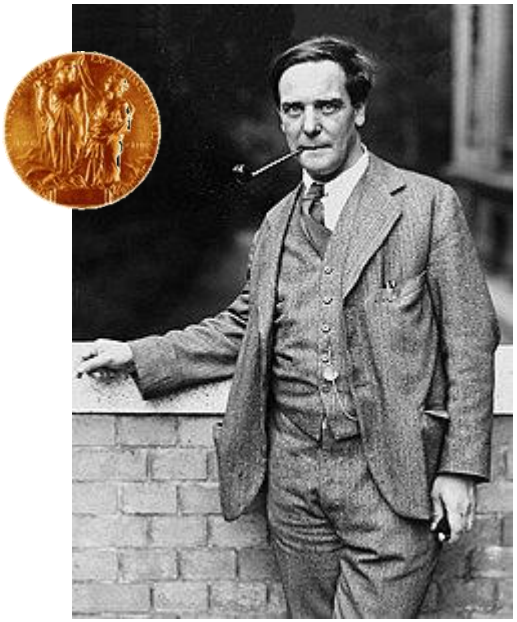
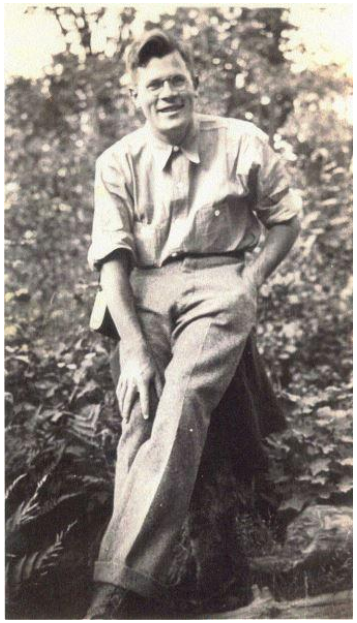
Condensed Matter	The Speed of the Second Sound	Lab logo: Second Sound

Measuring of the speed of the second sound in superfluid ^4He

History: Superfluidity was discovered in helium-4 by Pyotr Kapitsa and independently by John *F. Allen* and *Don Misener* in 1937.



Pyotr Kapitsa
1894 - 1984



Don Misener
(1911–1996)

John Frank Allen.
1908 - 2001

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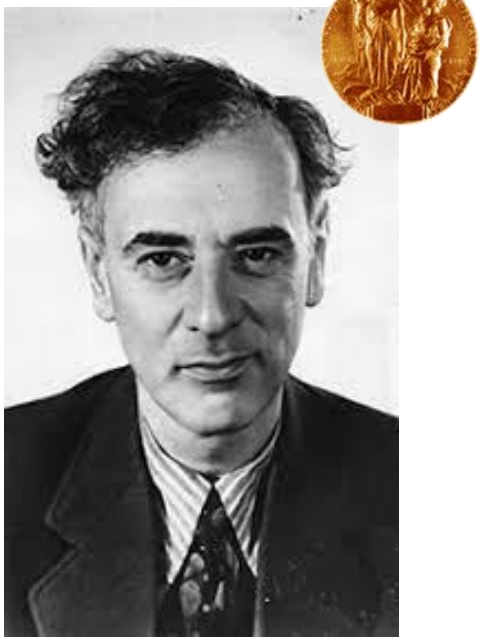
Second sound is a quantum mechanical phenomenon in which heat transfer occurs by wave-like motion, rather than by the more usual mechanism of diffusion. First observation of second sound in superfluid 4He was done by ***Vasilly Peshkov*** :

[1] V. Peshkov, "'Second Sound' in Helium II," J. Phys. USSR, v. 8, p. 381 (1944).
[2] V. Peshkov, "Determination of the velocity of Propagation of the Second Sound in Helium II," J. Phys. USSR, v. 10, pp. 389–398 (1946).

Vasiliy Peshkov
1913-1980



Lev Landau
1908 - 1968

The phenomenon of second sound was first described by ***Lev Landau*** in 1941:
Landau, L. (1941). Theory of the superfluidity of helium II. Physical Review, 60(4), 356

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Laszlo Tisza proposed the two fluid model of helium II where the normal and superfluid components have their own densities r_n and r_s . The total density of the liquid is $\rho = \rho_n + \rho_s$. The equation for the speed of the second sound comes as:

Laszlo Tisza
1907 –2009

$$U_2 = 26\sqrt{\frac{T}{T_\lambda}\left[1-\left(\frac{T}{T_\lambda}\right)^{5.5}\right]}\,(m/s)$$

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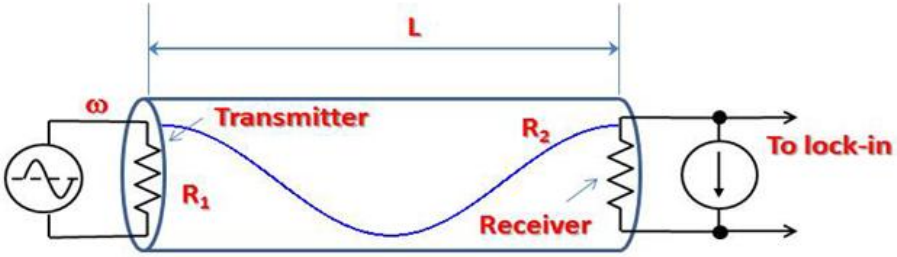
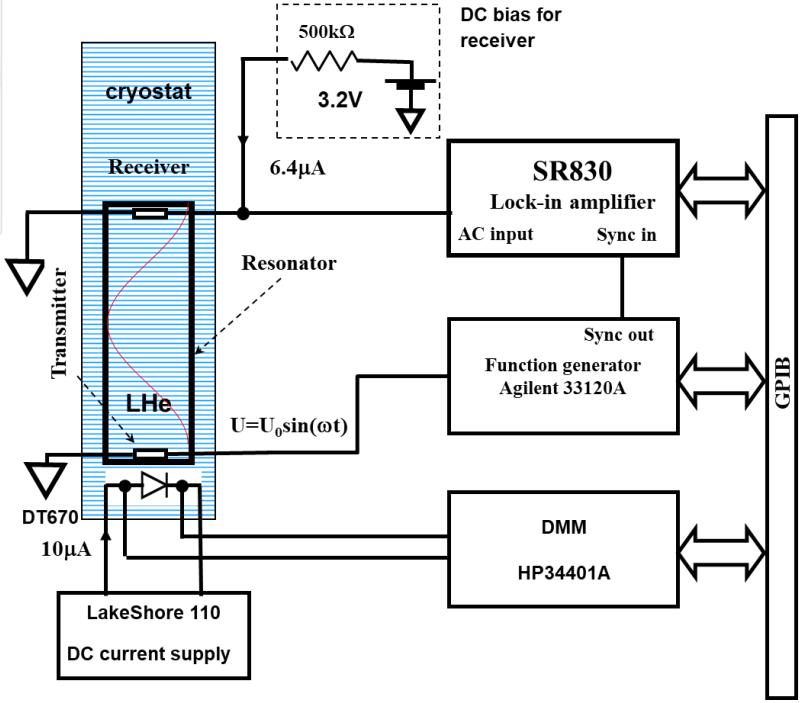
Experimental setup:

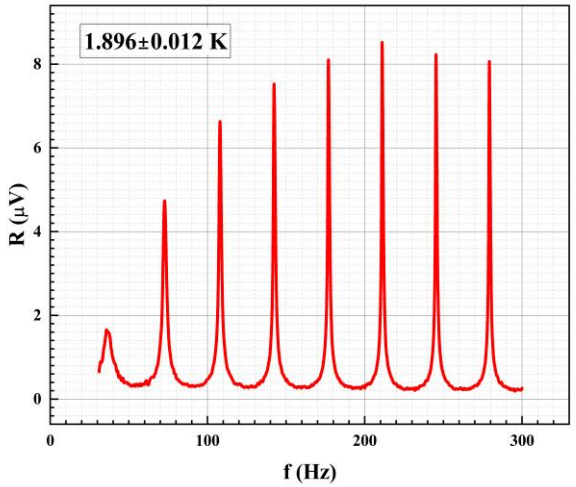




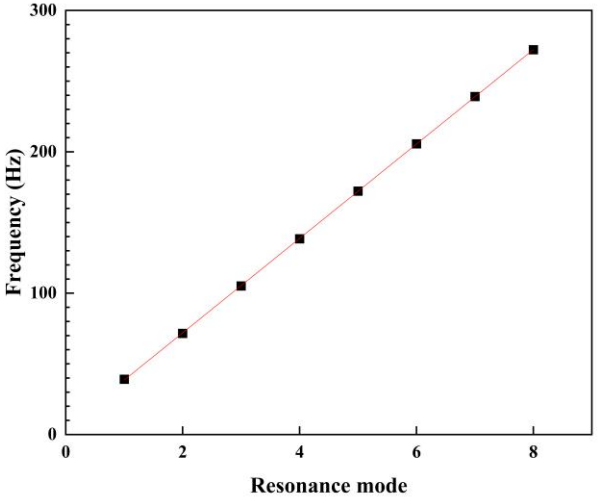
Measuring the standing waves resonance frequencies in Lucite cavity.

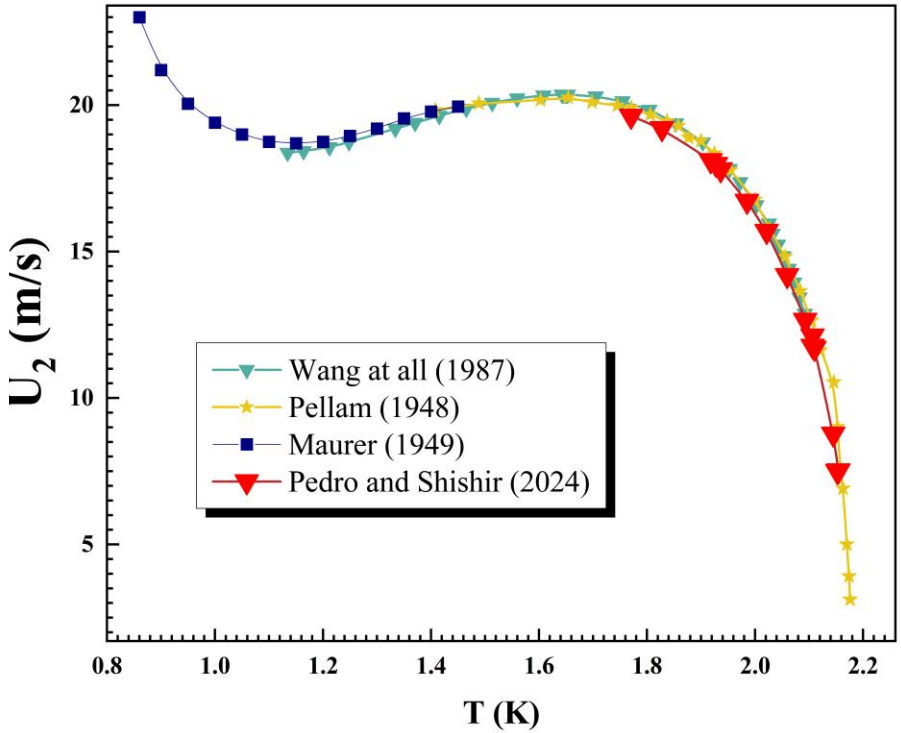
Condensed Matter	The Speed of the Second Sound	Lab logo: Second Sound

Results:



Standing wave resonances





Results obtained by P403 Spring 2024 students compared with published