STEADY BACKGROUND TURBULENCE LEVEL ON SECOND SOUND THERMAL SHOCK IN HE II

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Introduction

Here we report the maximum energy that second sound can carry as a function of background turbulence level in He II. Hilton [1] has previously shown the existence of a breakpoint in the energy transport capability of second sound pulses (SSP), see fig. 1; and he further suggested that this breakpoint was dependent on the overall turbulence level in the bath. To study this issue in more detail, we have conducted measurements in a bath of saturated He II at 1.7 K using the same apparatus as in [1], depicted in fig. 2. The heater (H) generates a low steady heat flux, ranging up to 2.63 kW/m^2 for a time exceeding the time required to reach a steady turbulence level. We then superpose a finite amplitude (100 or 200 kW/m^2) but short duration (t < 10 ms) square heat pulse on the background. The superconducting filament thermometers (SFT) record the temperature profile of the heat pulse as it passes the sensors along the channel.

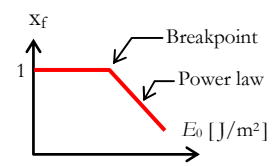

Figure 1: Breakpoint energy. The energy transport fraction x_f is the energy received on the thermometer over the total energy sent to the heater.

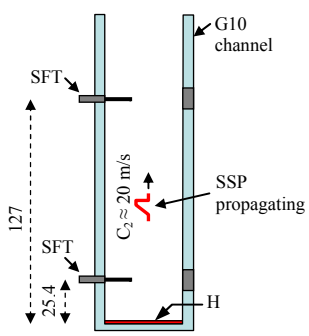

Figure 2: Experimental channel. Dimensions in mm.

Analysis

The analysis consists of determining the amount of energy contained in the pulses appearing as the time dependent temperature signals at each location. The energy transport fraction is then plotted against the total energy sent by the heater. This method leads to plots similar to fig. 1, for various background and main pulse heat fluxes. Determining the breakpoint energy for each case allows graphing the variation of the breakpoint energy with background heat flux for the two different main pulse heat flux values used.

Results and Discussion

The results in fig. 3 depict a dependence of the breakpoint energy on the background heat flux. Although we have very few data below 0.1 kW/m^2, we suspect two different regimes exist. First, at very low heat flux, the pulse self-induced turbulence seems to limit the energy transport to a value roughly 100 J/m^2 similar to that obtained by Hilton [1]. Above about 0.1 kW/m^2, however, the background turbulence becomes predominant and imposes an inverse power law. This trend does not change significantly with the main pulse heat flux value, despite a spread at the highest heat fluxes for the 200 kW/m^2 data, attributed to difficulties in the analysis at these turbulence levels. Finally, on the top sensor, the pulses have further to interact with the turbulent He II and thus got more attenuated, leading us to believe that the breakpoint energy decreases slightly as the distance from the heater is increased.

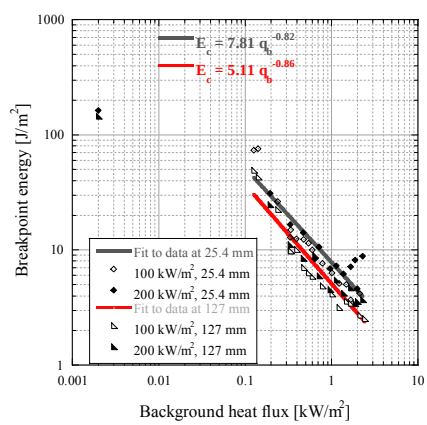

Figure 3: Breakpoint energy dependence on the background heat flux for both sensors and main pulse heat flux values.

Acknowledgements

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Mr. P. Barber, who greatly helped on building the thermometers.

References

[1] Hilton, D.K., *et al.*, J. of Low Temp. Phys., **141**, 501-536 (2005).