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AN INSTABILITY OF THE TWO FLUID HYDRODYNAMICS OF SURFACE WAVES ON SUPERFLUID ^{4}HELIUM

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Abstract: We describe a reorganization process showing various surface wave patterns.

1. Low intensity waves

When standing second sound waves are generated in helium II the resulting small pressure deforms the liquid surface. Low intensity waves have been studied and are fairly well understood [1,2]. The experiments were carried out in a cylindrical resonator where the fluid was heated periodically with an axial heater at frequencies between 1000 and 10000 Hz. In this range and at low intensities (fig. 1, region (A)) the surface wave patterns are stationary and no bulk motion occurs.

2. A reorganization process

We have found a critical heat current $\dot{Q}_c$ which depends on the wave number and the mean temperature of the fluid. The critical heat current separates a region of stable waves ($\dot{Q} < \dot{Q}_c$) from another ($\dot{Q} > \dot{Q}_c$) where unstable wave patterns occur. After switching on the wave generator at a time t_0 supplying a heat current above $\dot{Q}_c$ concentric waves develop. These look similar to the wave pattern shown in fig. 1, region (A). With time the waves become broader (fig. 1, region (B)) and a reorganization process has set in. After a time $(t - t_0)$ which is proportional to $1/(\dot{Q}^2 - \dot{Q}_c^2)$ the system reaches another stable position and the time average of the wave pattern shows a wave number doubling. This structure has been photographed with a long exposure time of 1/30 second (112 times the period of the second sound) and is shown in fig. 1, region (C).

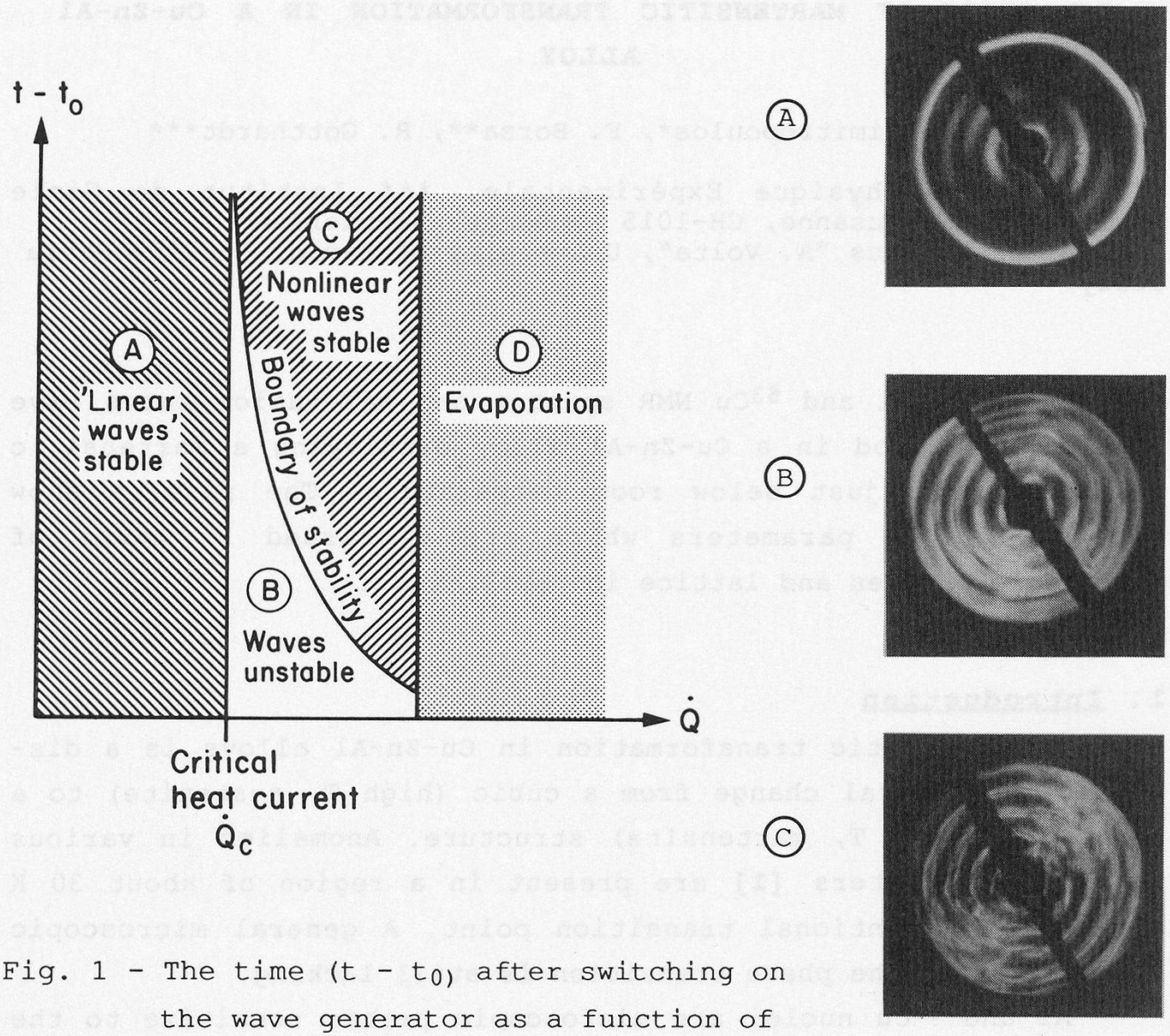

Fig. 1 - The time $(t - t_0)$ after switching on the wave generator as a function of the heat current $\dot{Q}$.

Experiments with stroboscopic illumination with a flash duration of 8 μs indicate irregular structures of the fluid surface above $\dot{Q}_c$. These wave patterns show temporally dependent behaviour and suggest a complicated motion of the surface.

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3. References

[1] Sorbello R.S., J. Low Temp. Phys. 23, 411 (1976)

[2] Olsen J.L., J. Low Temp. Phys. 61, 17 (1985)