Observation of Superfluid Transition in a Submicron ^{3}He Film

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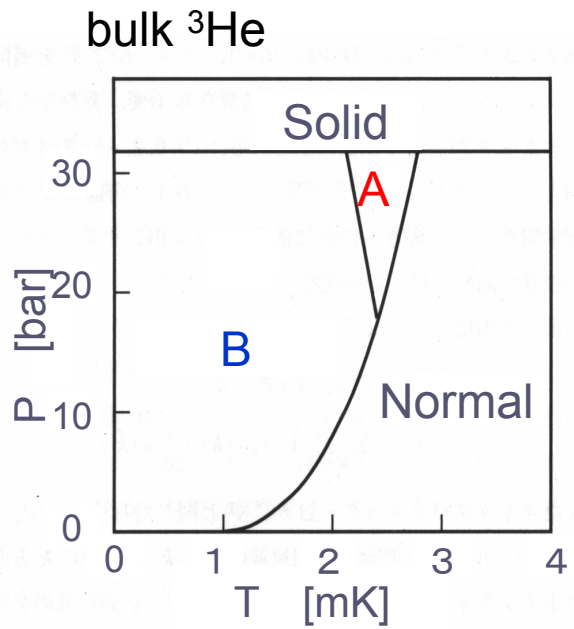
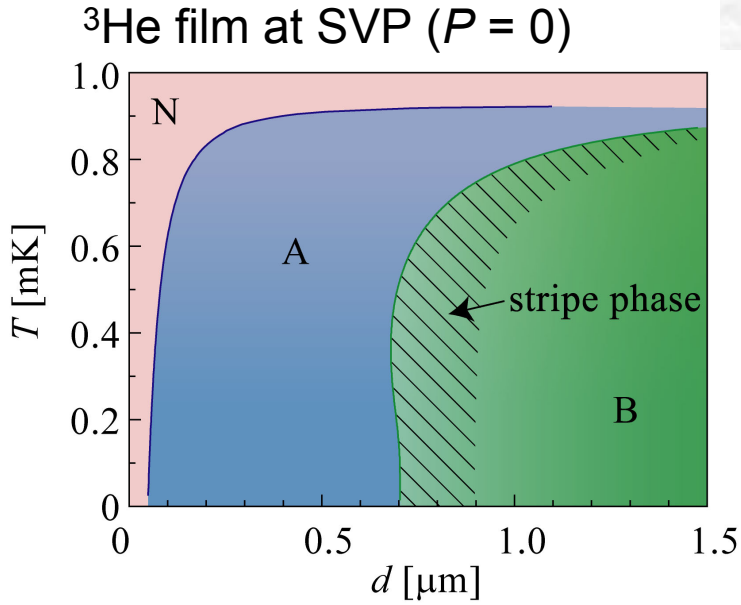
Superfluid ^{3}He Film



bulk



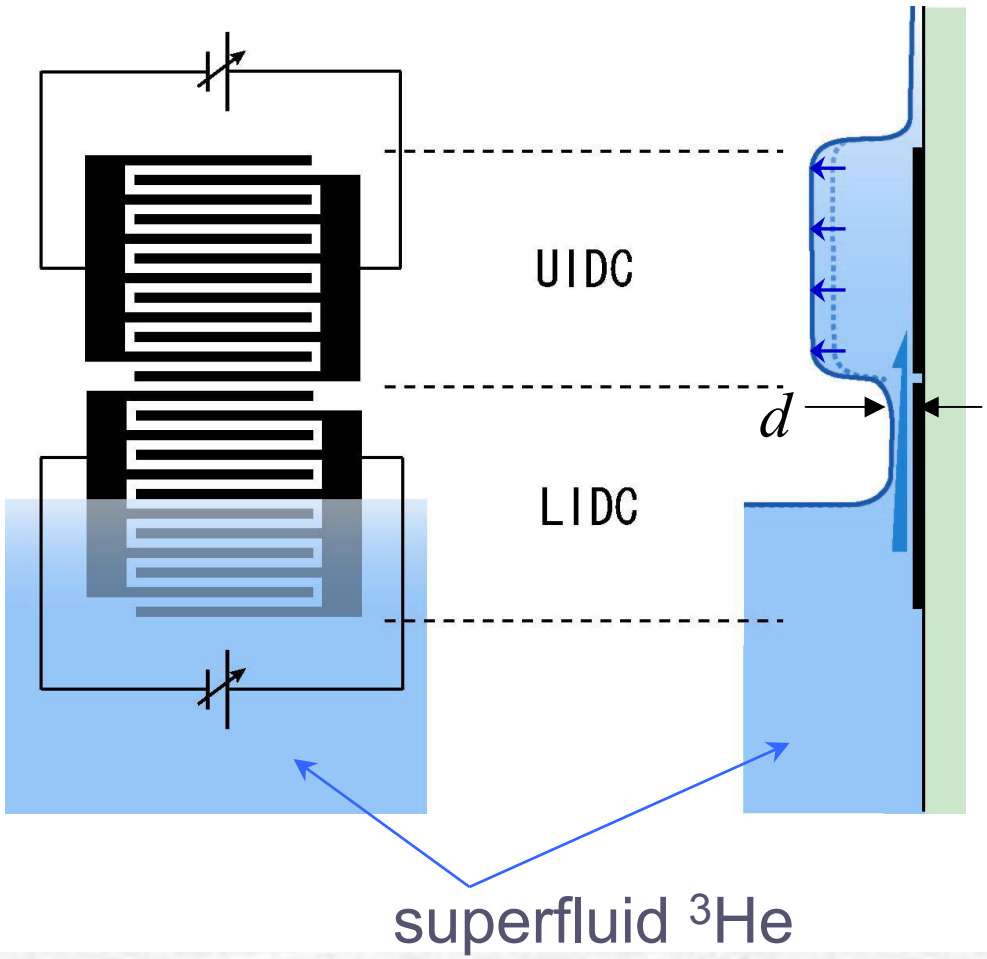
Vorontsov and Sauls, PRL(2007), PRB(2003)

^{3}He film (slab)

- phase transition induced by thickness
- stabilization of inhomogeneous superfluid state

Experimental Method

Inter-digitated Capacitors (IDC)

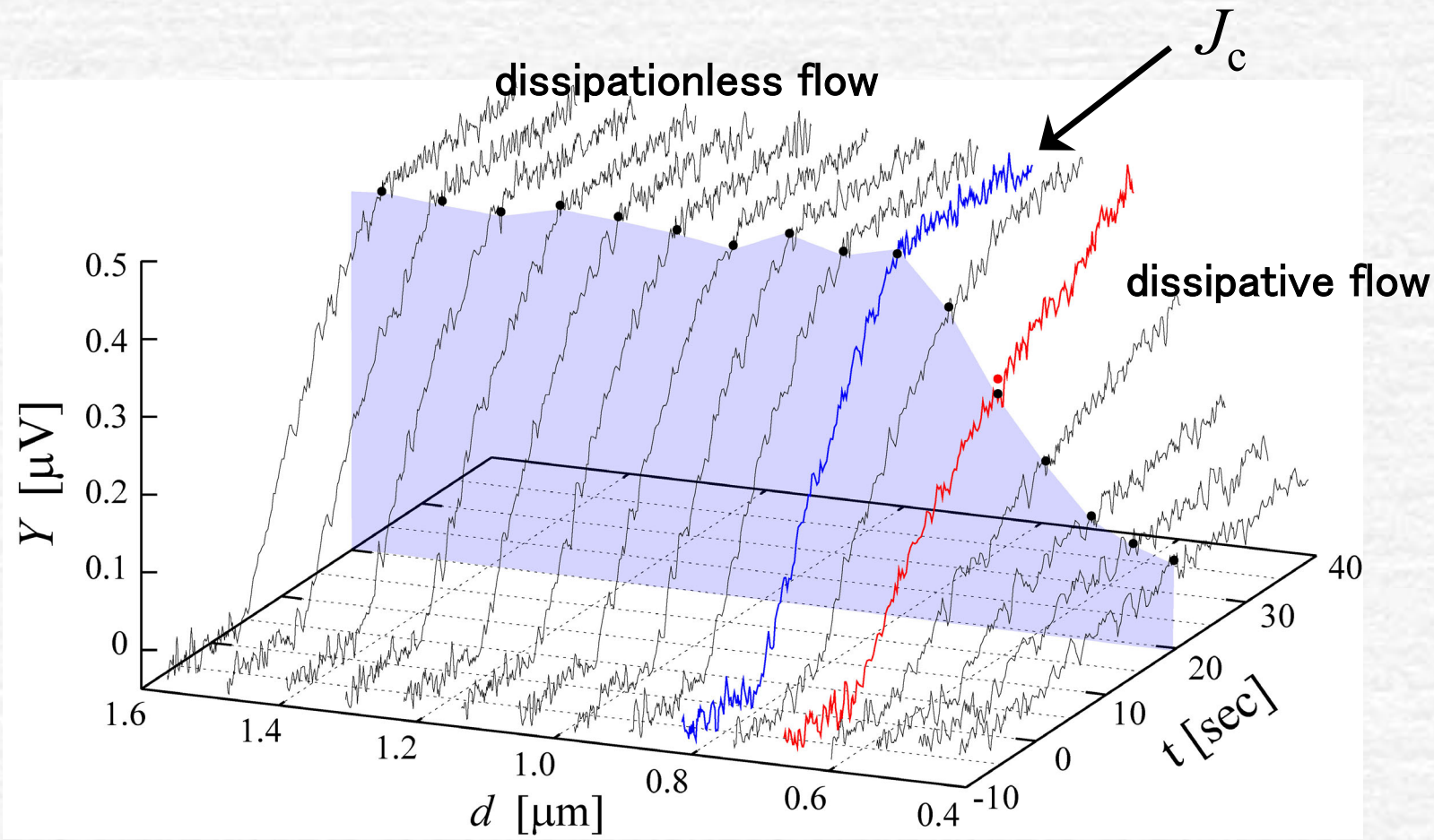


UIDC
manipulation(V_U)
observation (C_{IDC})
of a flow

LIDC
Film thickness d
control (V_L)
$0.1 < d < 9$ [μm]

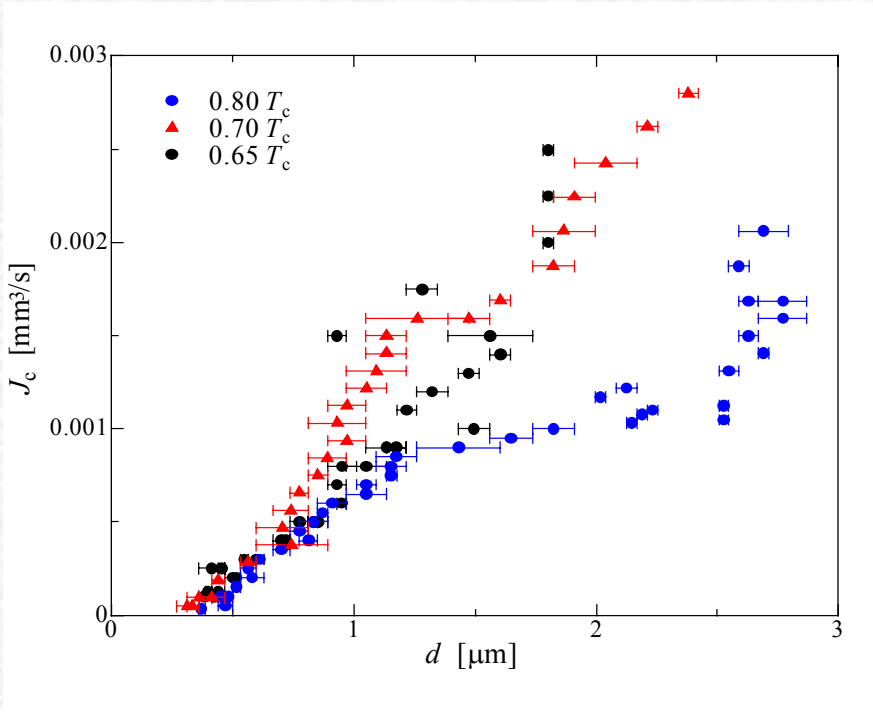
Previous Results

Critical current J_c as the onset of dissipation



Previous Results

Thickness dependence of J_c



Two distinct behavior was observed at the thickness of ～ 1 μm.

・thin region: similar thickness dependence

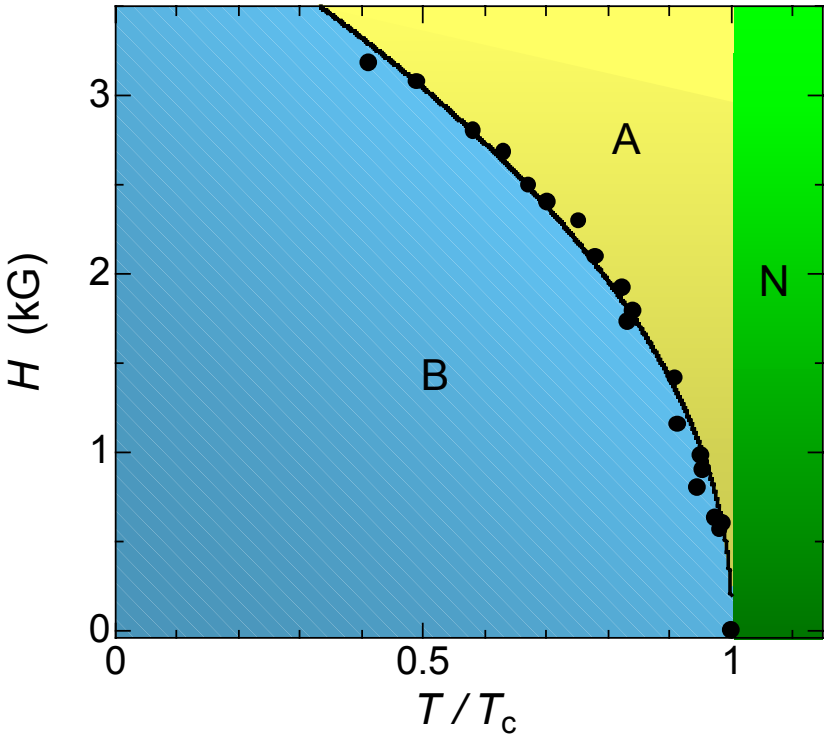
・thick region:different thickness dependence

→different dissipation mechanism?

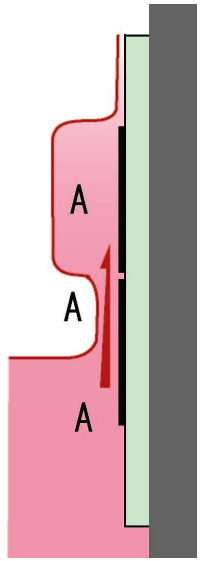
→Effect of the phase transition?

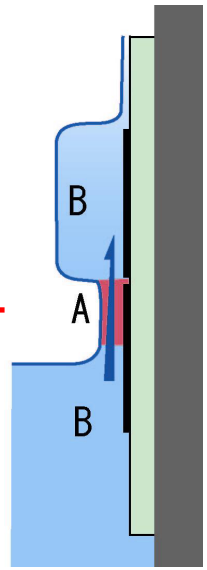
Control of Superfluid Phase by The Magnetic Field

phase diagram in magnetic field
at SVP ($P \sim 0$ bar)

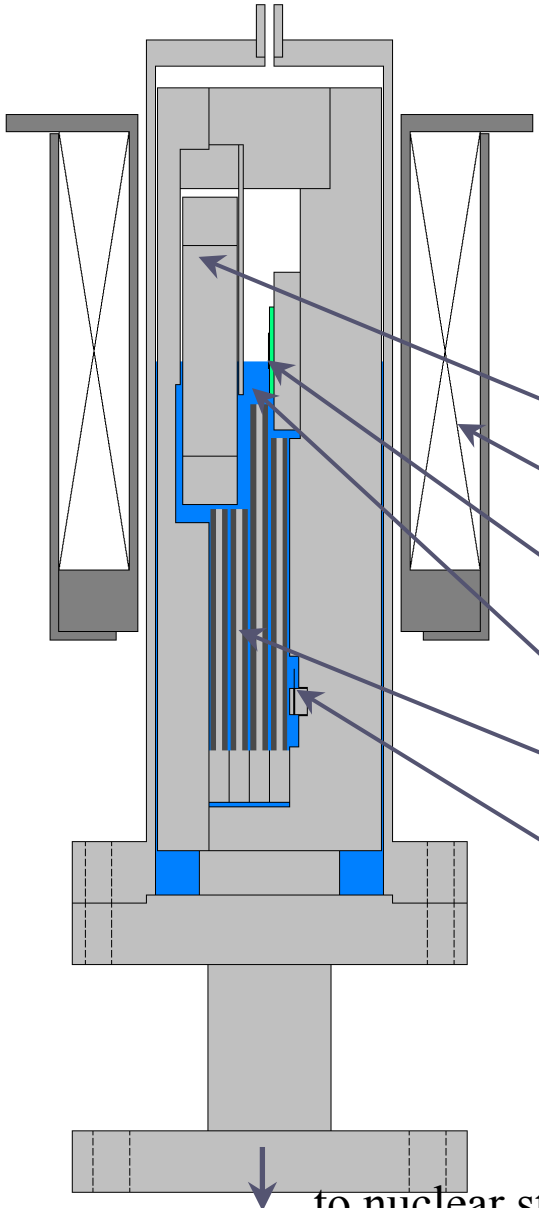


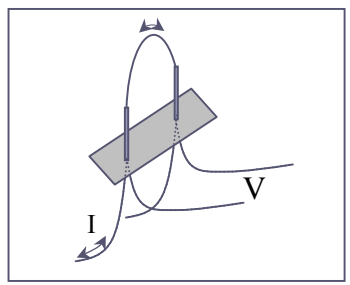
Kyynäräinen *et al*. 1990

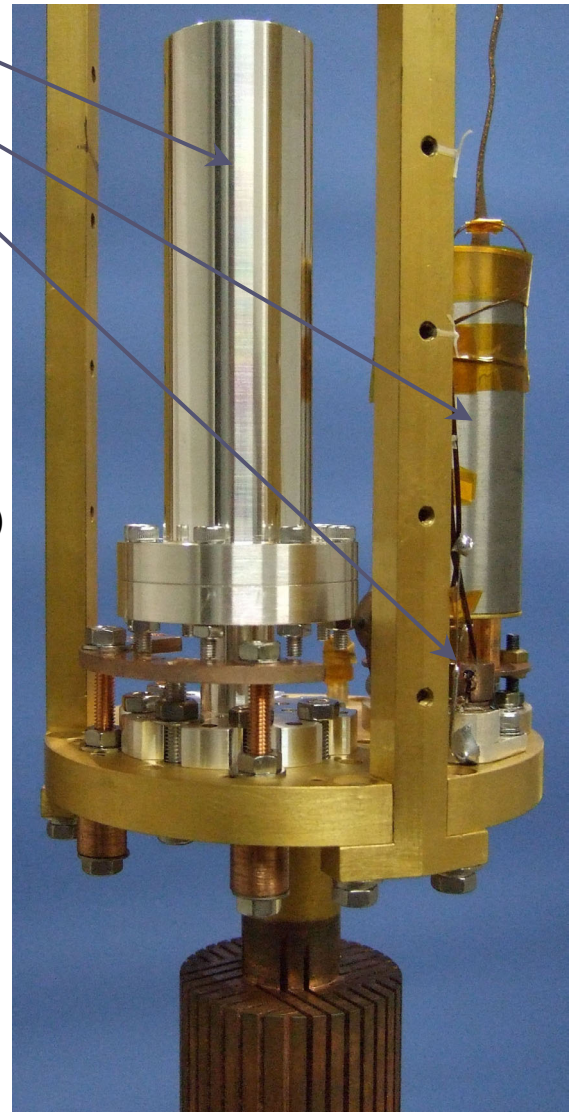




Experimental Setup



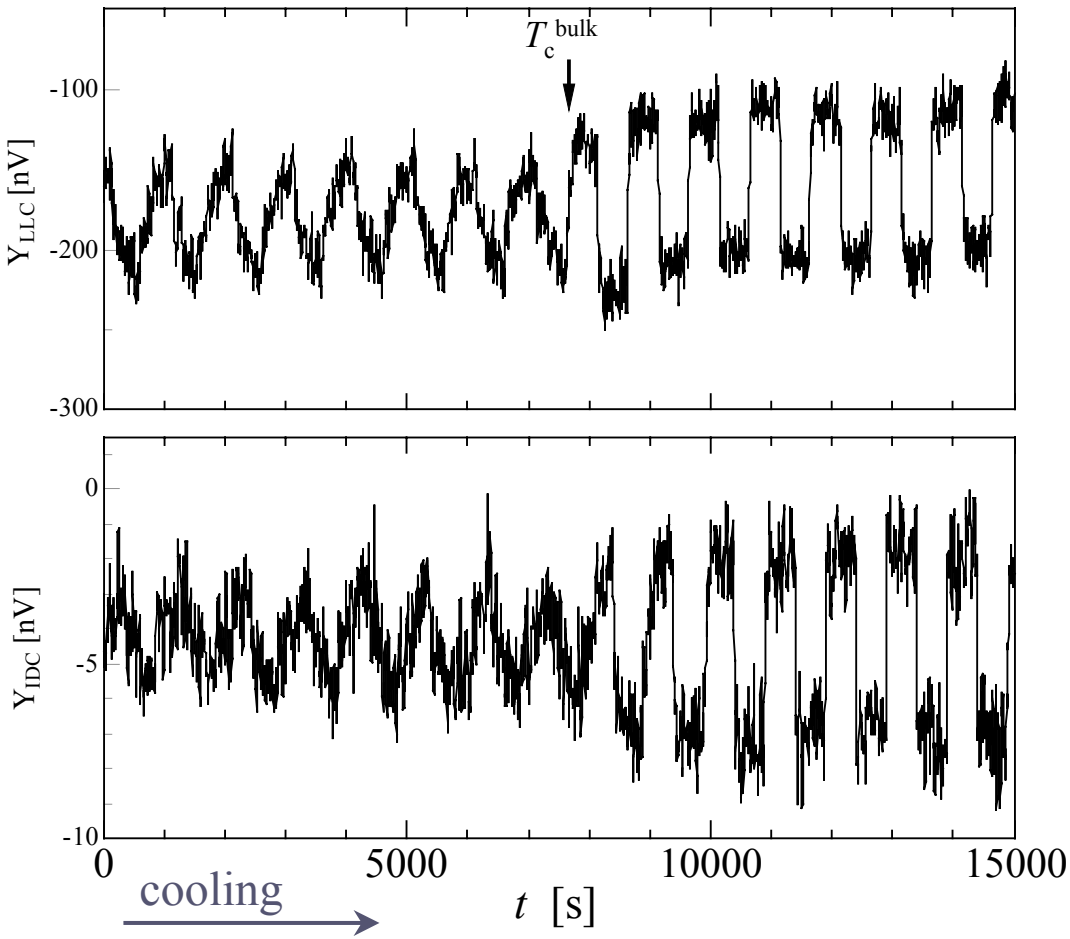


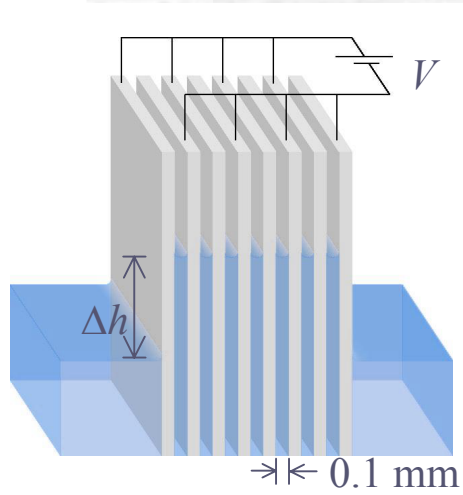


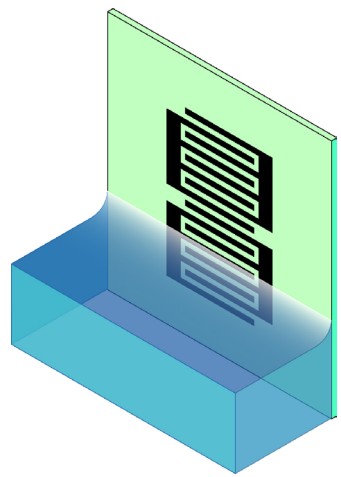
Observation of Superfluid Transition of the Film and the Bulk

LLC
0.1 mm

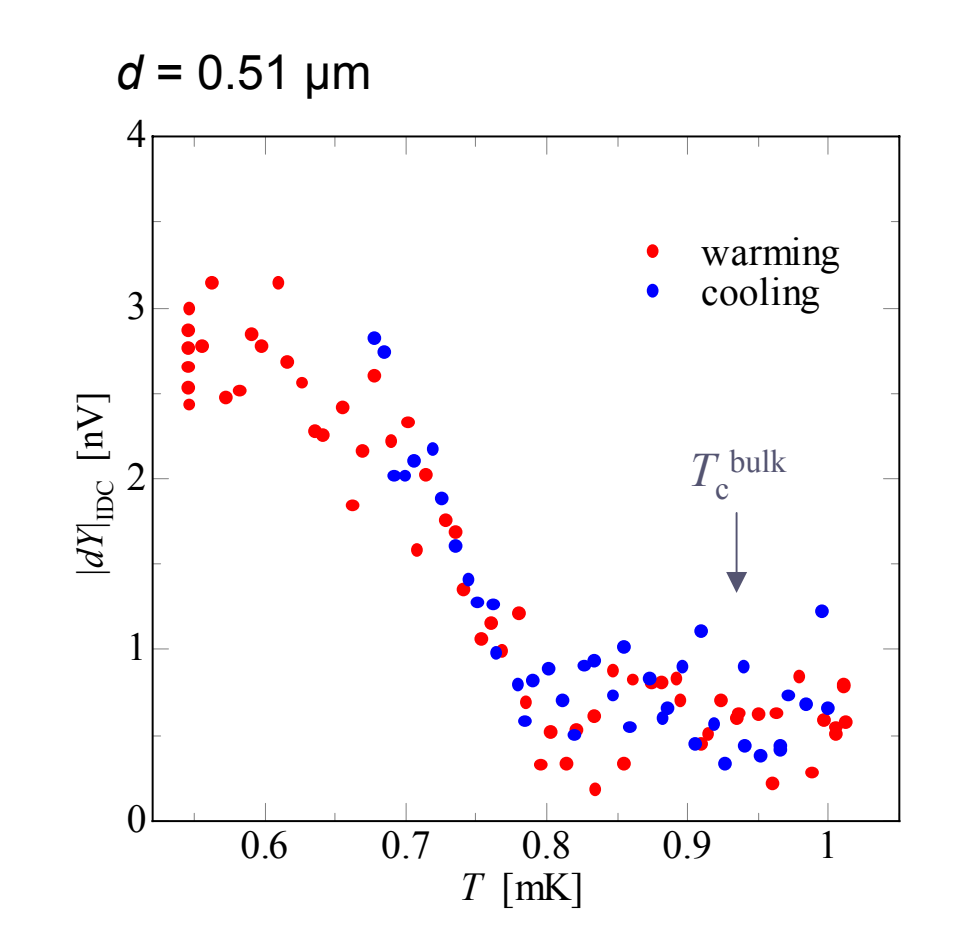
IDC
($V_L = 90$V)
$d \sim 8.3$ μm



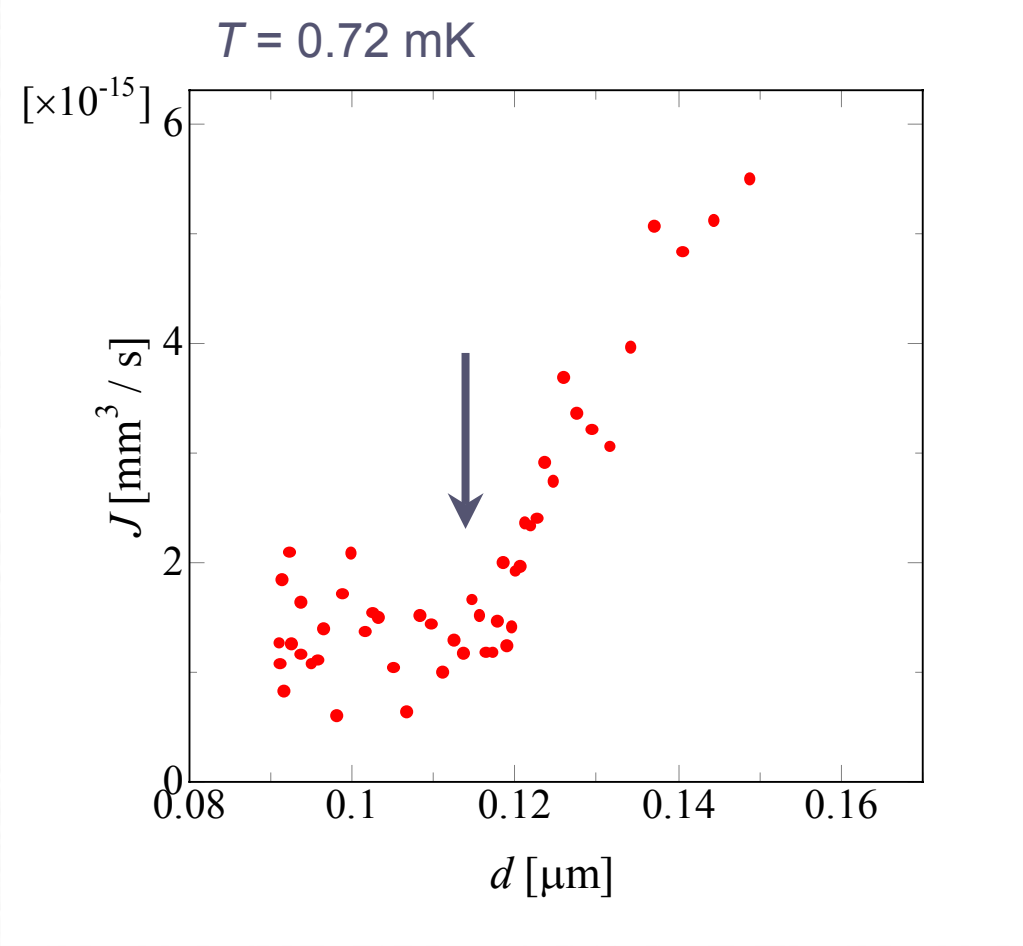




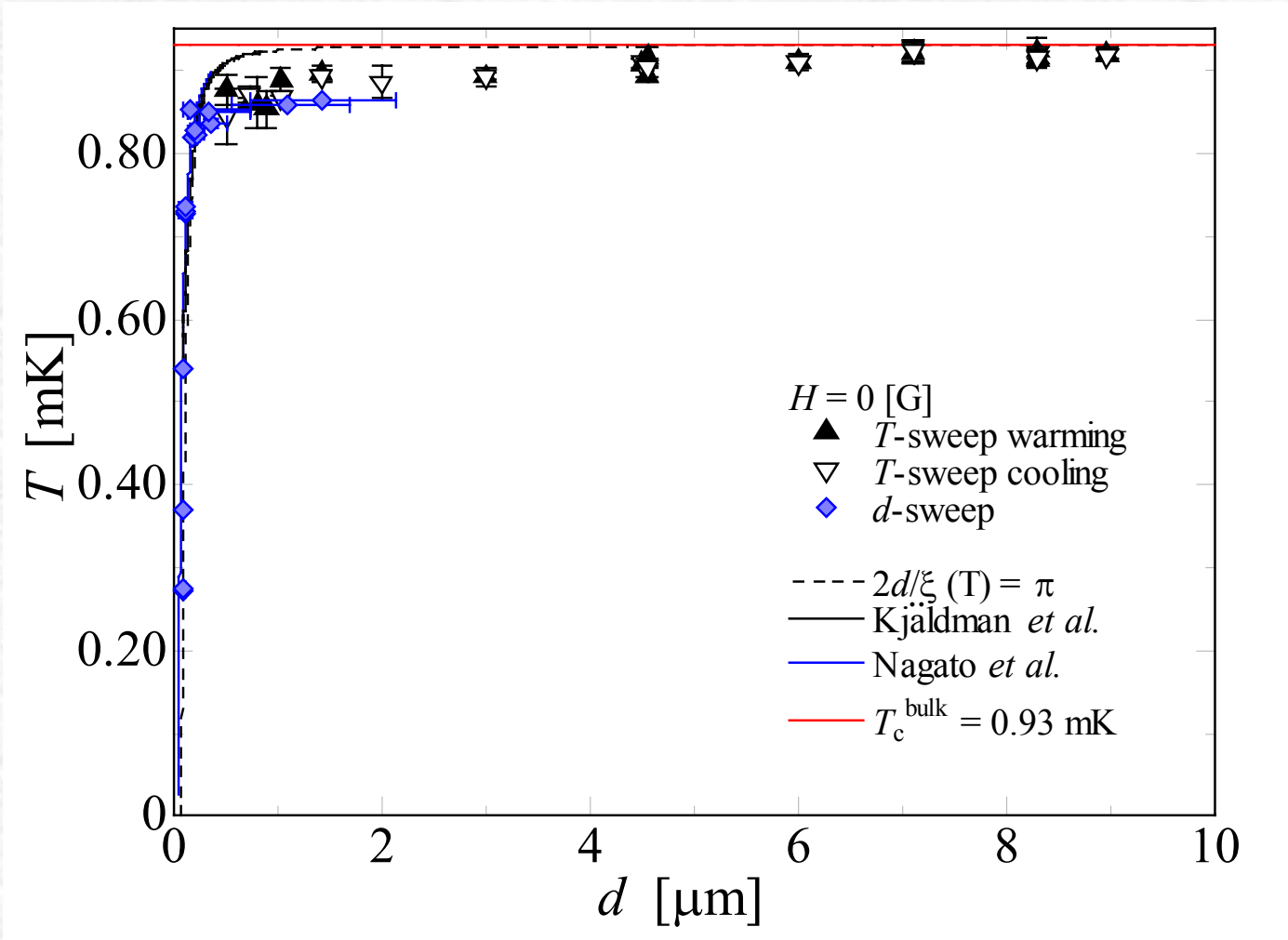
Observation of the Transition by changing T



Observation of the Transition by changing *d*

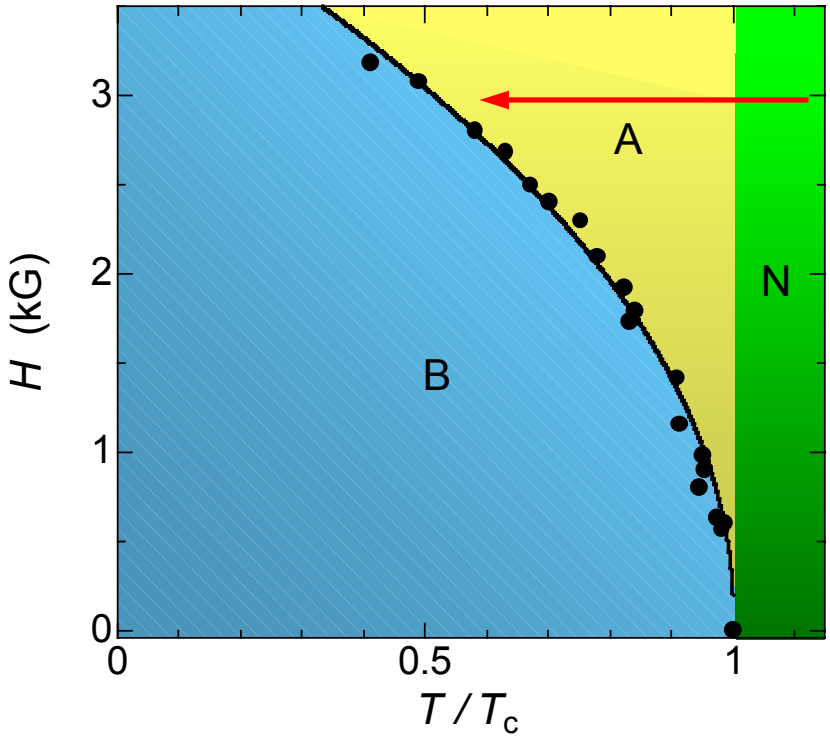


Thickness Dependence of T_c

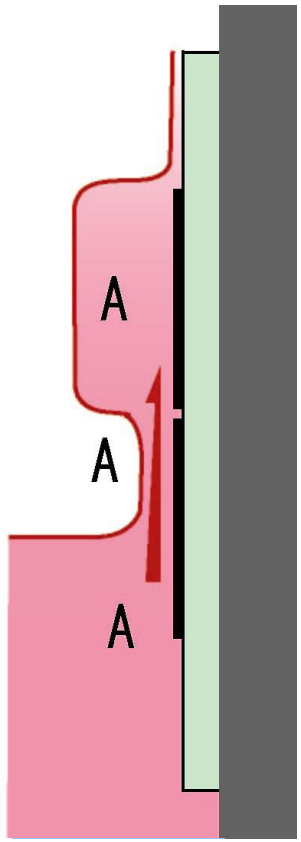


Measurement in the Magnetic Field

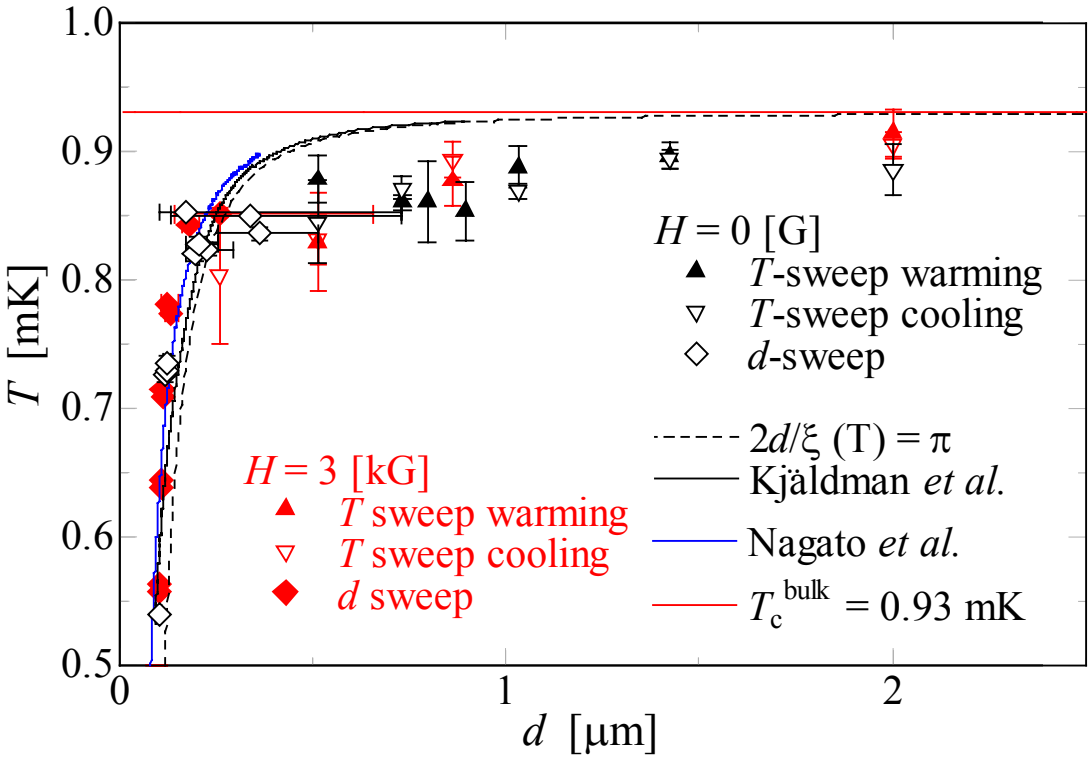
phase diagram in magnetic field



Kyynäräinen *et al*. 1990

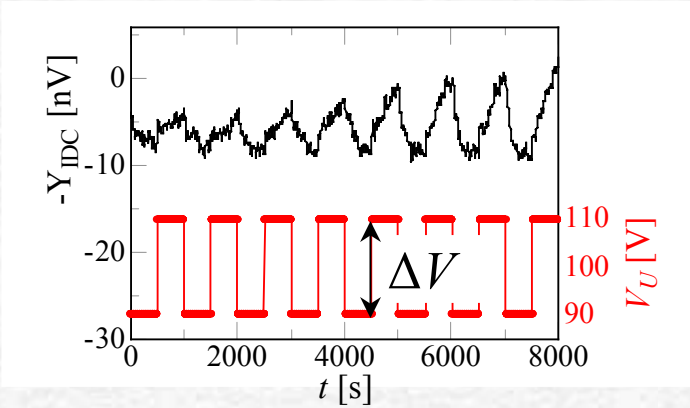


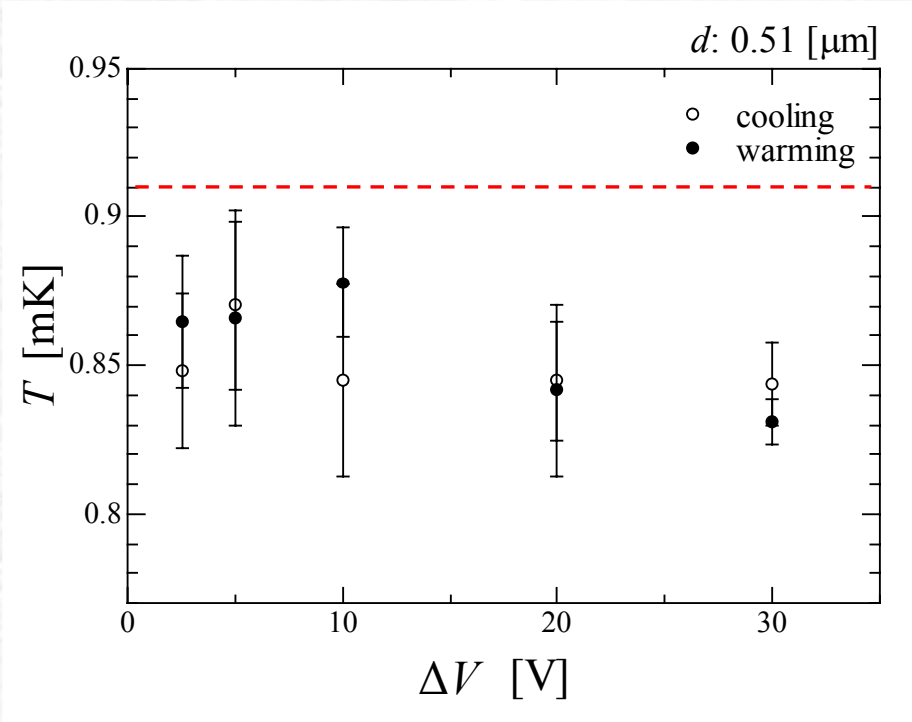
Thickness Dependence of T_c in the Magnetic Field



similar reduced T_c^f was observed in A phase

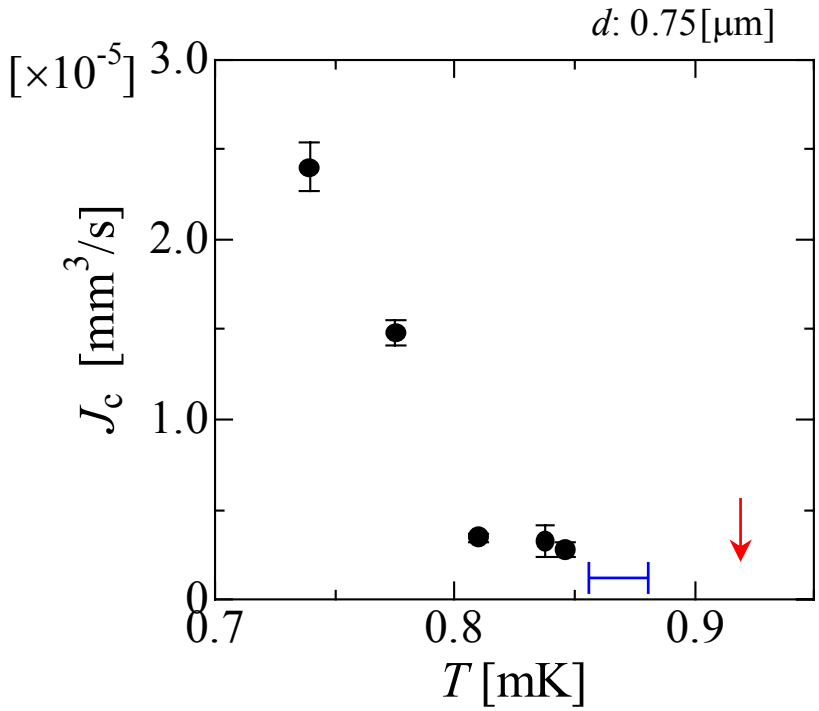
Drive Current Dependence of T_c^f





The effect of the current on T_c^f was not observed

T_c^f and Temperature dependence of J_c



Summary

- Superfluid transition of the ^{3}He film was measured for thickness of 0.1 ~ 9 μm, in zero field and 3 kG.
- The observed T_c^f was several percent lower than theoretical predictions.
- The reduction of T_c^f due to the current did not observed.
- In zero and 3kG field, different temperature dependences of J_c were observed.