Universität Basel

Department Physik

Journal Club

“Thermal Properties of the Superconductor-Quantum Hall Interface”

Thermal Properties of the Superconductor–Quantum Hall Interface

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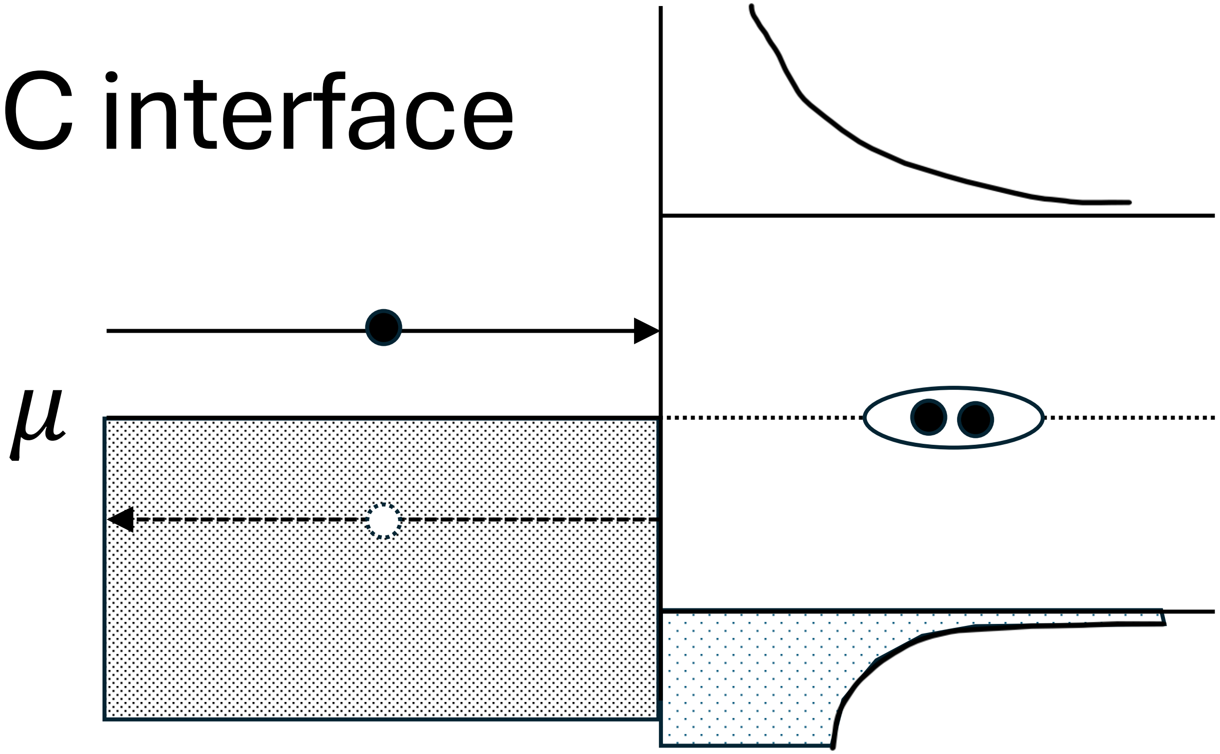
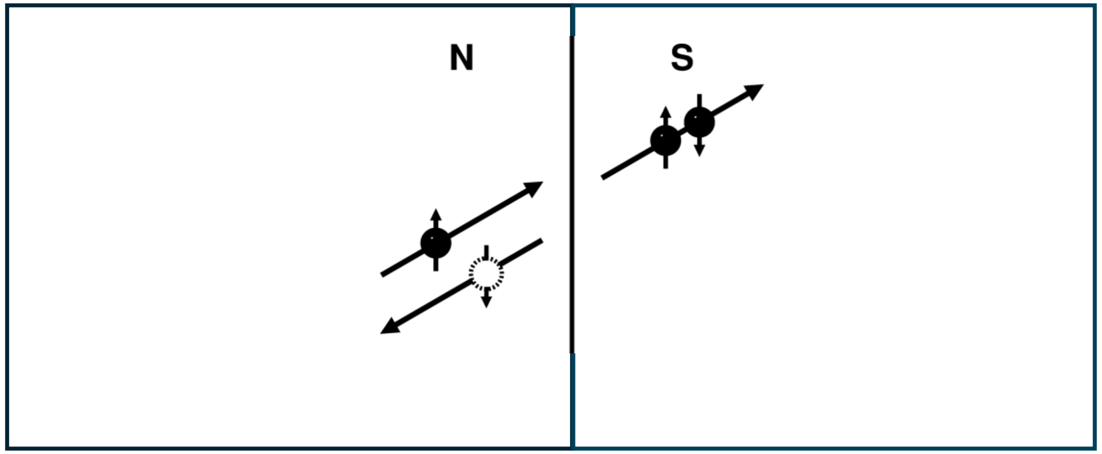
(Received 7 September 2024; revised 10 December 2024; accepted 23 January 2025; published 12 February 2025)

Andrea Chieppa, 05.09.2025

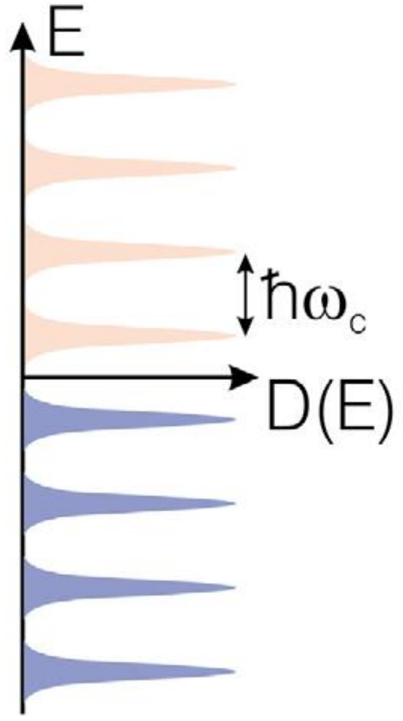
Introduction 1/3 – N/SC interface

- This mechanism is called Andreev reflection

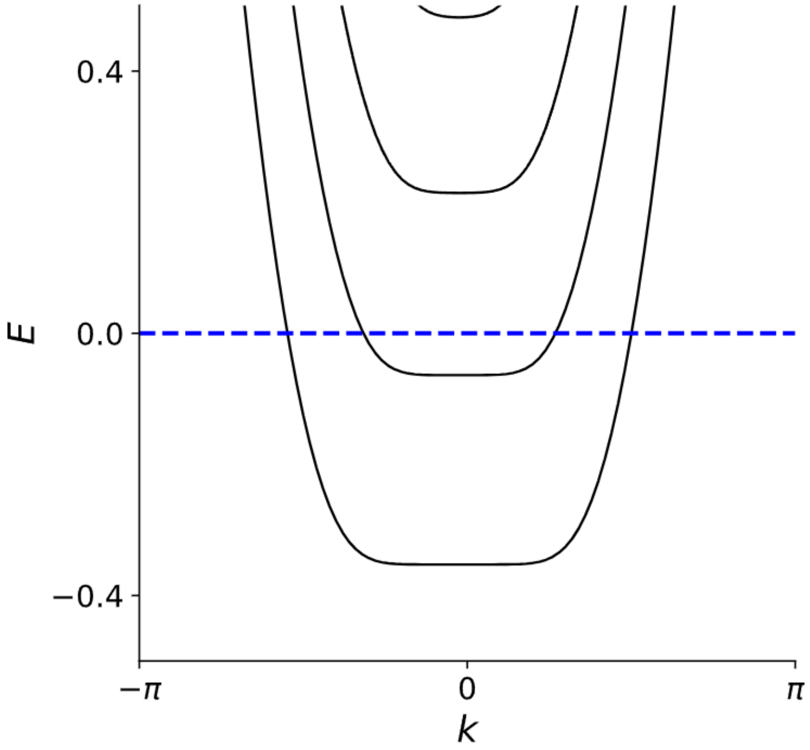


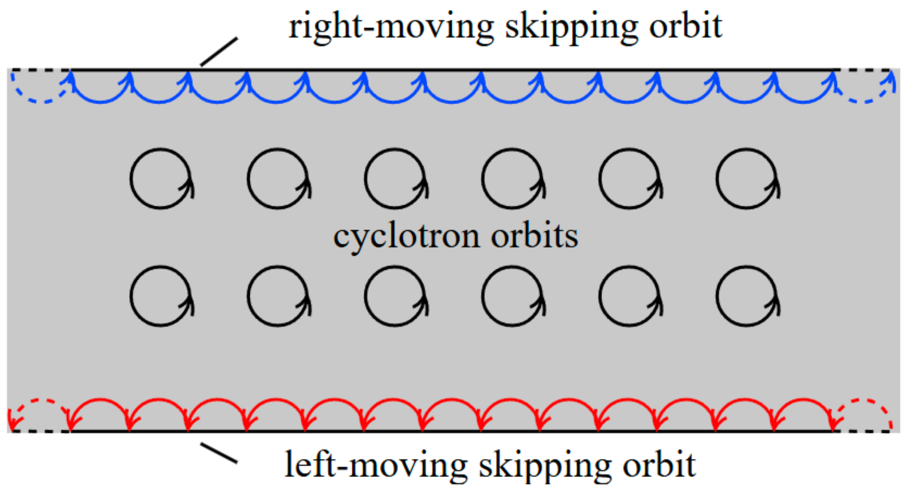


Introduction 2/3 – Magnetic fields



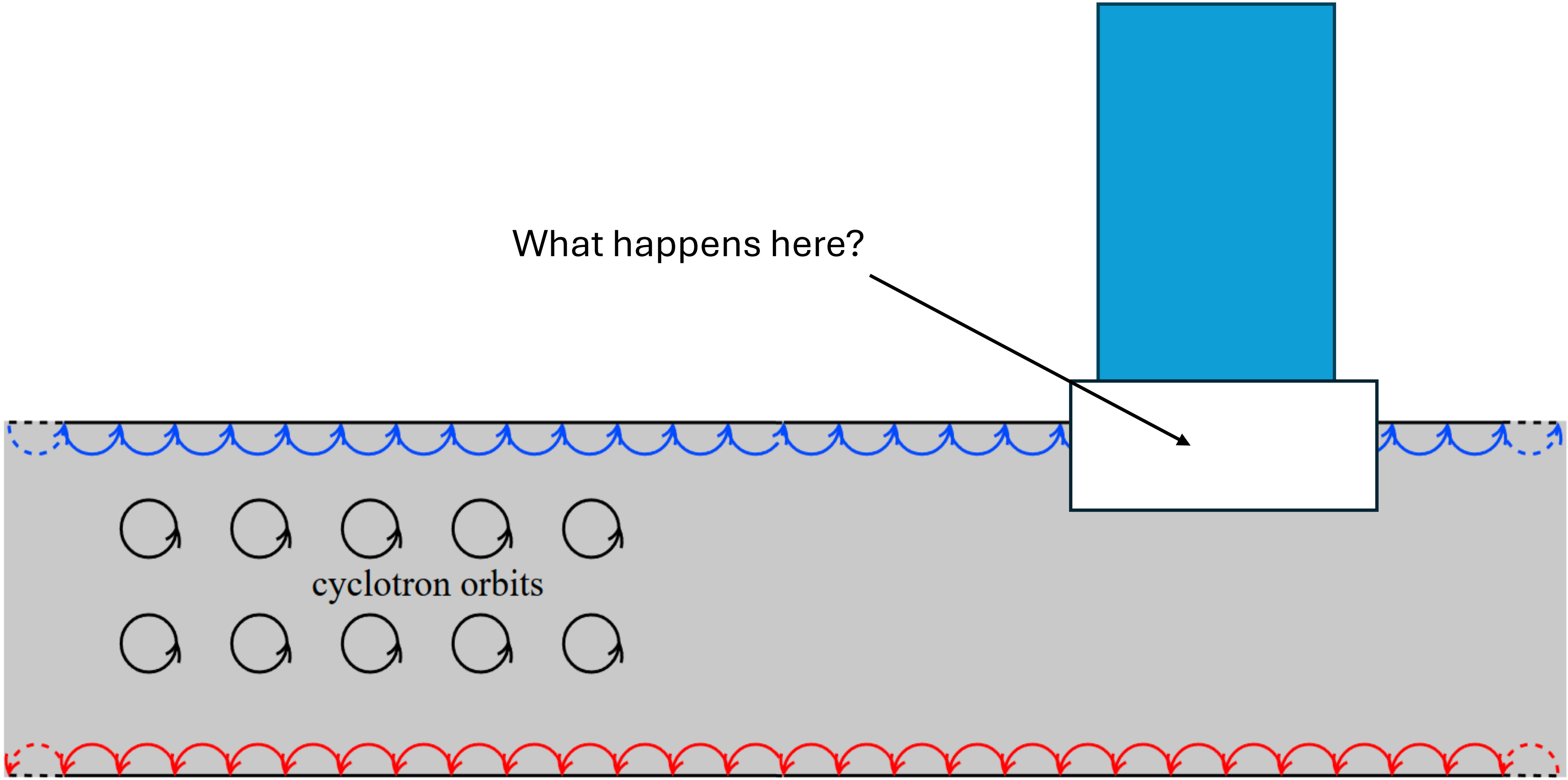
Parabolic dispersion



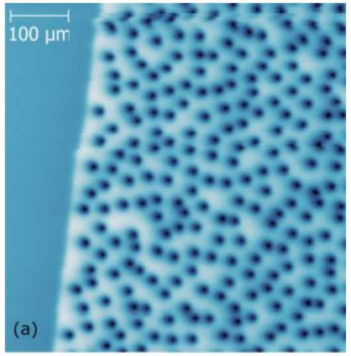


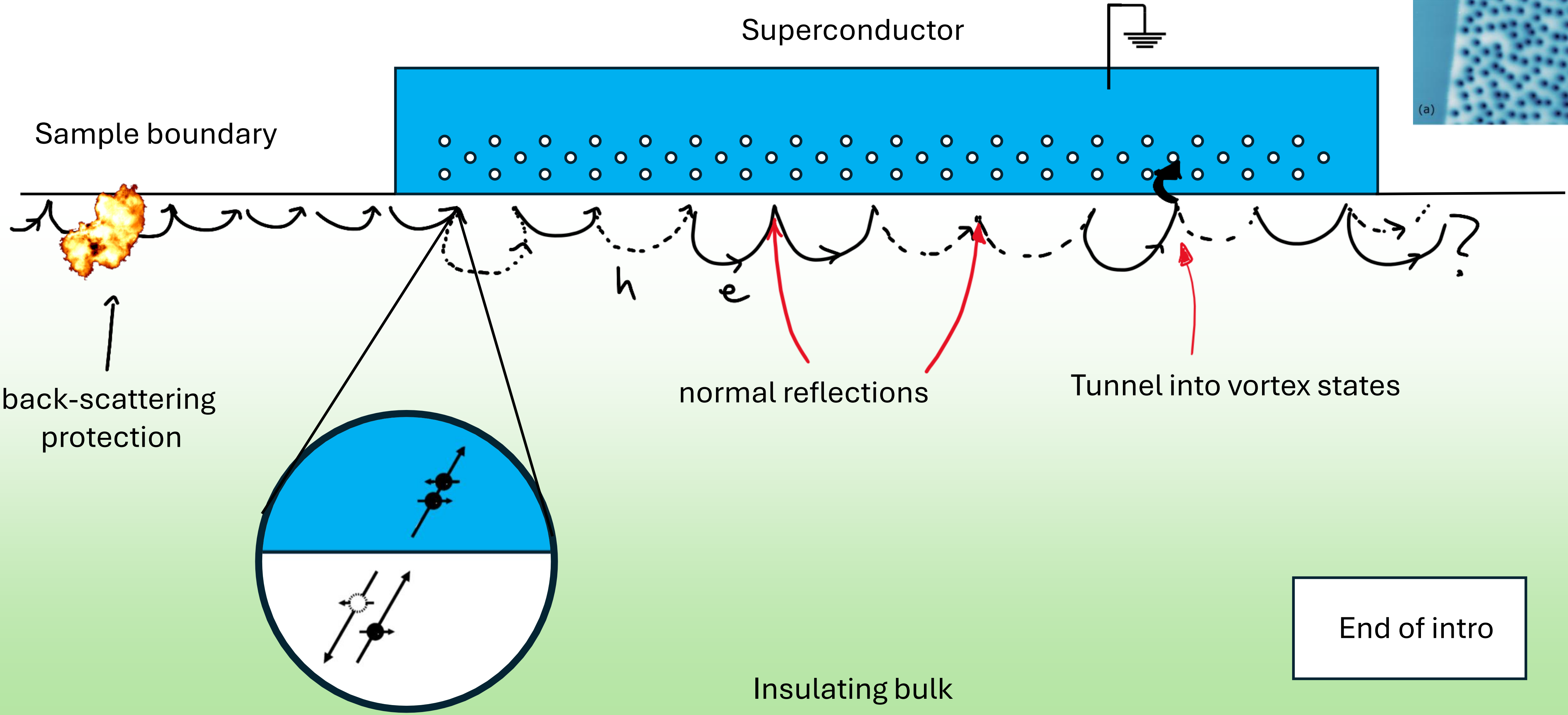
$$\omega_c = qB/m^*$$

Introduction 3/3 – SC/QH



Transport of charge in QH/SC interfaces

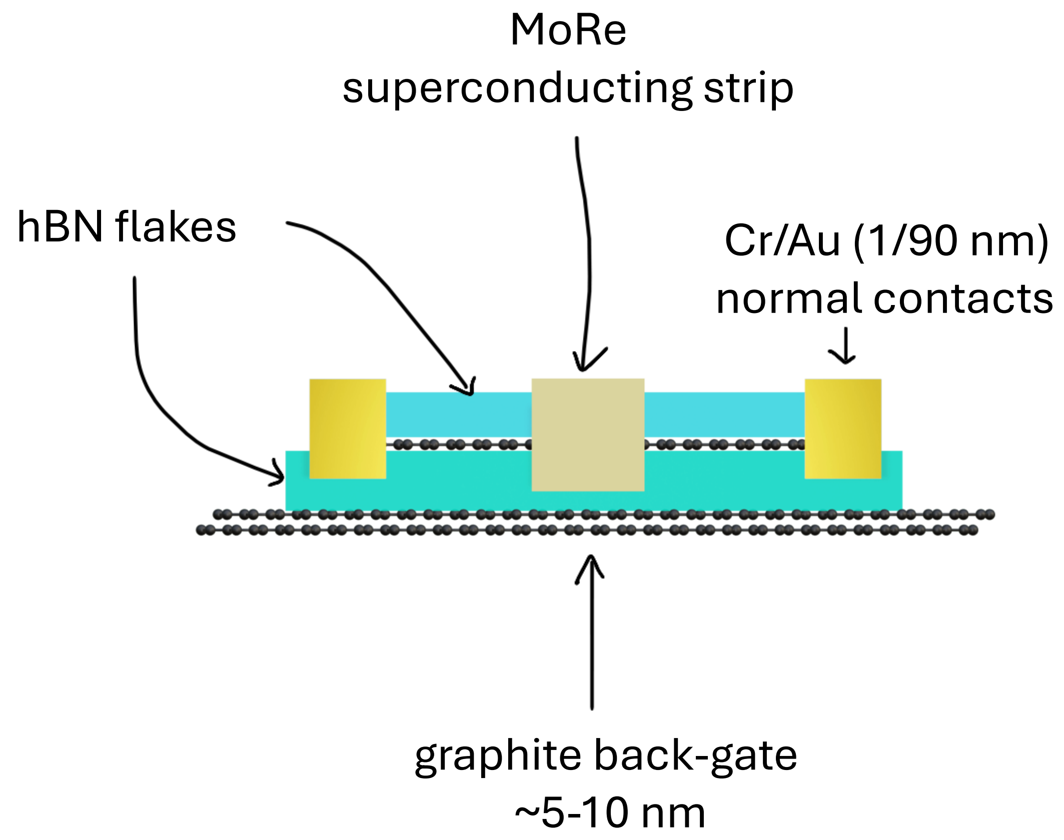




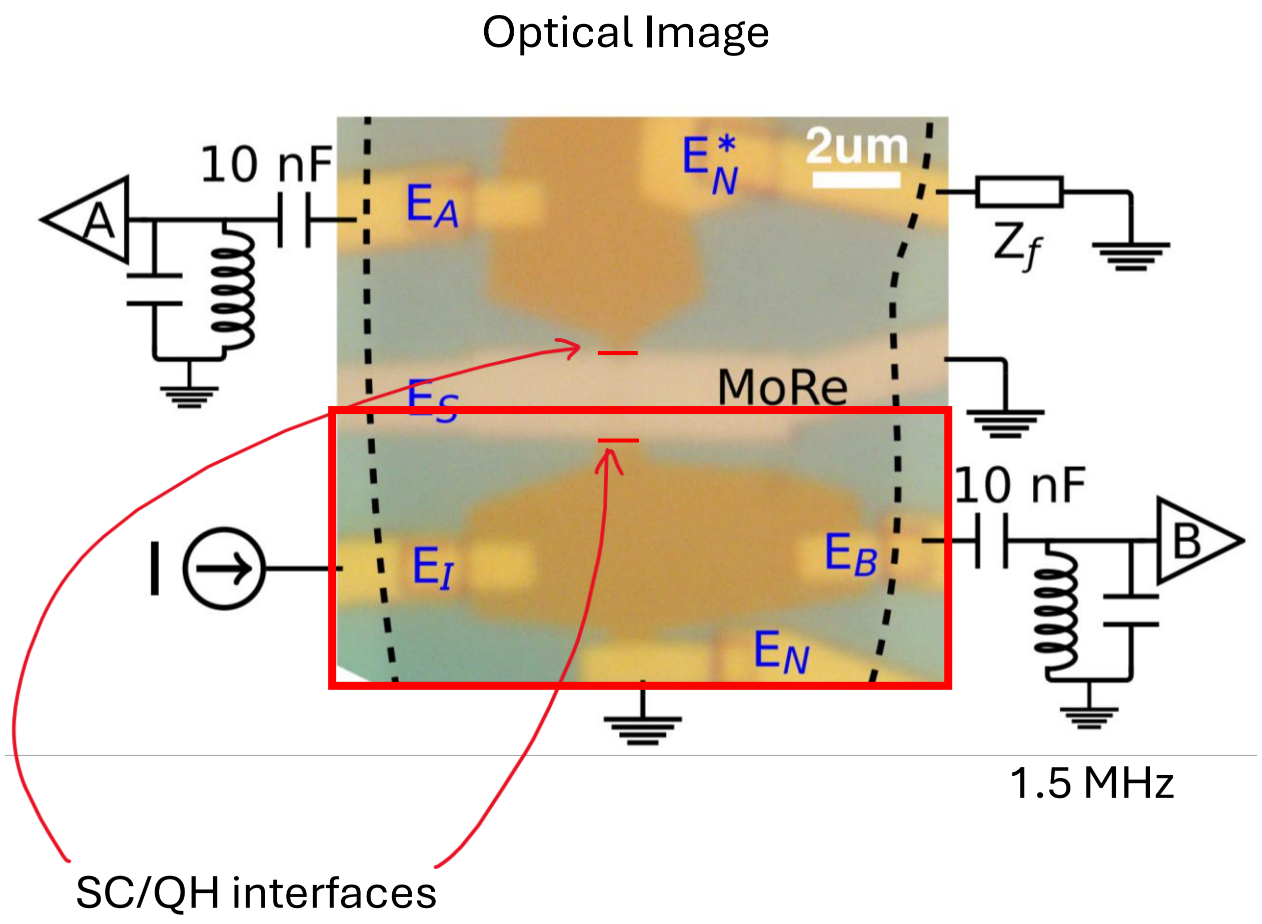
End of intro

Device and experimental setup

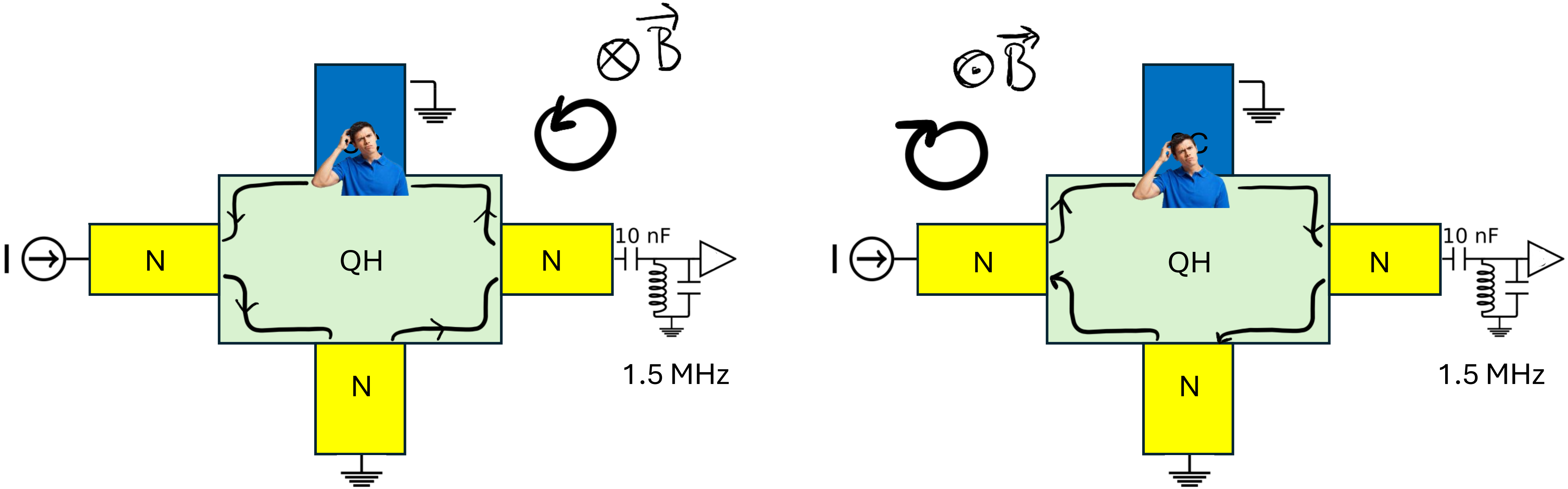
SIDE VIEW



TOP VIEW

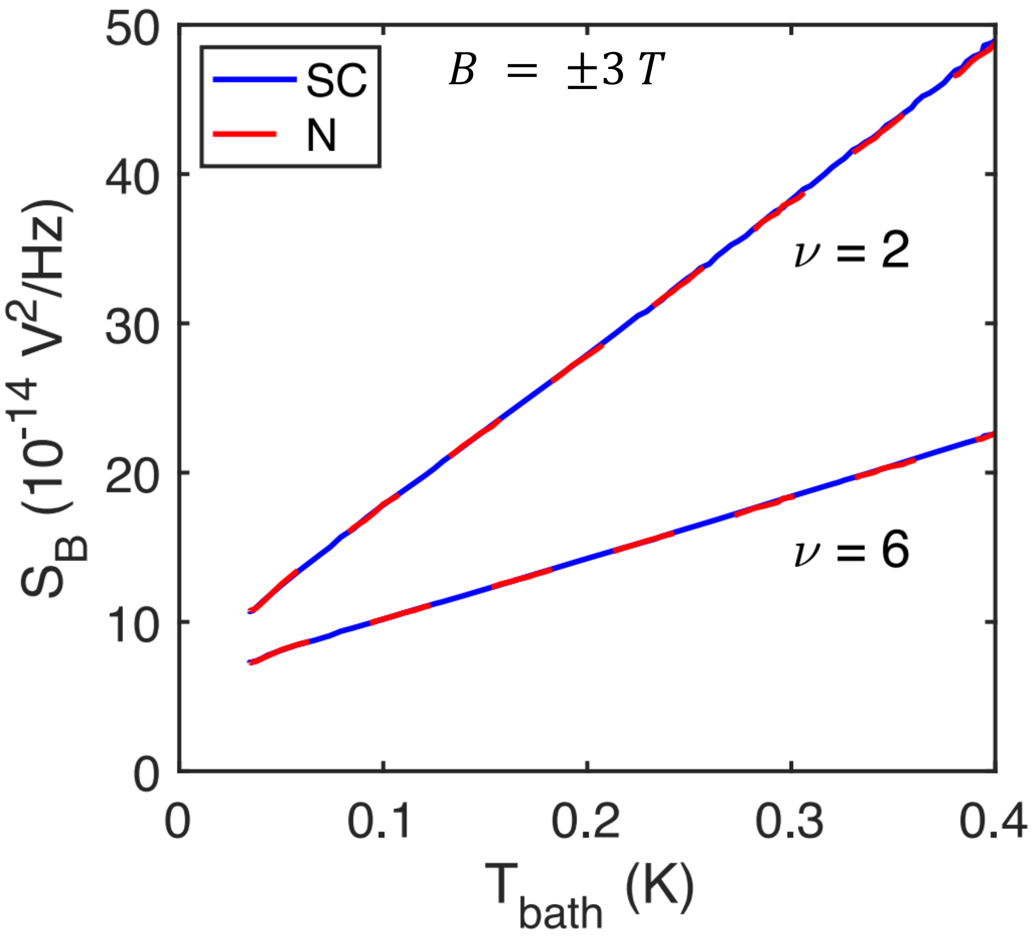


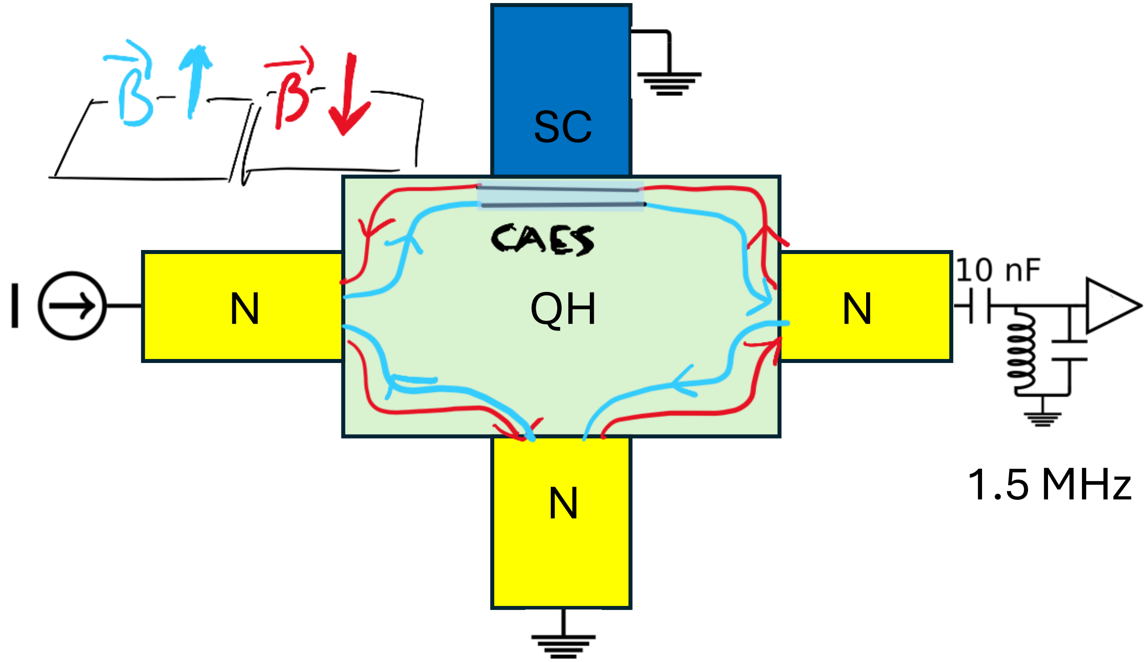
Interfaces, edge states, and amplifier



- The quantity of interest is the noise spectral density of the amplifier, S
- Length of the interfaces: 1 μm

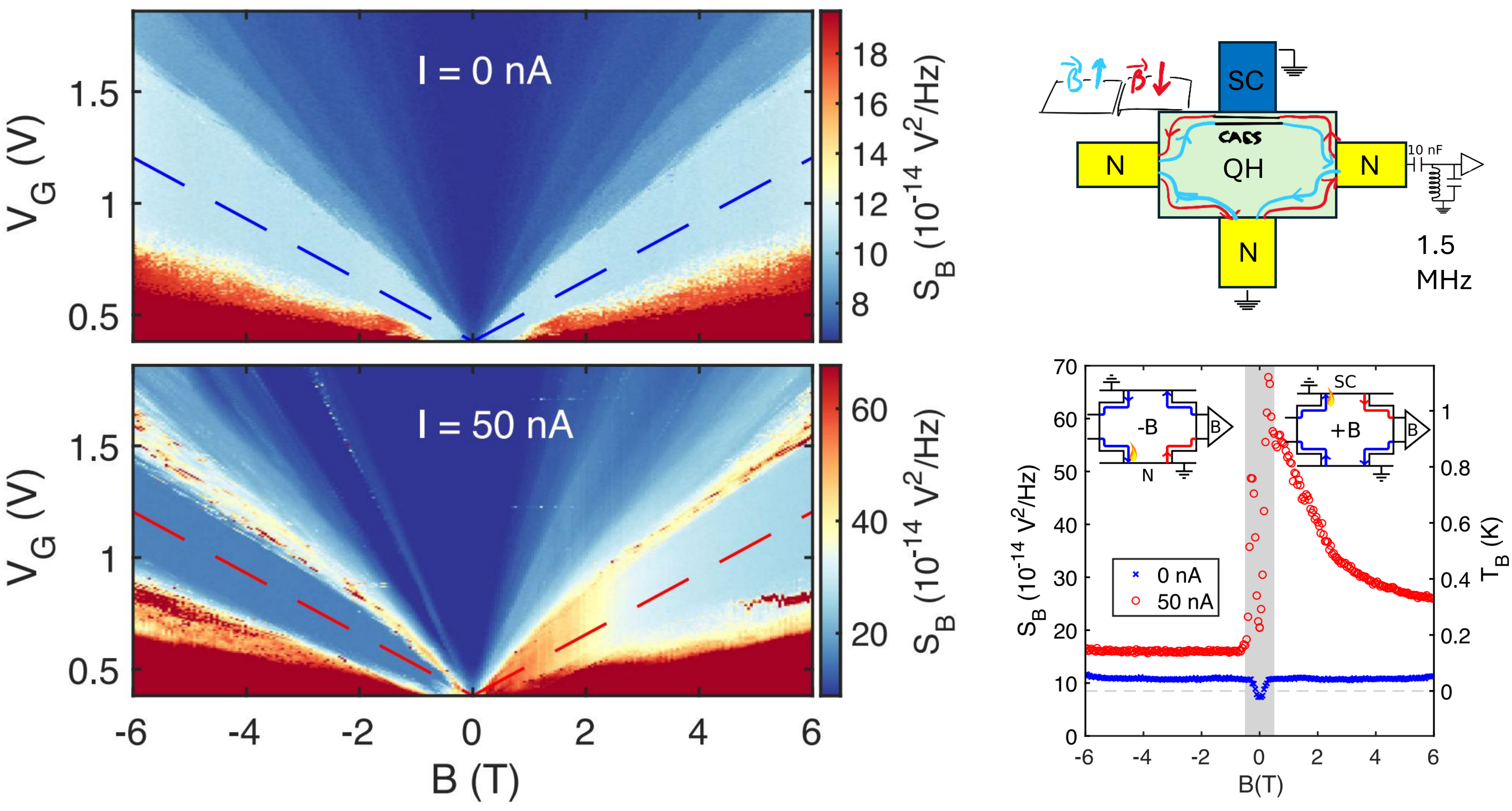
Temperature calibration





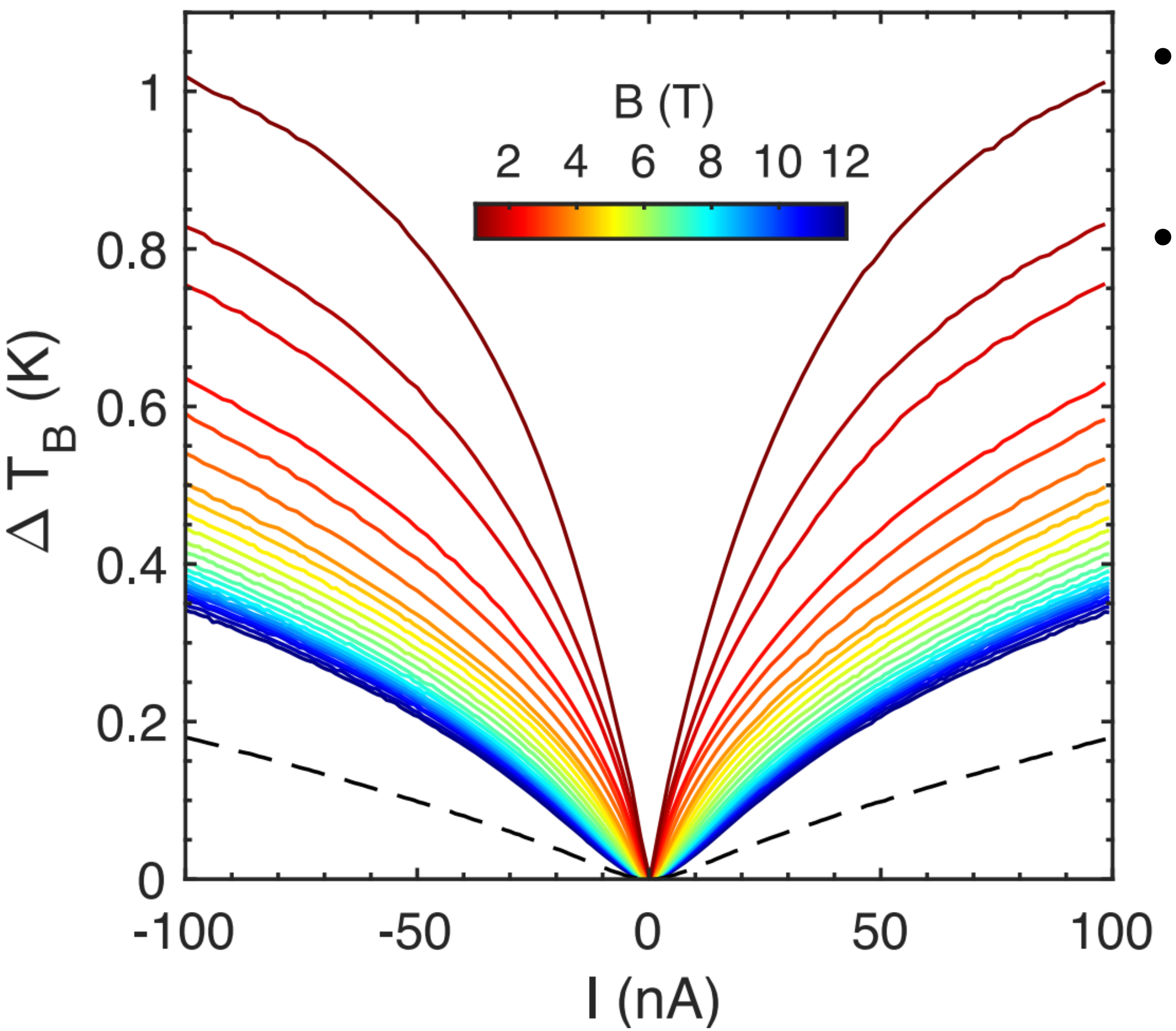
- The linear relation between S and T_{bath} serves as calibration
- For each ν, $S \leftrightarrow T$

$$\overline{V^2} = \int df\ 4k_B T \Re\{Z(f)\} = 4k_B T R \cdot \Delta f$$

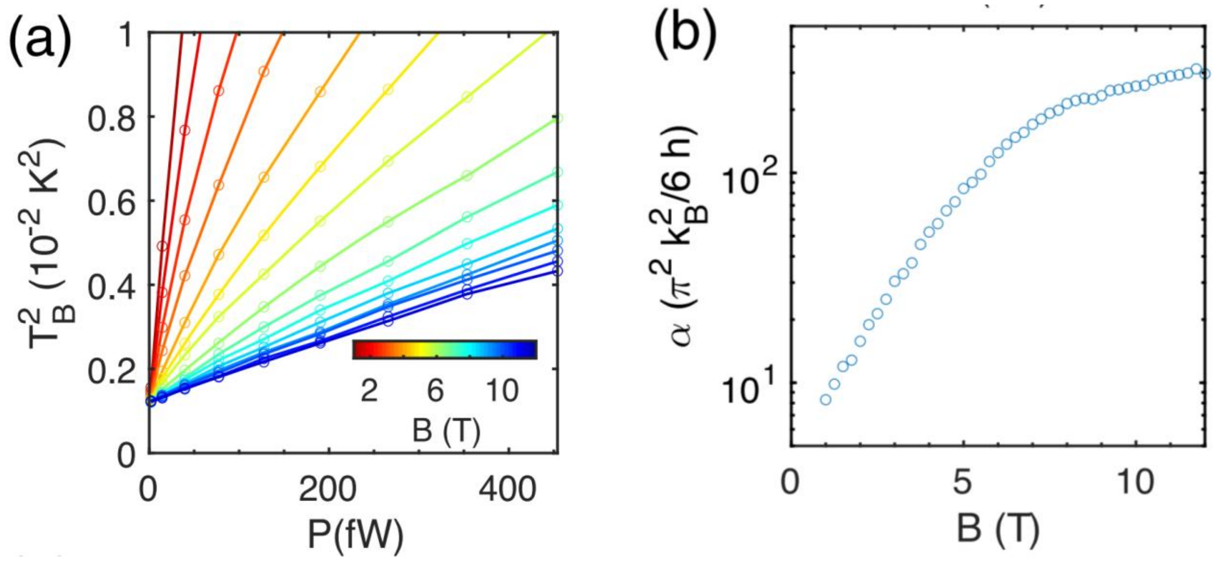


I = 0 nA
I = 50 nA
V_G (V)
B (T)
S_B (10^{-14} V^2/Hz)
SC
N
N
N
QH
CAES
10 nF
1.5 MHz
-B
+B
B
0 nA
50 nA
T_B (K)
B(T)

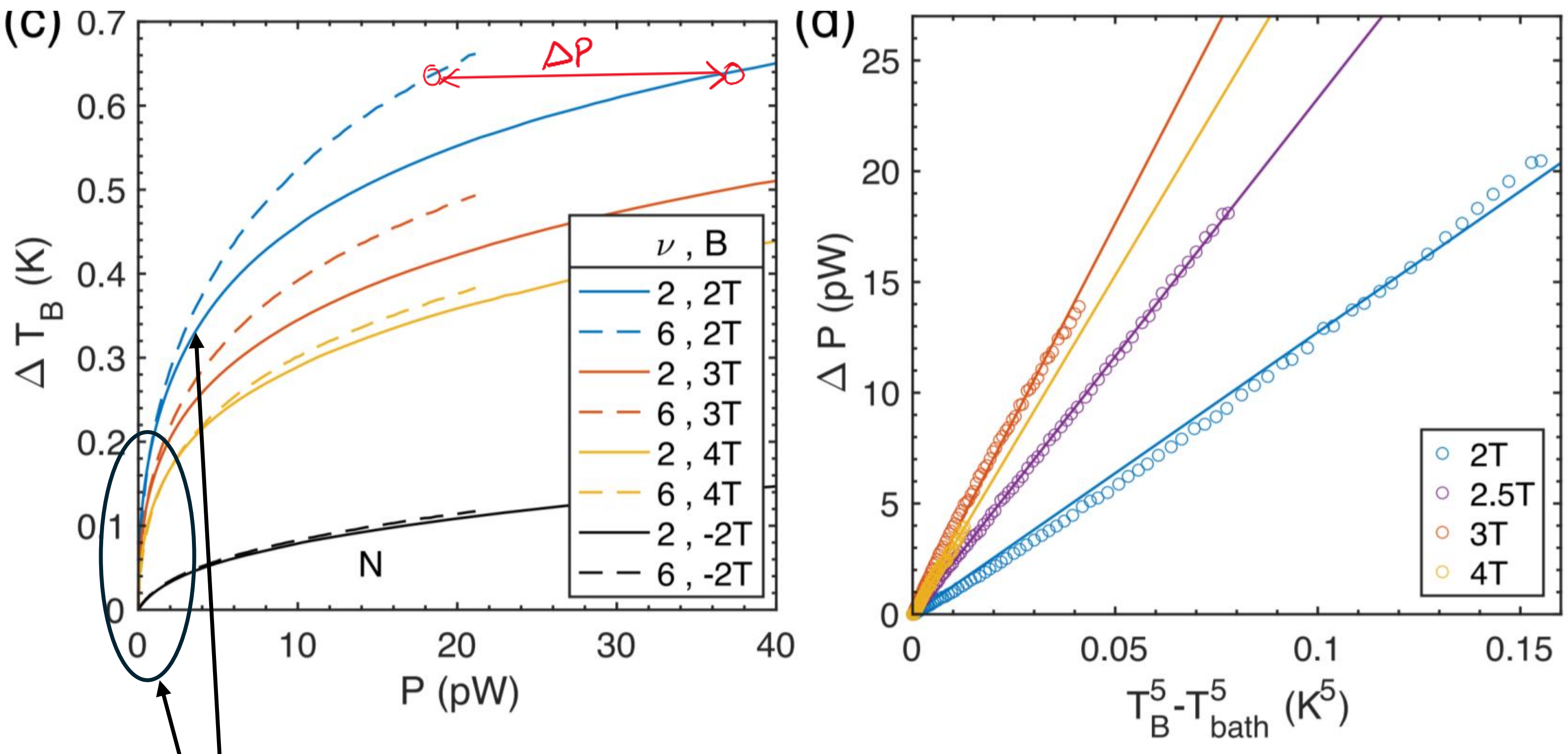
Current bias I effect on SC temperature at $\nu = 2$



- Applied power $P \propto I^2$
- $P_e = \frac{\pi^2 k_B^2}{6h}(T^2 - T_{bath}^2)$ ← WF law for a single channel



$\nu = 2 \,\&\, \nu = 6$

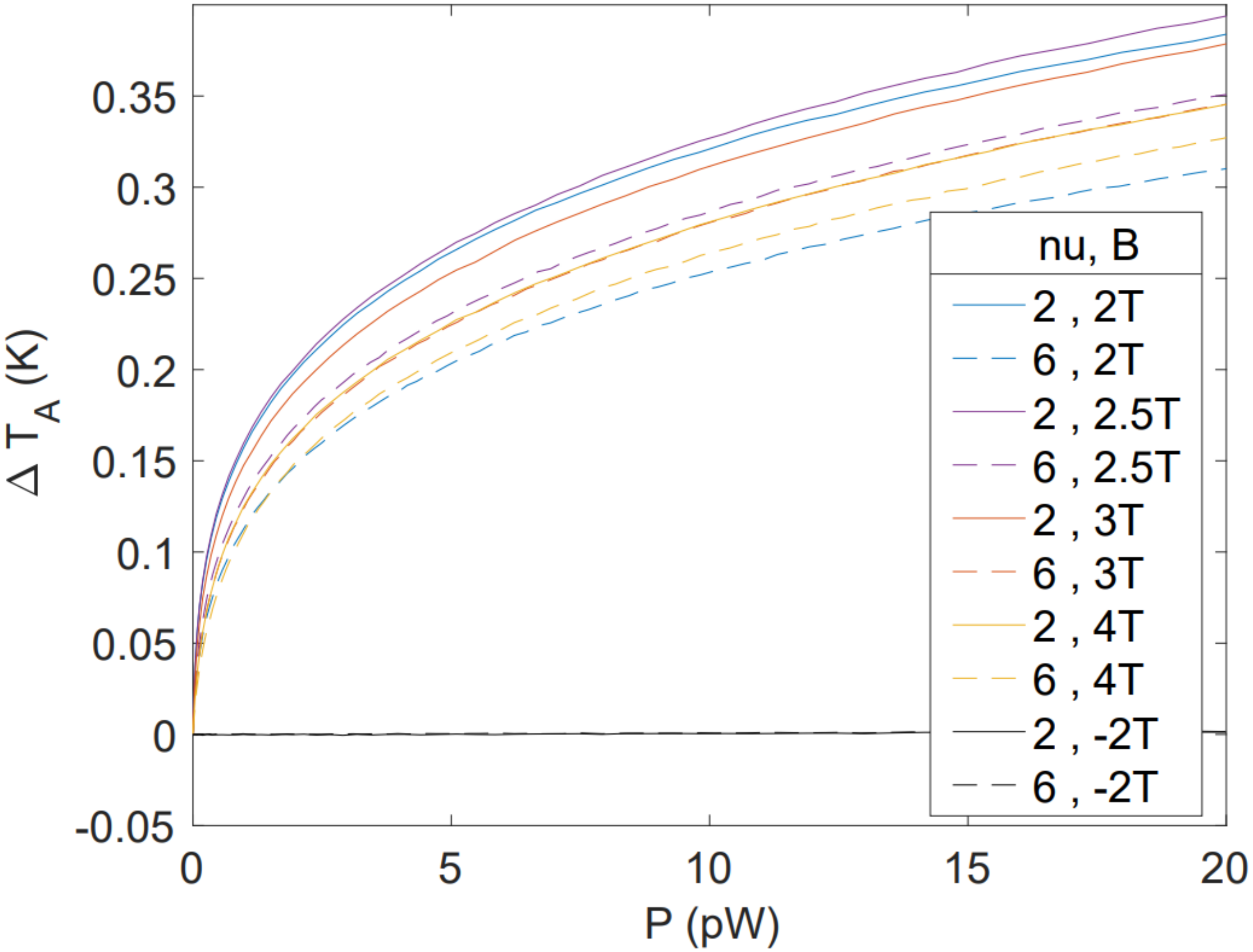


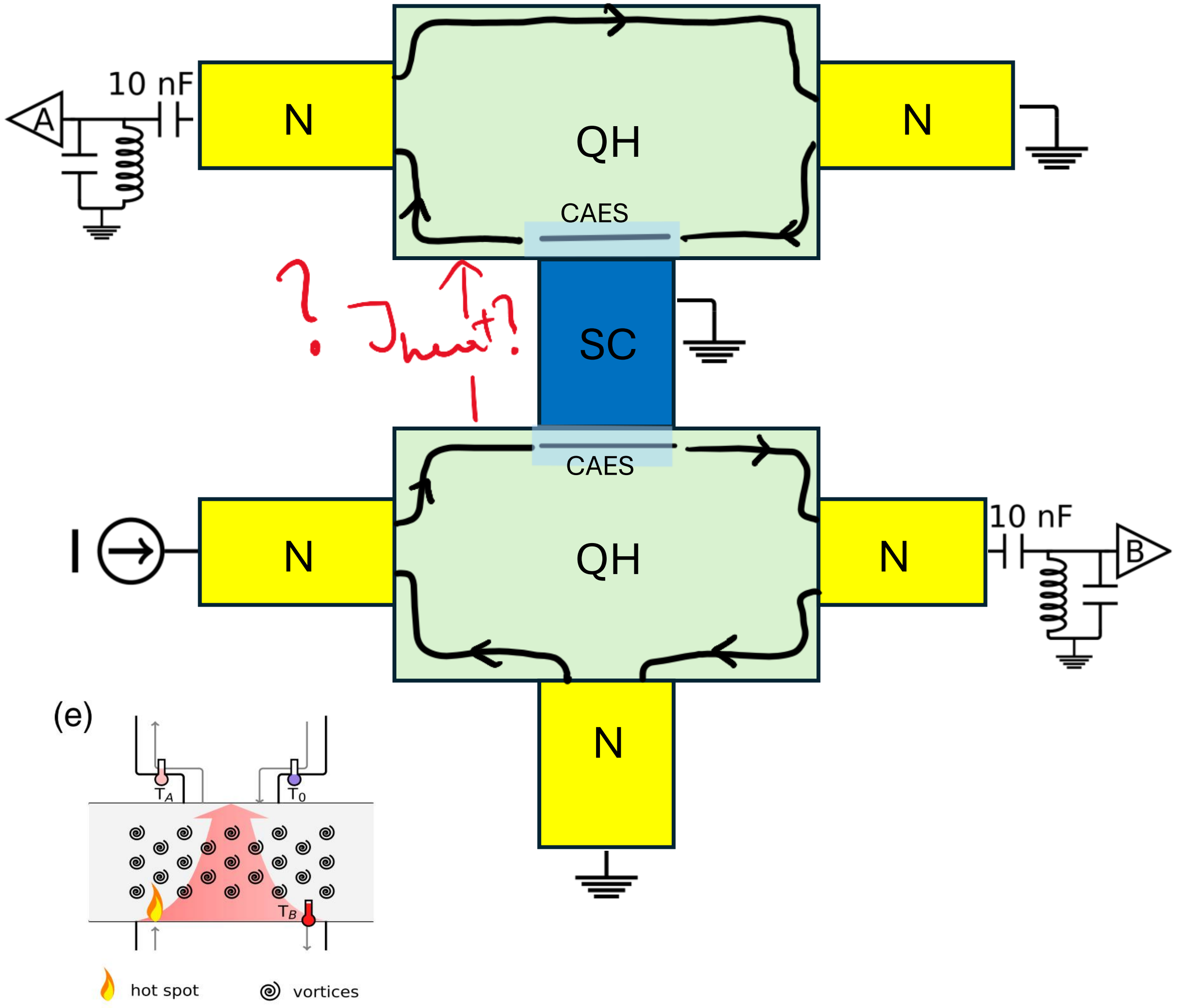
- $\nu = 6$ hotter than $\nu = 2$ →no more cooling with more edge states
- $P_{e-p} \propto (T^5 - T_{bath}^5)$

1. Overlap at low P;
2. Separation between $\nu = 2 \,\&\, \nu = 6$ increasing with T^5

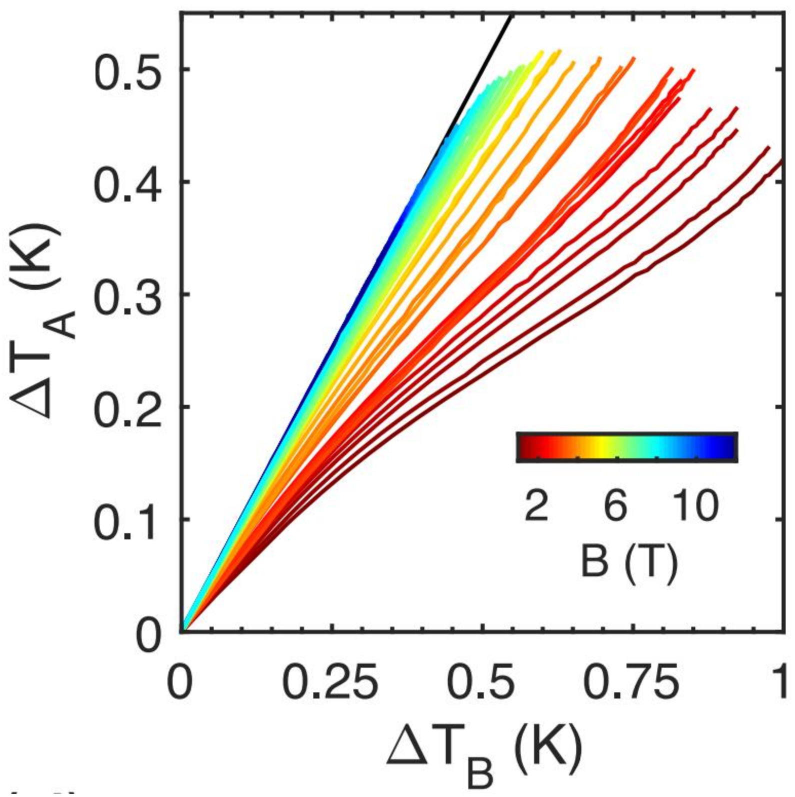
<u>Not clear why</u>

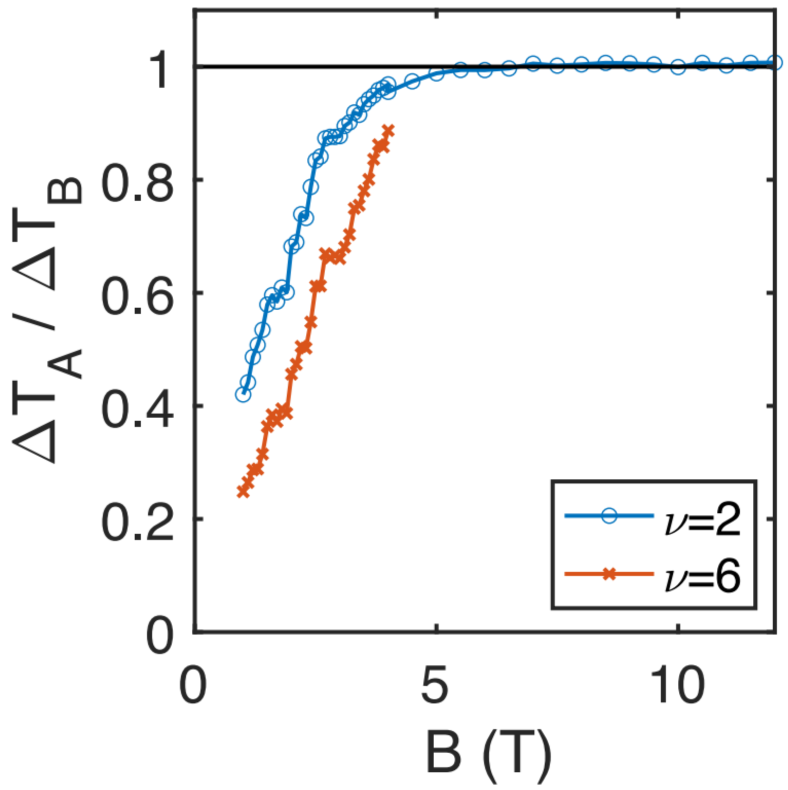
Heat conduction

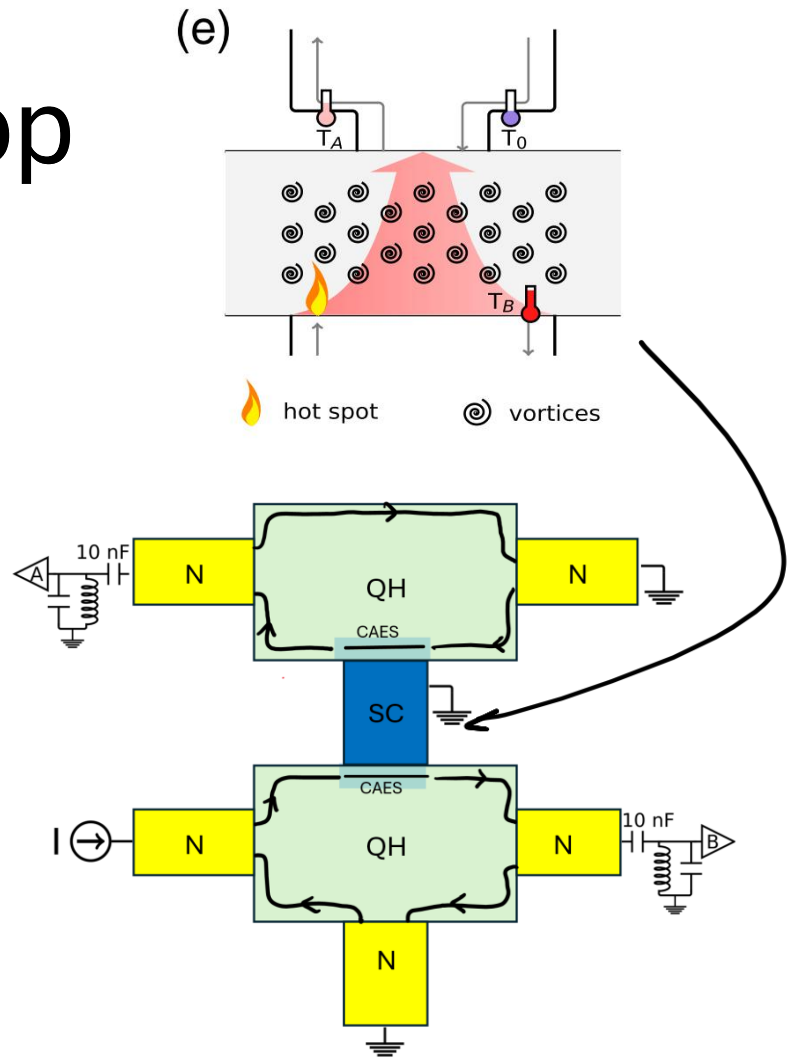




Heat transport from bottom to top







Take home messages

- Metals in superconducting phase are not always thermal insulators, and they can conduct heat
- The heat conduction is due to overlapping vortices : tunnelling of quasiparticles between vortex cores