# Thermoelectric transport at an atomic quantum point contact

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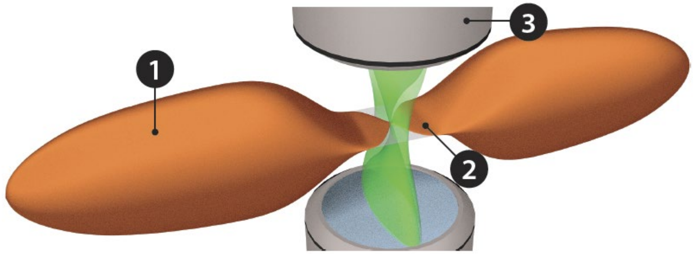
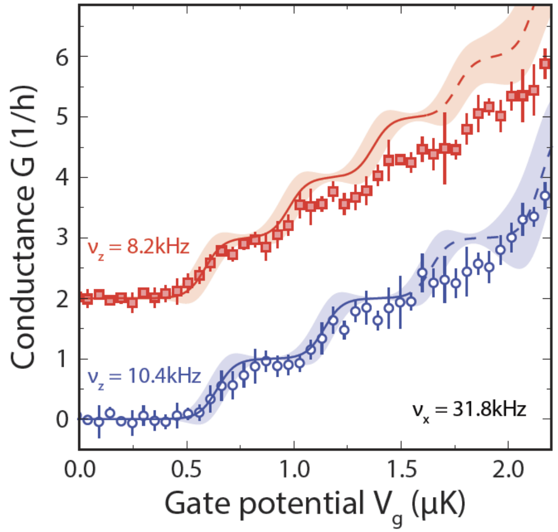
Using a two-terminal mesoscopic device made of ultracold Fermi gas, we study transport phenomena (particle, heat and spin) with tunable inter-particle interaction. In particular, heat transport in the strongly-interacting regime shows anomalous behaviours for solid-state systems. Our current efforts focus on engineering local spin-dependent dissipations.

## Atomic quantum point contact (QPC)




1. Reservoirs of ultracold $^{6}Li$
2. Atoms optically confined to 2D
3. Microscope objective to imprint mesoscopic structures

*Hallmark: quantized conductance*

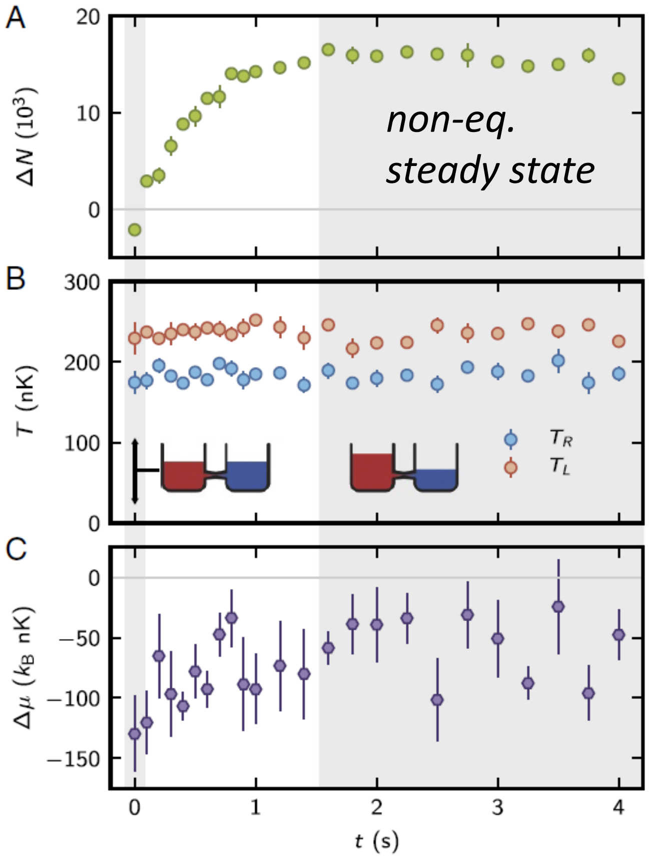


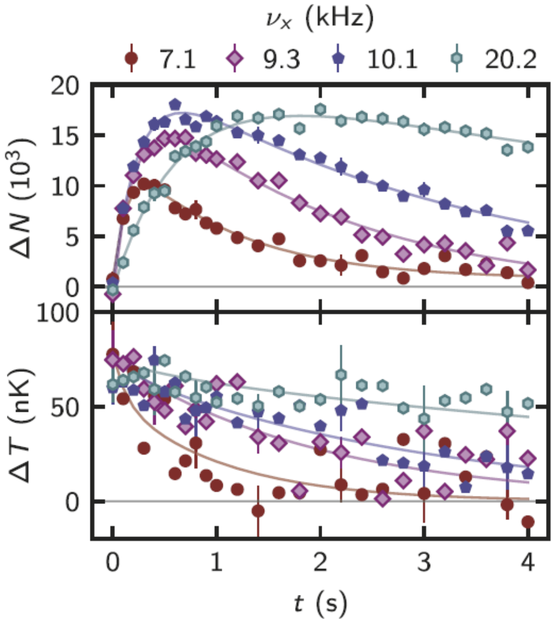

S. Krinner et al., Nature 517, 64 (2015)

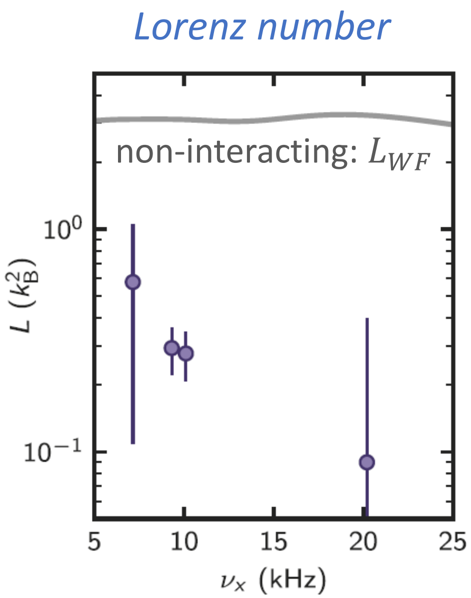
# Breakdown of Wiedemann-Franz law at Unitarity

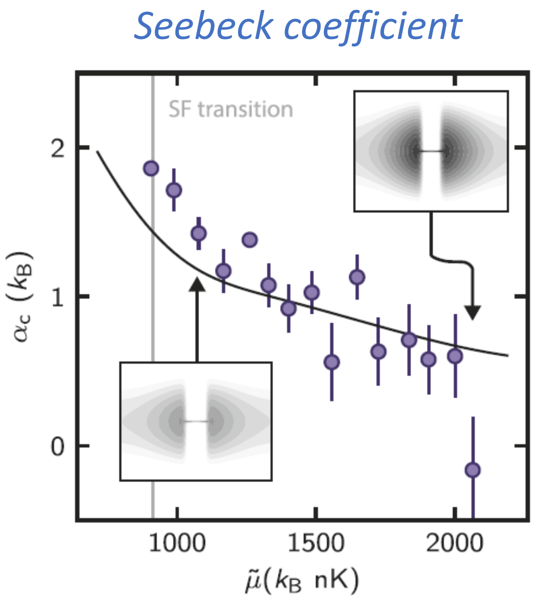
W-F law: the Lorenz number ($L = G_T/TG$, ratio of heat and particle conductance) should be a universal value for Fermi liquids ($L_{\mathrm{WF}} = \pi^2 k_B^2/3$)

D. Husmann, M. Lebrat, S. Häusler, J.-P. Brantut, L. Corman, T. Esslinger, PNAS 115, 8563 (2018)




- system relaxes towards equilibrium with reduced confinement
- 2 timescales captured by linear model

$$\begin{pmatrix} I_N \\ I_S \end{pmatrix} = G \begin{pmatrix} 1 & \alpha_c \\ \alpha_c & L + \alpha_c^2 \end{pmatrix} \cdot \begin{pmatrix} \Delta\mu \\ \Delta T \end{pmatrix}$$

- $\alpha_c = -(\Delta\mu/\Delta T)_{I_N=0}$: entropy per particle
- non-zero even for superfluid (contrary to BCS)

*QPC ↔ superleak in fountain effect in He-II*

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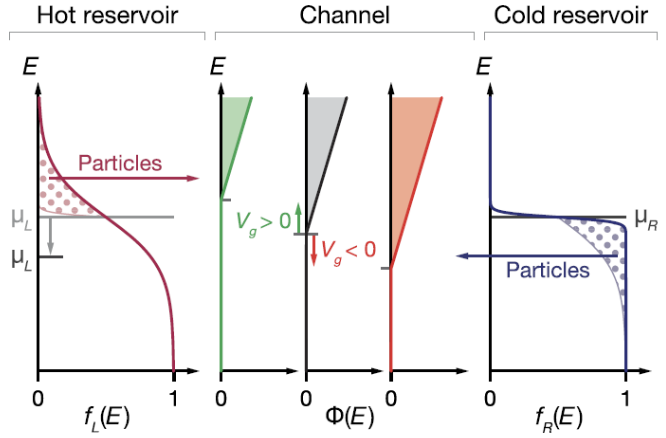
ETH zürich

# Reversal of thermopower

S. Häusler, P. Fabritius, J. Mohan, M. Lebrat,
L. Corman, T. Esslinger, PRX 11, 021034 (2021)

Comparing strong and weak interaction in a mesoscopic channel connecting a hot and a cold reservoir



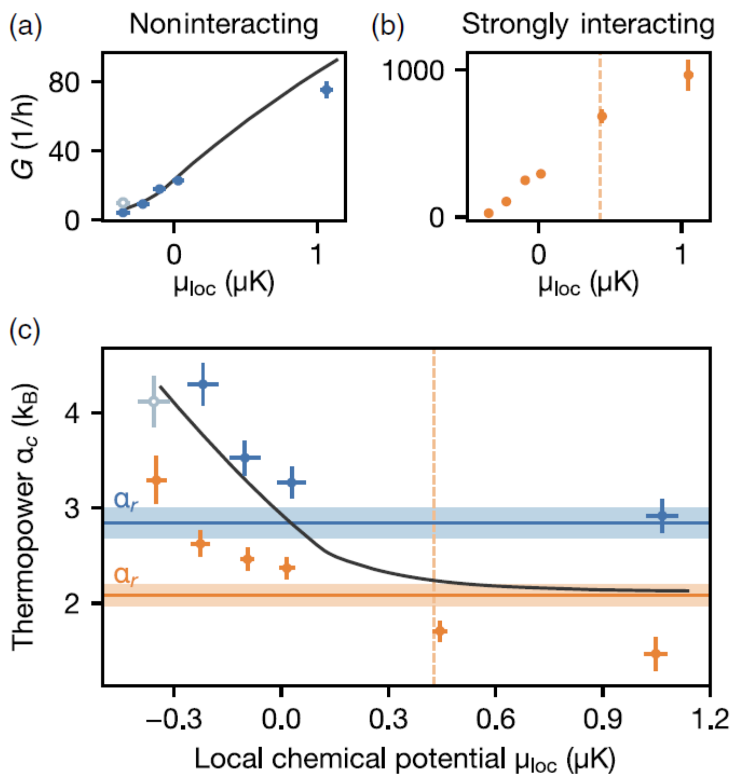

Competition btw. *reservoir asymmetry* (favoring cold to hot) & *channel asymmetry* (favoring hot to cold)

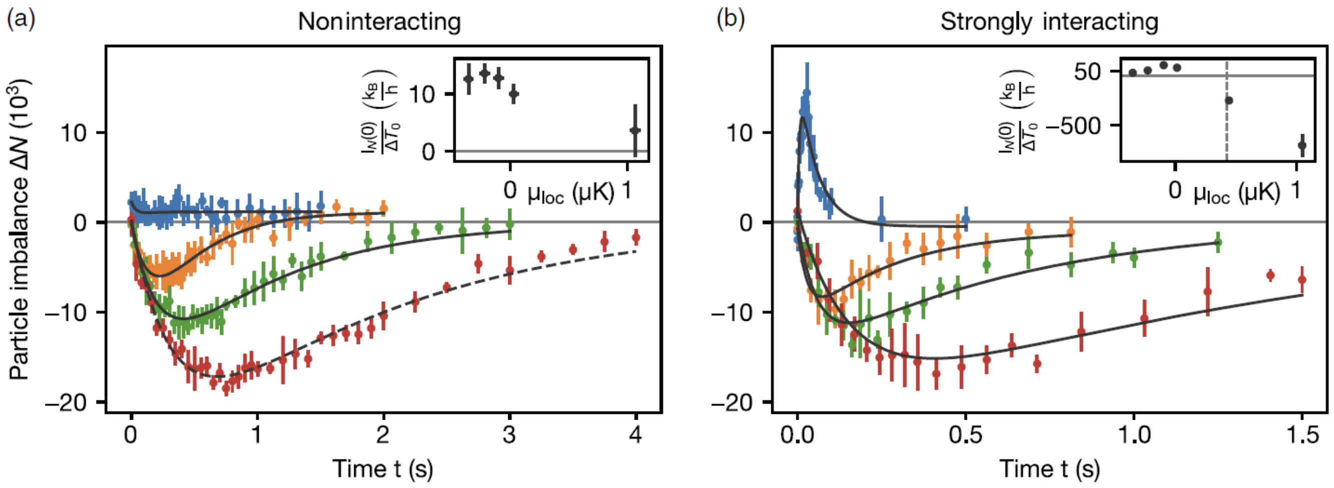
$$\begin{pmatrix} I_N \\ I_S \end{pmatrix} = G \begin{pmatrix} 1 & \alpha_c \\ \alpha_c & L + \alpha_c^2 \end{pmatrix} \cdot \begin{pmatrix} \Delta\mu \\ \Delta T \end{pmatrix}$$

$$I_N(0) = G(\alpha_c - \alpha_r)\Delta T_0$$

$$\alpha_c = \Delta\mu/\Delta T\,, \alpha_r = -(\partial\mu/\partial T)_N$$

## *Controlling thermopower*

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