

# 断熱量子ポンプにおける幾何学的ゆらぎの定理

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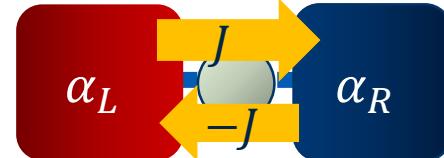


## Fixed parameters

### Steady Fluctuation Theorem

$$\lim_{\tau \rightarrow \infty} \frac{1}{\tau} \ln \frac{P(J)}{P(-J)} = AJ$$

$$A = \alpha_R - \alpha_L \\ A = 0 \Rightarrow \langle J \rangle = 0$$

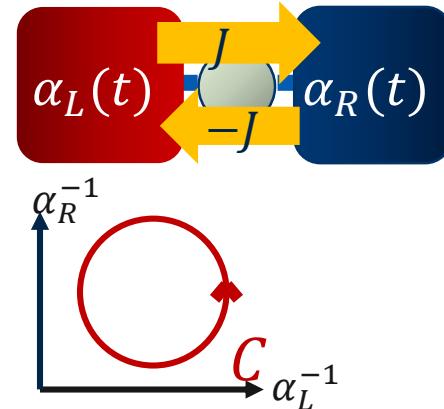


## Controlled parameters (periodic & adiabatic)

$$\langle J \rangle = \langle J \rangle^{\text{dyn}} + \langle J \rangle^{\text{geo}} \neq 0 \text{ even if } \overline{A(t)} = 0$$

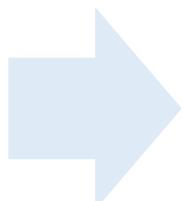
$$\langle J \rangle^{\text{geo}} = -\frac{1}{\tau_p} \oint_C d\alpha \cdot \langle \langle l'_0(\alpha) | \nabla_\alpha | r_0^0(\alpha) \rangle \rangle$$

### Geometrical pumping



Question: FT for geometrical pumping exists?

Local (instantaneous):



Global (1-cycle): ???

$$\frac{P_n(J_n)}{P_n(-J_n)} = e^{\sigma_n(J_n)}$$

$$\sigma_n(J_n) := \frac{1}{\epsilon N} [A_n J_n - \epsilon \{ v_n^{\chi_c} - v_n^{-\chi_c} \}]$$