Phys529B: Topics of Quantum Theory

Lecture 19: introduction to 2D an 3D CFT states

instructor: Fei Zhou

- Final presentation:
- Holographic matter, Hartnoll, Lucas and Sachdev, Chapter 3 and 5 (transport physics near QCPs and metal without quasi-particles).

Constructing fermions (Mandelstam 1975)

$$\psi(x) = e^{i\sqrt{\pi}\,\Theta(x) + i\sqrt{\pi}\,\phi(x)}$$

$$J_0(x) = \frac{1}{\sqrt{\pi}}\Pi(x), \qquad \Theta(x) = \int_{-\infty}^{x} J_0(x')\,dx'$$

$$J(x) = \frac{1}{\sqrt{\pi}}\partial_x\phi(x), \qquad \phi(x) = \int_{-\infty}^{x} J(x')\,dx'$$

$$[\phi(x), \Pi(x')] = i\,\delta(x-x') \longrightarrow [\phi(x), \theta(x')] = i\,\Theta(x-x')$$

$$\{\psi(x), \psi(x')\} = 0 \text{ if } x \neq x'$$

Via Baker-Bansdorff Relation

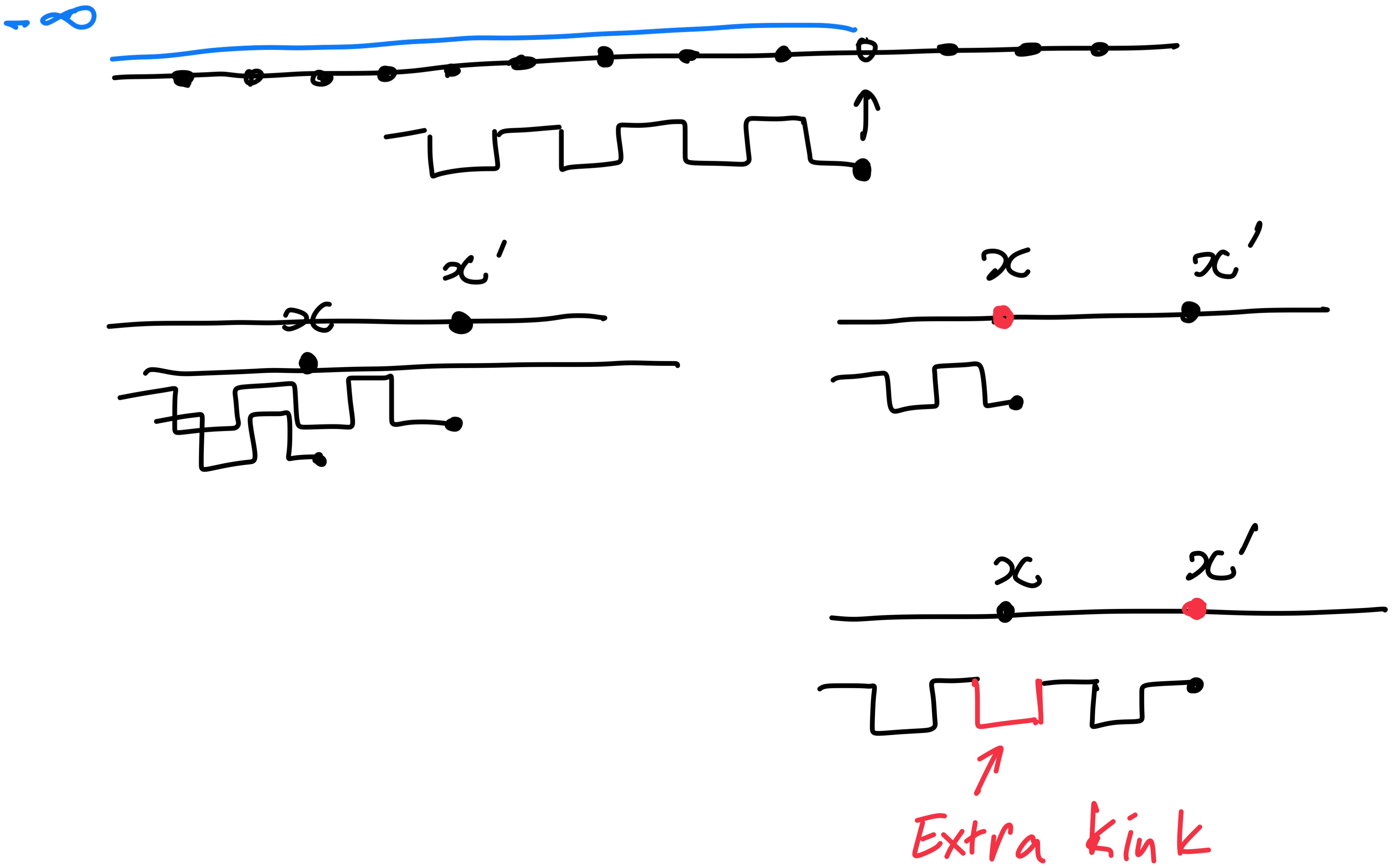
$$e^A e^B = e^B e^A e^{-[A,B]}$$

$$\psi(x)\psi(x') = \psi(x')\psi(x)\, e^{-i\phi(x,x')}$$

$$i\phi(x,x') = -[\sqrt{\pi}\,\Theta(x) + \sqrt{\pi}\,\phi(x),\ \sqrt{\pi}\,\Theta(x') + \sqrt{\pi}\,\phi(x')]$$

$$= i\pi\,\Theta(x'-x) - i\pi\,\Theta(x-x')$$

illustration of Mandelstam Construction



Conformal field Theory states I: Non-Relativistic CFT

Hagen, 72; Niederer, 72; Nishida, Son, 07; on CFT

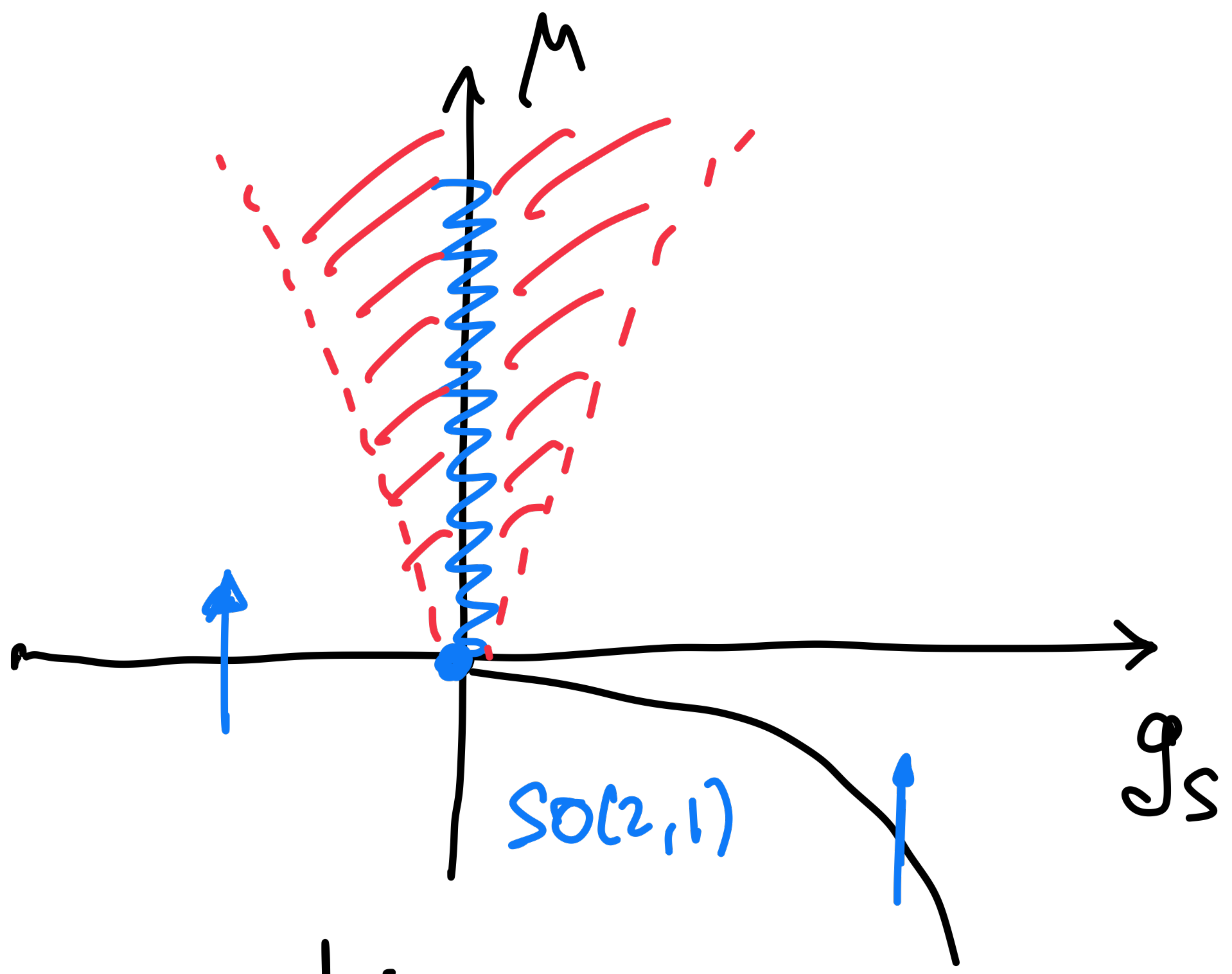
Maki and Zhou, PRA 98, 13602 (2018)

PRA 100, 23601 (2019)

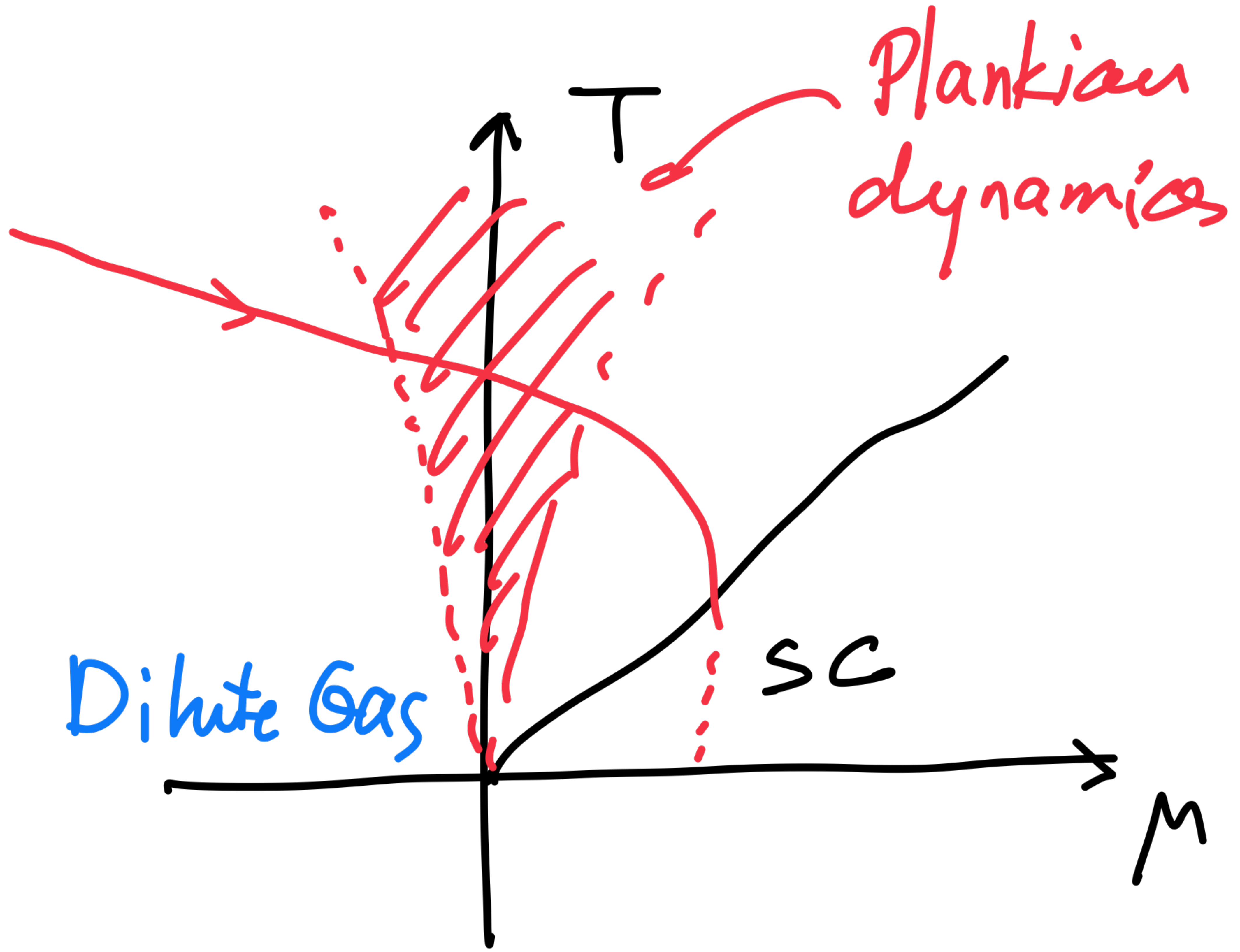
PRA 102, 063319 (2020)

PRL 128, 040401 (2022)

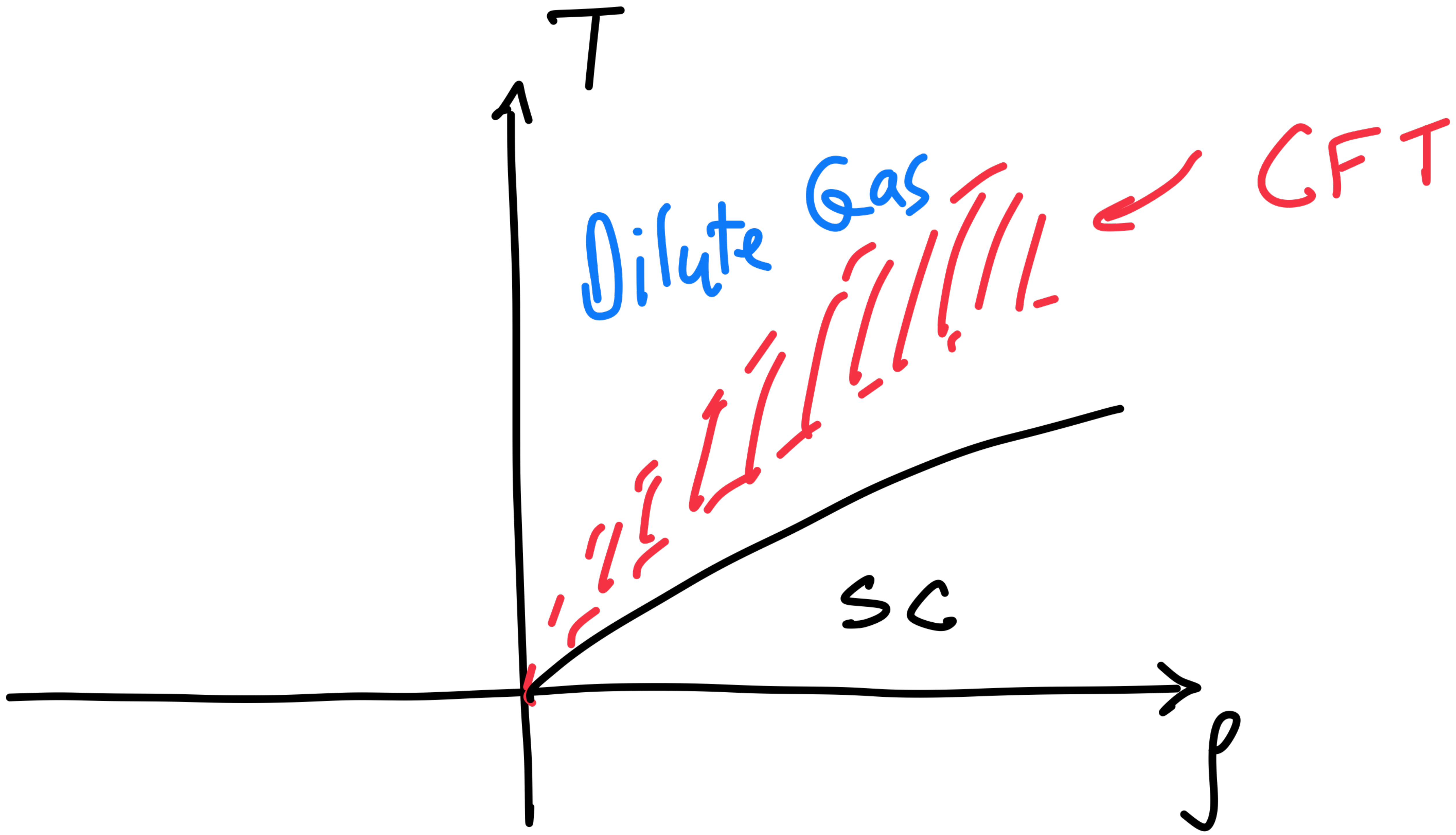
$$H-\mu\hat{N} = \int \psi^\dagger\left(-\frac{\nabla^2}{2}-\mu\right)\psi - g_s\int \psi^\dagger\sigma_y\psi^\dagger\,\psi\sigma_y\psi$$



$d > 2$



$g_s = g^*$



$$g = g^*$$