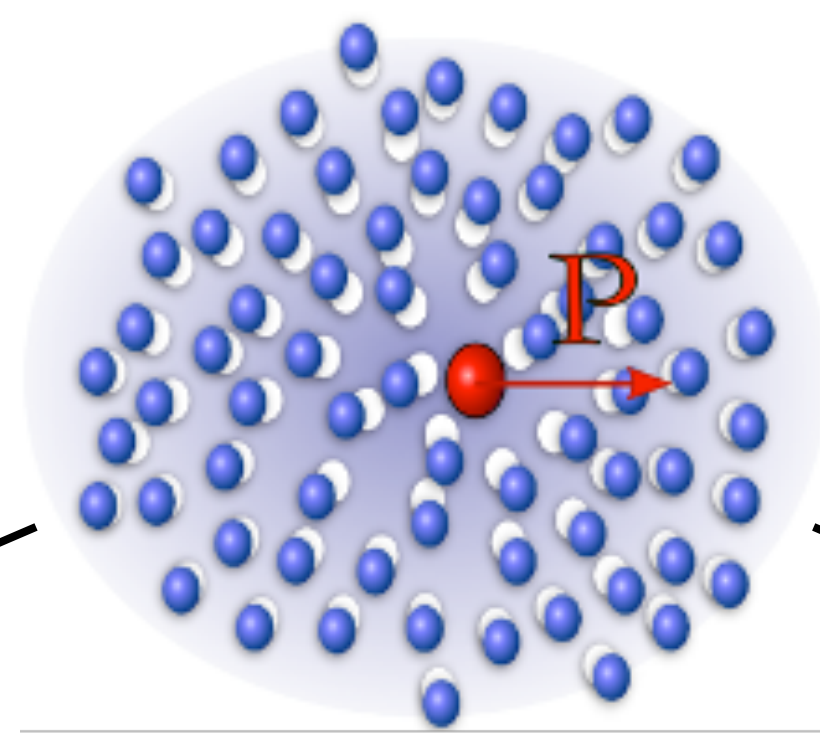# Dynamical quantum Cherenkov transition of fast impurities in quantum liquids

Kushal Seetharam (MIT, Harvard)
August 25th, 2021
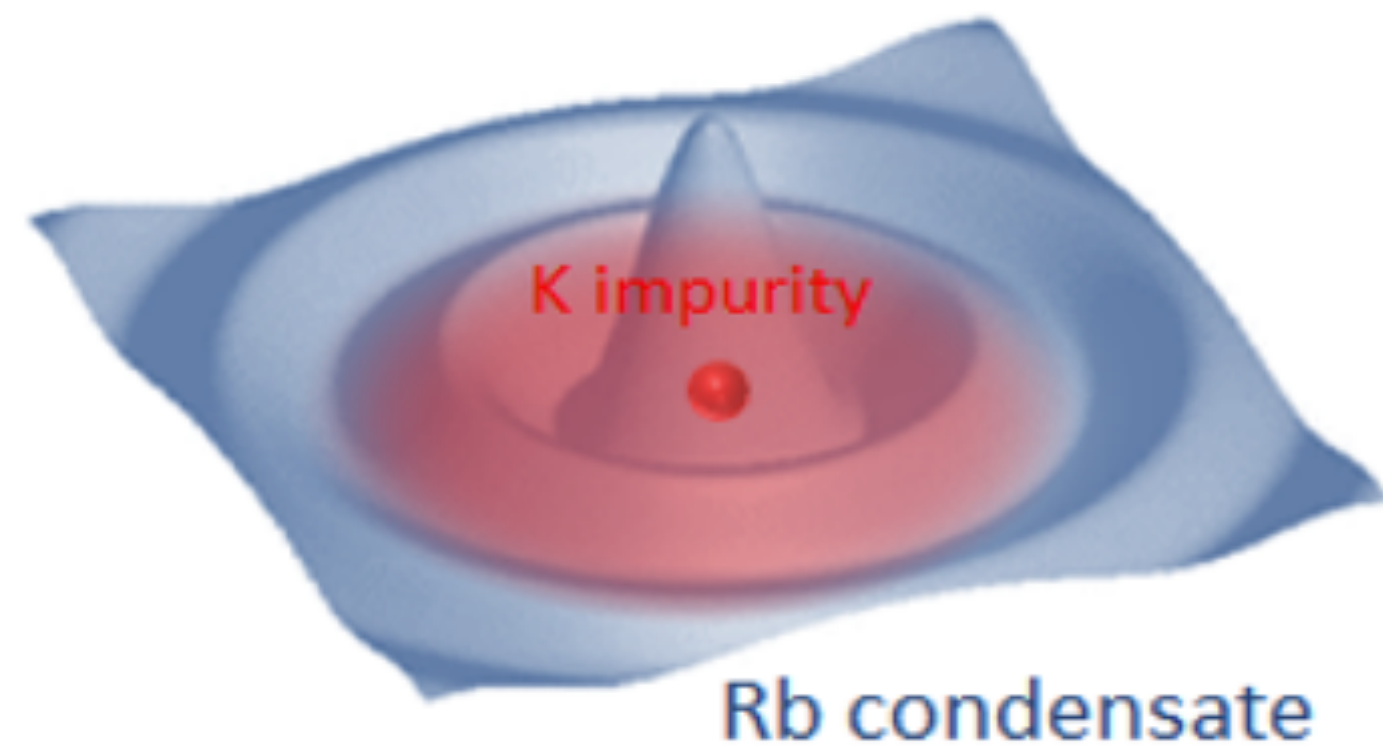
Mobile impurity in a BEC
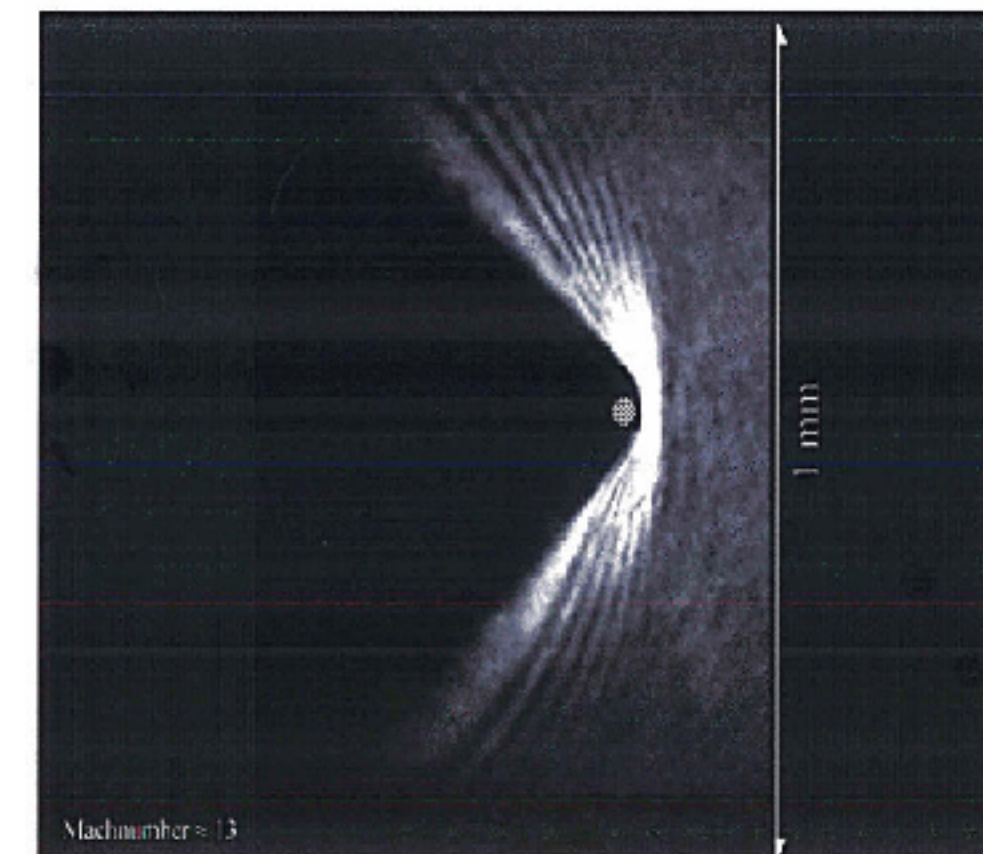
P

finite mass, slow

infinite mass, <u>fast</u>

Polaron

K impurity

Rb condensate

finite mass
+
fast?
+
strong interactions

Cherenkov
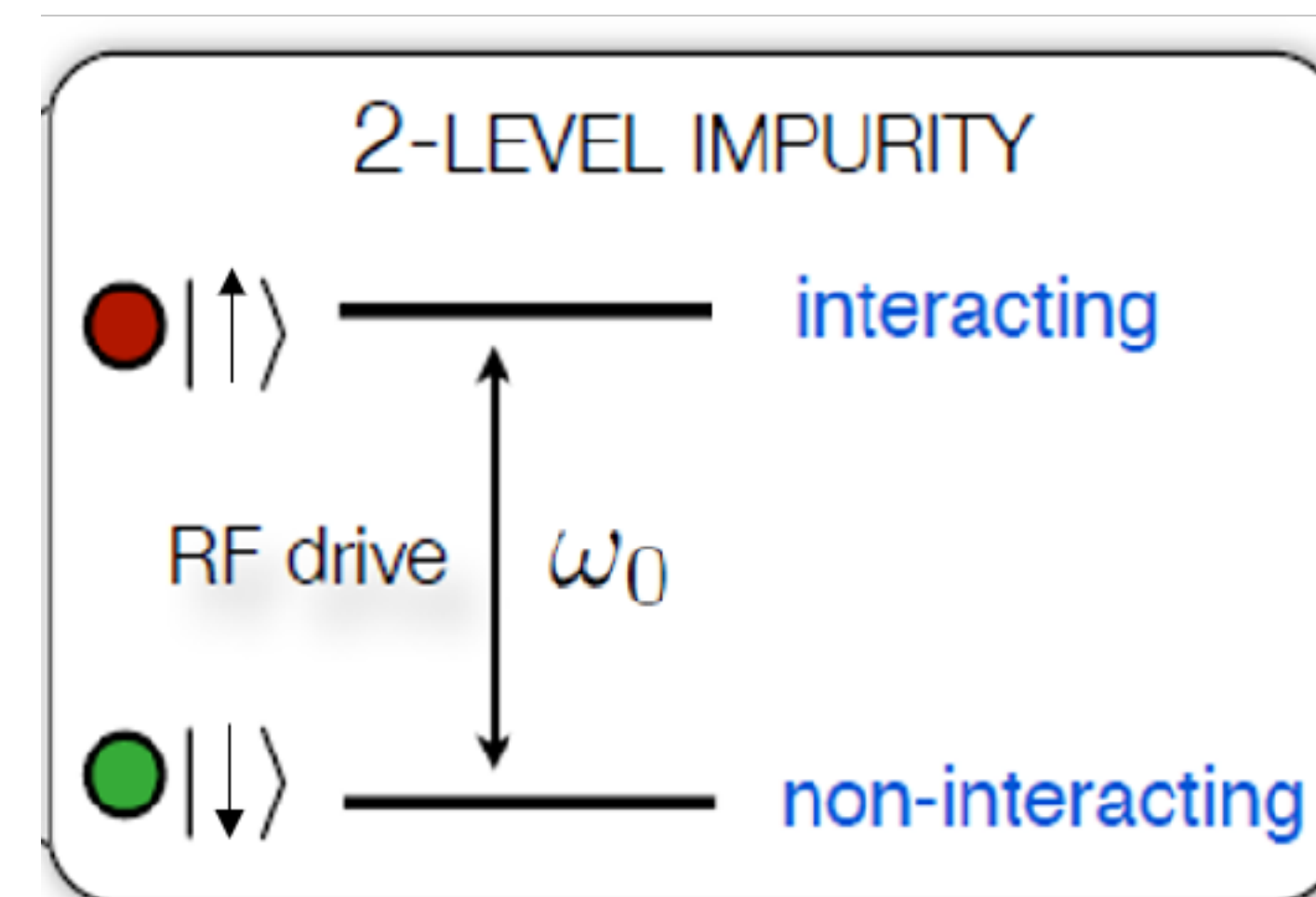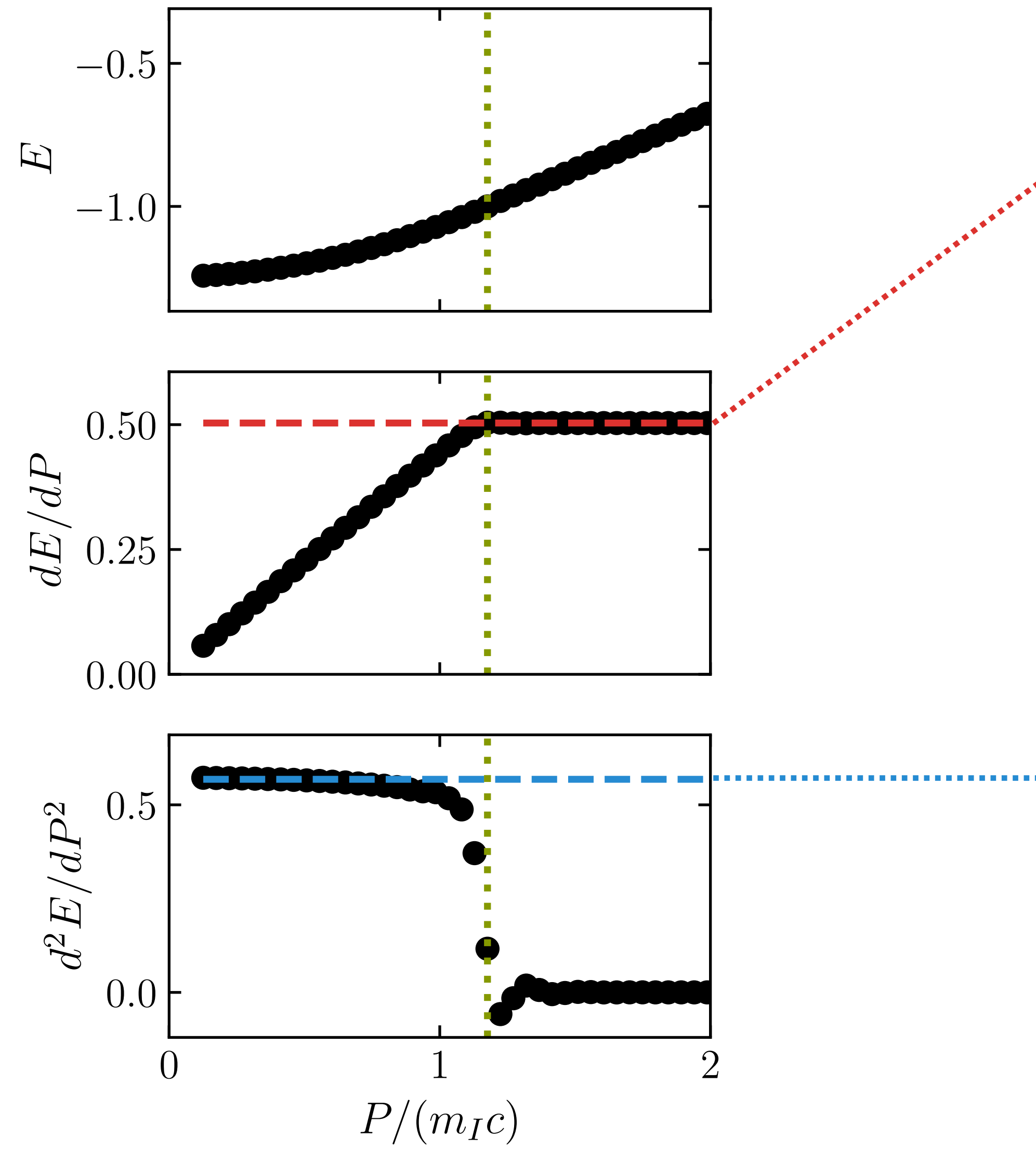
Settings

Finite momentum ground state (FMGS)
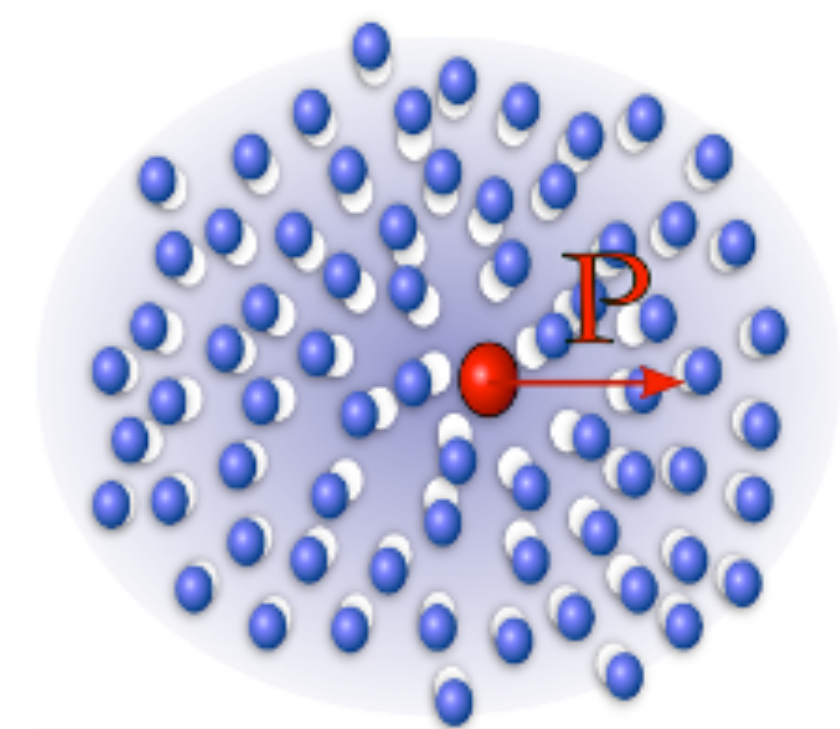
Far-from-equilibrium quench protocol
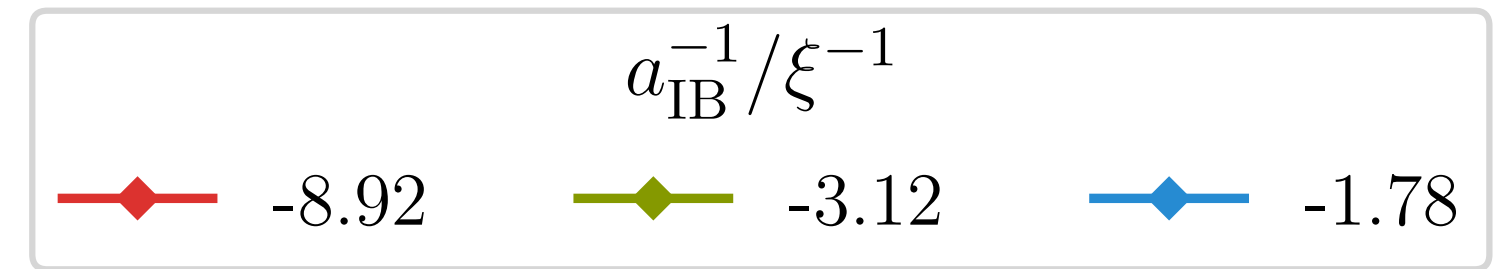
FMGS

Cherenkov transition
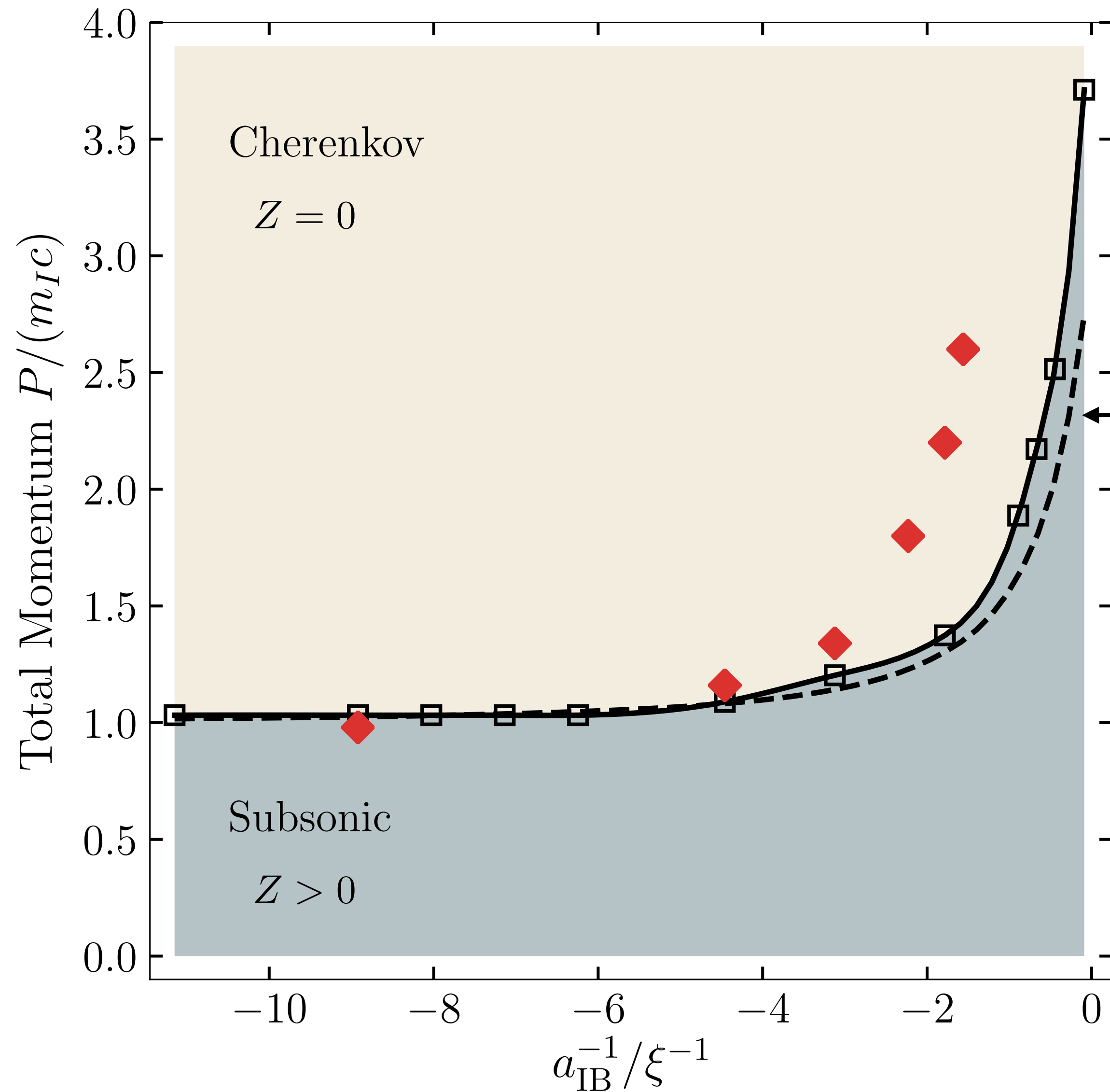
$$Z = \left| \langle 0 | \Psi_{gs}^{\uparrow} \rangle \right|^2$$

Transition happens at
$P_{\mathrm{crit}} = m^* c$

Dynamical transition
happens at same place

Observables

FMGS

Quench
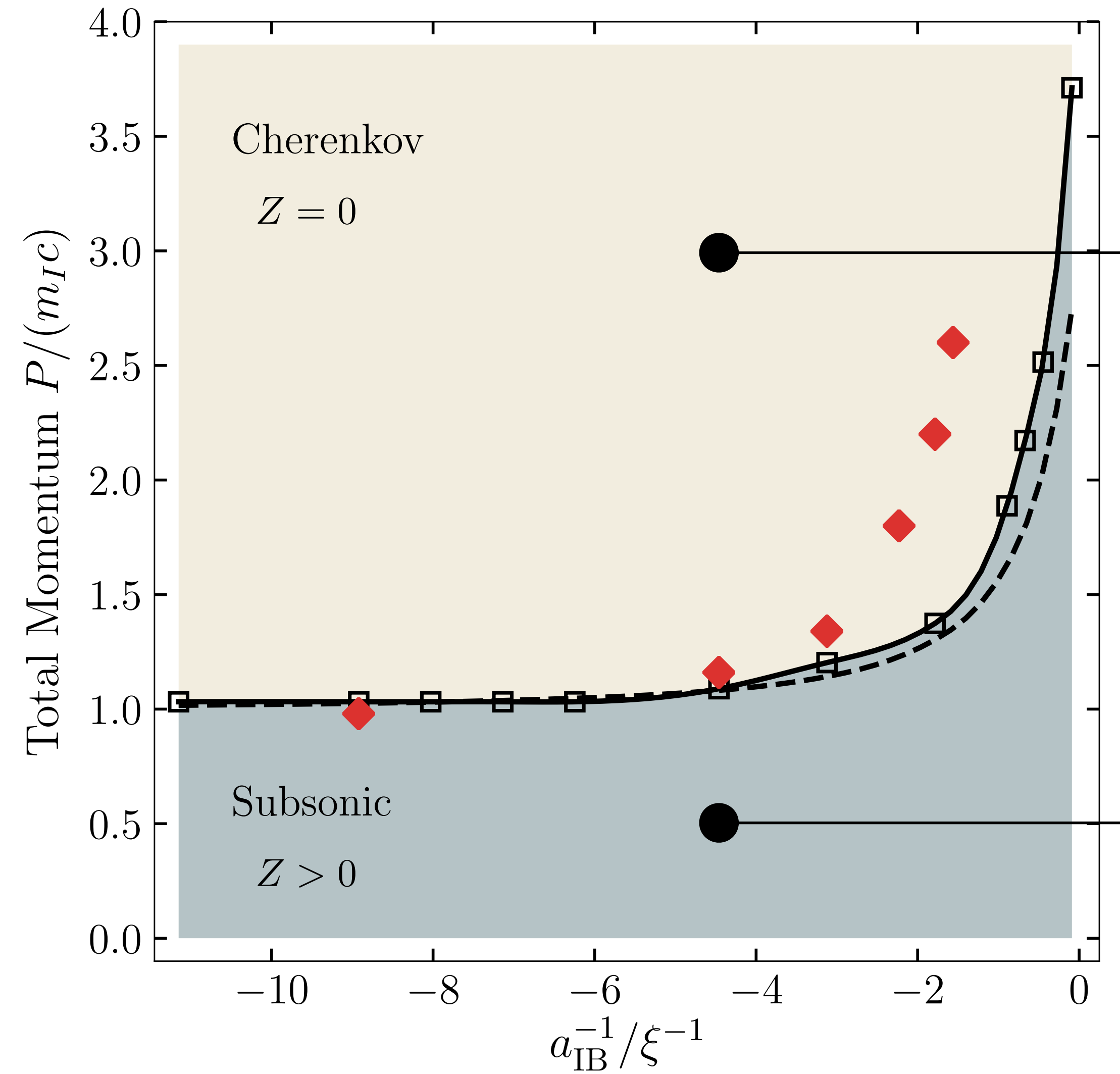
Impurity ends up
at speed of sound
in Cherenkov regime

$$Z = \left| \langle 0 | \Psi_{gs}^{\uparrow} \rangle \right|^2$$

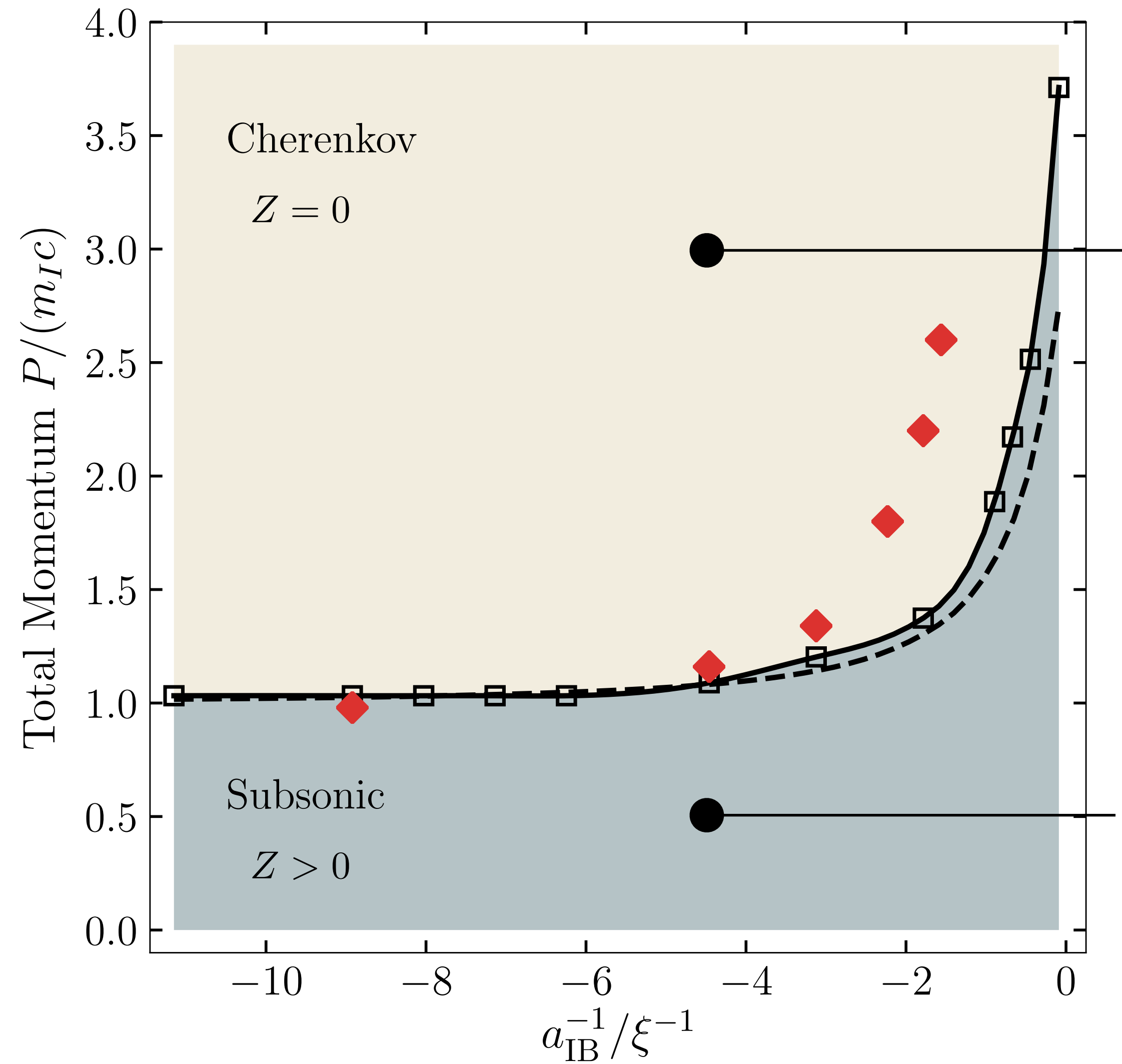$$|S(t)| = \left| \langle 0 | \Psi^{\uparrow}(t) \rangle \right|$$

$$|S(t_\infty)| \to Z$$

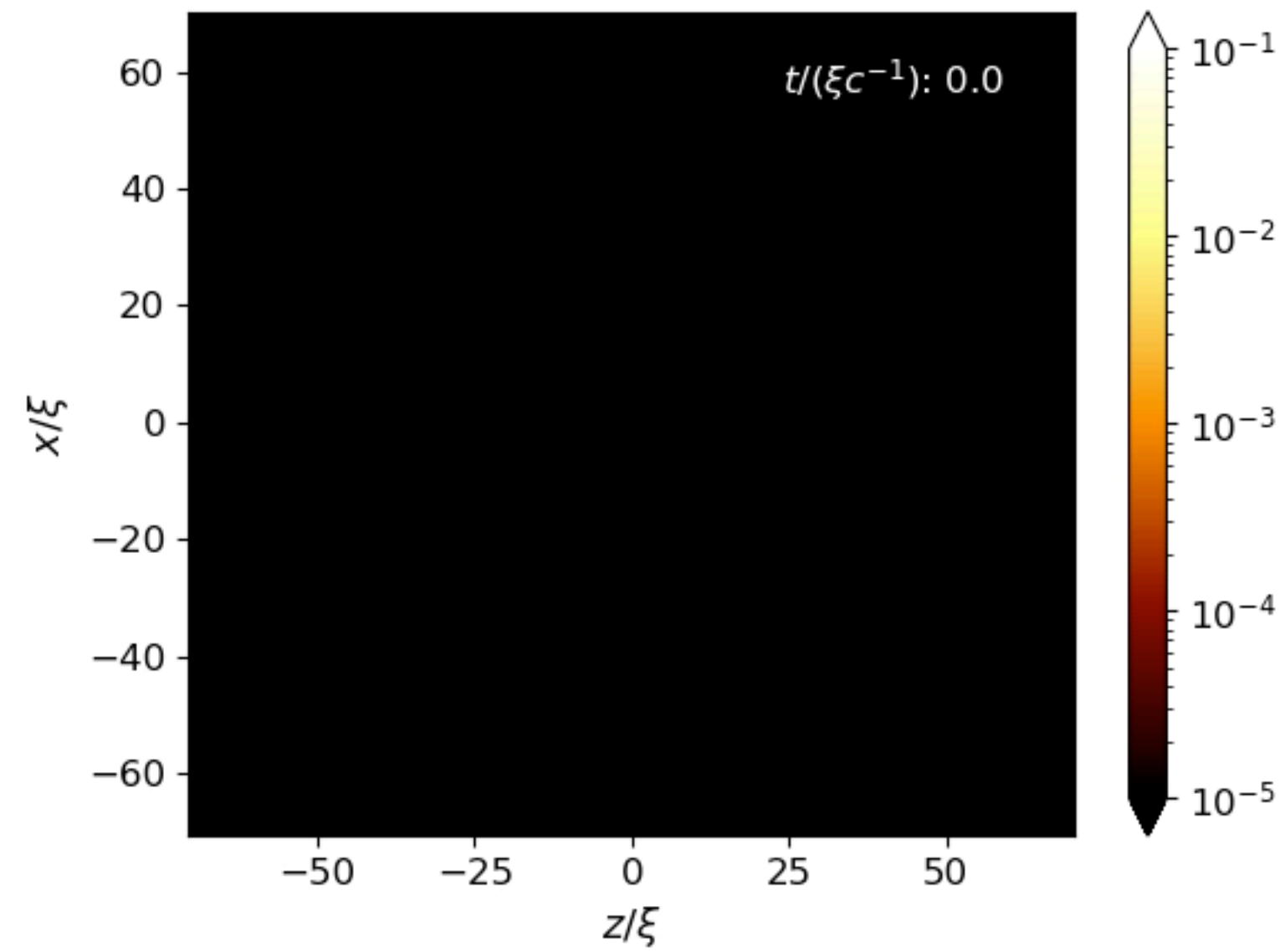Dynamical and FMGS
transitions coincide
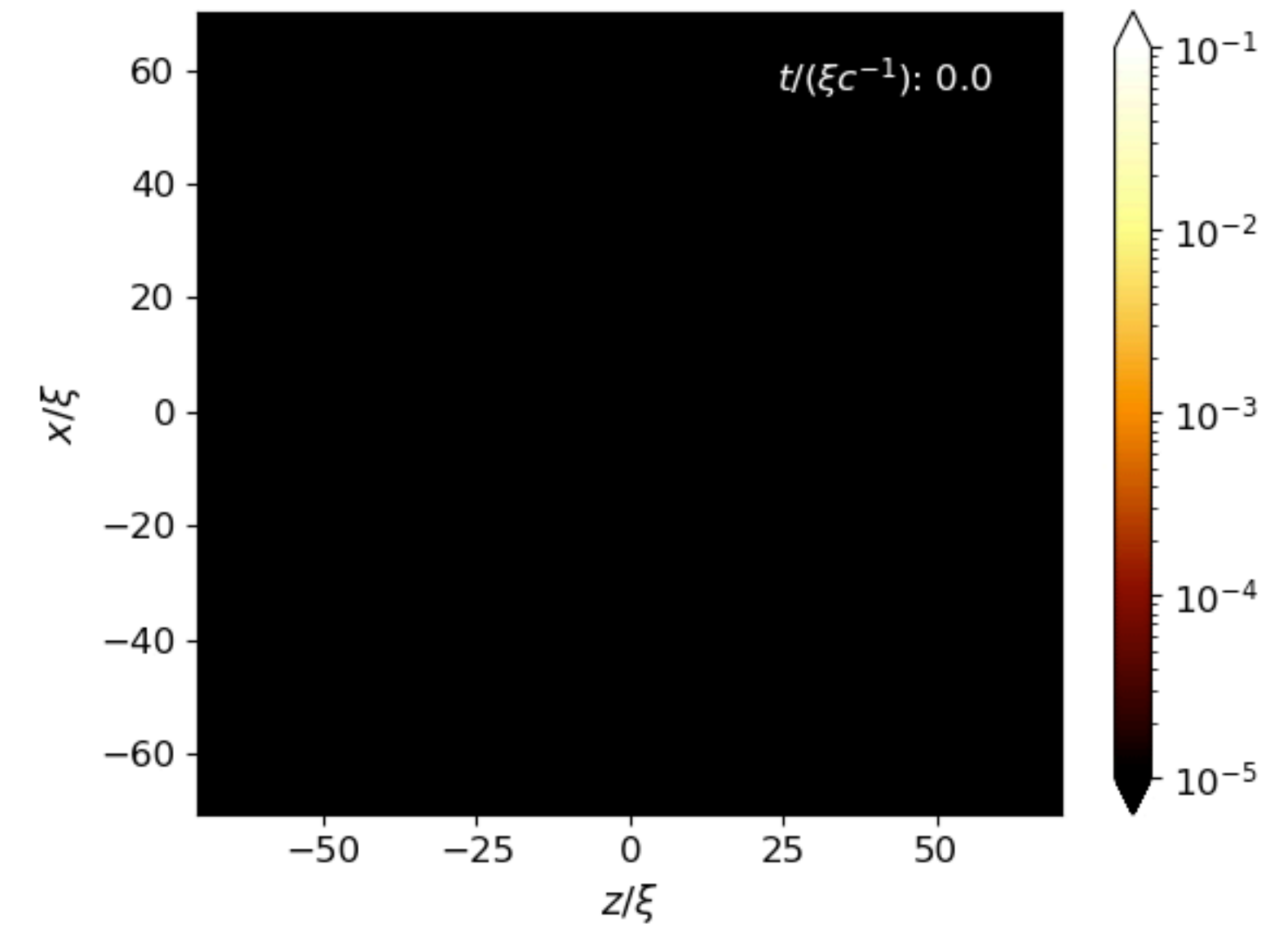
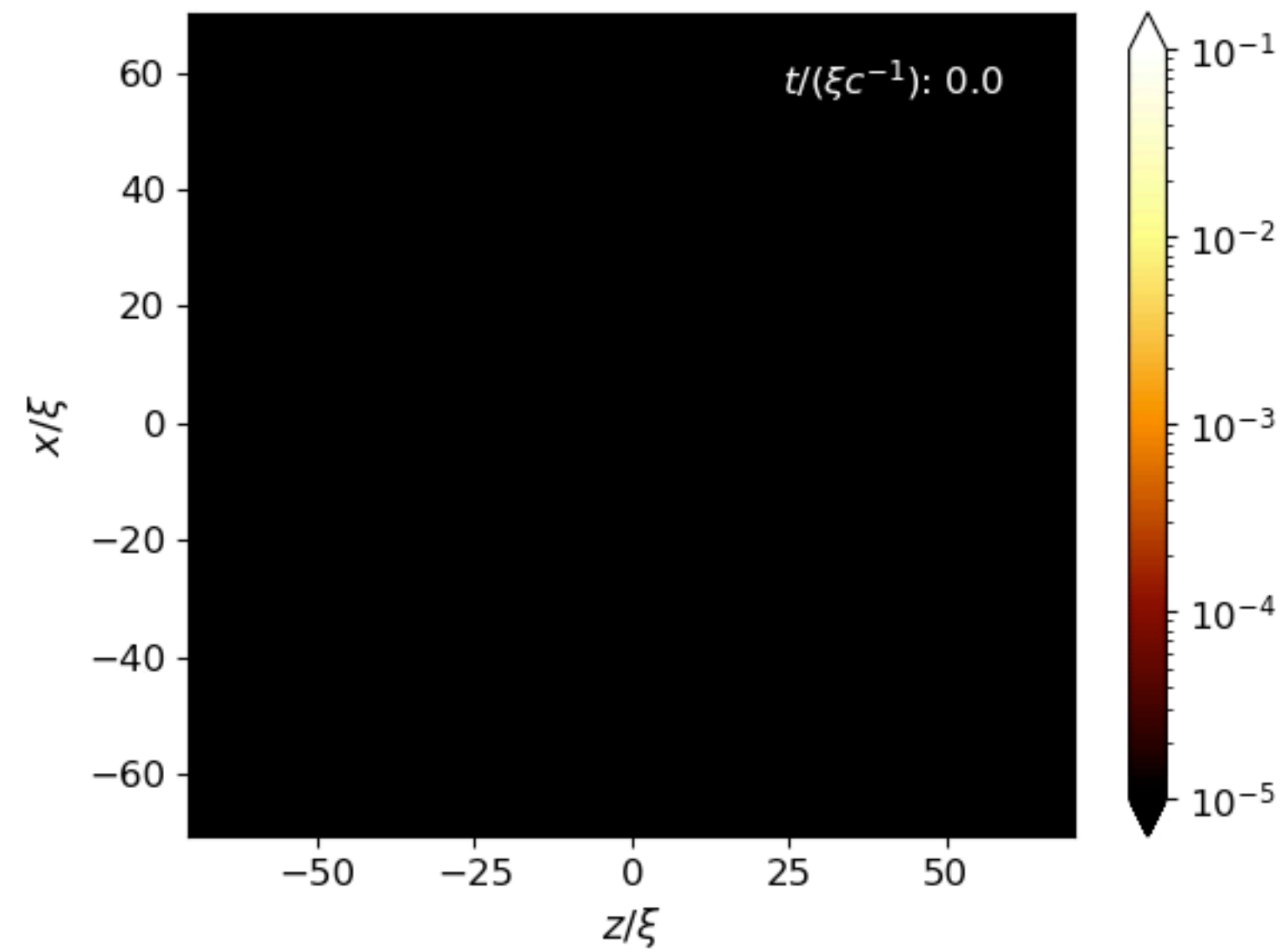# Distributions (FMGS)

Distributions (Quench)
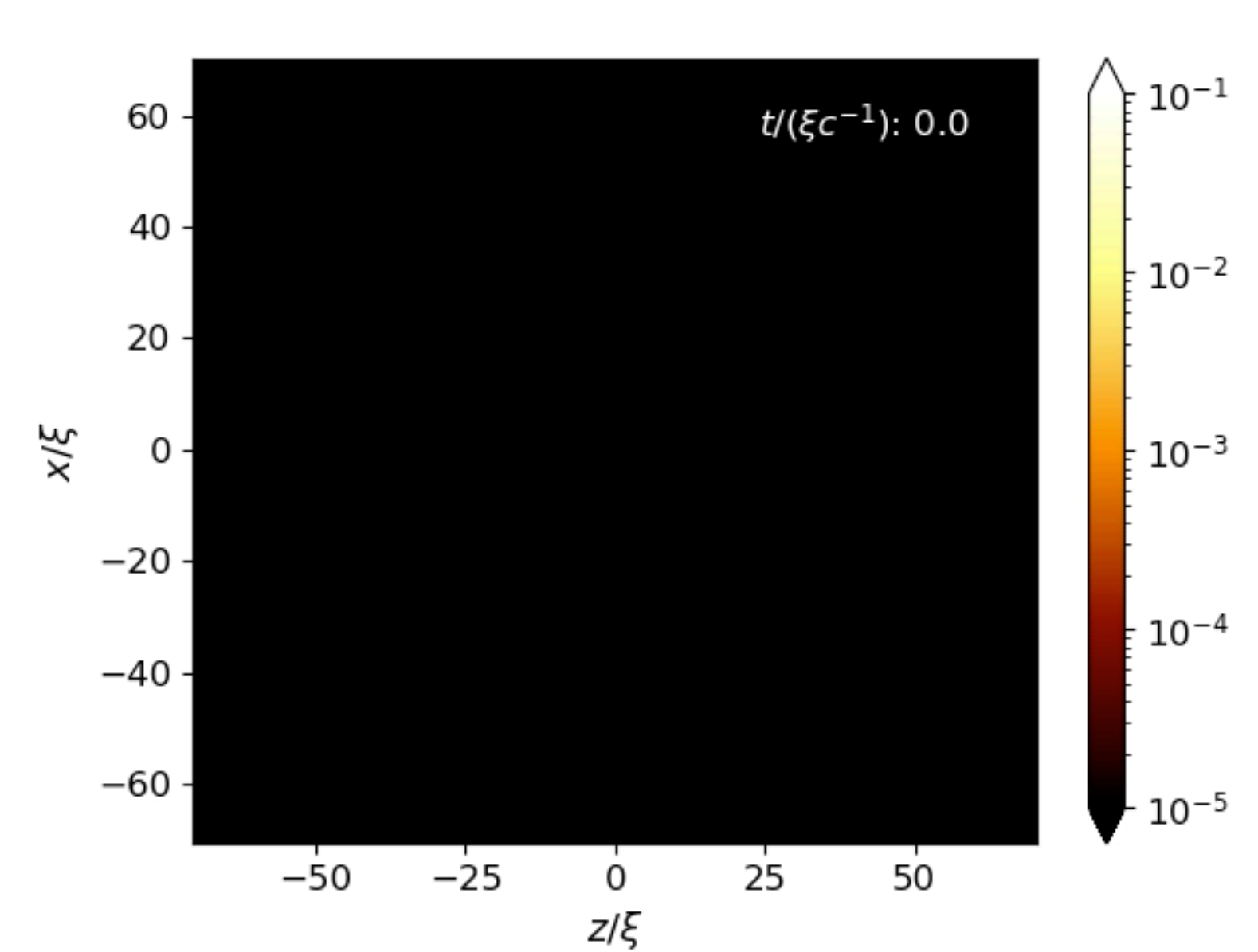
weak interaction, subsonic
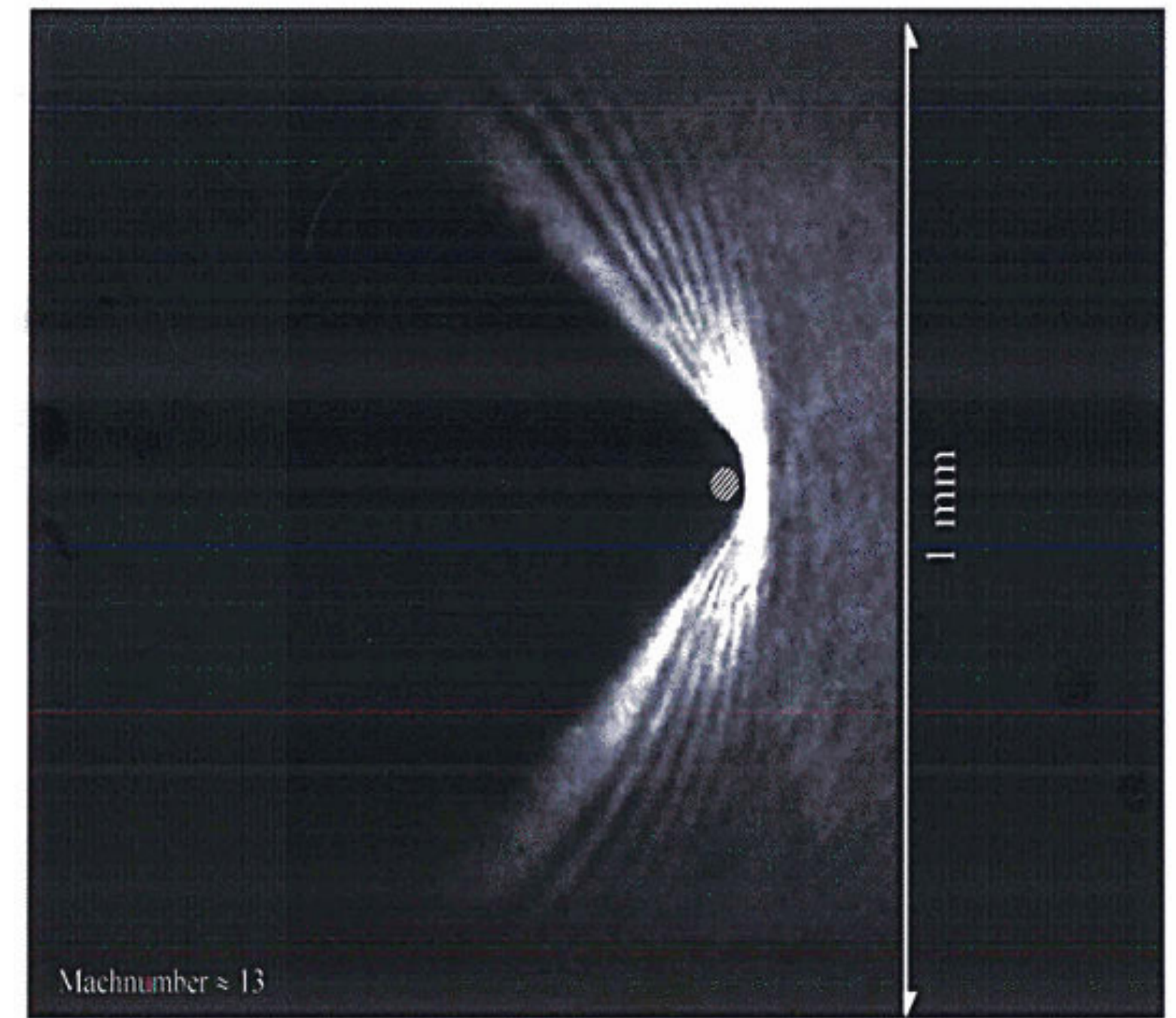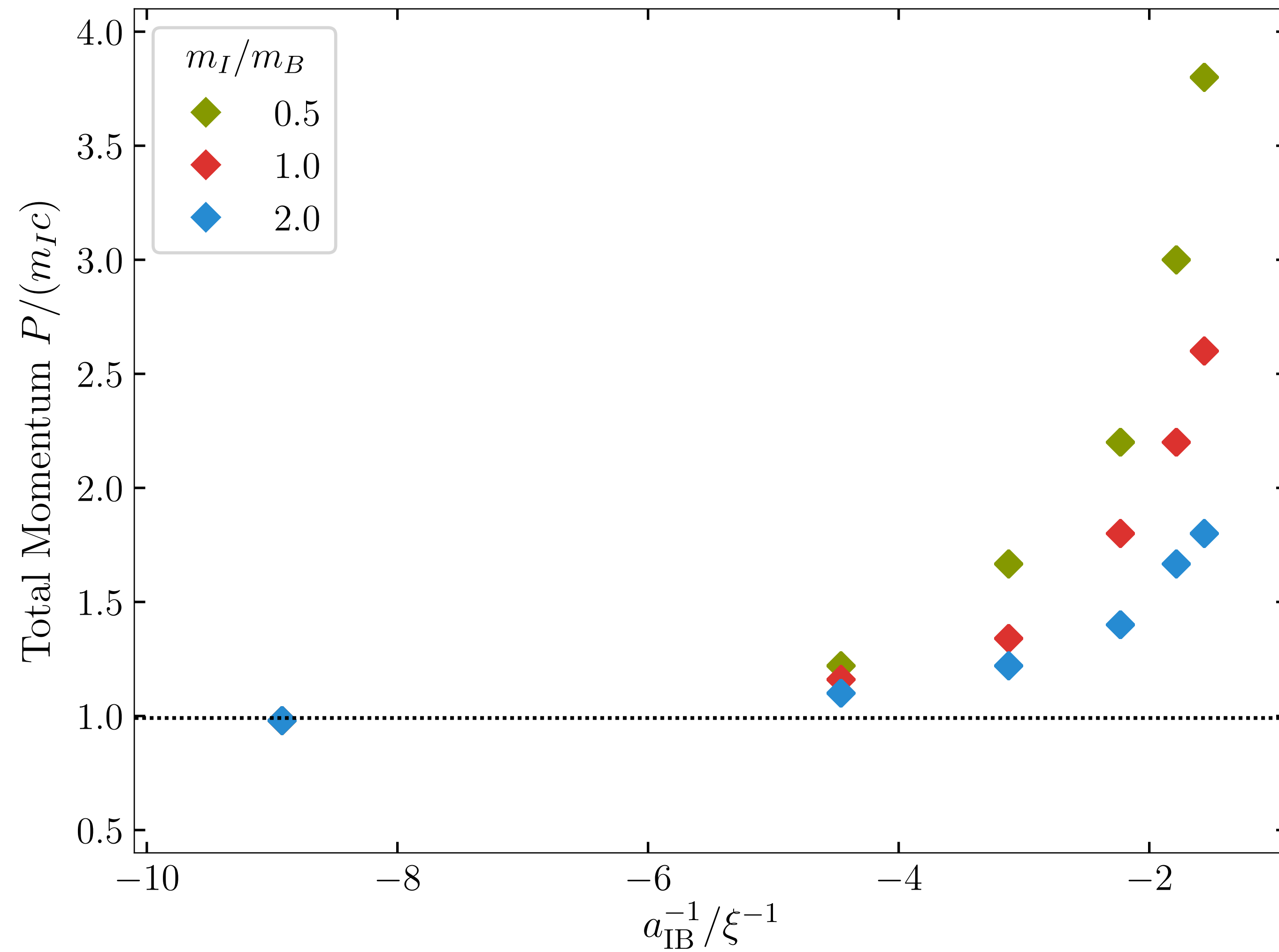

weak interaction, supersonic

strong interaction, supersonic (below transition)

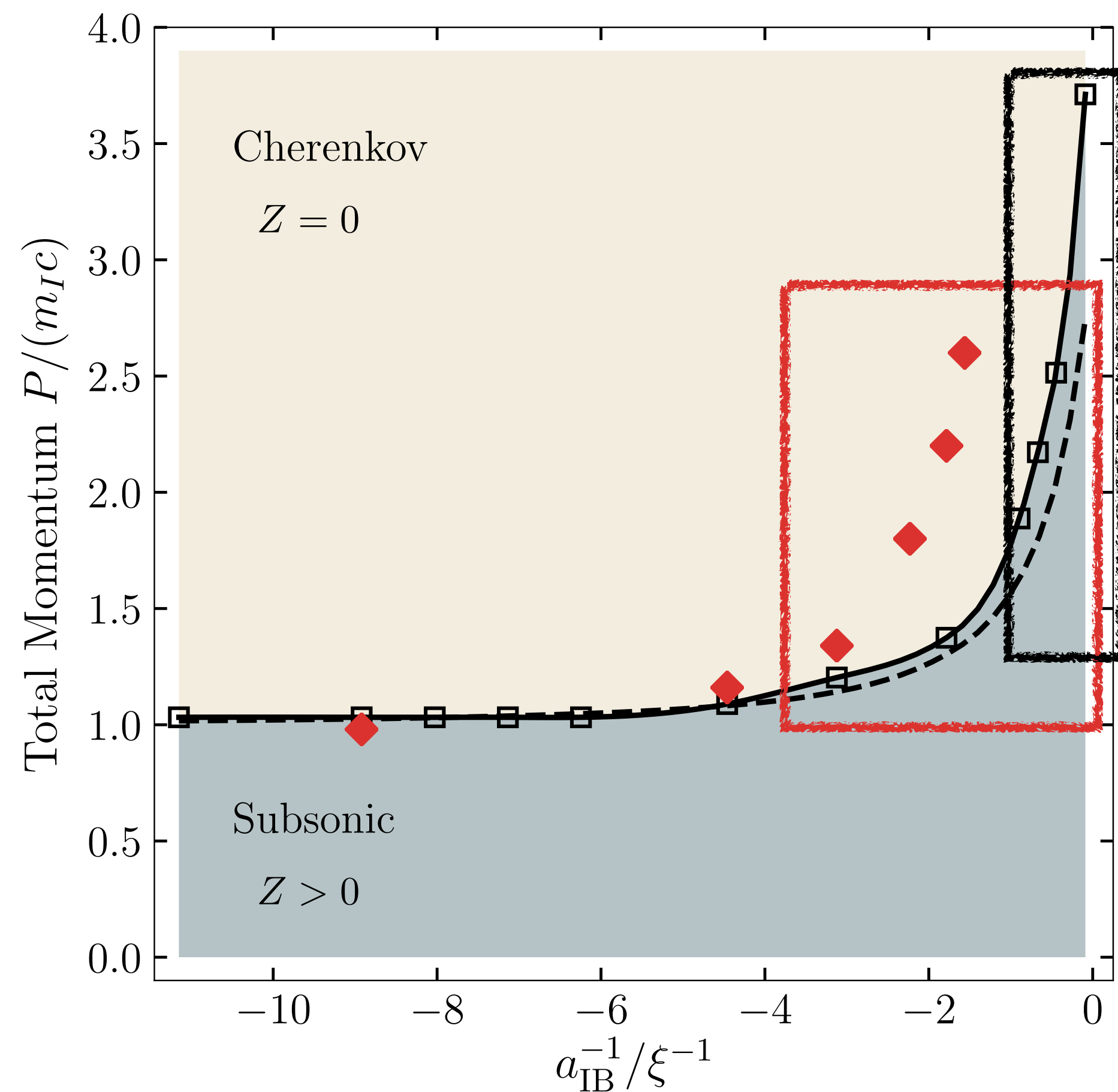## strong interaction, supersonic (above transition)

Different mass ratios

E. Cornell (2004) - unpublished

Prospectives

- FMGS critical momentum at strong interactions

  ➡ No longer $P_{\text{crit}} = m^* c_s$

- Discrepancy in dynamical critical momentum

Transition in gases with other dimensions/statistics?

➡ No transition in 1D Fermi gas   Gamayun (2018) - PRL