

Hydro attractor in heavy-ion collisions: some perspectives from Fermi Liquid

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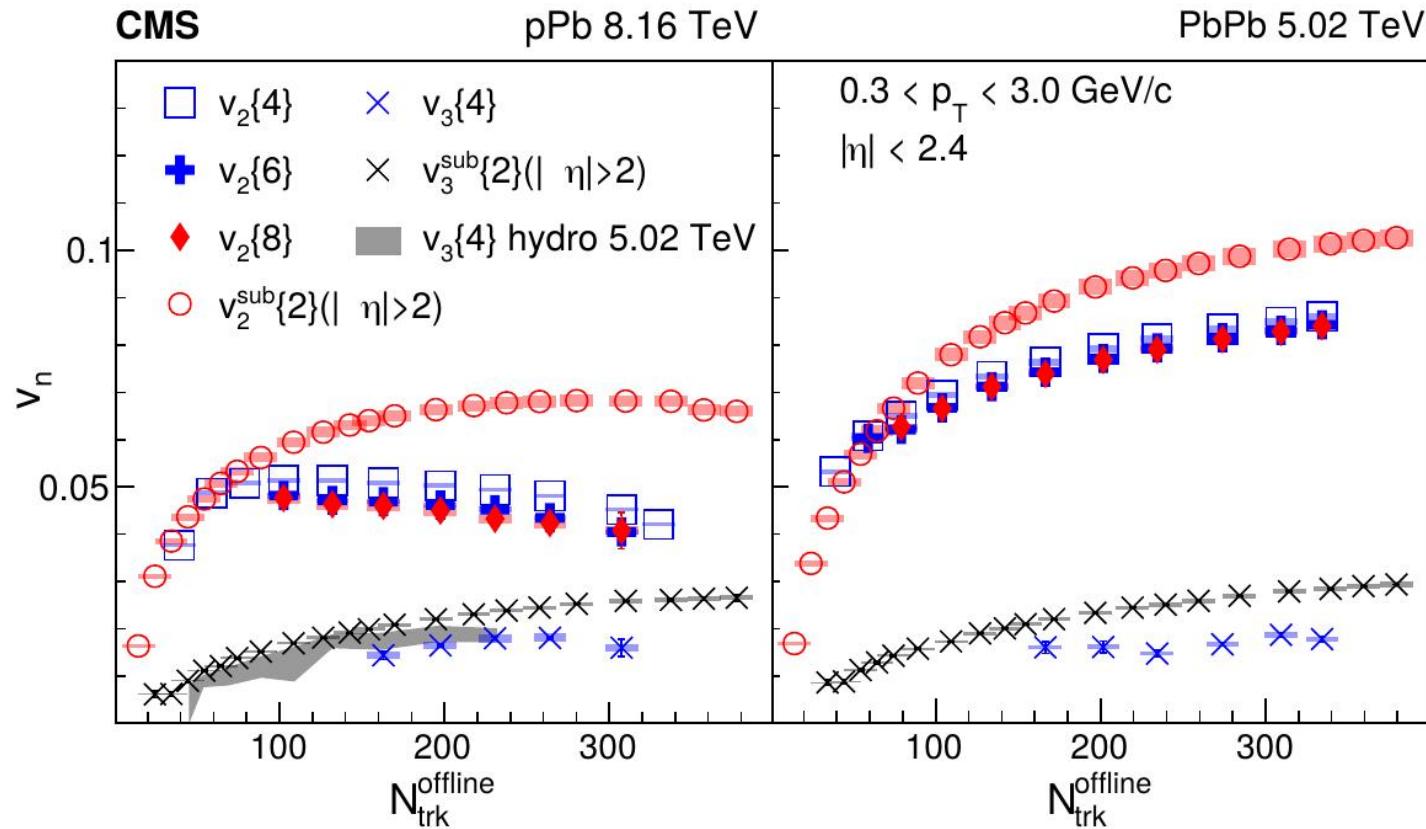
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Dec. 12, 2025, Institute of Modern Physics, Huizhou

Hydro modeling is unreasonably successful

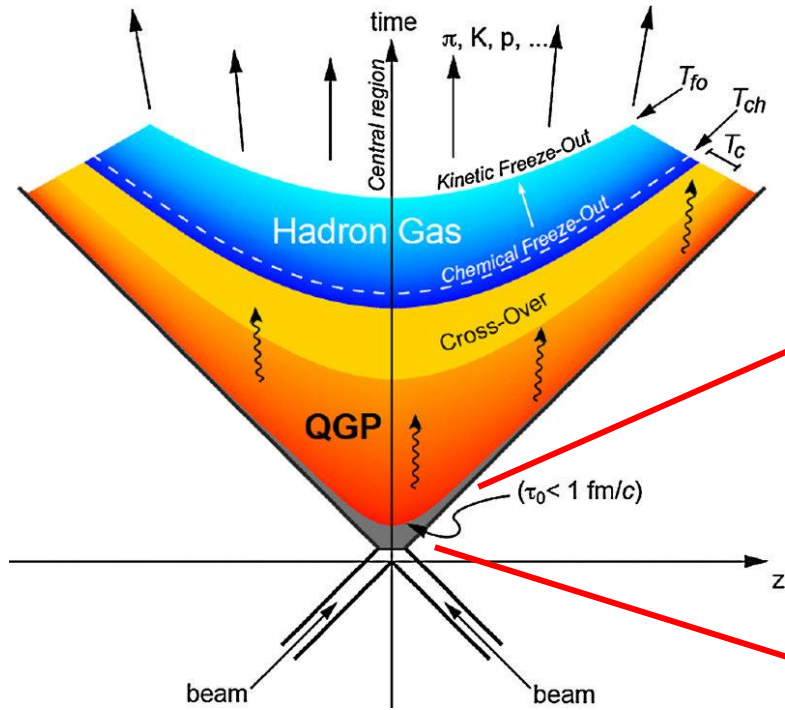
- Multi-particle correlation and collective flow in small colliding systems,



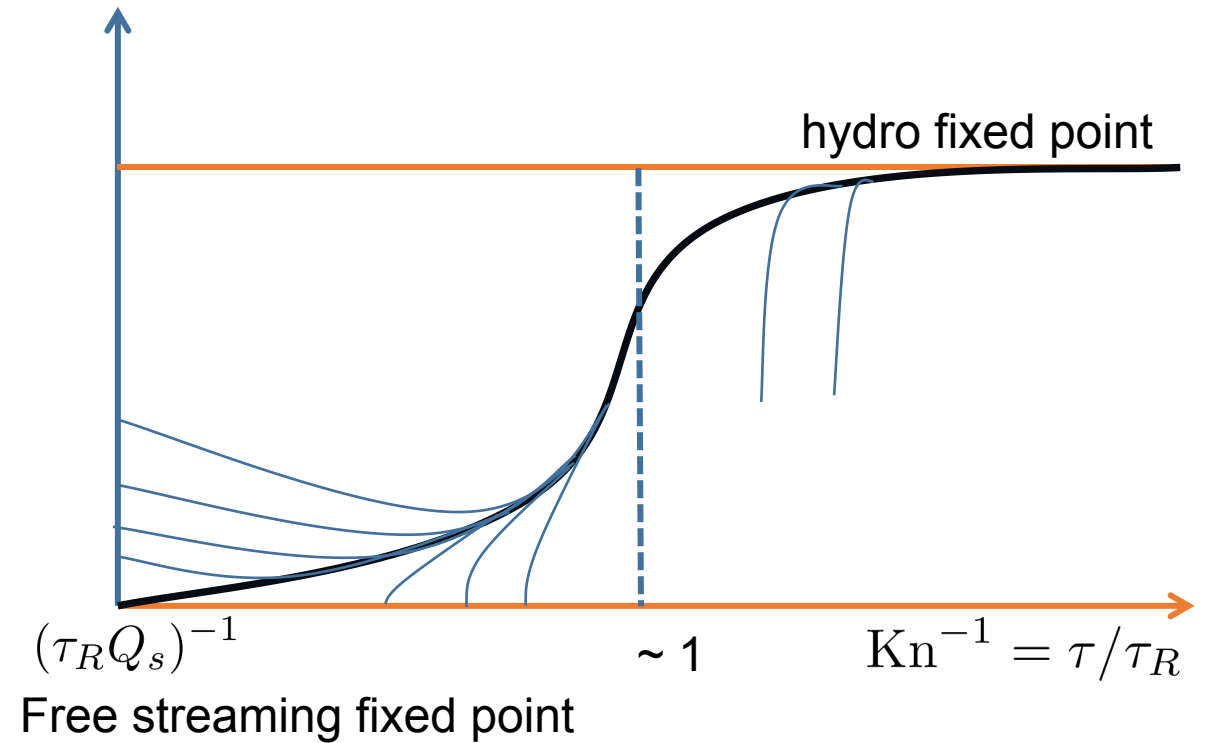
[CMS, 1904.11519]

Out-of-equilibrium QGP in high energy collisions: very early times

[Heller and Spalinski, 2015]

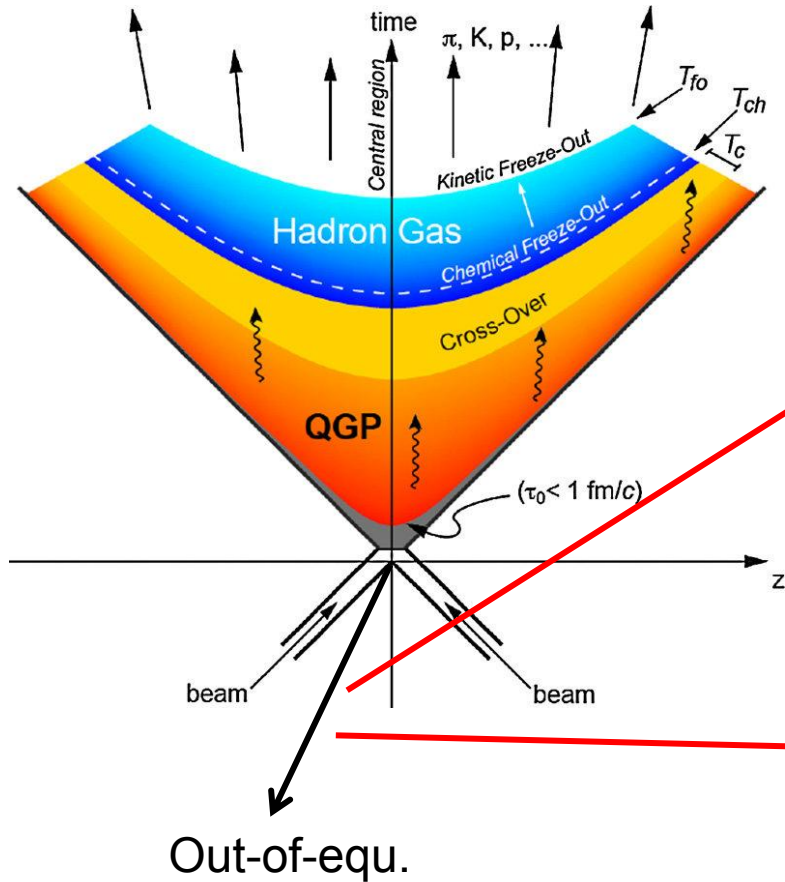


inverse Reynolds number $\sim P/e \sim \partial \ln e / \partial \ln \tau \sim P_L / P_T$

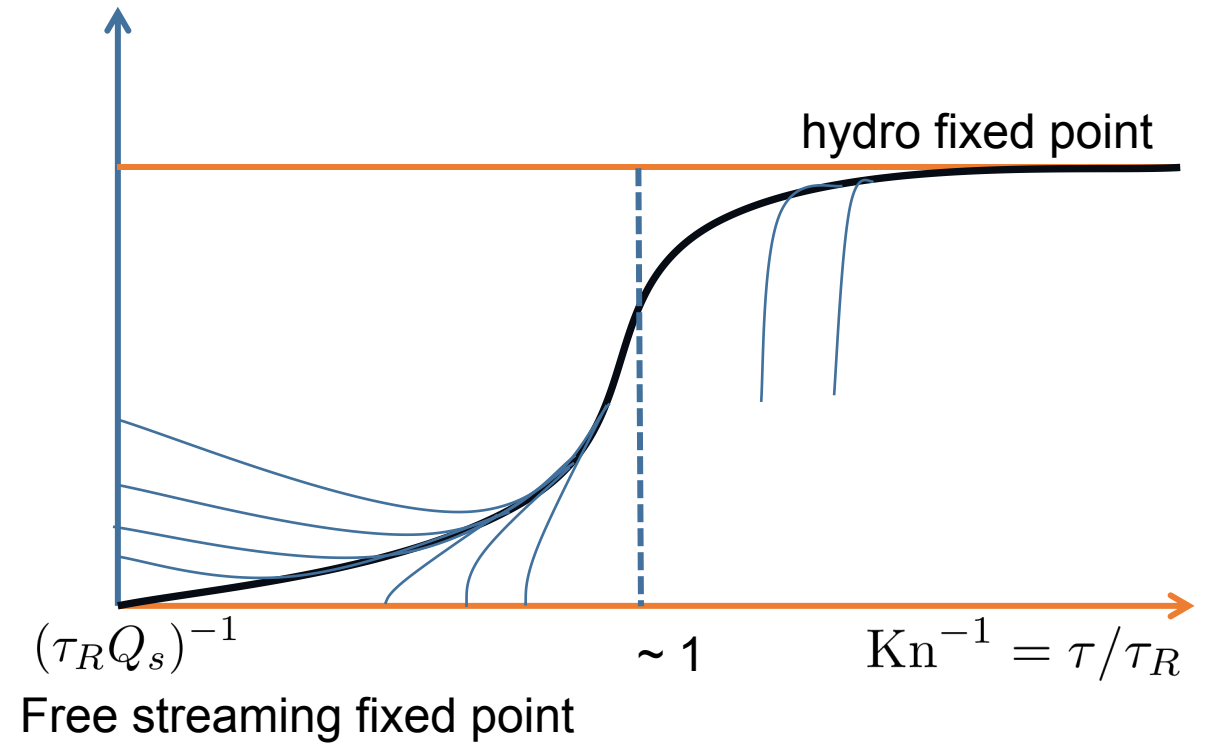


Out-of-equilibrium QGP in high energy collisions: low energies?

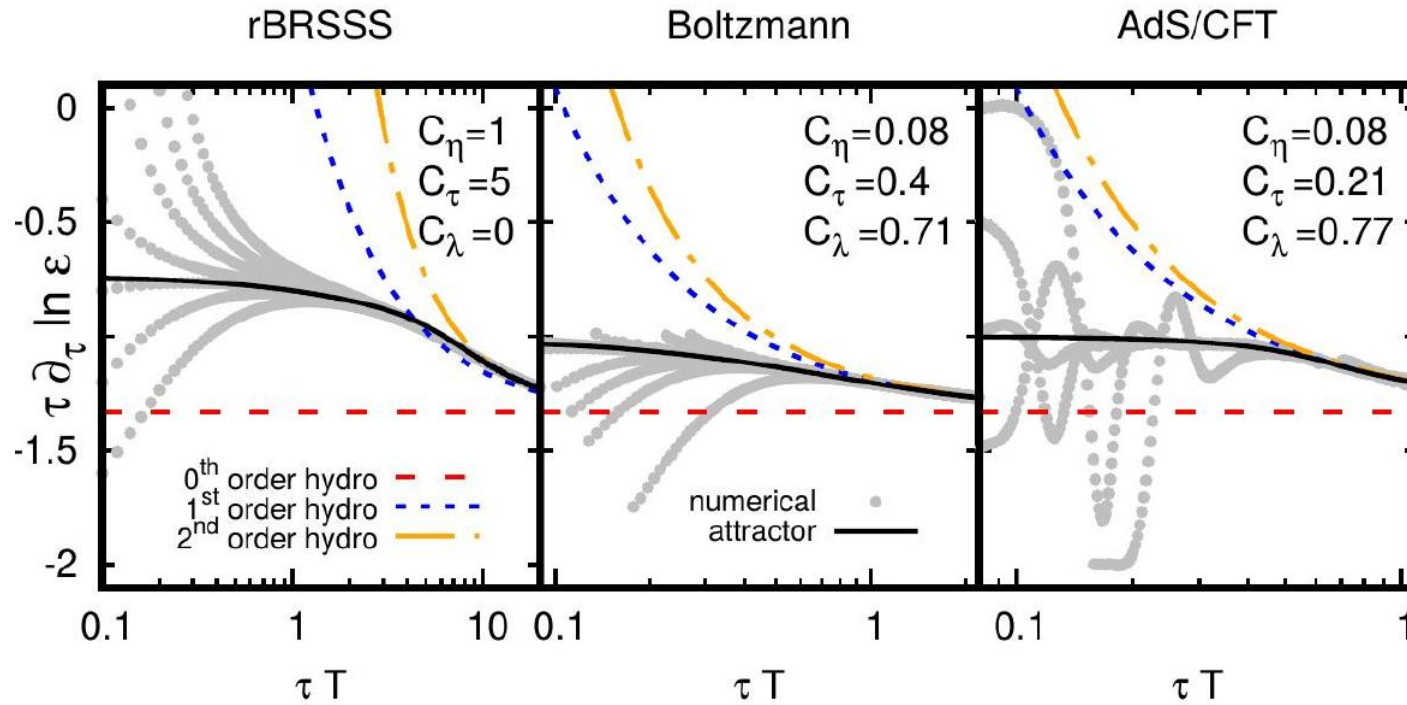
[Heller and Spalinski, 2015]



inverse Reynolds number $\sim P/e \sim \partial \ln e / \partial \ln \tau \sim P_L/P_T$



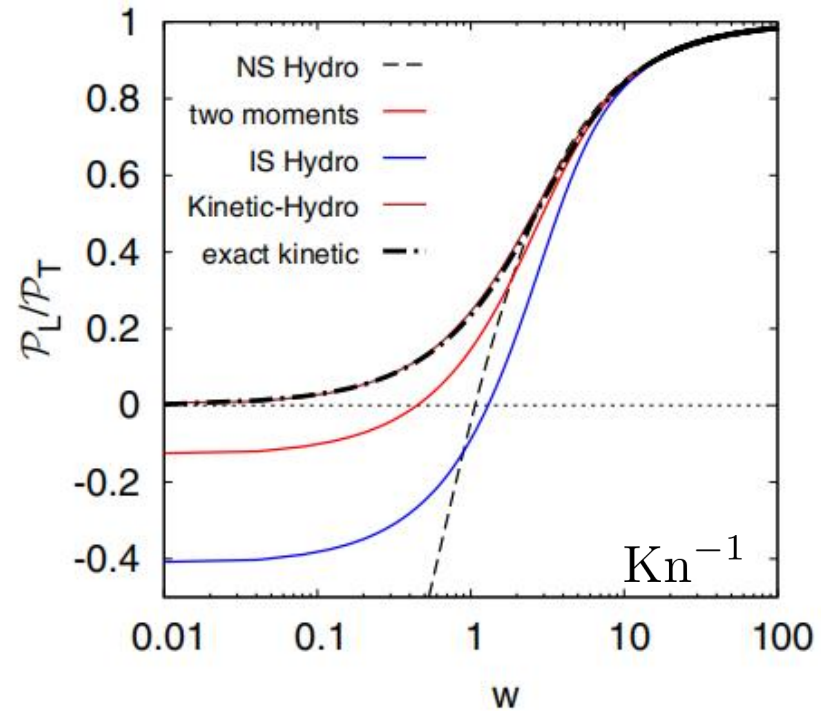
Different types of attractor solutions for out-of-equilibrium system



[P. Romatschke, 2017]

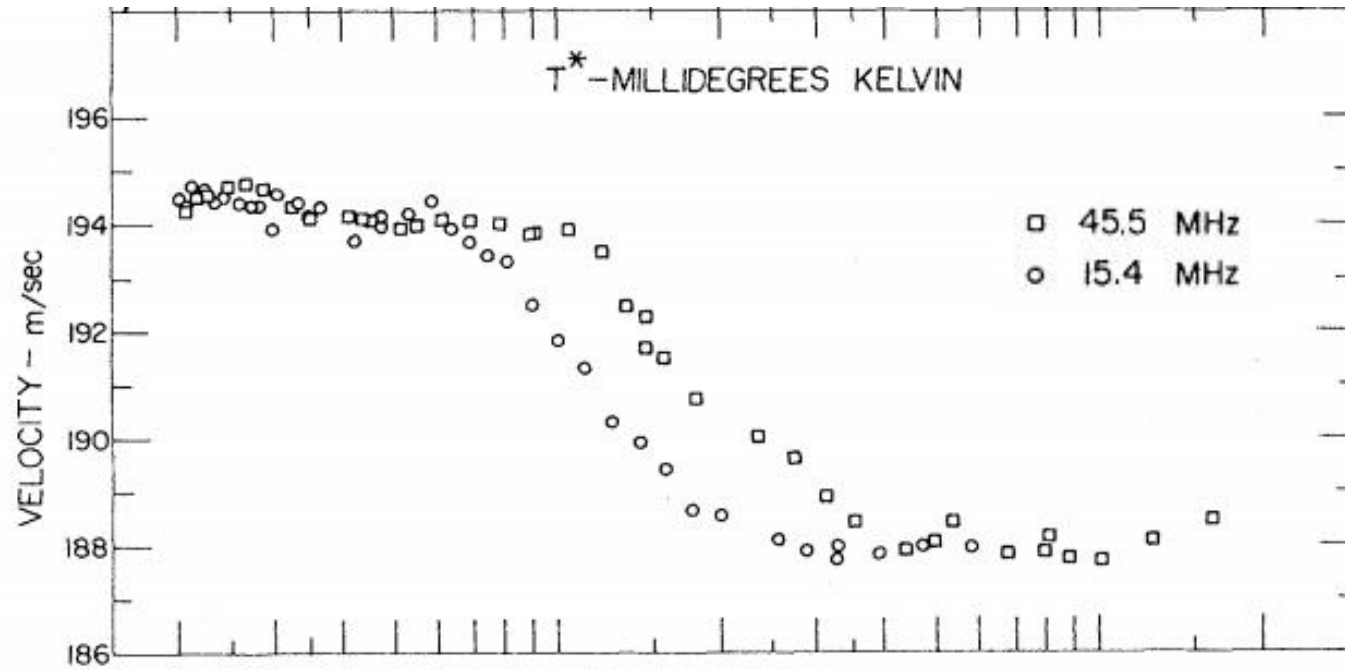
- Characteristics in out-of-equ. dynamics
- Theoretical, no exp. evidence yet.

Renormalization scheme and extended hydro



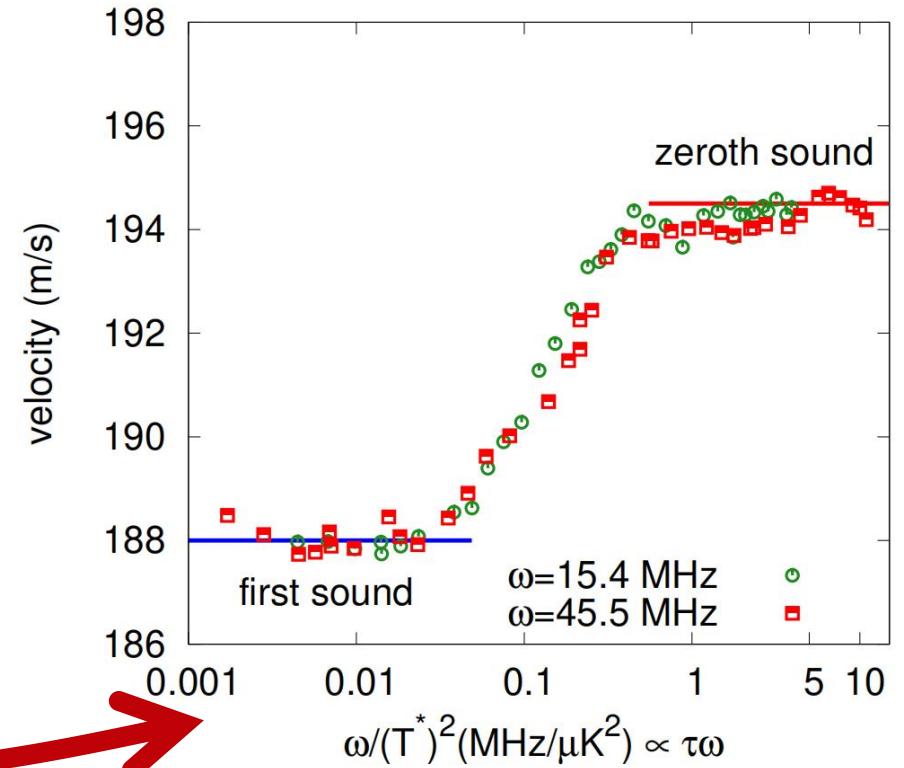
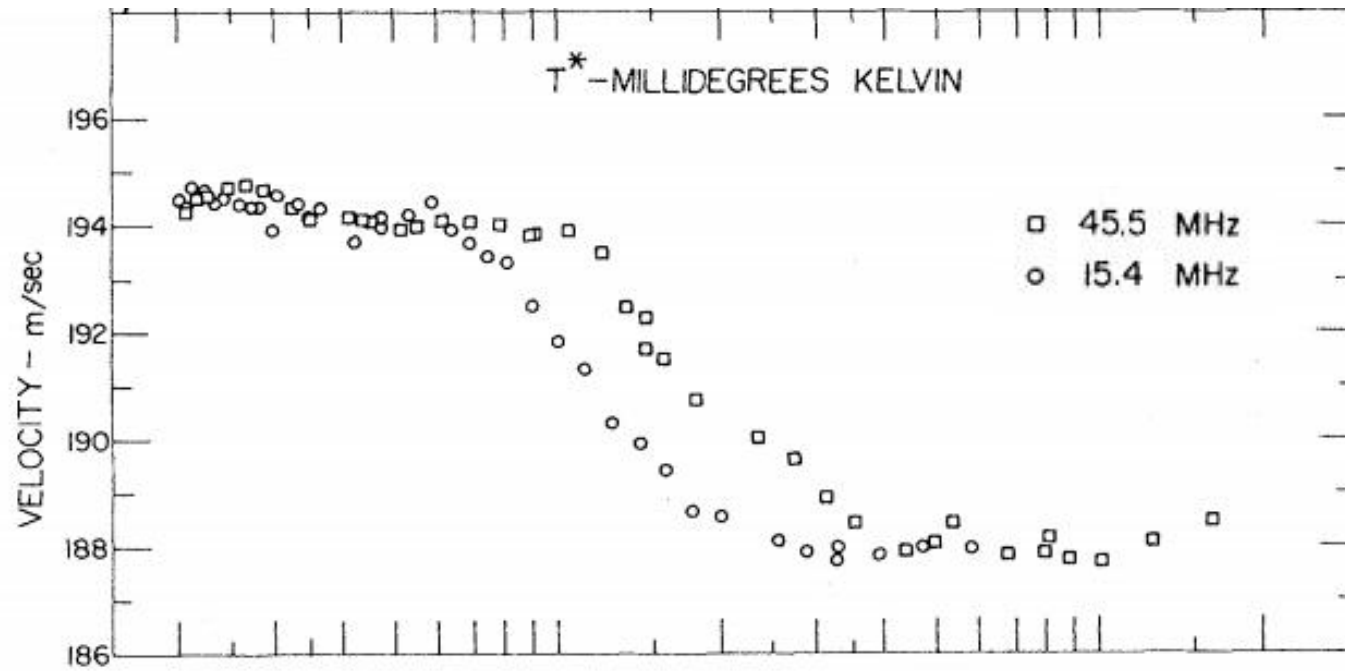
- 2nd order viscous hydro can be extremely powerful.

Two sounds observed in ^3He

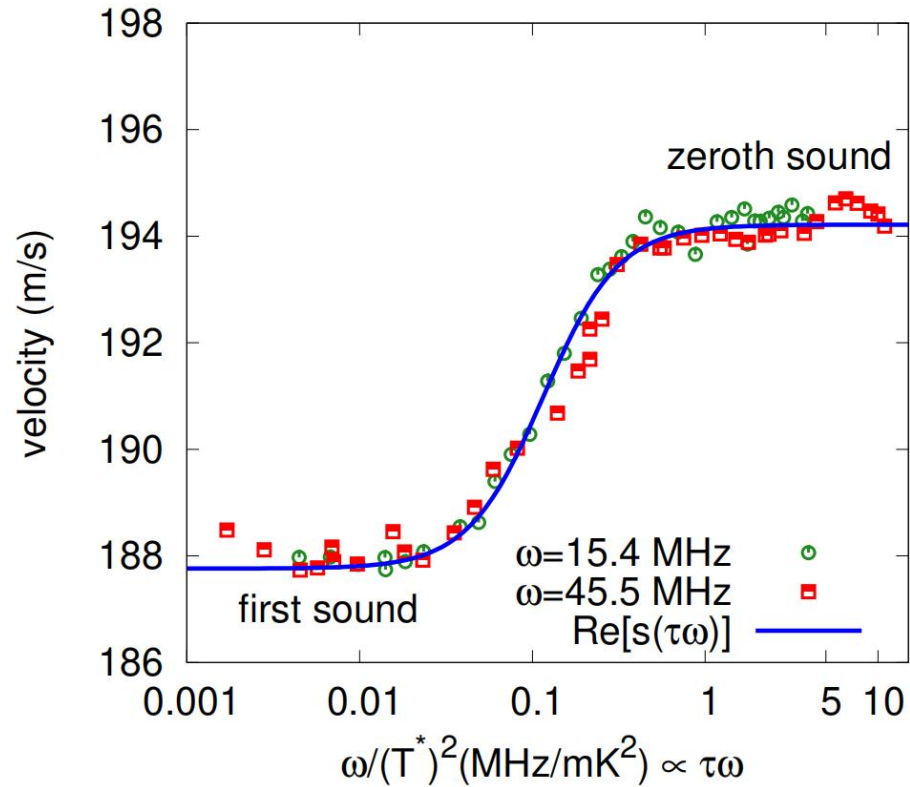


[Phys. Rev. Lett. 17,74 (1966)]

Two sounds observed in ^3He



Propagation between two sounds represents attractor in LFL



Real part of the generalized hydro dispersion

$$\text{Re}[s(\omega\tau)]$$