

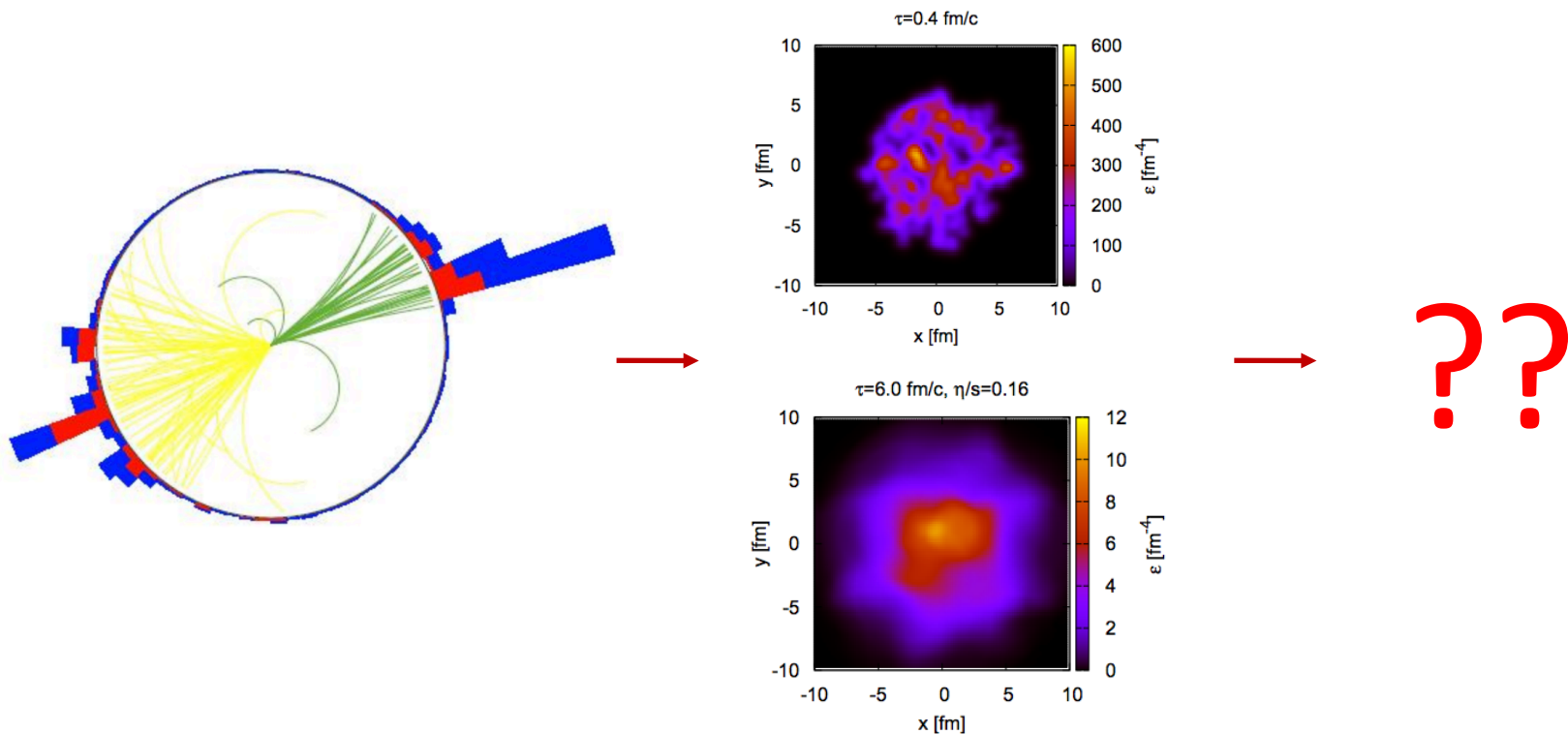
Dynamical medium effects on jet quenching in holography

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Work done in collaboration with
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Want to use jets as a short-distance probe of the QGP



- complicated by the presence of many effects

Many approaches for understanding the modification of jets in medium

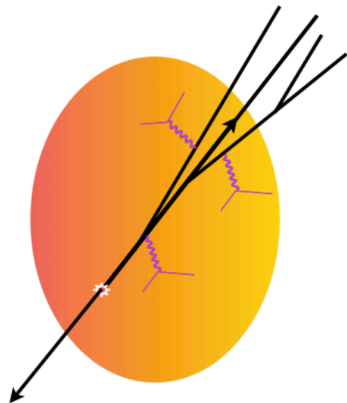
- Perturbative methods (weak coupling; quasi-particle picture of the QGP)
- Jets in holography (infinitely strong coupling, not QCD)

This talk: effects of a dynamical medium on jet energy loss in holography

- Usual assumptions: evolving temperature and zero velocity
- Goal: qualitative lessons to inform other calculations

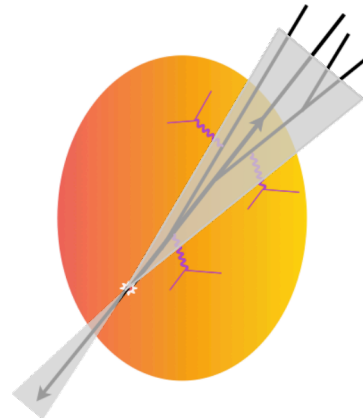
Holographic models of jet quenching

Hybrid model



local parton energy loss
from holography

This work

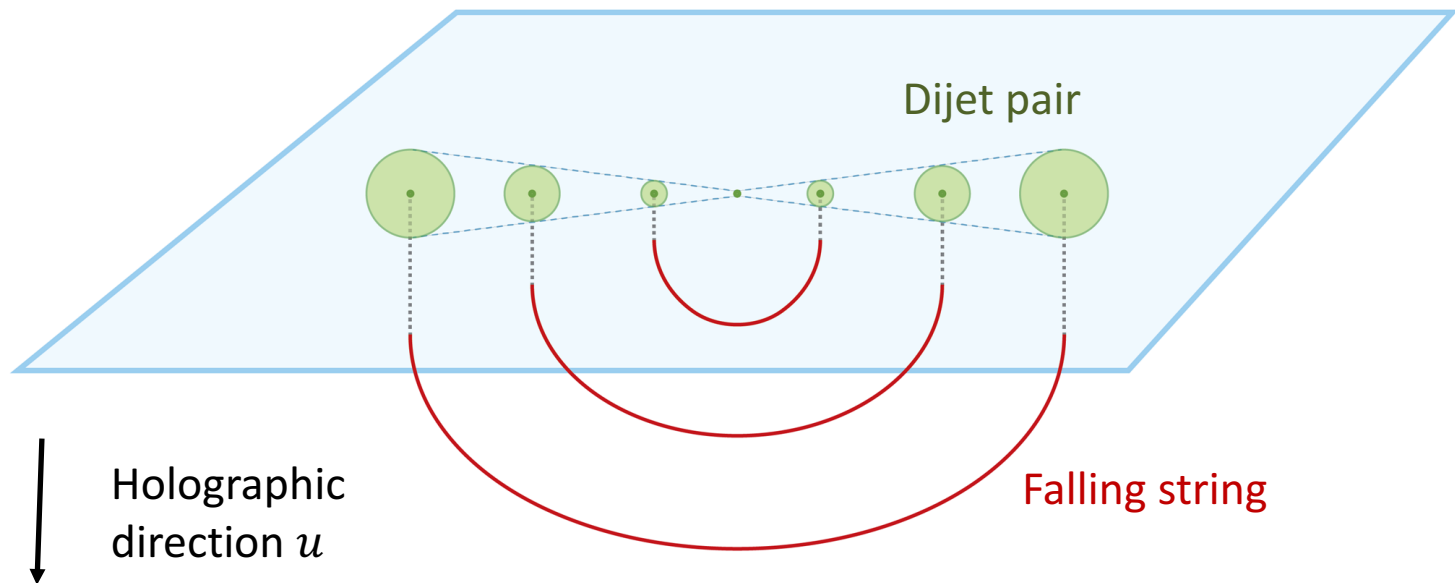


entire jet described
in holography

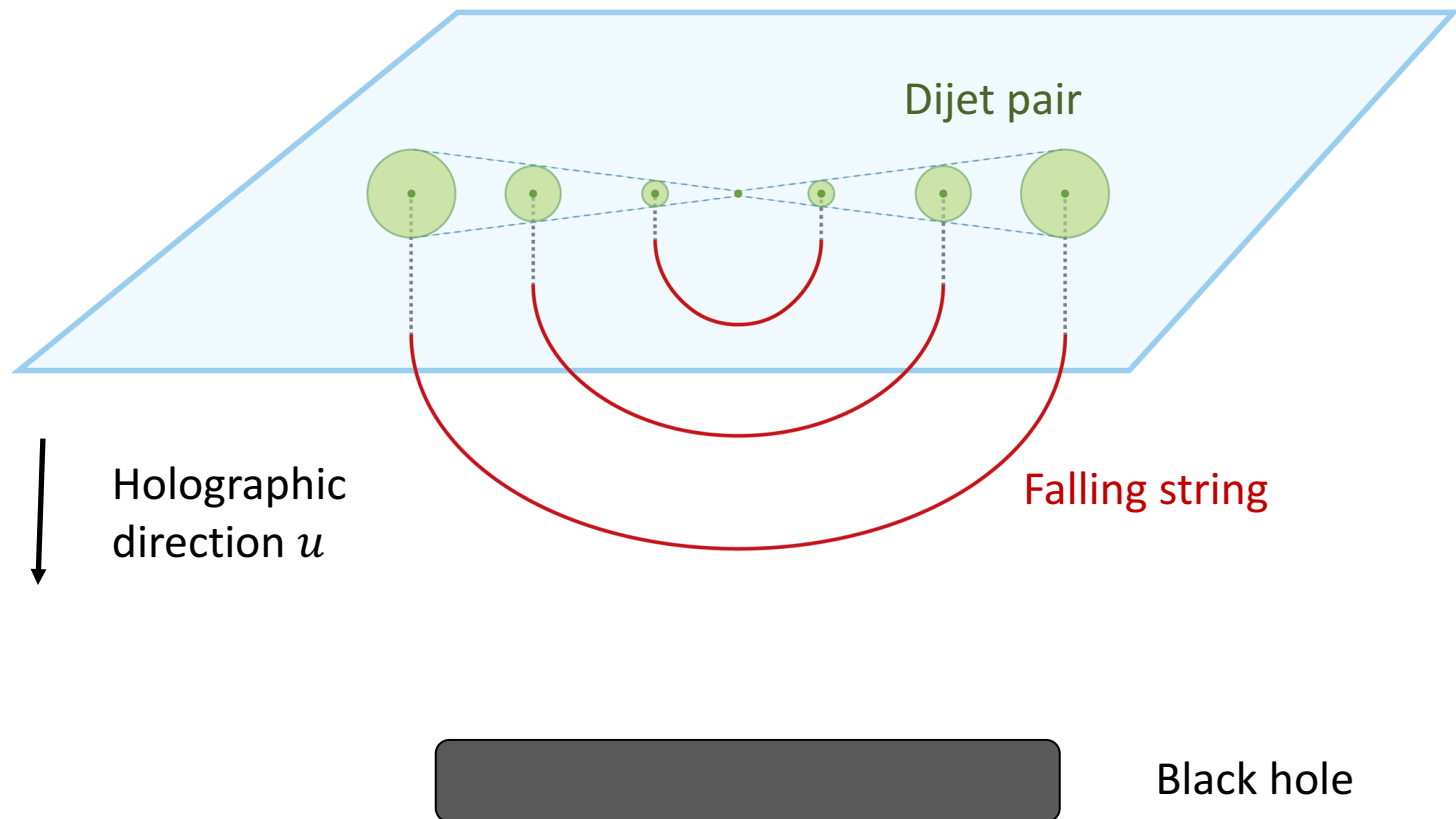
Roadmap

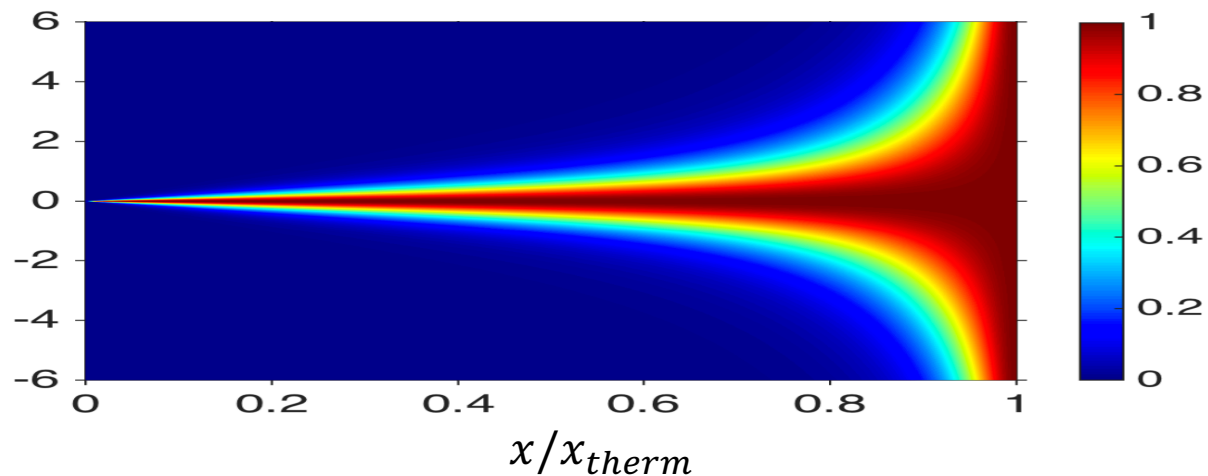
- Introduction to jets in holography
- A simple model of cooling plasma
 - Small fluid gradients can have large effects on dynamics of holographic jets
- Jet energy loss in Gubser flow
 - Effects of velocity can change stopping distance by a factor > 2
 - $E \sim x_{stop}^3$ -- can be a large effect

“Jets” in holography

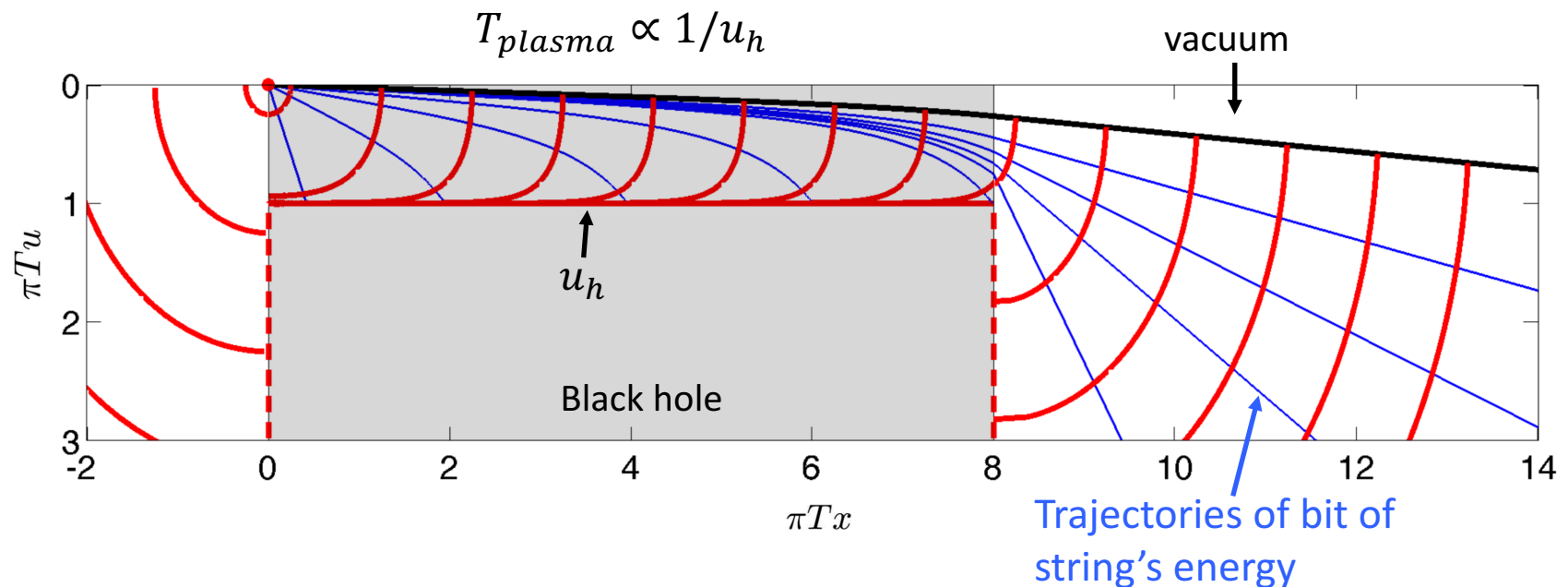


“Jets” in holography

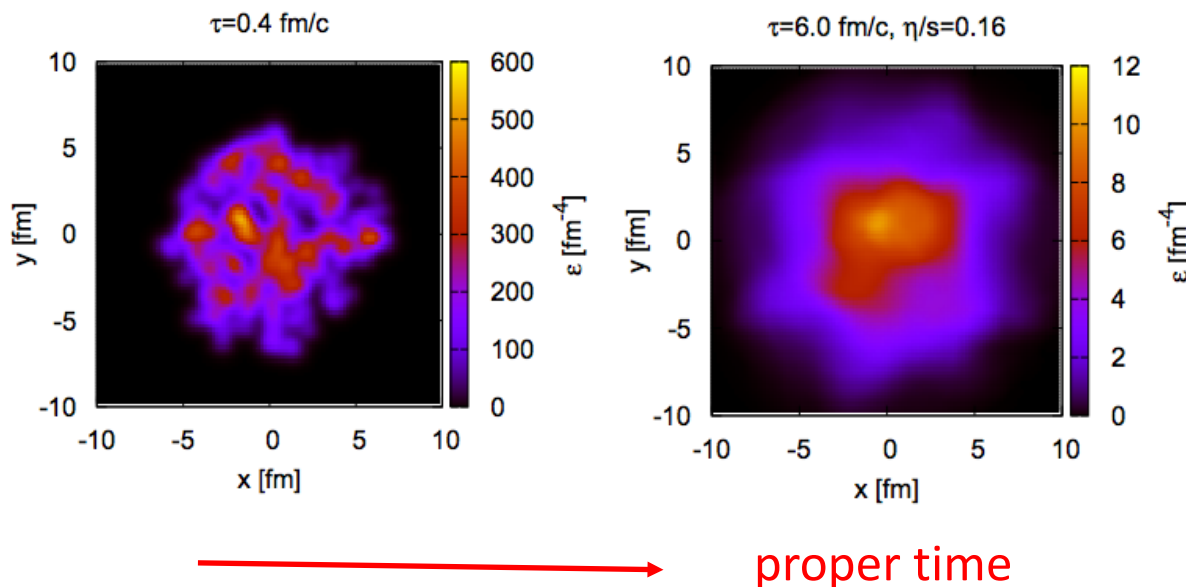




- For a finite-sized plasma, some energy lost, some escapes

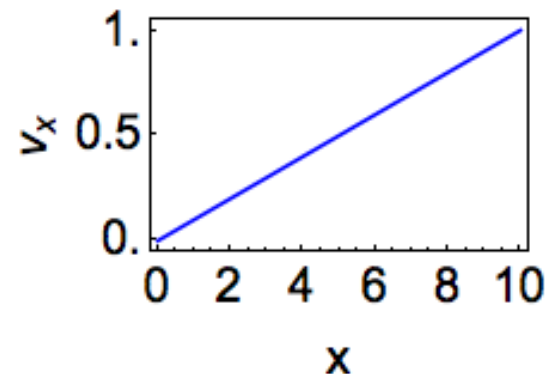
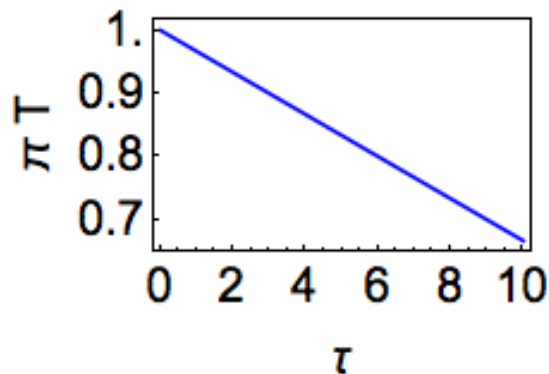


QGP is not a static slab of plasma at all



- Usual assumptions: evolving temperature and zero velocity
- What are the effects of a dynamical medium on jet energy loss in holography?

Simplest non-trivial hydrodynamic profile



Hydrodynamic equations:

$$T^{\mu\nu} = -pg^{\mu\nu} + (\epsilon + p)u^\mu u^\nu + \Pi^{\mu\nu}$$

“u=0”

“ideal”

“viscous”

$$\partial_\mu T^{\mu\nu} = 0$$

- To study jets: couple null geodesics to hydrodynamic evolution

The trajectory of null geodesics are very sensitive to gradients in the hydrodynamic evolution

$$\left. \frac{\partial^2 u}{\partial t^2} \right|_{t=0} = \boxed{-\frac{\partial v_x}{\partial x}} + 2(\pi T)^4 u_{in}^3 + \mathcal{O}(\partial^3) \quad (E_{jet} \sim u_{in}^{-3}) \quad \text{“ideal”}$$

cancels in viscous case

$$\left. \frac{\partial^2 u}{\partial t^2} \right|_{t=0} = 2(\pi T)^4 u_{in}^3 \left(1 + \mathcal{O} \left(\frac{1}{\pi T} \frac{\partial v_x}{\partial x} \right) \right) + \mathcal{O}(\partial^3)$$

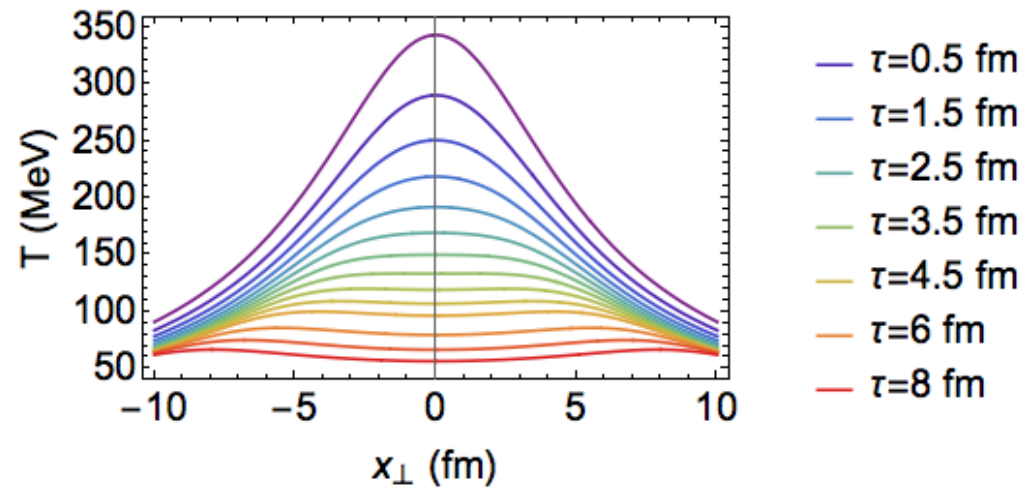
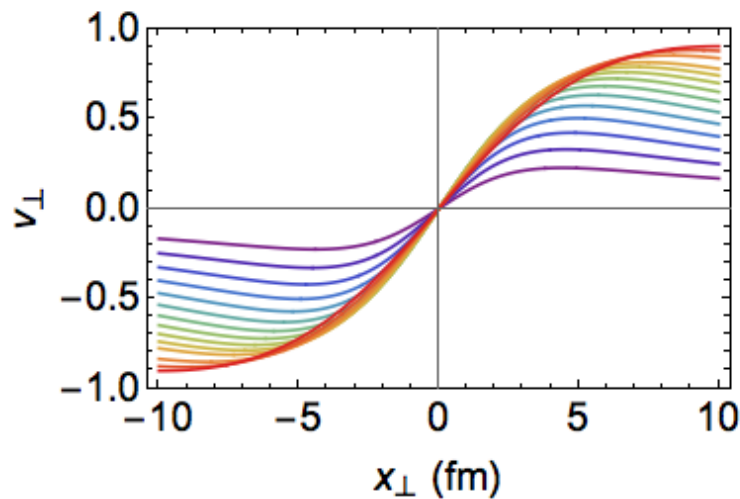
“viscous”

- Even for fairly small gradients, geodesics in ideal hydro are sick, since $\pi T u_{in} \sim 0.01$

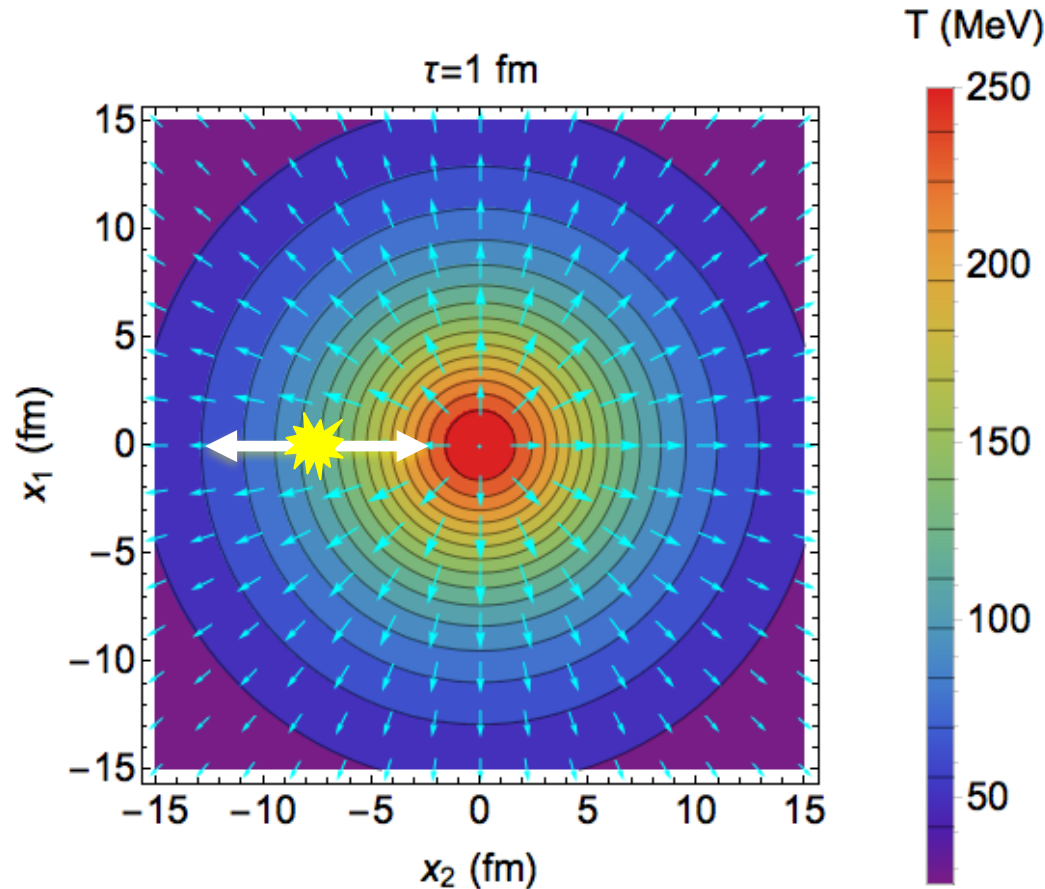
QGP is not a static slab of plasma or a simple system

- What are the effects of a dynamical QGP-like medium on jet energy loss in holography?

Example: Gubser flow

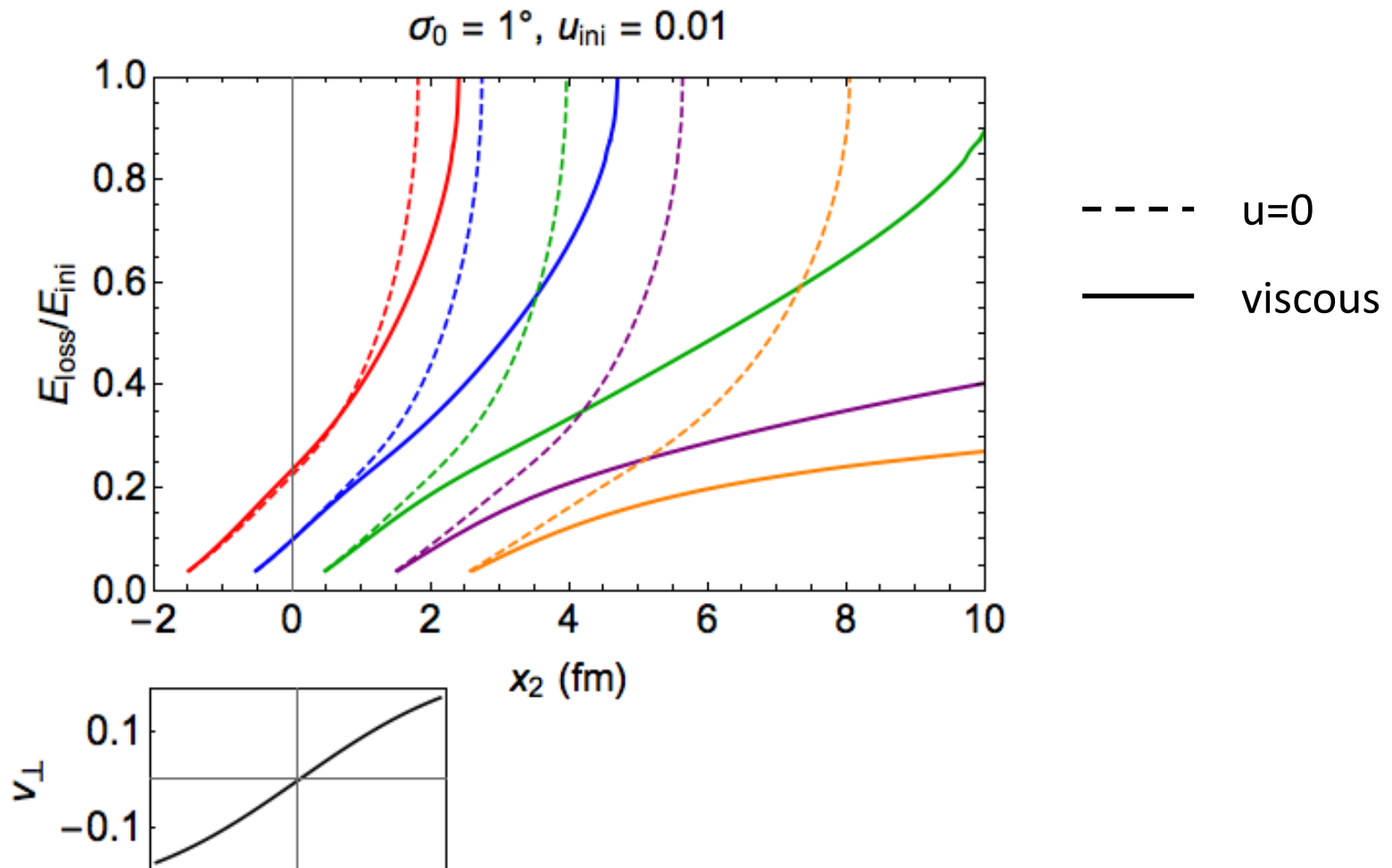


Jets starting at different points in the transverse plane experience different velocity field



Gubser flow

- Velocity gradients in a holographic picture have a large effect on energy loss



Wrap-up

- Velocity gradients in the fluid can have a large effect on the quenching of holographic jets
- For Gubser flow, including the effects of velocity gradients significantly decreases energy loss
- Outlook: can this kind of effect be seen in other models?