

Emergence of Hot and Dense QCD in Small systems



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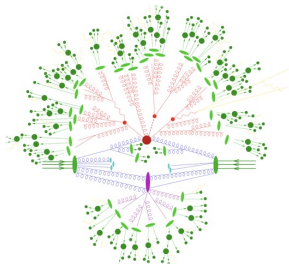
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- ▶ RHIC/LHC probe QGP
with increasing detail
- ▶ This with fluid dynamical
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⇒ nearly perfect fluid

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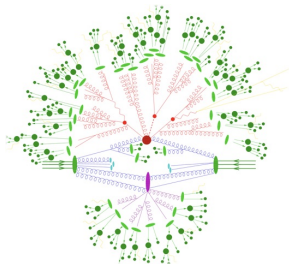


- ▶ No *final state interactions*: free streaming

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Goals for the coming years:

- ▶ Further characterisation of the fluid properties
 $\eta/s(T), \zeta(T), \hat{q} \dots$
- ▶ How does the nearly perfect fluid arise from the fundamental interactions of the medium constituents?

What is the microscopic structure of QGP?

Inner workings of QGP:

- ▶ Fluid dynamics is an effective description valid at scales
length, time, 1/energy

$$l \gg l_{\text{micro}}$$

- ▶ The search for structure is search for the scale l_{micro}
- ▶ Perfect fluid is fluid without microscopic length scale \Rightarrow structure lies beyond perfect fluid paradigm

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- ▶ Structure where hydrodynamical paradigm is strained:
 - ▶ Hydrodynamization as function energy scale:
Jet thermalization, jet modification

 - ▶ Hydrodynamization as function of time:
Pre-equilibrium evolution

 - ▶ Hydrodynamization as function of size:
Small systems

Open questions:

Observation of collectivity in small systems challenges both the perfect fluid and free streaming paradigm.

Questions:

- ▶ To what extent the signs we have taken as sign of perfect fluidity are unique to perfect fluid?
AMPT: large v_2 from the first scattering, strangeness enhancement from DIPSY
- ▶ Is there perfect fluid present in MB pp collisions?
~ "hydro" solution
- ▶ Are there mesoscopic systems with only few final state interactions?
~ "escape" solution
- ▶ Is the physical origin of collectivity the same in small and large systems?
~ "initial state/CGC" solution

Theory status and implications

Several theoretical models available:

Weak coupling: CGC, AMPT, BAMPS, ...

Strong coupling: AdS/CFT, ...

Phenom. transport: ITA

pp-string: DIPSY, Angantyr, ...

- ▶ All models limited
- ▶ To what extent model independent questions can be asked?
 - ▶ What are jets recoiling against? Are there quasiparticles?
 - ▶ Can mean free path be measured l_{mfp} ? Energy dependence?
 - ▶ Relation of jet energy loss and v_n 's

Need for both pPb and pp?

- ▶ pPb bridges multiplicity between pp and PbPb
- ▶ pp as a baseline for pPb
- ▶ For fixed multiplicity, different geometry. Test “universality”
- ▶ May be used to reduce modelling uncertainty of UE

Multiplicity good measure only if unbiased

e.g. color reconnection uncertainty for top mass

Observables: Maxime...