Attractors In Relativistic Viscous Hydro

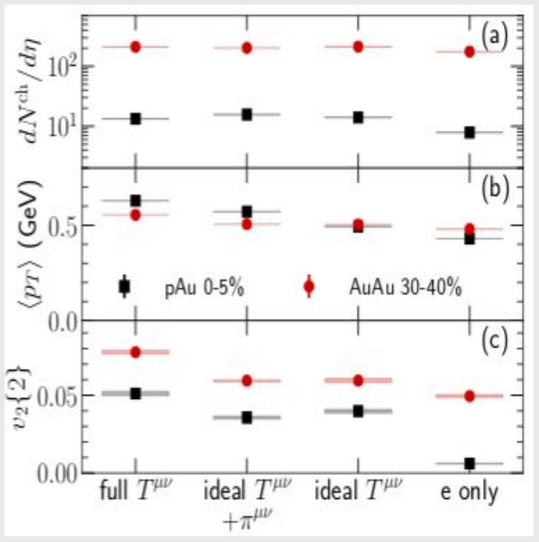
T. Dore[1], *J. Noronha-Hostler*[1]

University of Illinois at Urbana-Champaign[1]

FUNDED BY US-DOE
DE-SC0019175

Importance of Initial Conditions

- **Fast Equilibration Problem**
- **Initial state captures important physics**
- **A full $T_0^{\mu\nu}$ can drastically change observables in small systems**[1]
- **How might the full $T_0^{\mu\nu}$ at BES energies affect $T-\mu_B$ trajectories?**
  - ***Important implications for critical point search***



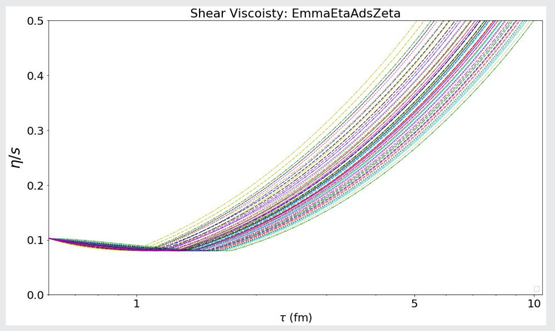
Hydrodynamic Equations

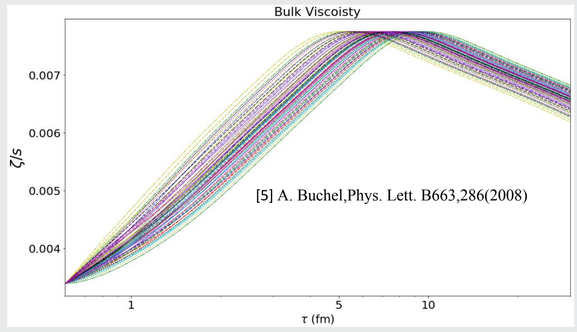
Bjorken Symmetric Expansion

$$\dot{\epsilon} = -\frac{\epsilon+p+\Pi+\pi}{\tau} \qquad \dot{\rho} = \frac{\rho_0}{\tau}$$

$$\tau_\pi \dot{\pi} + \pi = -\frac{4\eta}{3\tau} - \frac{1}{\tau}\left(\left(\frac{4}{3}+\lambda\right)\pi + \frac{2}{3}\lambda_{\pi\Pi}\Pi\right)$$

$$\tau_\Pi \dot{\Pi} + \Pi = -\frac{\zeta}{\tau} - \frac{1}{\tau}\left(\delta_{\Pi\Pi}\Pi + \frac{2}{3}\lambda_{\Pi\pi}\pi\right)$$





Attractors

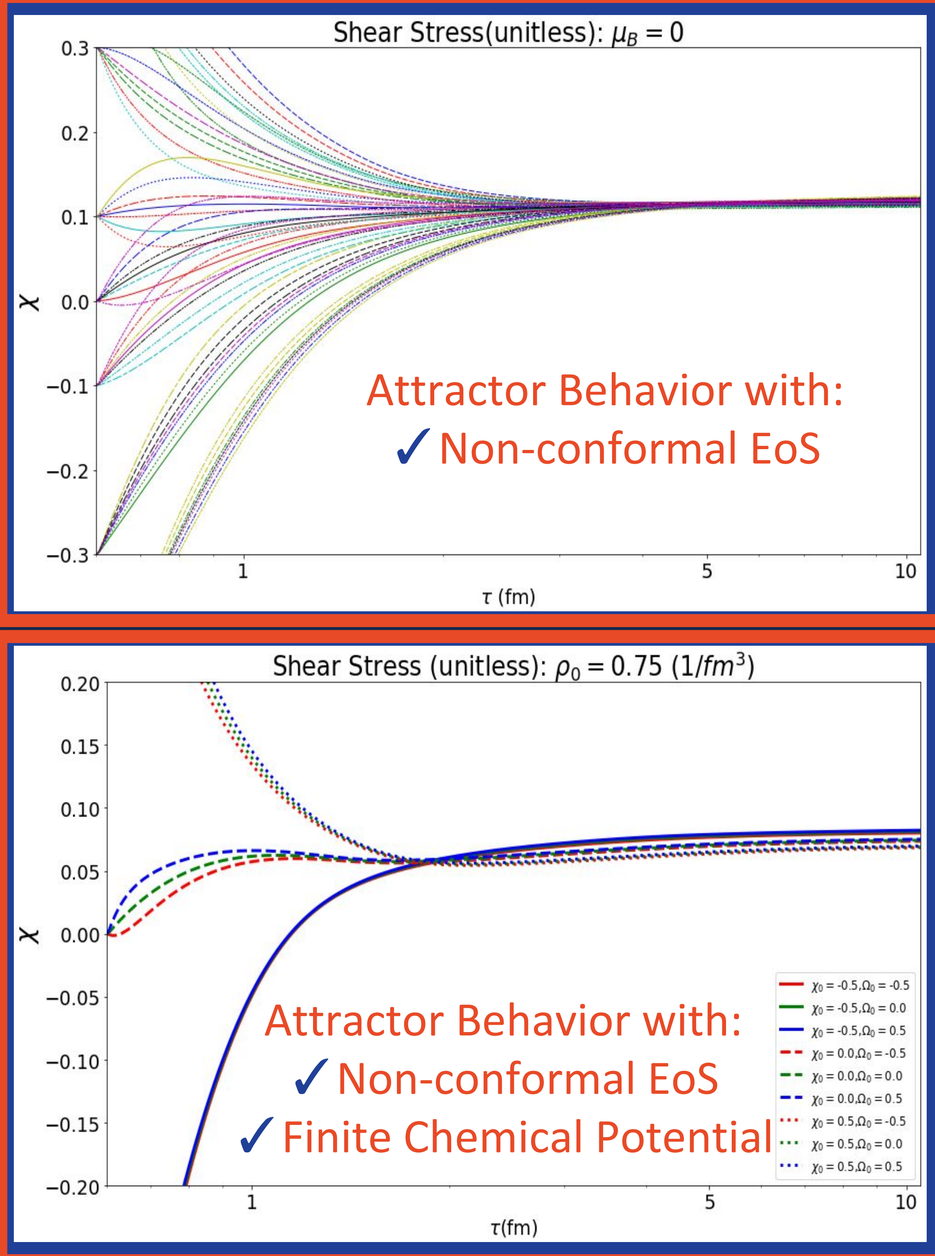
Equation of State

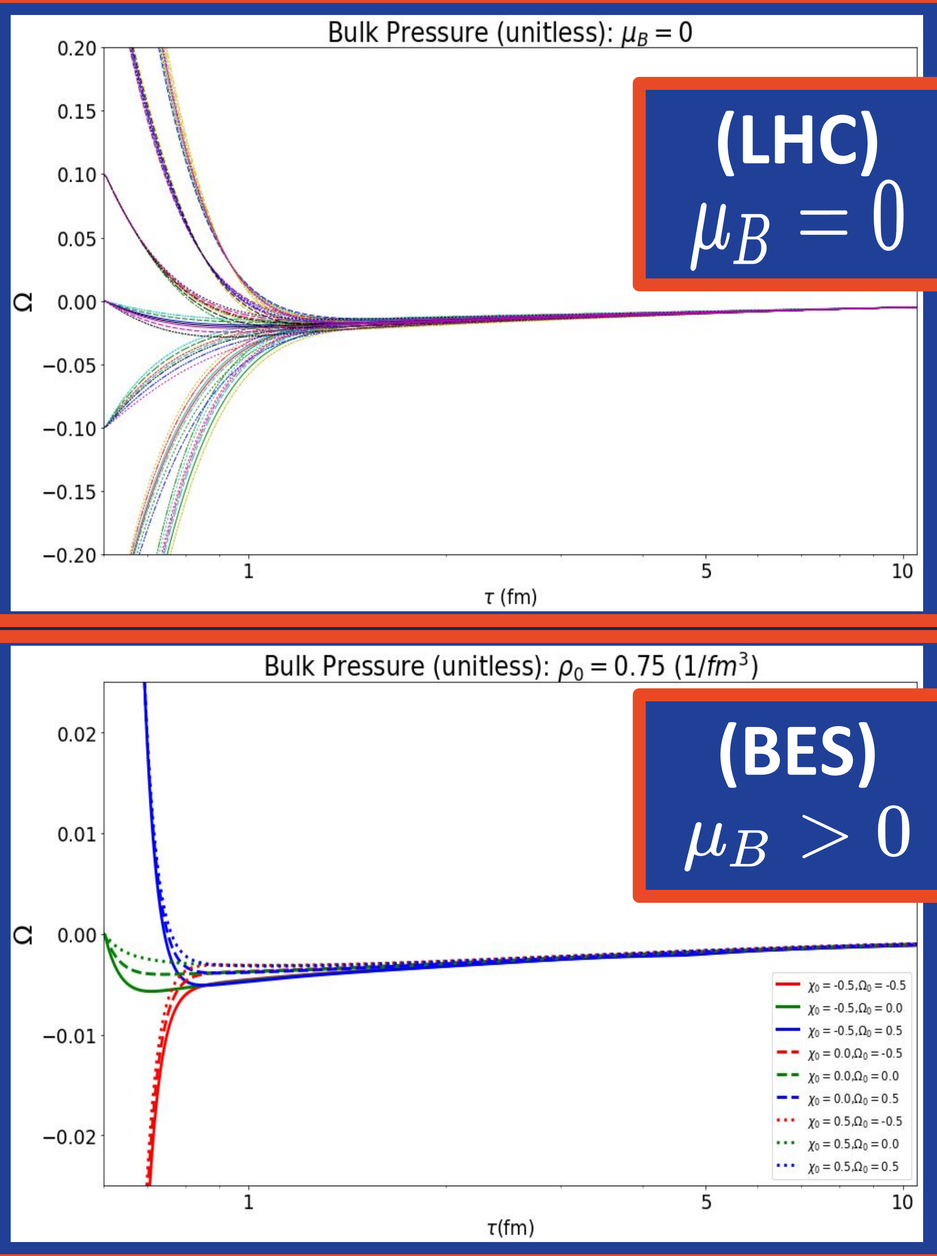
Needed to close hydrodynamic eqn's

- BEST Collaboration EoS[2]
- Taylor expansion in T/μ_B
- 3D Ising contribution in critical region

Working Definition

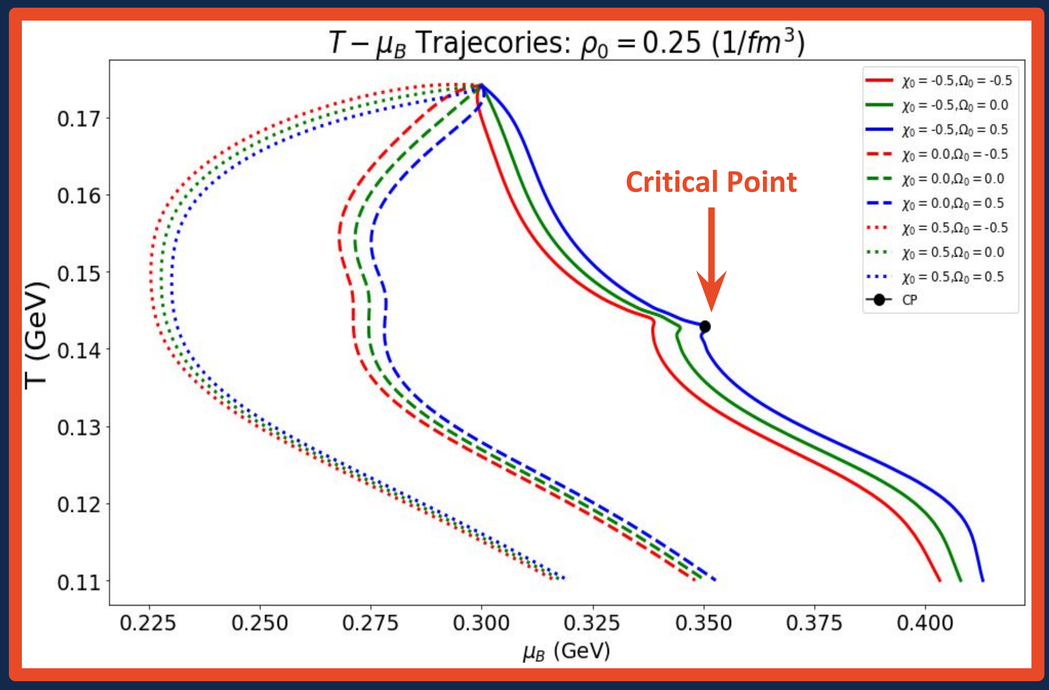
There exists an attractor if, after some finite amount of time, solutions converge on to a non-trivial, universal curve.





Conclusion/Outlook

- **Attractor behavior found to be still present after relaxing assumptions of previous work (see also [3][4])**
- **Important implications for critical point search and answering initial state questions (i.e. fast equilibration problem)**
- **Future: include hydrodynamic critical fluctuations, implement BSQ EoS into (2+1) hydro**



- **Trajectories in the Temperature-Chemical Potential plane can vary wildly with initial conditions**
- **Indication that critical point can be found with lower initial baryon densities**
  Important for BES

References

[1] B. Schenke, C. Shen, P. Tribedy, arXiv:1908.06212v1 , [2] Parotto et al, arXiv:1805.05249v1,
[3] Gabriel S. Denicol and Jorge Noronha, Phys. Rev. D 97, 056021, [4] Romatschke, P. J. High Energ. Phys. (2017) 2017: 79,
[5] A. Buchel,Phys. Lett. B663,286(2008)