

Heavy Ion Collisions with *Trajectum*

Luen Malshi

January 26, 2022

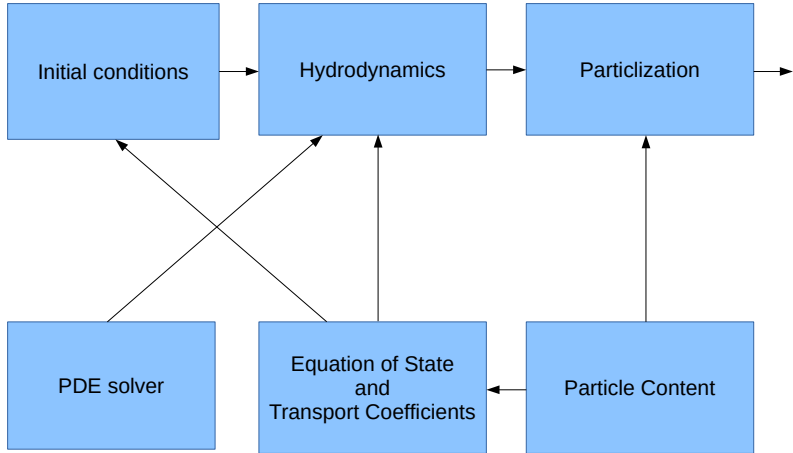
Multiple Uncertainties in the Quark Gluon Plasma Models

- Current heavy ion collisions model results in a pre-hydrodynamic phase and a relativistic hydrodynamic phase called Quark Gluon Plasma.
- Relies on early description as strongly interacting fluid described by hydrodynamics.
- Needs initial energy profiles and fluid velocity.
- Different models with different uncertainties.

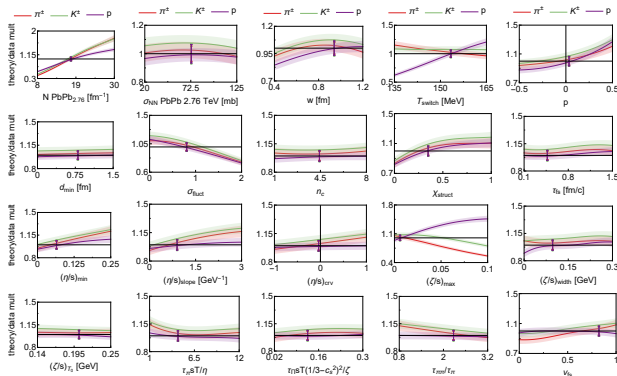
Trajectory Provides Flexible Framework Incorporating Multiple Models

- There exist multiple modelling computational tools that describe each phase of heavy ion collisions.
- *Trajectory* provides a flexible base for global analysis.
- Existing computational models for each phase are incorporated and can interact with each other in various combinations according to user's selection
- Enlarged model: 20 total parameters.

Trajectum Incorporates and Facilitates Information Flow Between Existing Models for Each Component



Experimental Data and Closure Tests validate *Trajectum*



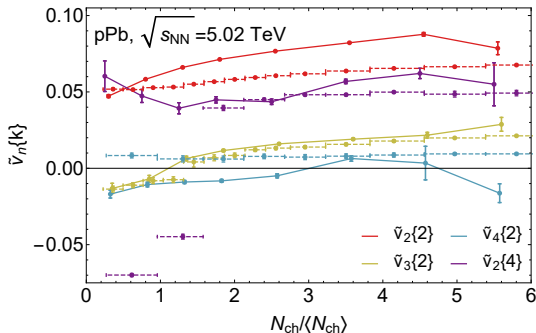
- Experimental Tests: Check observable dependencies on a parameter

- Closure Tests: Parameters \rightarrow Model \rightarrow Parameters

[Nijs, Van der Schee, Gürsoy, Snellings, 2020]

Anisotropic Flow Coefficients as a Function of Centrality

- Pb - Pb collisions
- Study anisotropy of particles in final state.
- Evaluate integrated flow coefficients as a function of centrality.
- Focus on why $\tilde{v}_3\{2\}$ changes sign.



[Nijs, Van der Schee, Gürsoy, Snellings, 2020]

The Submit Cluster is Used to Generate Events

- Need to generate millions of events to compute and analyze observables.
- Storage space is needed for the data from collision simulations.
- Submit cluster helps generate events in a time efficient way and provides space for stored data to be analyzed.

Submit Cluster Used for Multiple Other Studies with *Trajectum*

- Can explore how well different models describe each phase of QGP
- Study sensitivity of models to parameter values
- Explore QGP in proton ion collisions.
- Helps gain insight in the simplest form of complex matter and into strong coupling.