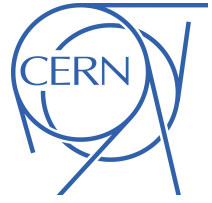
Phenomenological computing

Korinna Zapp

LIP (Lisbon) & CERN



Soft physics

Motivation

- extract material properties of strongly interacting matter
- understand equilibration in QCD

State of the art

- simulation chain:
  - initial condition
  - \+ 3+1 D viscous hydro
  - \+ freeze-out
  - \+ hadronic afterburner
- event-by-event

Challenges

Is a quasi-particle description with finite mean free path conceivable?

- requires major developments in kinetic theory phenomenology
- study correlations

Hard physics

Motivation

- gives access to scale dependence of QGP properties
- allows to observe process of equilibration

State of the art

What is needed to model jet shapes/sub-structure:

- vacuum baseline: jet production + evolution
- \+ radiative energy loss
- \+ collisional energy loss + medium response

State of the art

- separation between jet and background ambiguous
- need unification of jet and background modeling

Small systems

Motivation: the big surprise

- soft particle production in high-multiplicity p+p and p+A closely resembles A+A
- but jets seem to be unmodified
- challenges our understanding of p+p and A+A collisions

State of the art

- heavy ion models applied to p+p
- extensions of soft QCD models in p+p

Challenges

- understand jet quenching in small systems
- smoothly interpolate between small and large systems
- unification of modeling of soft and hard physics

Phenomenology tools

- hydro codes

  VISHNU, ECHO-QGP, MUSIC, Hirano, Romatschke, HYDJET, ...
- kinetic theory/transport

  AMPT, BAMPS, LBT, ...
- jet quenching models

  Q-PYTHIA/Q-HERWIG, HYDJET++/PYQUEN, MARTINI, JEWEL, hybrid model, LBT/coLBT, ...
- building A+A from N+N

  HIJING, ANGANTYR
- improvements & extensions of soft QCD models in p+p

  rope hadronisation (PYTHIA/DIPSY), string hadronisation (PYTHIA), SHRiMPS (SHERPA), ...

$\mathcal{O}(100 - 200)$ people worldwide

Phenomenology trends

Increasing complexity

- physics: models have to encompass many different aspects of HIC
- needed: collaboration with different communities jets, hydro, p+p, ...
- needed: collaboration between theorists and experimentalists
- computational demands (cpu & storage) increase

Organisation of efforts

- traditionally: models developed by many small groups
- support and maintenance of public codes bind resources
- group size limits possibilities of diversifying expertise

$\Rightarrow$ Cannot be scaled up to challenges of next decade.

Phenomenology needs

- richness in concepts, methods and tools is worth preserving
- divide and conquer: future success depends on clever division of work
- helpful would be a structure to
  - standardise and centralise repetitive elements
  - develop common event formats — e.g. HepMC
  - develop and support common analysis framework — e.g. Rivet
  - enhance collaborations between groups
  - support publication of tools
  - create platform for sharing of results, tools, event files, ...
- currently such a support structure is missing in Europe
- community efforts without significant funding

Lisbon accord, TH Institute, workshops