Jet evolution in a dense QCD medium

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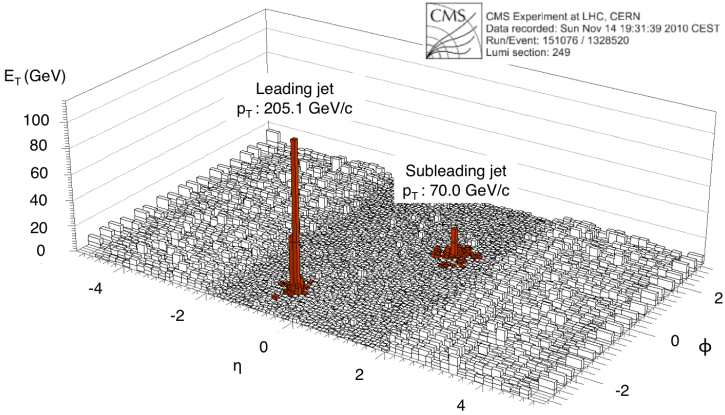
- *the medium: a quark gluon plasma created in a heavy ion collision*
- *the jet: a collimated spray of particles generated via successive branchings of a parton with high energy produced in the collision*

Structure of presentation:

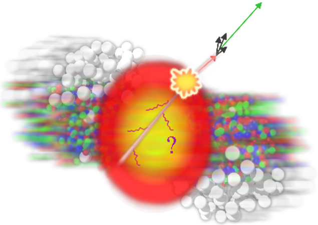
- Context
- Physics
- Stochastics
- Numerics

Heavy ion collisions, quark gluon plasma and jets, what we observe:



Di-jet asymmetry. Missing energy found among soft hadrons propagating at large angles $\Rightarrow$ different from in vacuum jet evolution.

Heavy ion collisions, quark gluon plasma and jets, the stereotypical picture:



Implicit assumption: small energy fluctuations.

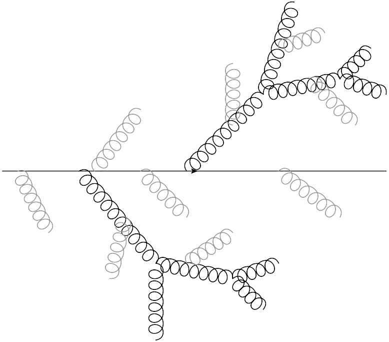
We need a model that answers:

- How can the lost energy end up at such large angles?
- How large are the energy fluctuations?

Physics

Start describing model, give expression for formation time and describe consequences of it, angles, multiple branching

A typical event:



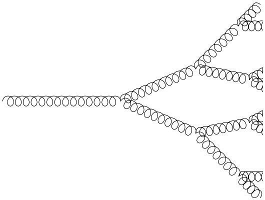
- A number of $\mathcal{O}(1)$ of primary gluons emitted from leading particle.
- They then branch democratically.
- Grey gluon lines $=$ large number of non democratic, soft emissions.

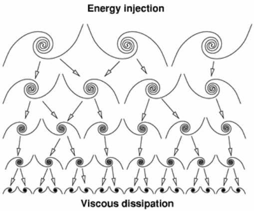
Stochastics

In medium evolution as a Markovian process.
Describe D, D2, splitting kernels

Energy fraction left in gluon cascade: $\int_0^1 \mathrm{d}x\, D(x,\tau) = e^{-\pi\tau^2}$
$\Rightarrow$ decreasing in time. Fate of lost energy, formally: condensate at $x = 0$. Physically: thermalization.

Note: (fix point...) Democratic branching compared to wave turbulence:

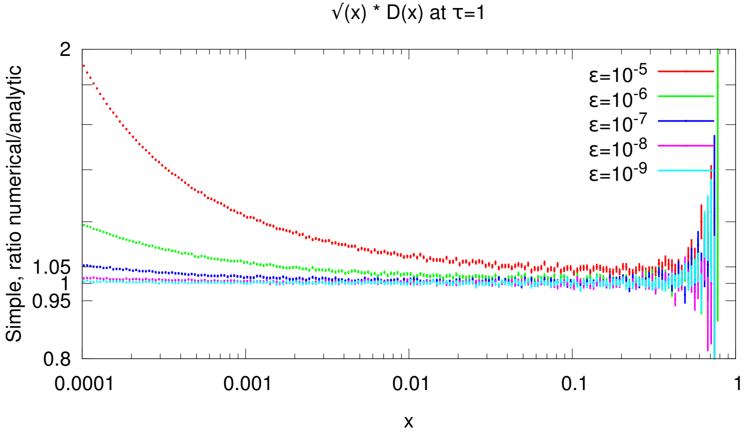




Numerics

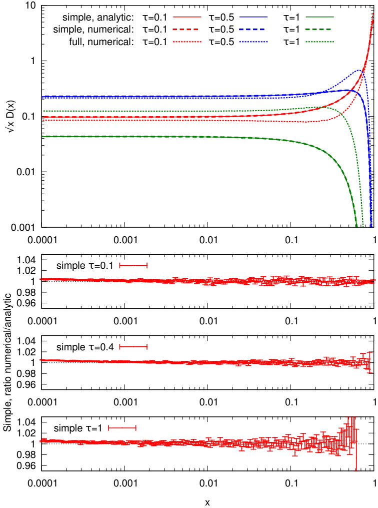
Numerical considerations, IR cutoff, pileup.

- ϵ: IR cutoff for x in splitting kernel
- x_{min}: lowest x considered



Result: full kernel ⇒ less efficient branching

$$\sqrt{x}D(x)$$



Simple splitting kernel, numerical versus analytic:

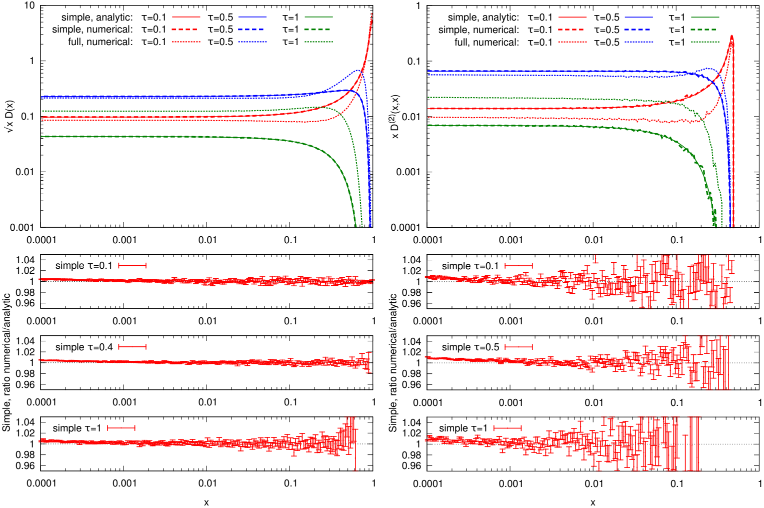
- Good agreement overall
- Bias at small x (pileup)

Corrections from the full splitting kernel:

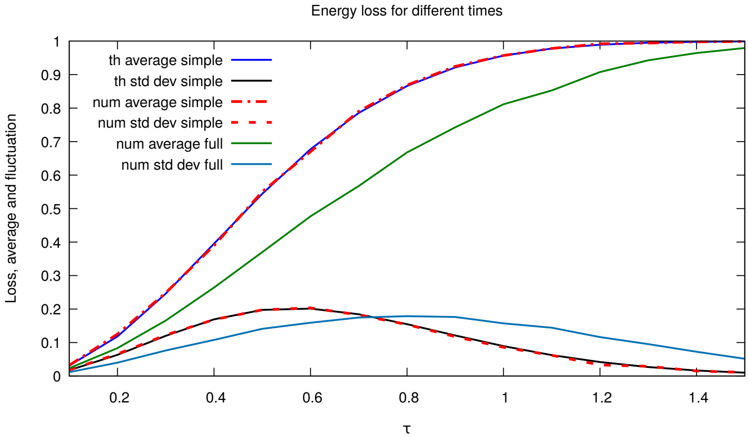
- Leading peak still present at $\tau = 0.5$
- Less energy lost at $\tau = 1$

Result: full kernel $\Rightarrow$ less efficient branching

$\sqrt{x}D(x)$ $\qquad$ $xD^2(x,x)$



Energy loss: $1 - \int_0^1 \mathrm{d}x\, D(x,\tau) = 1 - e^{-\pi\tau^2}$



Summary:

- Democratic branchings $\Rightarrow$ energy found at large angles
- Prediction: large fluctuations in energy loss
- Possible to make Monte Carlo simulation
- Full kernel $\Rightarrow$ less efficient branching

Possible extensions:

- Things

THE END

Questions?