What can the event transverse energy distribution tell us about the longitudinal flow?

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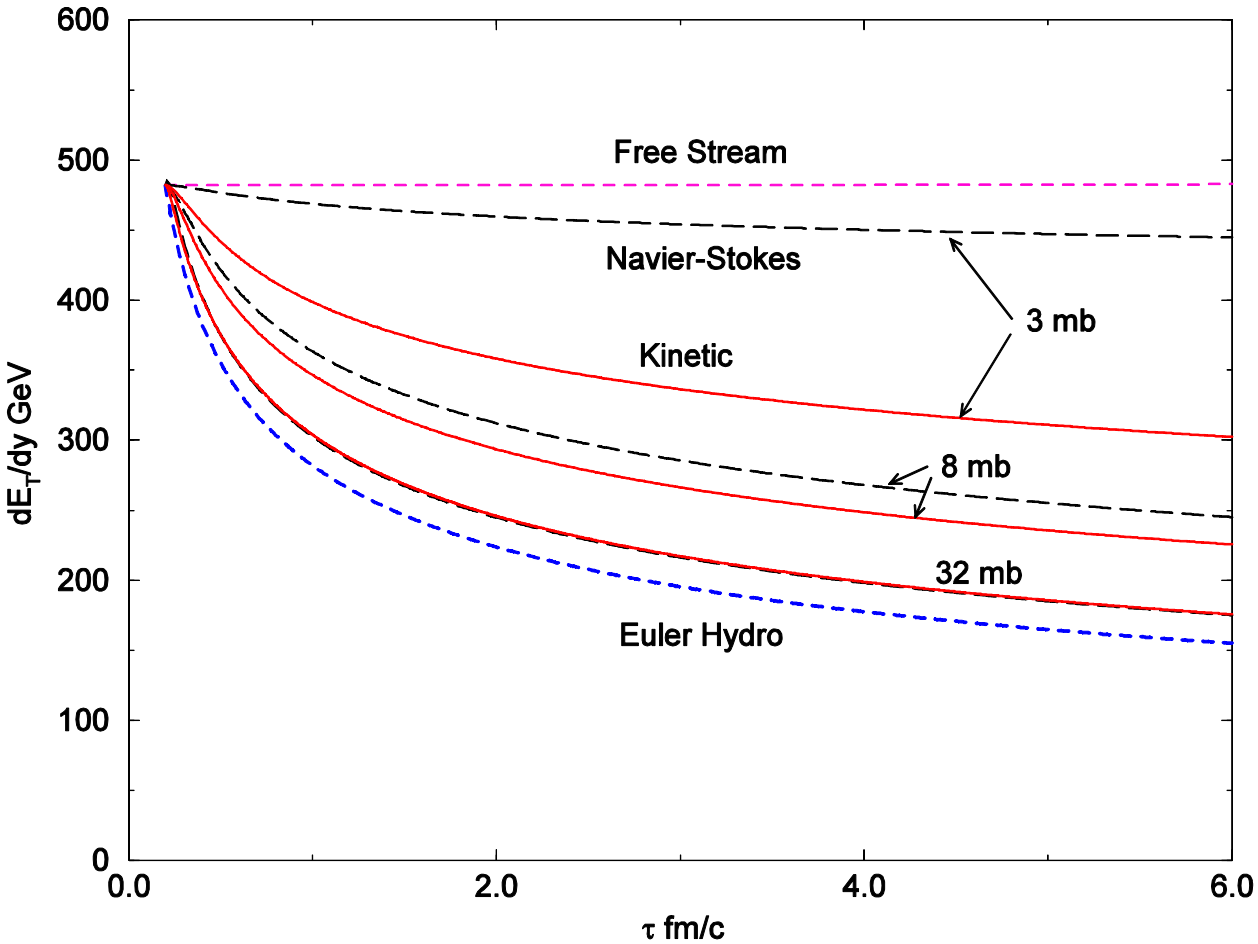
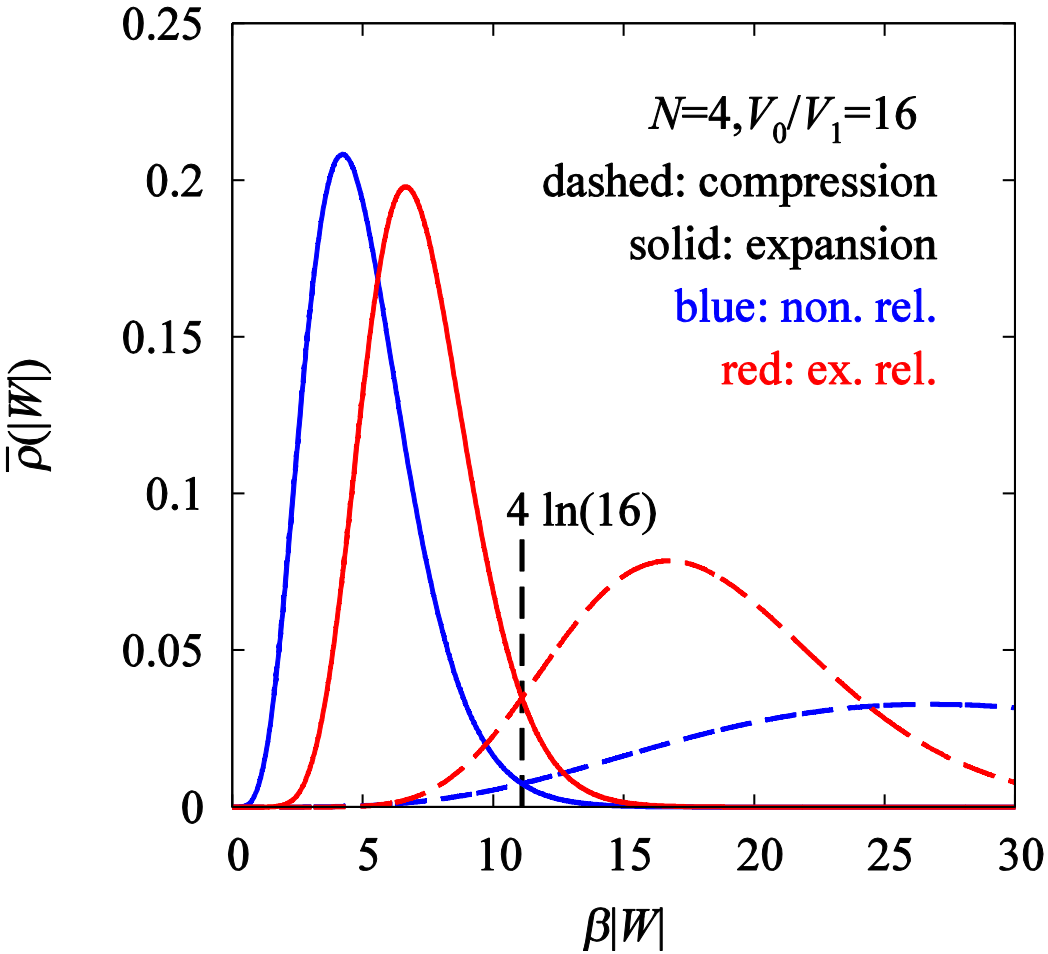
Introduction



Gyulassy et al., Nucl. Phys. A 626, 999 (1997)

Longitudinal work distribution



- The non-relativistic work magnitude distribution is a gamma distribution.

- Jarzynski equality

$$-\ln\left\langle \exp(-\beta W)\right\rangle = \beta\Delta F$$

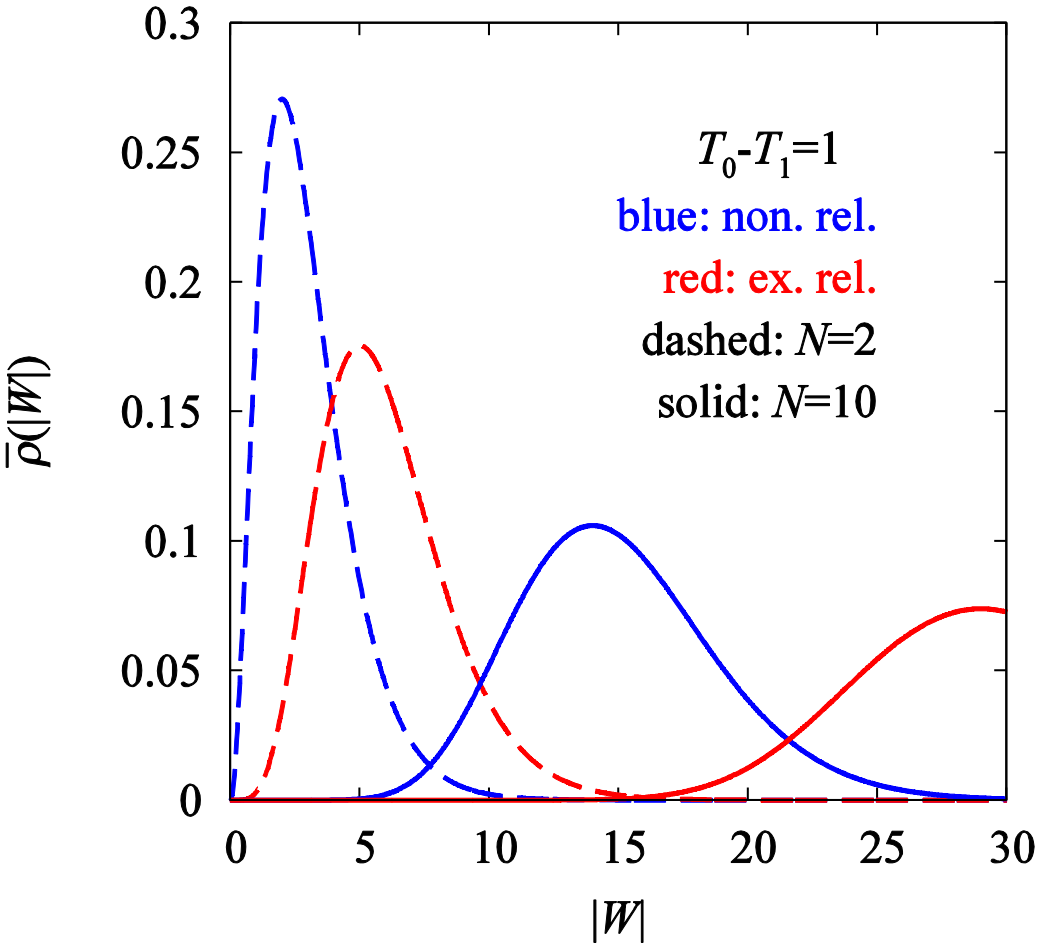
and the second law.

- Crooks theorem.

- The extreme relativistic work magnitude distribution is also a gamma distribution.

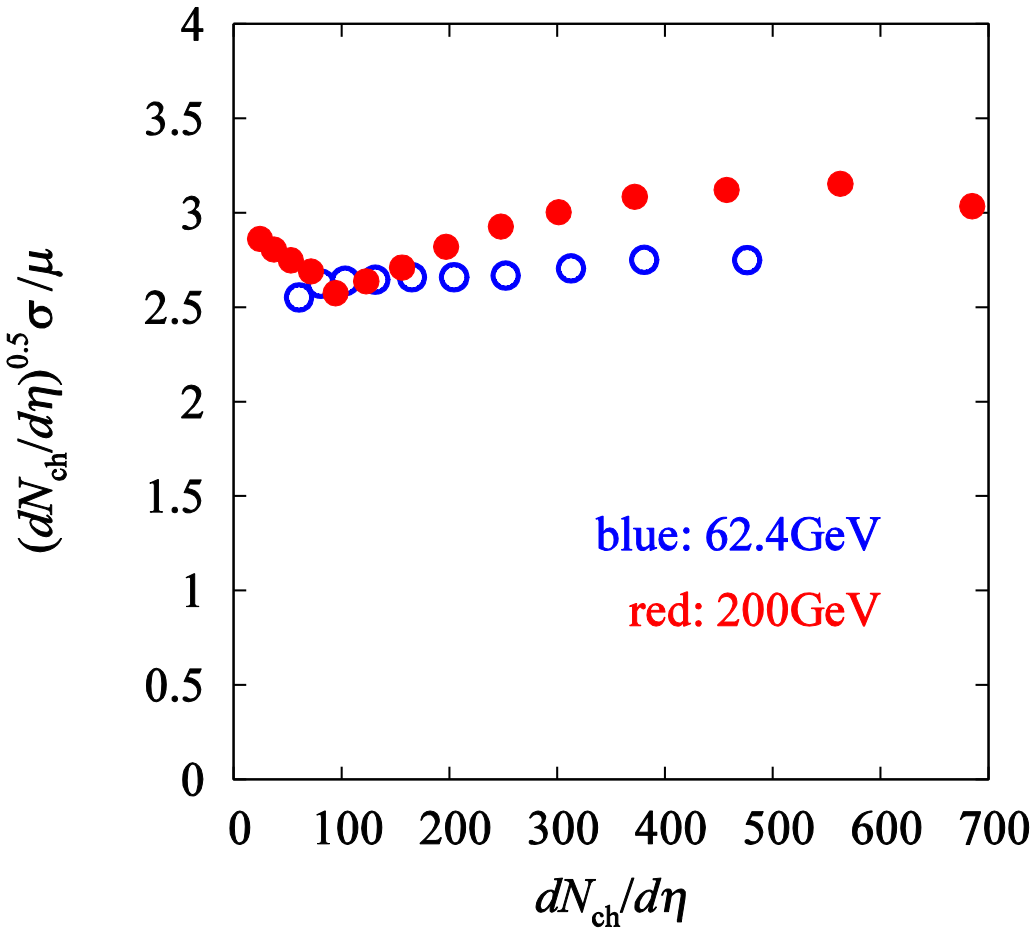
- The ordering of averages.

Work distribution and ET distribution



- Non-relativistic shape $3N/2$; extreme relativistic shape $3N$.
- Scale parameter $|\Delta T|$.
- The transverse energy distribution is also a gamma distribution.
- The transverse energy shape parameter ($\{3N/2, 3N\}$) depends on the mass.
- The transverse energy scale parameter ($\{2/3, \pi/4\}T_1$) is sensitive to the freeze-out and the mass.

Transverse energy fluctuations



- The variance σ^2 and mean μ are related to the shape and scale parameters.
- The relative width is related to the shape parameter ($\sigma/\mu \sim 1/\sqrt{k}$).
- $(\frac{\sigma}{\mu})/(\frac{1}{\sqrt{dN_{ch}/d\eta}})$ reflects particle contents.
- Why non-monotonic for 200 GeV?
- Why monotonic for 62.4 GeV?

Summary and discussions

• The {work magnitude, transverse energy} distribution is a gamma distribution for a {non-relativistic, extreme relativistic} gas.

• The transverse energy shape parameter is sensitive to the mass, and the scale parameter is mainly determined by the freeze-out.

• Numerical studies are necessary to sort out the changing particle contents, transverse expansion, differential freeze-out, etc..

• What is the reason for the different centrality dependences for 62.4 GeV and 200 GeV? Could this reflect liquid excitations (phonons, maxons, rotons, etc.) and liquid structure factors?

• What are the effects of the initial conditions? Can Bose-Einstein condensation have measurable effects?