

# One Slide about myself: Urs Wiedemann

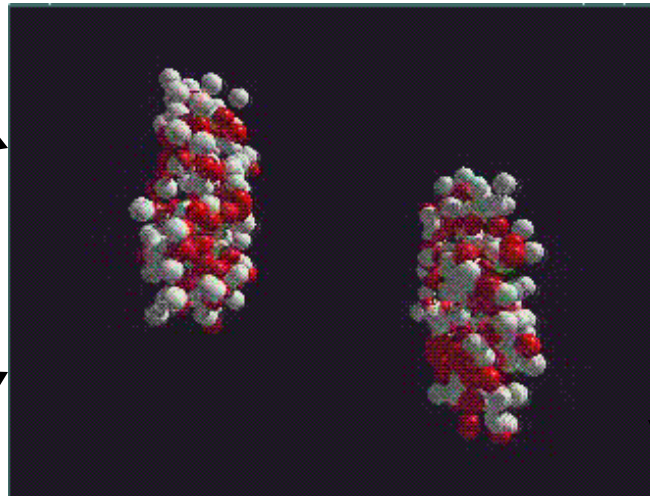
- In CERN PH/TH since 1999 (fellow -> junior staff -> senior staff)
- Reasons to talk to me in TH include:
  - contact person for short term visitor programme
  - note: you can have visitors, they can get support (per diem)  
but they have to apply in time  
[http://ph-dep-th.web.cern.ch/ph-dep-th/content2/visitors/visitor\\_form.html](http://ph-dep-th.web.cern.ch/ph-dep-th/content2/visitors/visitor_form.html)
  - from 2014 onwards:  
contact for “associates and fellows committee”
  - science (see following slides)

# “Heavy Ion (HI) Physics”

Short Intro of Urs for TH retreat  
7 Nov 2013, Les Houches

Fluid  
Dynamics

High  
Energy  
Physics



Computational  
Physics

How do collective phenomena and macroscopic properties of matter emerge from fundamental interactions?  
Question relevant also outside HI and research in CERN TH not limited to HI applications

String  
Theory

# Fluid Dynamic Description of Heavy Ion Collisions

- Dynamics defined by:  $\nabla_m T^{mn} = 0$   
 2<sup>nd</sup> law of thermodynamics:  $\nabla_m S^m(x) \stackrel{?}{=} 0$

- Input calculable in QFTs

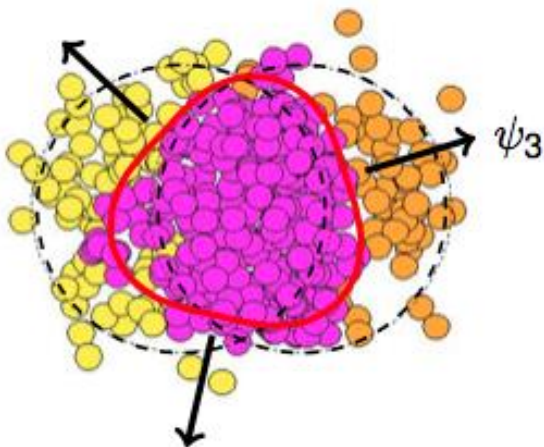


- **EOS**:  $e = e(p, n)$  and **sound velocity**
- **transport coefficients**: shear  $\eta$ , bulk  $\chi$  viscosity, conductivities ...
- **relaxation times**: , , ...

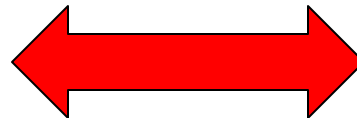


Stefan Flörchinger

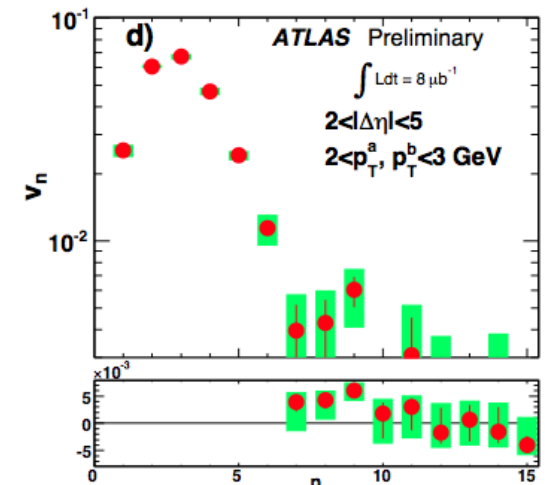
- Strong experimental support for fluid dynamic behavior:



Expected fluctuations in initial spatial distribution



Measured fluctuations in momentum distribution



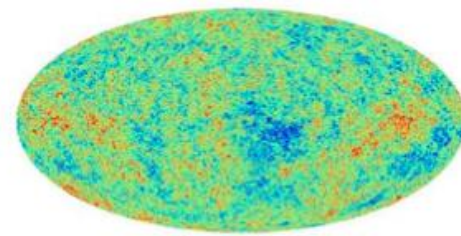
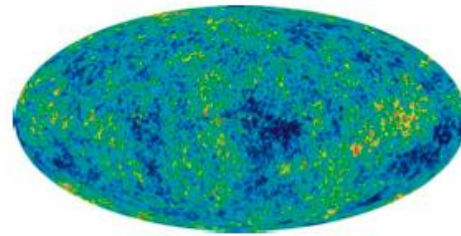
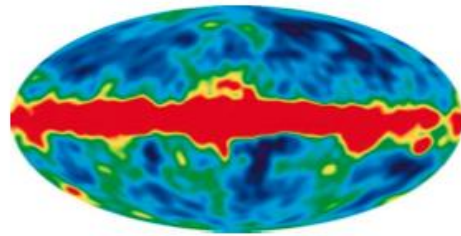
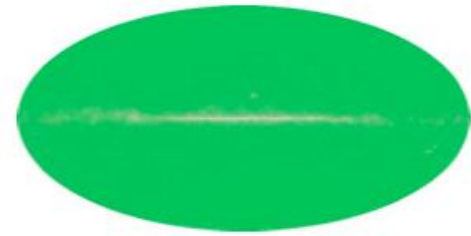
# A (valid) analogy

Penzias/Wilson  
1965

COBE  
2003

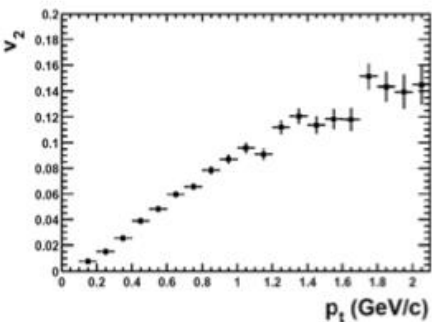
WMAP  
2007

Planck  
2012

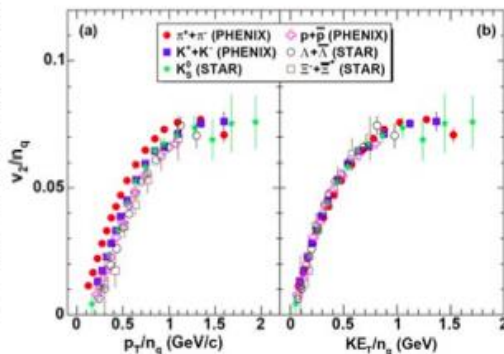


From a signal ... via fluctuations ....

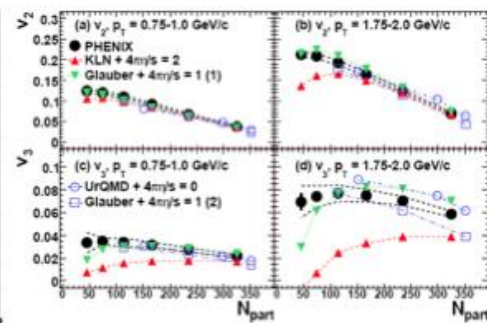
.... to properties of matter



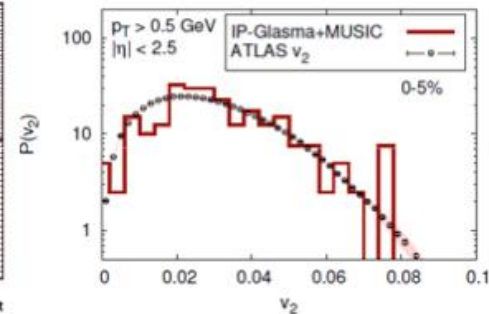
2001



2004



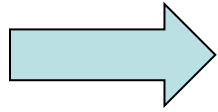
2008



2012

# One Example: Mode-by-mode fluid dynamics

Decomposing  
initial conditions  
in modes

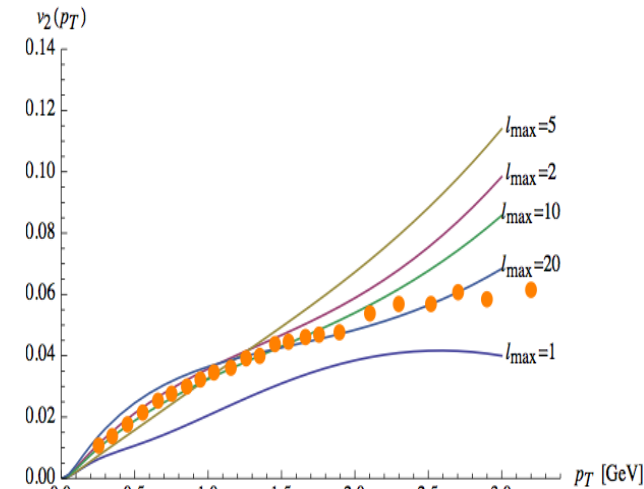
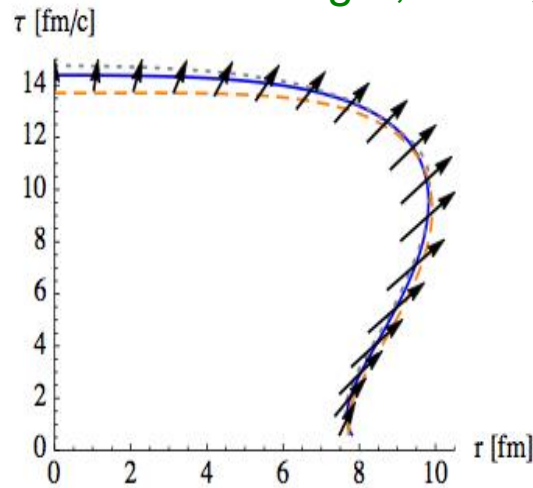
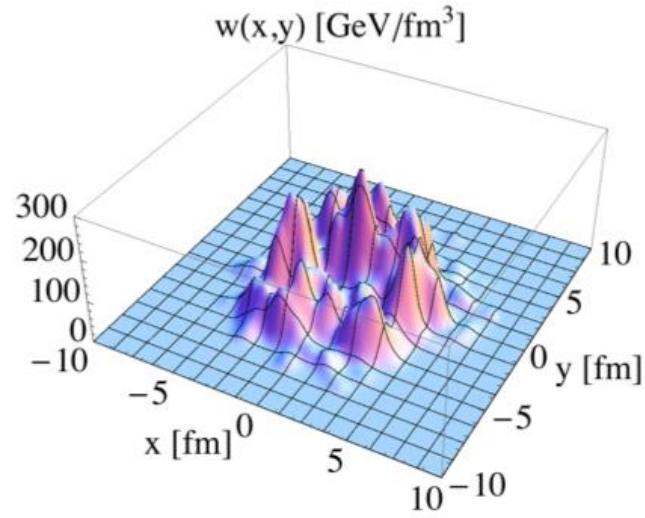


Propagating  
each mode  
individually

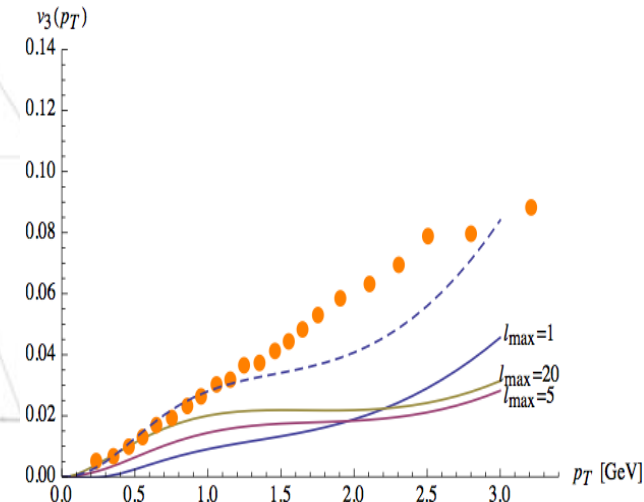
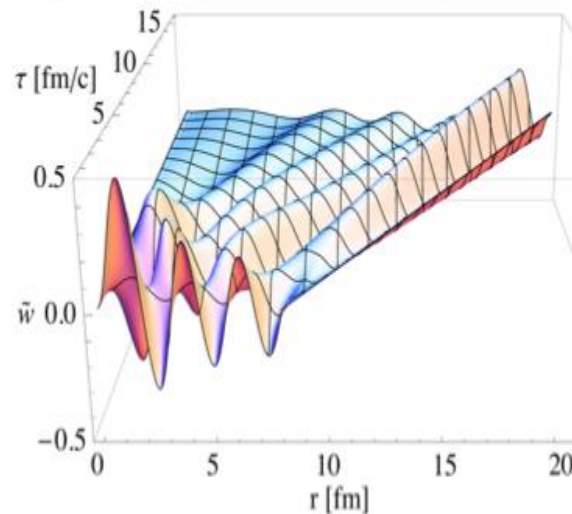
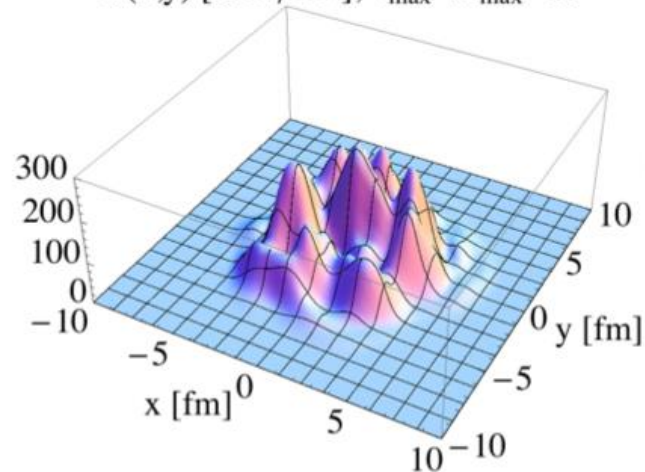


Understanding the  
signal composition  
mode-by-mode

S. Flörchinger, UAW, 1307.3453; 1307.7611



$w(x,y) [\text{GeV}/\text{fm}^3], l_{\text{max}}=m_{\text{max}}=10$

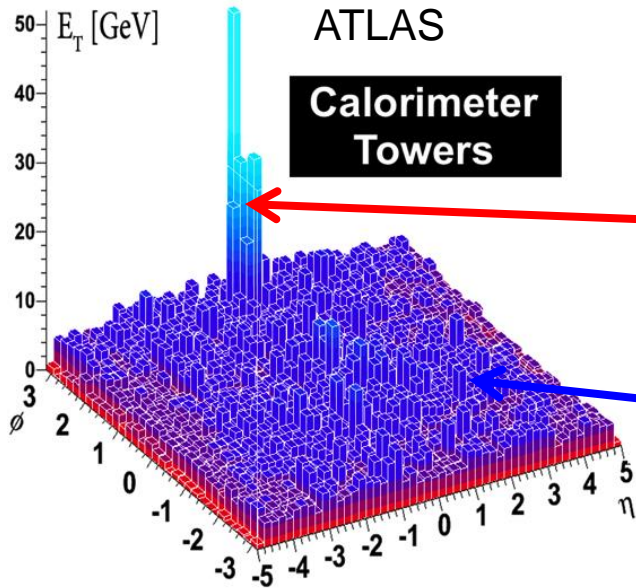
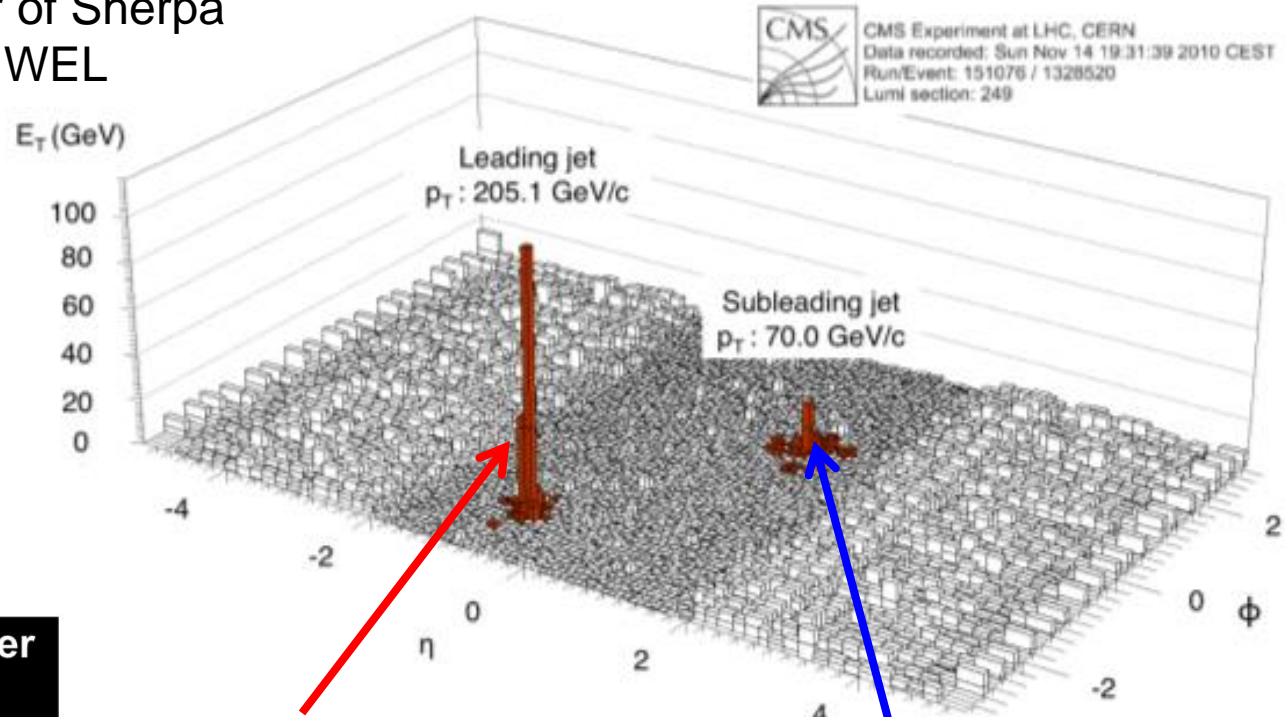


# pQCD in dense nuclear environment



Korinna Zapp,

- Field: QCD / HI
- Collaborator of Sherpa
- Author of JEWEL



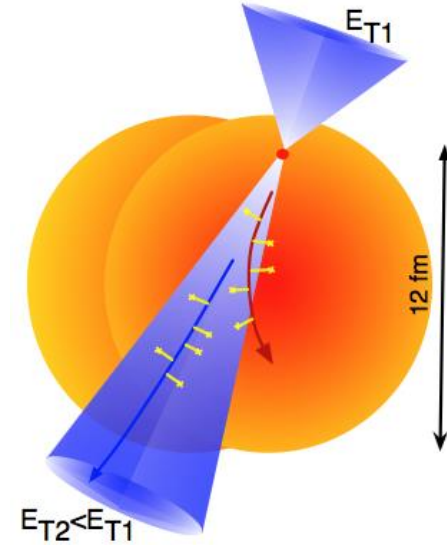
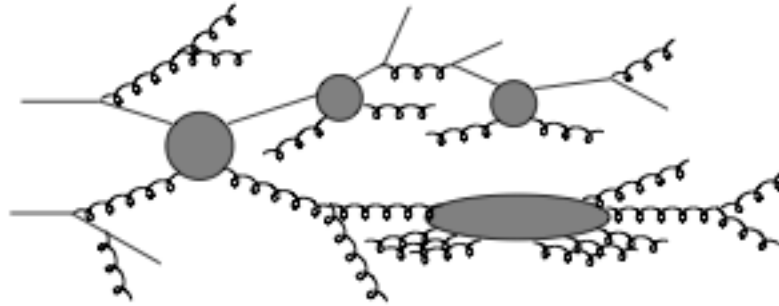
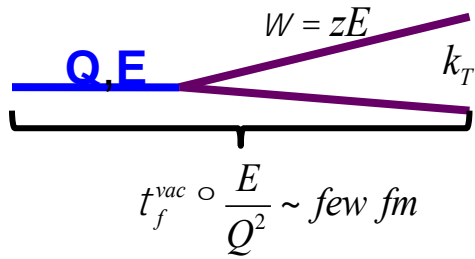
Trigger jet  
 $E_T \sim 100$  GeV

Recoil  
**GONE**  
Or reduced

# JEWEL – Jet Evolution With Energy Loss

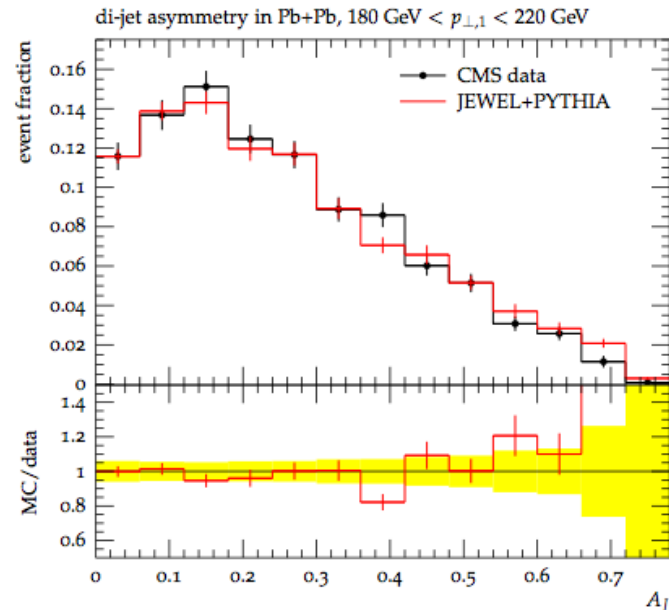
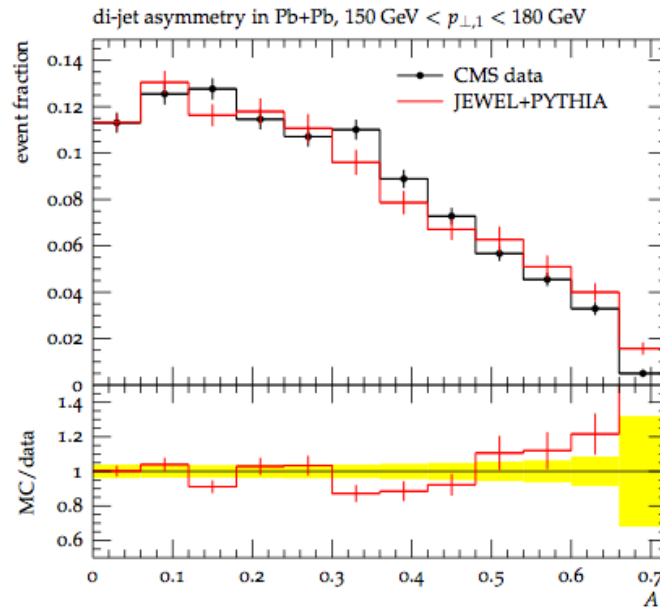


- Time-scales of parton shower comparable to system size => interference between vacuum shower and in-medium bremsstrahlung

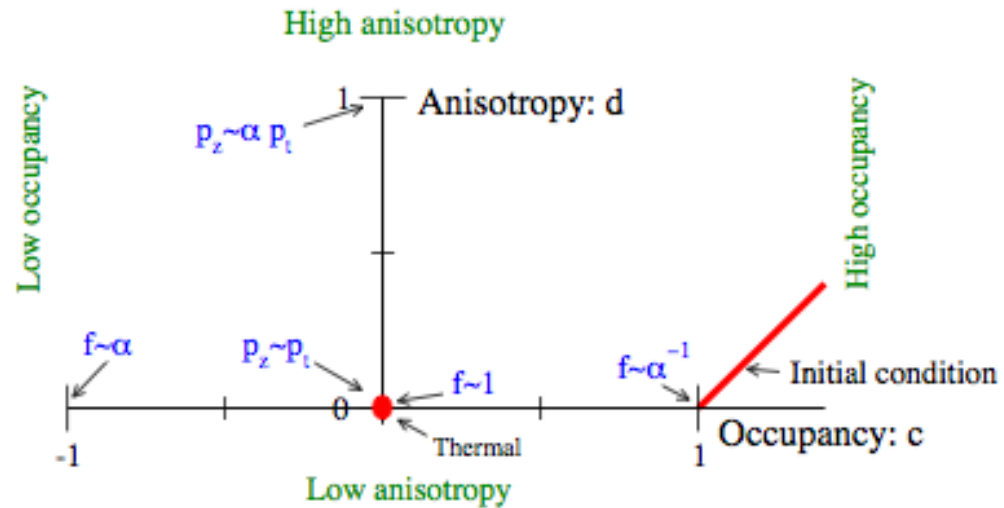
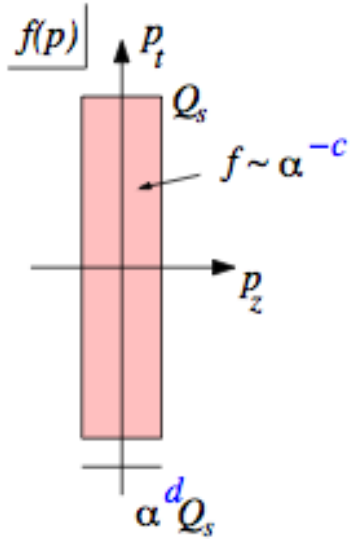


K.C. Zapp JEWEL 2.0.0  
arXiv:1311.0048

Zapp, Krauss, UAW  
JHEP 1303 (2013) 080



# How does thermalization occur in QCD?



- Finite temperature field theory
- Classical gauge theory simulations
- Lattice QCD

Alexi Kurkela

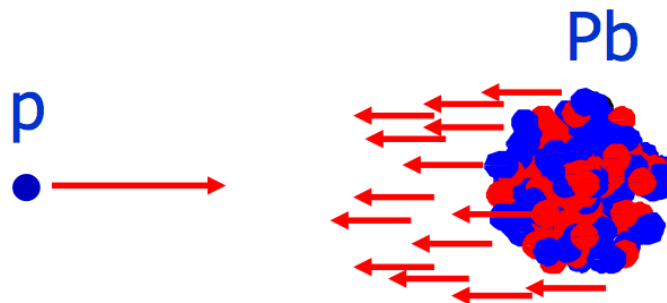


# Paid Associates

Recent paid associates: Carlos Salgado, Nestor Armesto, Krishna Rajagopal and now: Mark Strikman



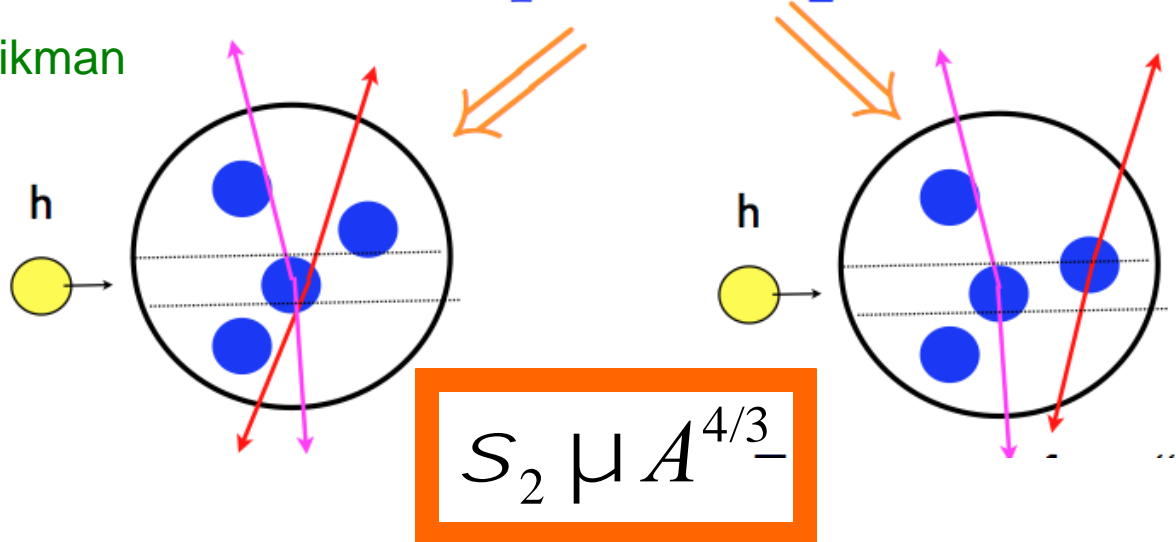
One of his many interests:  
MPI – multi parton interactions

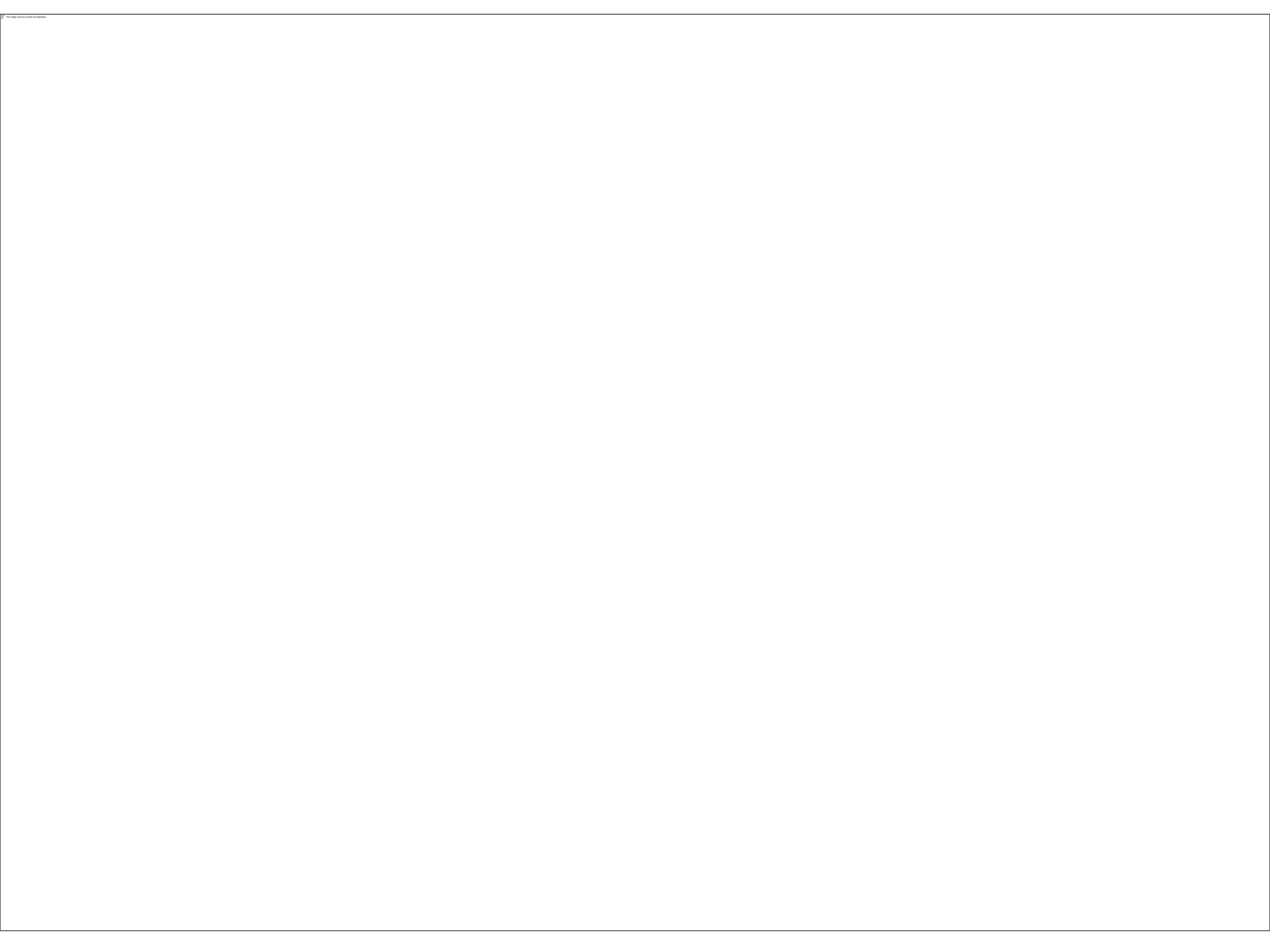


$$\sigma = \sigma_1 \cdot A + \sigma_2$$

Blok, Dokshitzer, Frankfurt, Strikman  
PRD83 (2011) 071501

For  $pA$ :  
Blok, Strikman, UAW  
EPJC 73 (2013) 2433





# Guilherme Milhano

Assistant Professor in Lisbon, long-term visitor



- Hard probes in heavy ion collisions
- Small-x saturation physics