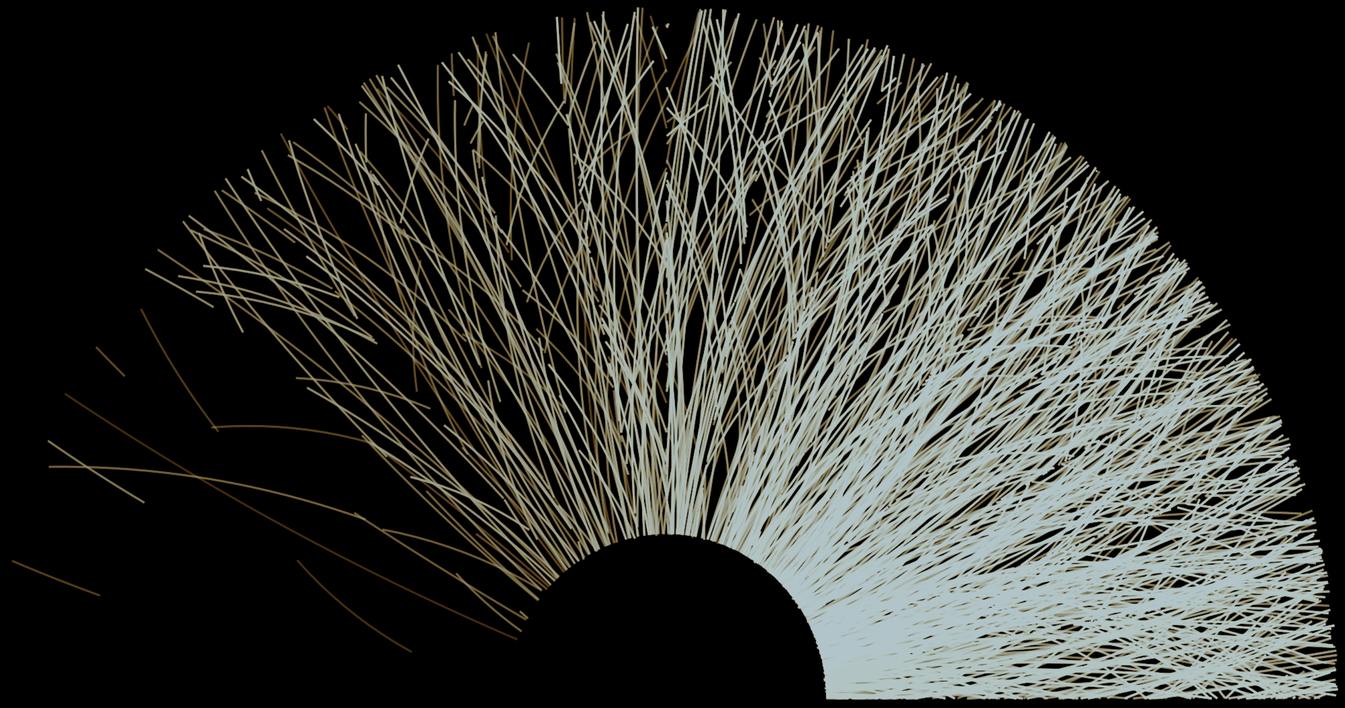
KØBENHAVNS UNIVERSITET

Particle production in small and large systems

Vytautas Vislavicius, Niels Bohr Institute, DK

THE VELUX FOUNDATIONS
VILLUM FONDEN × VELUX FONDEN



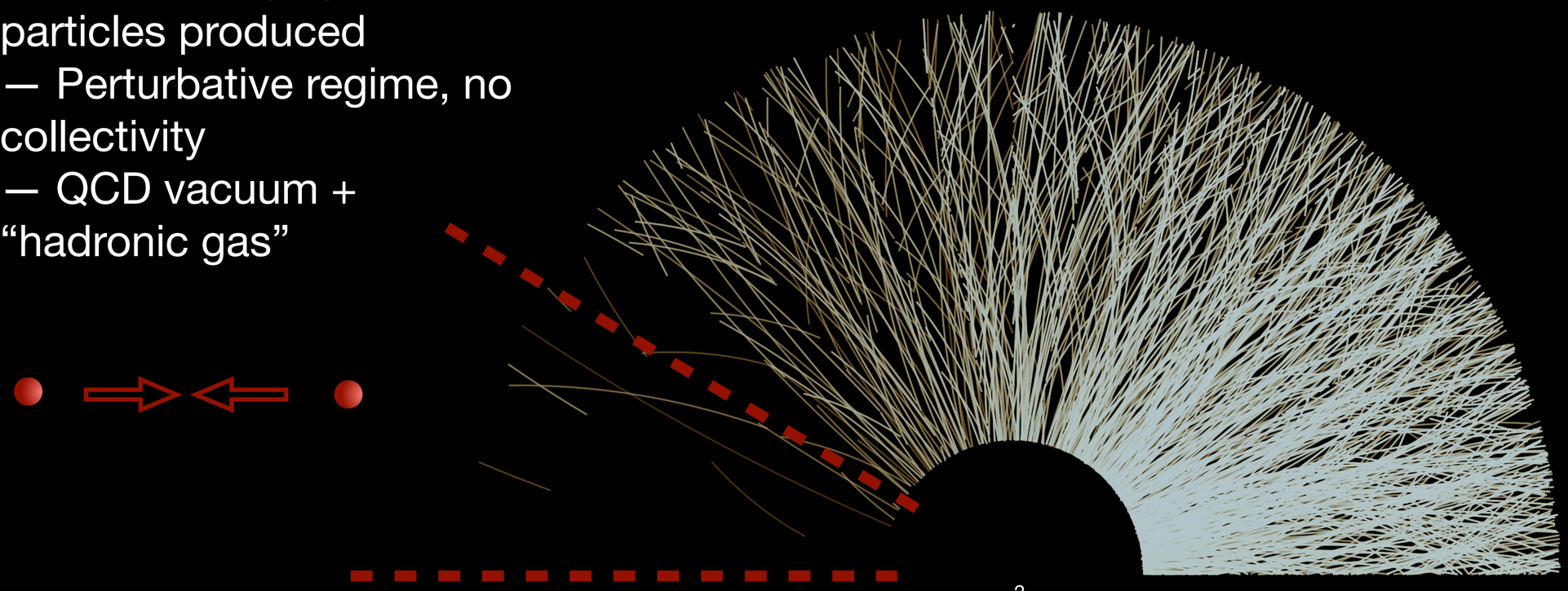
What is a small/large system?

pp

— Elementaty system, few particles produced

— Perturbative regime, no collectivity

— QCD vacuum + “hadronic gas”



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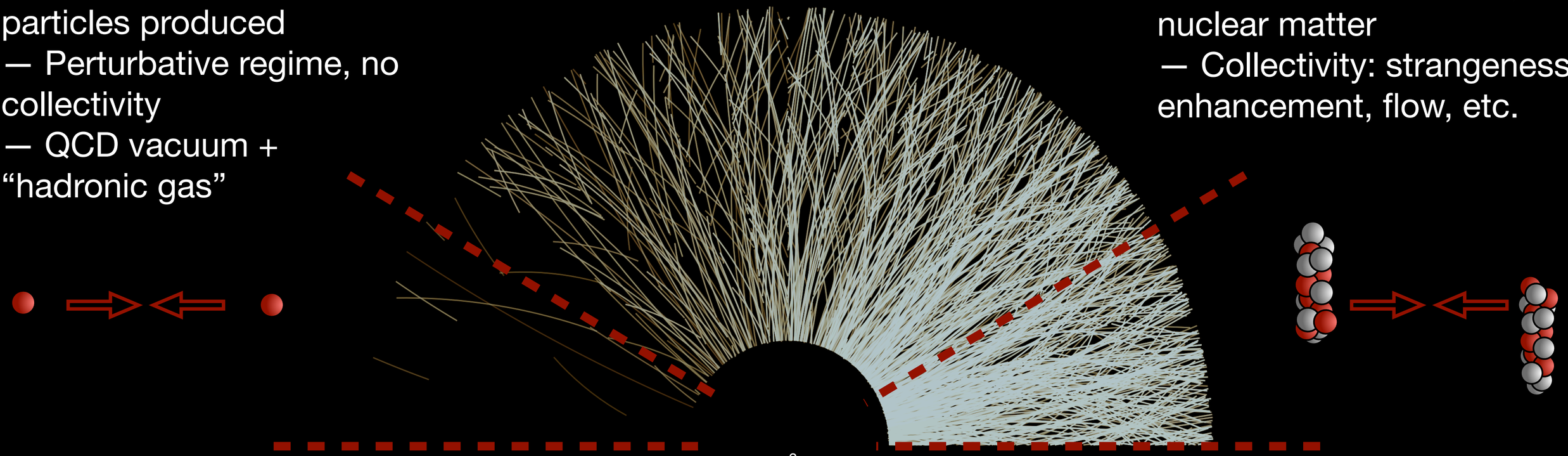
Pb-Pb

— Very large multiplicites (up to ~2000 tracks per η)
— Deconfinement/QGP, hot nuclear matter
— Collectivity: strangeness enhancement, flow, etc.



What is a small/large system?

p-Pb

— Cold nuclear matter, $\lesssim$ 100 particles per η

— Potentially, transition between pp and Pb—Pb

pp

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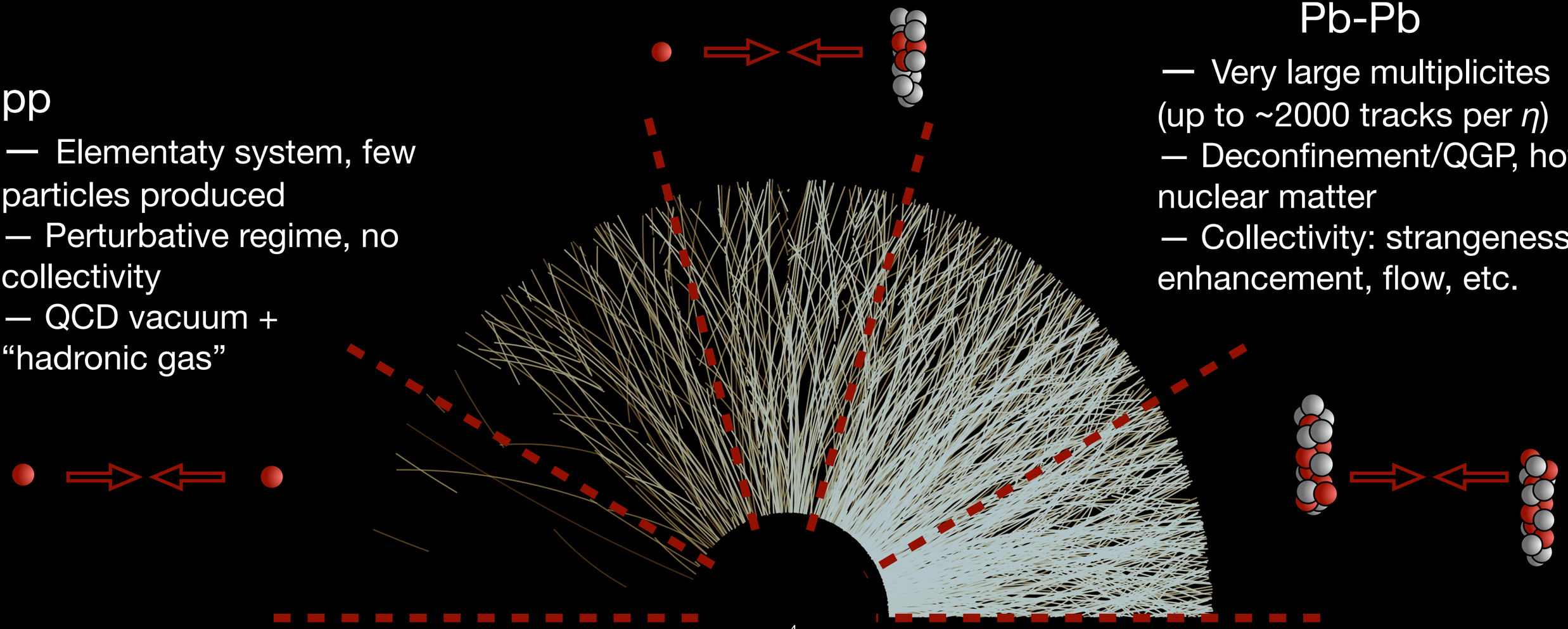

Collectivity in Pb—Pb

Hot and dense medium of quarks and gluons (the quark gluon plasma, QGP):

— Rapid expansion (and cooling), described by hydrodynamics ⇒ *flow*

— Hadronization, chemical freeze-out ⇒ *particle production*

— Hadronic rescatterings, kinetic freeze-out

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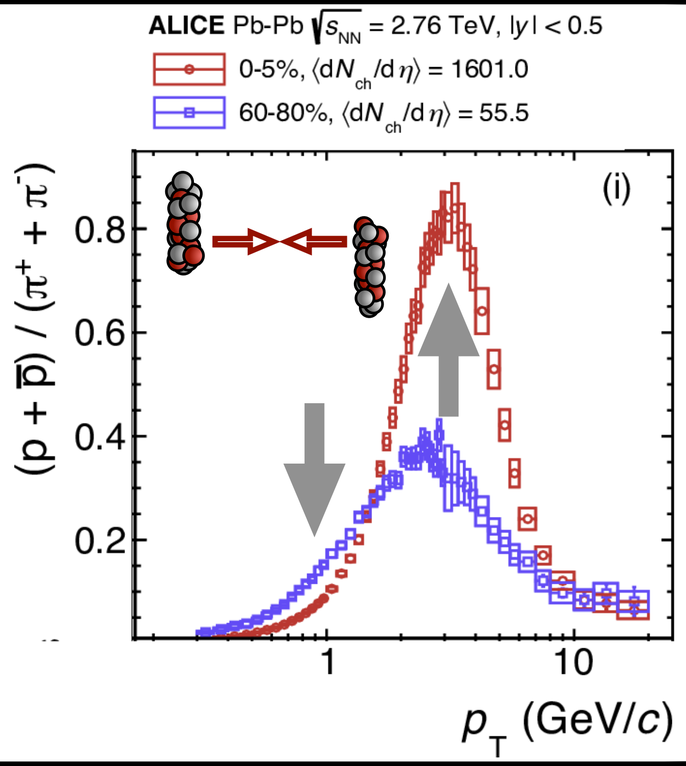
$p_{\mathrm{T}} = \beta m \Rightarrow$ **for a given** $\beta \to \beta + \Delta\beta$,

shift in p_{T} **is larger for heavier particles**

⇒ One of the smoking-gun signatures of the QGP



ALICE, Phys. Rev. C 99 (2019) 024906

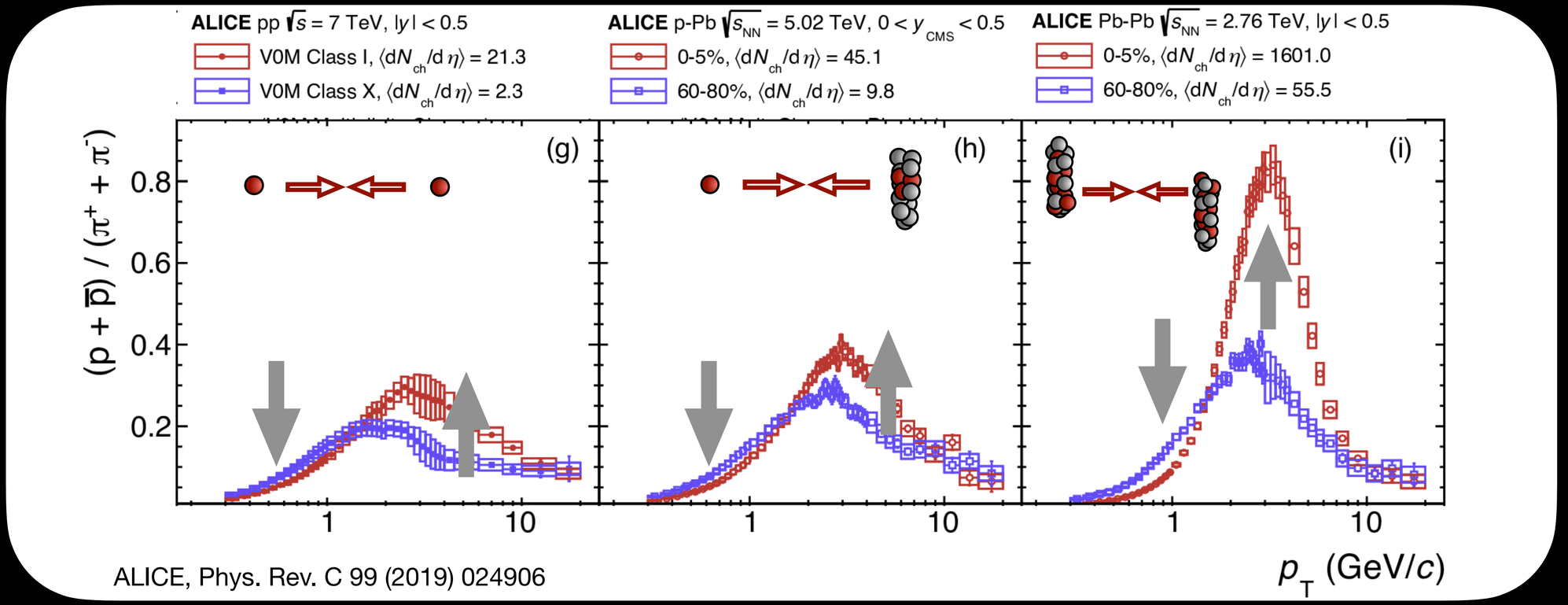
Collectivity in Pb—Pb — and smaller systems?

Mass-dependent spectral modifications also observed in p-Pb and even pp collisions!

— Different multiplicity ⇒ different magnitude, but trends are there

⇒ Different nature of the effect, or same physics in pp and Pb—Pb?

Look into other observables



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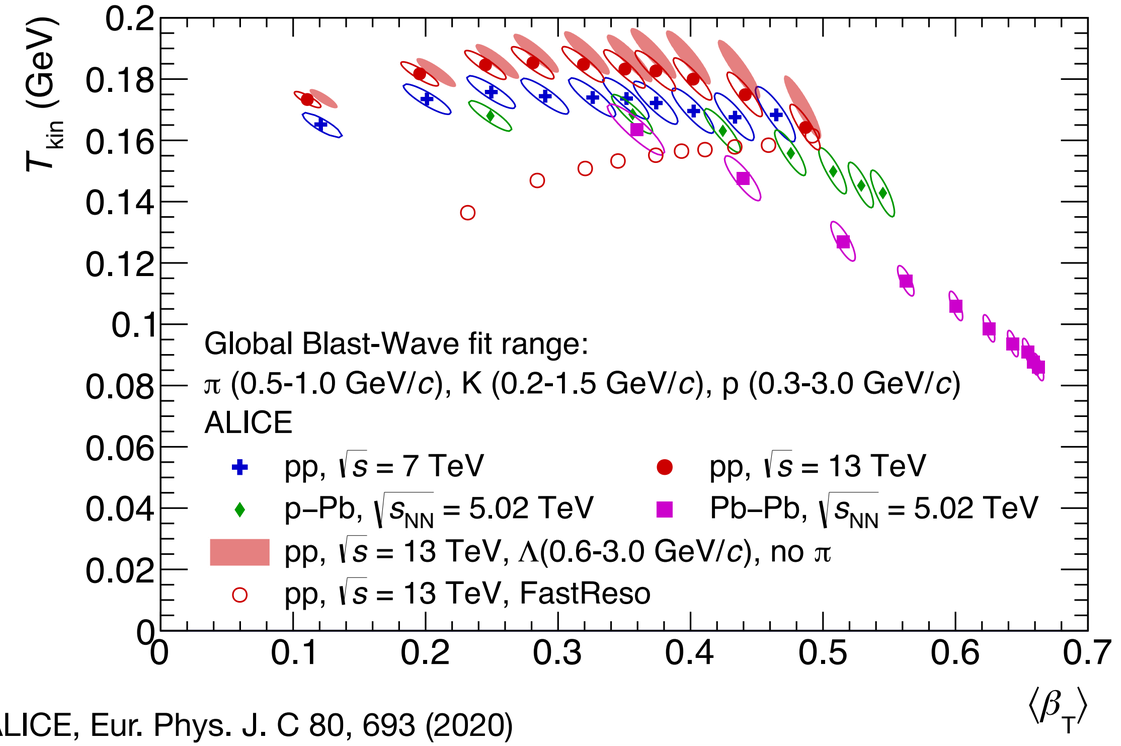
Freeze-out in different collision systems

Blast wave model: a ball of thermal sources expands radially with common velocity field.

Thermal spectra slope given by T_{kin}, then modified by β ⇒ fit particle spectra to extract FO parameters

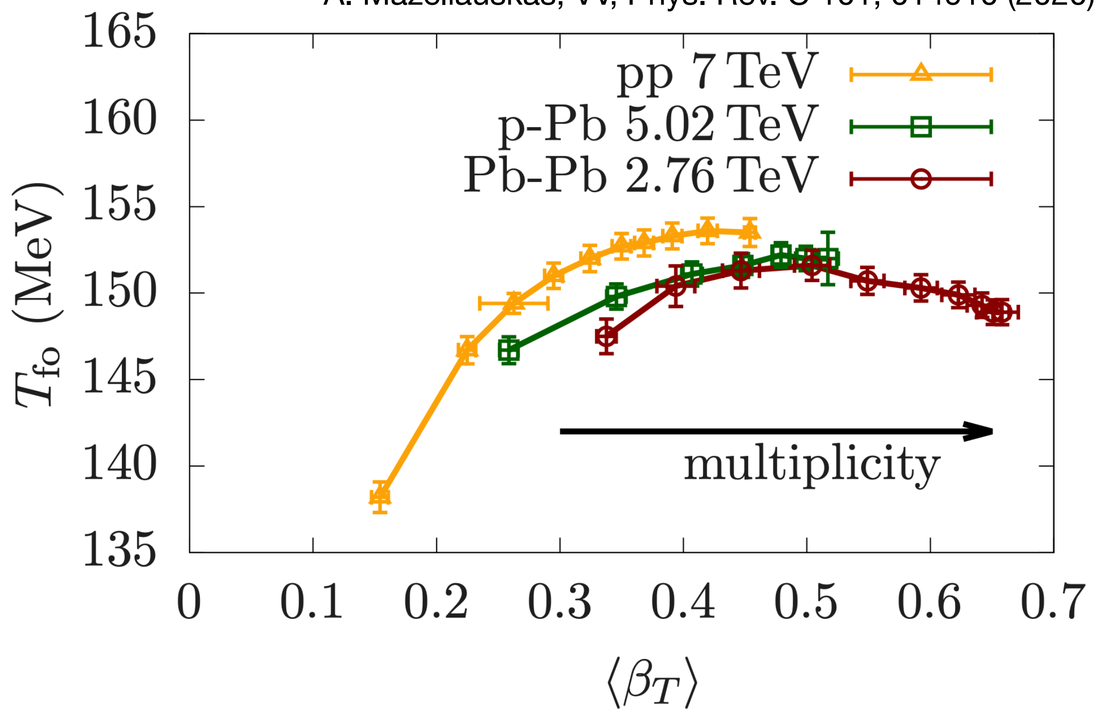
⇒ “Standard” BW: similar trends in pp and p—Pb, later FO in Pb—Pb

⇒ Including resonance decays: similar freeze-out in dif. collision systems



ALICE, Eur. Phys. J. C 80, 693 (2020)

A. Mazeliauskas, VV, Phys. Rev. C 101, 014910 (2020)



Hadrochemistry in different collision systems

"Standard model" of heavy-ions:

— Particles produced thermally,

subject to canonical suppression

⇒ Enhanced (suppressed) production of

strange hadrons at high (low) multiplicities!

Standard model in pp:

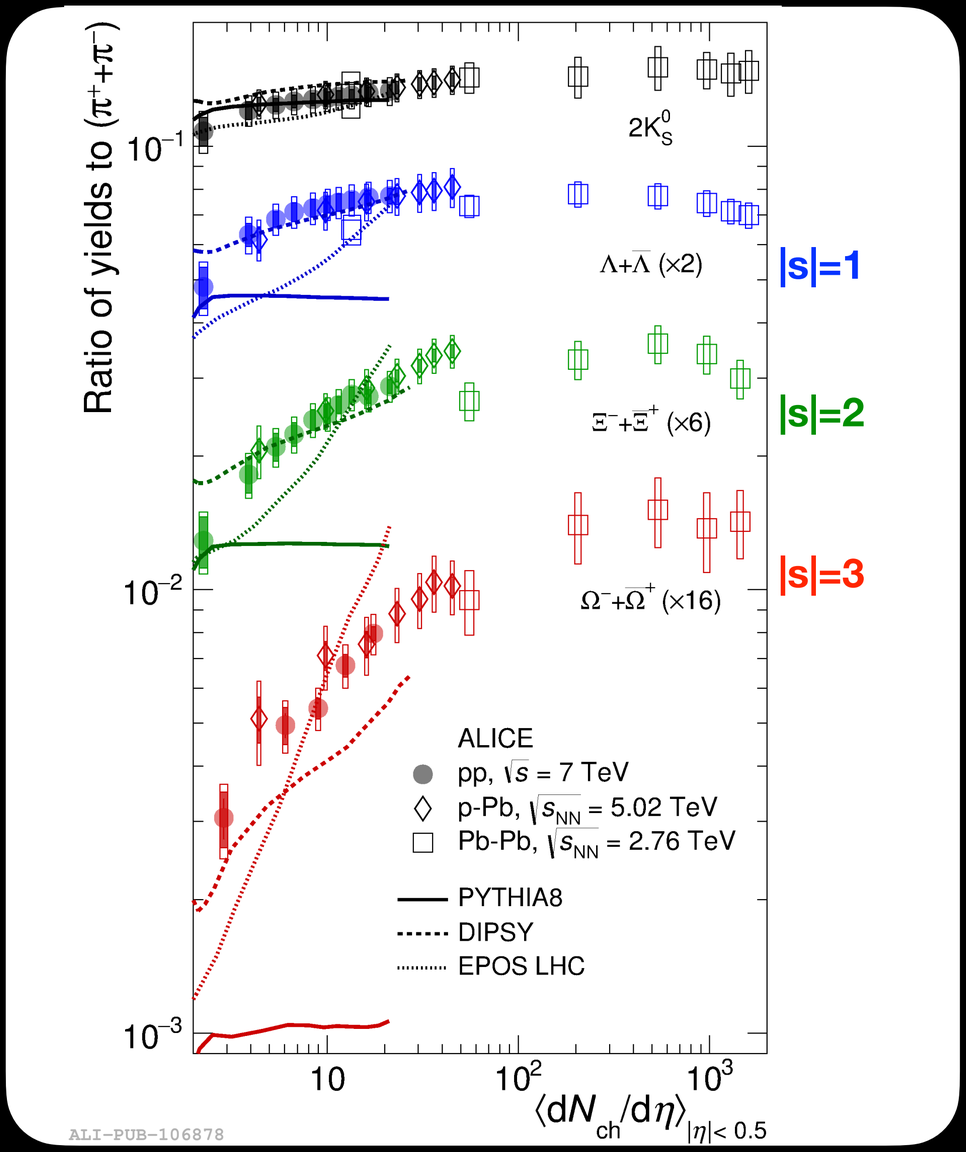
— Vanilla pQCD (ala PYTHIA)

— Particles produced in string breaking

— No multi. dependence

⇒ Data suggests a common mechanism

for particle production in pp and Pb—Pb



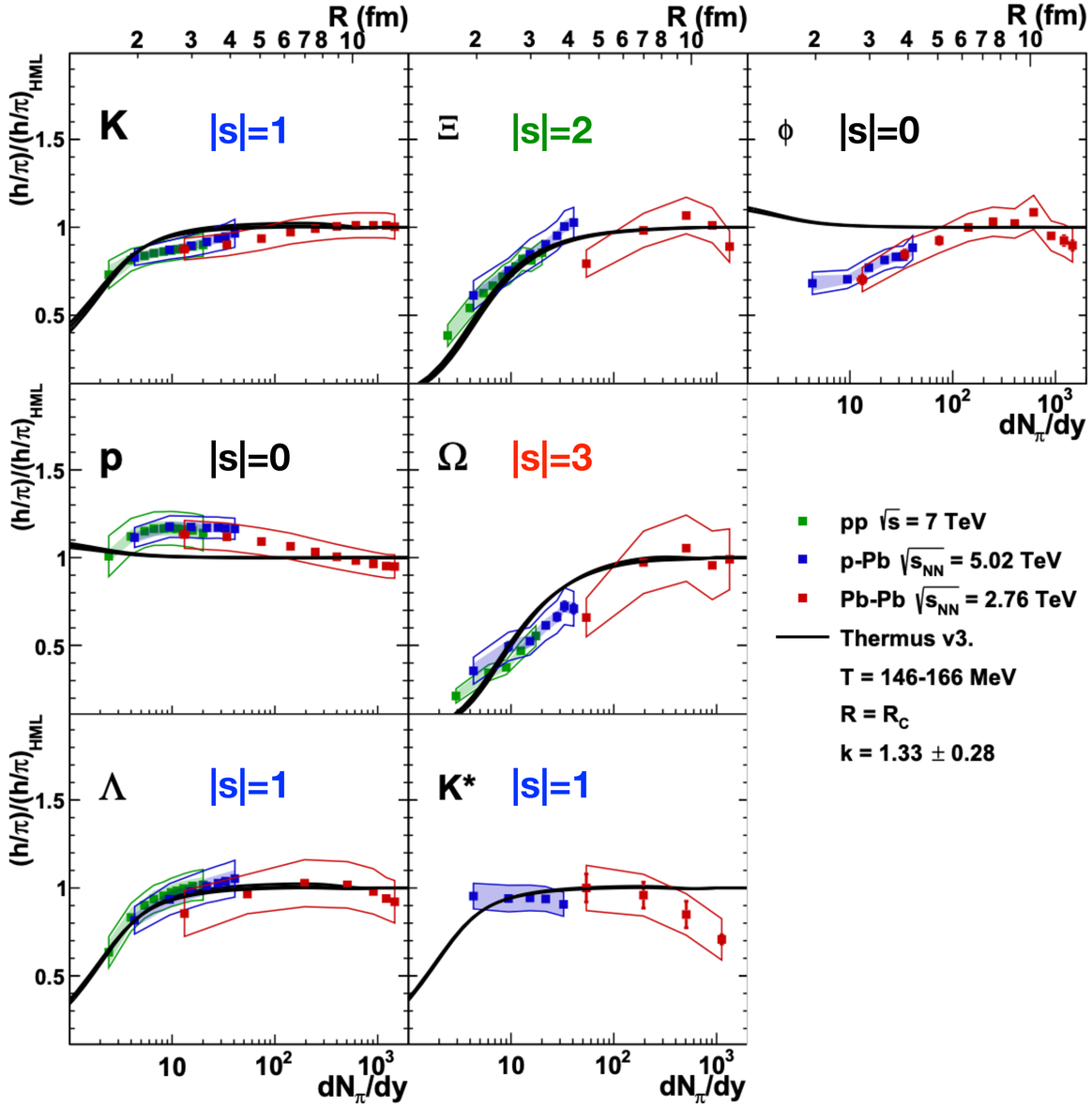
ALICE, Nature Physics 13 (2017) 535-539

Hadrochemistry in thermal picture

ALICE, Phys. Rev. C 99 (2019) 024906
A. Kalweit, VV, arXiv:1610.03001 [nucl-ex]

— Evolution with multiplicity in dif. col. syst. is well-described by thermal models for most of the particles

— K^*: rescatterings in hadronic phase
— ϕ:
  — Strangeness = 0, no suppression in thermal picture
  — Two strange quarks, double-suppressed in pQCD string breaking



Summary

— Similarities in particle production in pp, p—Pb and Pb—Pb collisions

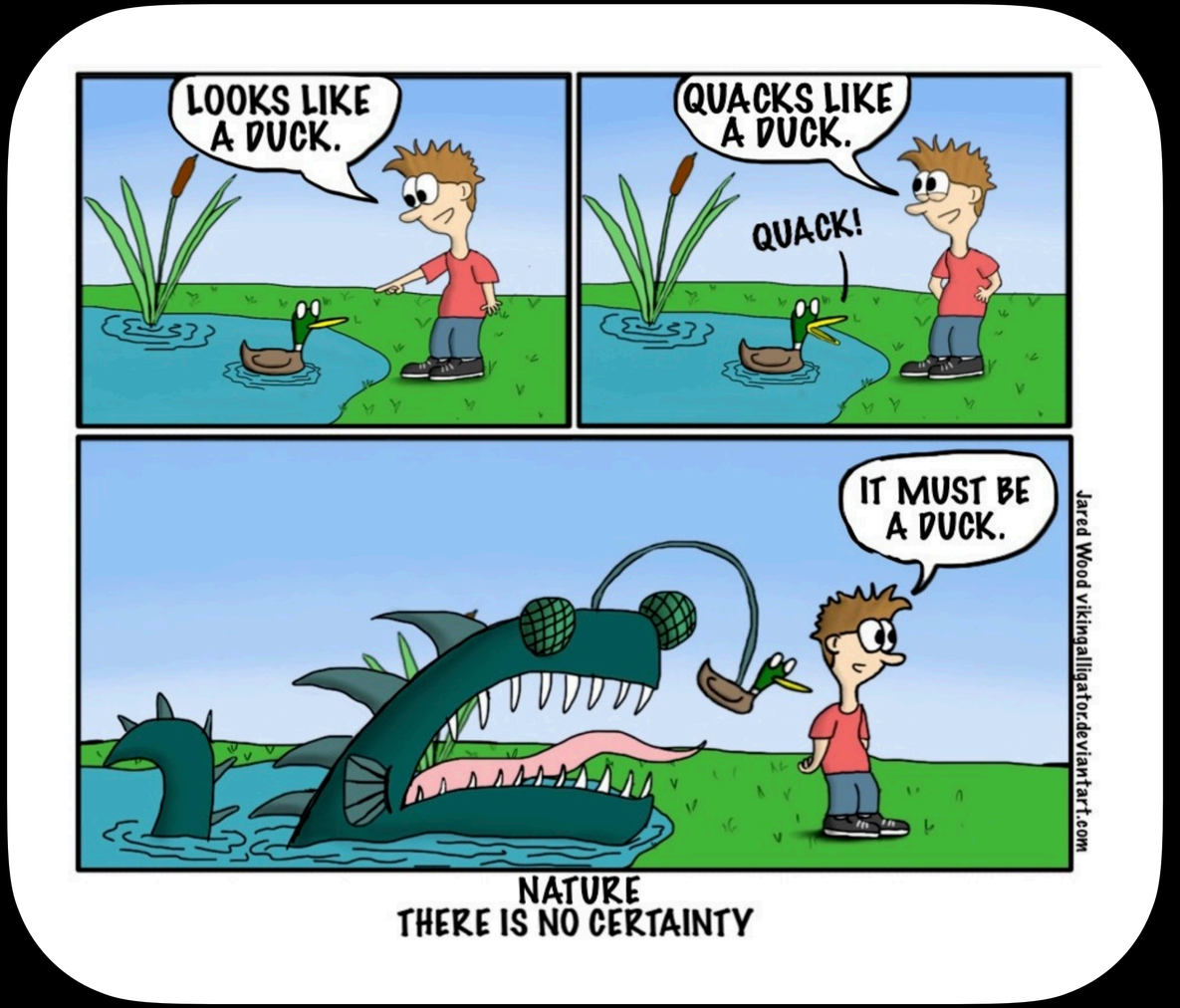
  — Mass-dependent boost of particle spectra

  — Particle production dominantly driven by multiplicity, not system size or collision energy[1]

Paradigm shift:

— Is Pb—Pb an extension of pp (= no QGP?)

— Is pp an extension of Pb—Pb (= QGP in small systems?)



[1]Collision energy dependence not discussed here, see eg ALICE, Eur. Phys. J. C 80, 693 (2020)

Personal road to particle physics

— 2007 - 2011 BSc., Vilniaus Universitetas, LT
— 2010 - 2011 BSc., Charles University, CZ
— 2011 - 2013 MSc., Lund University, SE
— 2011 Joined ALICE Collaboration
— 2014 - 2018 PhD, Lund University, SE
— 2018 - current PostDoc, Niels Bohr Institute, DK