Wearing the pink non-extensive glasses

an XX-years journey with Tamás Biró

Gergely Gábor Barnaföldi

HUN-REN Wigner Research Centre for Physics (Budapest, Hungary)

BTSLXX Symposium

11 June 2026

HUN REN

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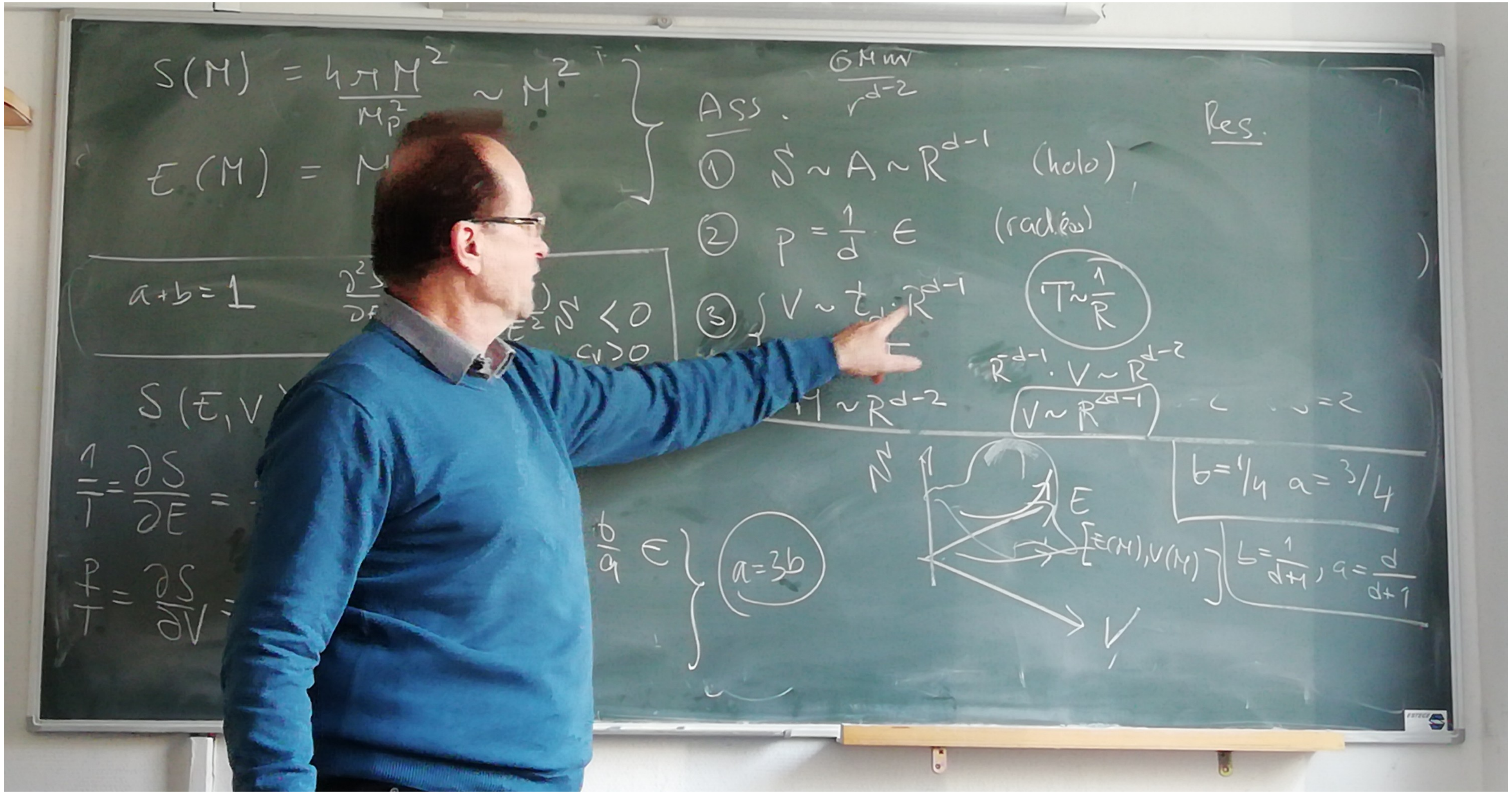
of Excellence

When Tamás is mentioned… you think on this.



But there is another side...

Újpest 1958

Újpest 1962

Berzsenyi Dániel
High School 1973

Army 1974-75

Alföld 1978

and this family guy....

GSI, Giessen, Duke, CERN Copenhagen, Budapest (1980-99)

Scientific Qualification

Dr.Sci.: Physics, March 1994, Hungarian Academy of Science (MTA)

Dr.habil.: Theoretical Physics, February 1991, Justus Liebig Univ. Giessen, Germany

Ph.D.(rer.nat.): Nuclear Physics, February 1982, Eotvos Roland Univ. Budapest, Hungary

M.S.(diploma): Physics + Biophysics, May 1980, Eotvos Roland Univ. Budapest, Hungary

Employment

Deputy Director for the Institute for Particle and Nuclear Physics, Wigner RCP, Budapest, Hungary (2013-)

Head of the Heavy Ion Research Group, RMKI Budapest, Hungary (2006-2013)

Széchenyi Professor, BME Budapest, Hungary (2000-2003)

Associate Professor, MTA KFKI RMKI Budapest, Hungary (since 1994)

Assistant Professor (C2), Giessen University, Germany (1993-94)

Assistant Professor (C1), Giessen University, Germany (1987-93)

Research Associate, Giessen University, Germany (1985-87)

Research Associate, GSI Darmstadt, Germany (1983-85)

Research Fellow, MTA KFKI Budapest, Hungary (1982-83)

Stipendiate, MTA KFKI Budapest, Hungary (1980-82)

Duke, Giesse, Budapest (1996-99)

Duke 1990-91

Grossenlinden 1992

Budapest 2002

Meeting Tamás in Lévai’s office 1996-99)

Duke 1990-91

Budapest 2002

The 1st non-extensive  (2010)

TSALLIS – PARETO-LIKE DISTRIBUTIONS IN HADRON-HADRON COLLISIONS *

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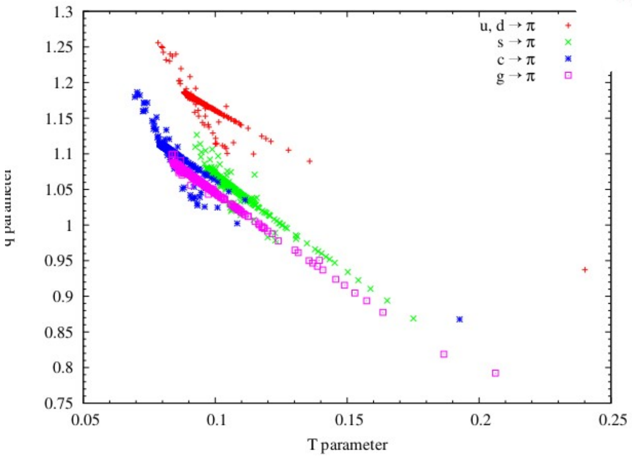
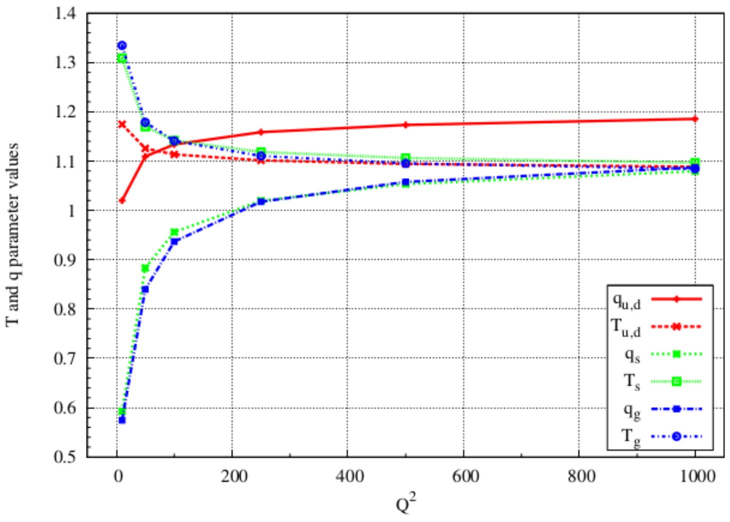
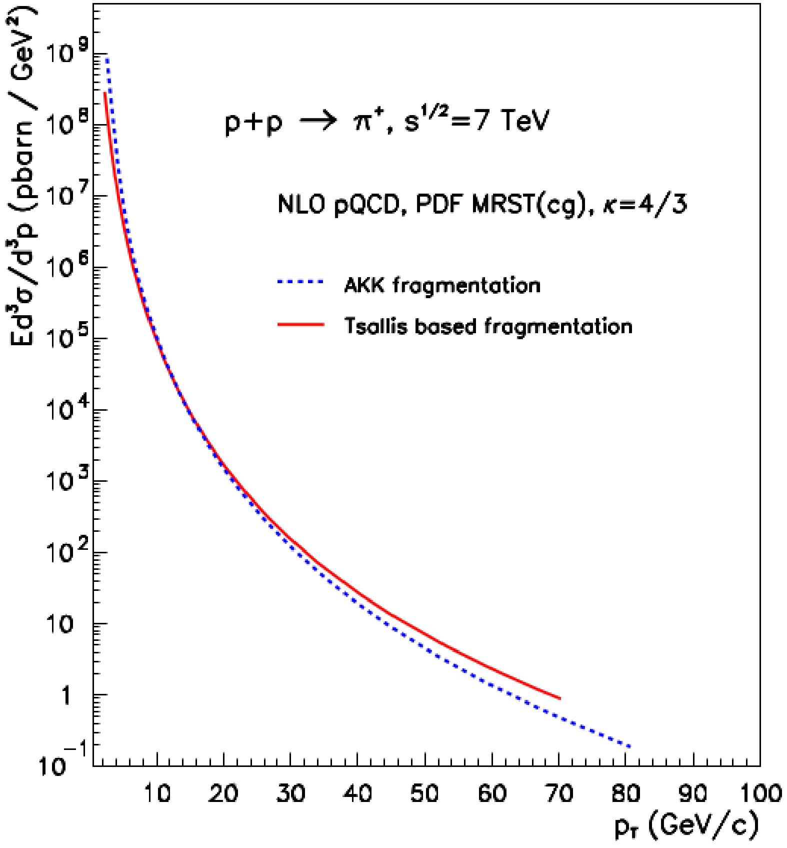
K. ÜRMÖSSY AND G. KALMÁR

Eörtvös University
1/A. Pázmány Péter Sétány
H-1117 Budapest, Hungary







The HCBM 2010

The 2nd non-extensive  (2012)

Derivation of Tsallis Entropy and the Quark-Gluon-Plasma Temperature

T.S. Biró, G.G. Barnaföldi and P. Ván[1]

[1] *Wigner Research Centre for Physics of the HAS, H-1525 Budapest, P.O.Box 49, Hungary*

(Dated: September 19, 2012.)

We derive Tsallis entropy, S_q, from universal thermostat independence and obtain the functional form of the corresponding generalized entropy-probability relation. Our result for finite thermostats interprets thermodynamically the subsystem temperature, T_1, and the index q in terms of the temperature, T, entropy, S, and heat capacity, C of the reservoir as $T_1 = T\exp(-S/C)$ and $q = 1 - 1/C$. In the infinite C limit, irrespective to the value of S, the Boltzmann – Gibbs approach is fully recovered. We apply this framework for the experimental determination of the original temperature of a finite thermostat, T, from the analysis of hadron spectra produced in high energy collisions, by analyzing frequently considered simple models of the quark-gluon plasma.

PACS numbers: 12.38.Mh, 05.70.-a, 12.40.Ee

Nonadditive thermostatistics and thermodynamics

P Ván[1,2], G G Barnaföldi[1], T S Biró[1], and K Ürmössy[1]

[1] Wigner RCP, Hungarian Academy of Sciences H-1525 Budapest, P.O.Box 49, Hungary
[2] Department of Energy Engineering, Budapest University of Technology and Economics, Bertalan Lajos u. 4-6, H-1111, Budapest, Hungary

E-mail: van.peter@wigner.mta.hu

Abstract. Nonadditive composition rules for several physical quantities are treated in thermodynamics. It is argued that the zeroth law defines the existence of their additive forms, the formal logarithms. A further principle, the universal thermostat independence leads to a particular formal logarithm, equivalent to Tsallis entropy S_q. We connect q with generalized susceptibilities of the thermostat.

Stat… …ower-Law Spectra due to Reservoir Fluctuations

T.S. Biró, G.G. Barnaföldi, P. Ván and K. Ürmössy

Heavy Ion Research Group
MTA Wigner Research Centre for Physics, Budapest

(Dated: October 29, 2018)

LHC ALICE data are interpreted in terms of statistical power-law tailed p_T spectra. As explanation we derive such statistical distributions for particular particle number fluctuation patterns in a finite heat bath exactly, and for general thermodynamical systems in the subleading canonical expansion approximately. Our general result, $q = 1 - 1/C + \Delta T^2/T^2$, demonstrates how the heat capacity and the temperature fluctuation effects compete, and cancel only in the standard Gaussian approximation.

Statistical Power Law due to Reservoir Fluctuations and the Universal Thermostat Independence Principle

Tamás Sándor Biró*, Péter Ván, Gergely Gábor Barnaföldi and Károly Ürmössy

MTA Wigner FK RMI, Konkoly-Thege M. 29-33, Budapest, Hungary

New Entropy Formula with Fluctuating Reservoir

T.S. Biró, G.G. Barnaföldi and P. Ván

Heavy Ion Research Group
MTA Wigner Research Centre for Physics, Budapest

(Dated: June 15, 2021)

Finite heat reservoir capacity, C, and temperature fluctuation, $\Delta T/T$, lead to modifications of the well known canonical exponential weight factor. Requiring that the corrections least depend on the one-particle energy, ω, we derive a deformed entropy, $K(S)$. The resulting formula contains the Boltzmann – Gibbs, Rényi, and Tsallis formulas as particular cases. For extreme large fluctuations, in the limit $C\Delta T^2/T^2 \to \infty$, a new parameter-free entropy – probability relation is gained. The corresponding canonical energy distribution is nearly Boltzmannian for high probability, but for low probability approaches the cumulative Gompertz distribution. The latter is met in several phenomena, like earthquakes, demography, tumor growth models, extreme value probability, etc.

The 2nd non-extensive  (2012)

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Nonadditive thermostatistics and thermodynamics

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[2]Department of Energy Engineering, Budapest University of Technology and Economics, Bertalan Lajos u. 4-6, H-1111, Budapest, Hungary

E-mail: van.peter@wigner.mta.hu

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Since then...

Journal of Physics G: Nuclear and Particle Physics

PAPER

Tsallis-thermometer: a QGP indicator for large and small collisional systems

Gábor Bíró, Gergely Gábor Barnaföldi and Tamás Sándor Biró

Published 13 August 2020 •

Journal of Physics G: Nuclear and Particle Physics, Volume 47, Number 10

Citation Gábor Bíró *et al* 2020 *J. Phys. G: Nucl. Part. Phys.* **47** 105002

DOI 10.1088/1361-6471/ab8dcb

Authors ▾ References ▾

Article information ▾

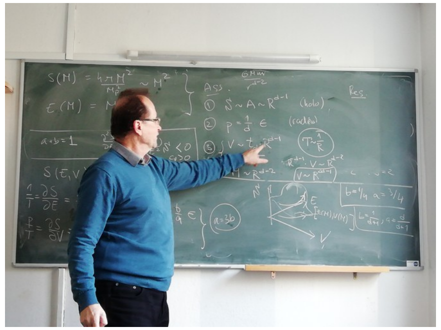
Abstract

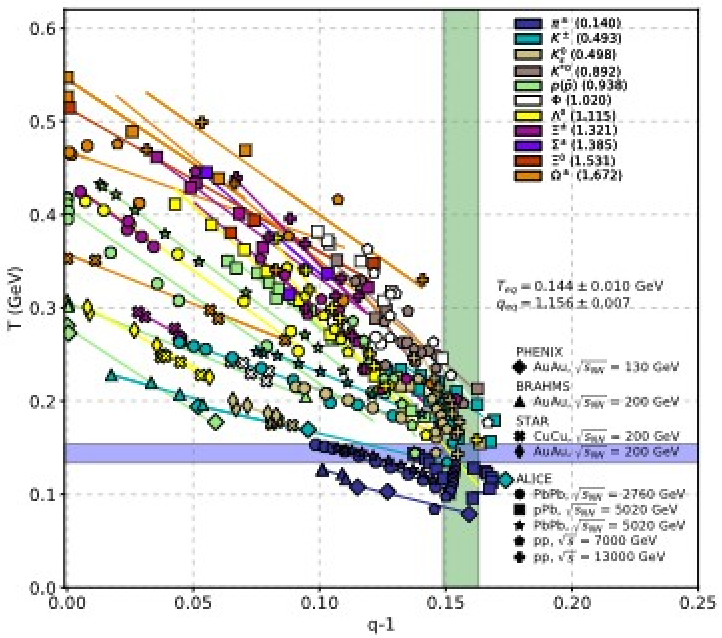
The transverse momentum distribution of identified hadrons from recent years are analyzed within the thermodynamically consistent formulation of non-extensive statistics. A wide range of center-of-mass energies and average event multiplicities are studied for various hadron species. We demonstrate that the average event multiplicity is a key variable in the study of high-energy collisions and a smooth transition in the description from small to large systems is possible. For this purpose the non-extensive statistical approach is more than appropriate. The validity of the non-extensive description is explored in multiple ways: such as the calculation of integrated yields per unit rapidity, the analysis of radial flow and the consistency check of the thermodynamical variables. The 'Tsallis-thermometer' is introduced as an indicator of quark-gluon plasma in small collisional systems.

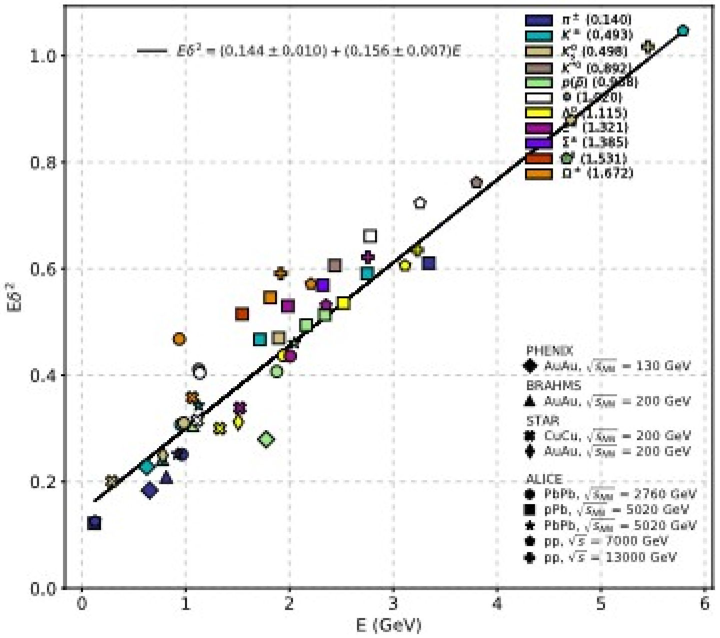
$$T(\sqrt{s_{NN}}, \langle dN_{ch}/d\eta\rangle, m) = T_0 + T_1 \ln\frac{\sqrt{s_{NN}}}{m} + T_2 \ln\ln\langle dN_{ch}/d\eta\rangle,$$

$$q(\sqrt{s_{NN}}, \langle dN_{ch}/d\eta\rangle, m) = q_0 + q_1 \ln\frac{\sqrt{s_{NN}}}{m} + q_2 \ln\ln\langle dN_{ch}/d\eta\rangle,$$

$$A(\sqrt{s_{NN}}, \langle dN_{ch}/d\eta\rangle, m) = A_0 + A_1 \ln\frac{\sqrt{s_{NN}}}{m} + A_2 \langle dN_{ch}/d\eta\rangle,$$







Since then…

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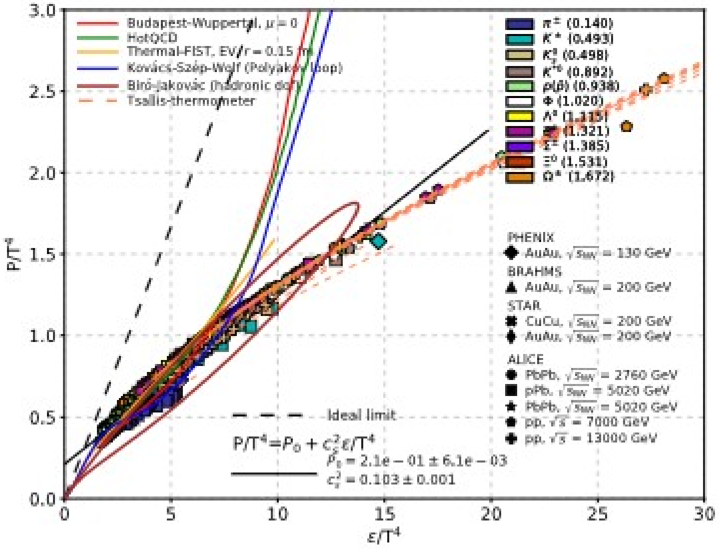
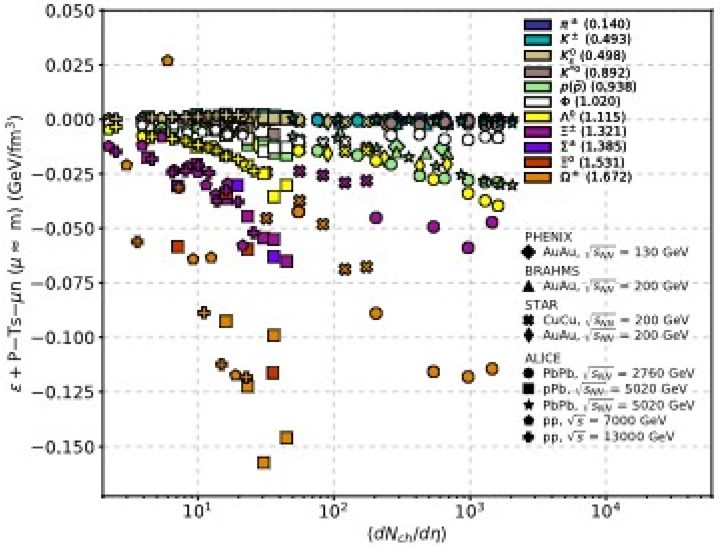




Since then...

How far can we see back in time in high-energy collisions using charm hadrons?

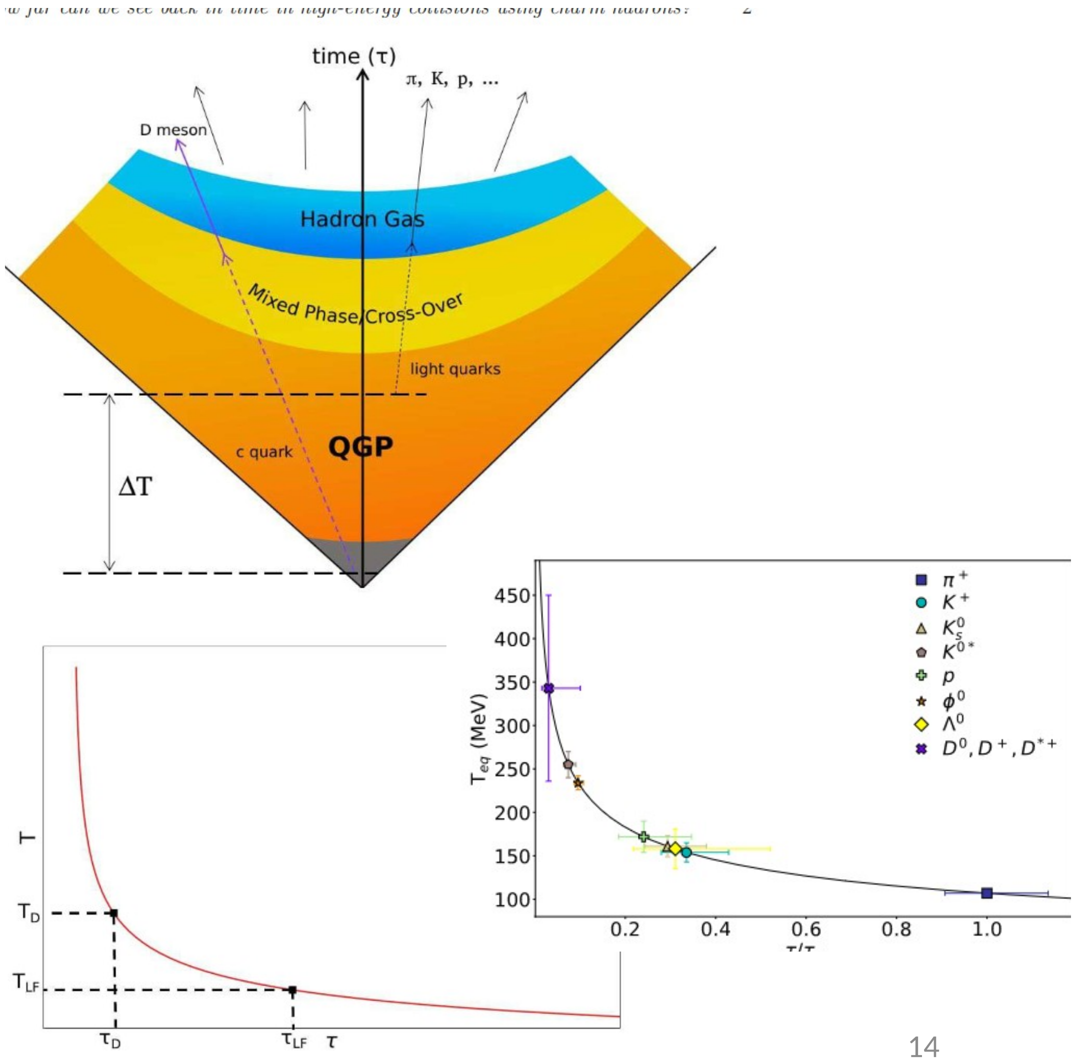
László Gyulai[1,2], Gábor Bíró[2,3], Róbert Vértesi[2,†], Gergely Gábor Barnaföldi[2]

[1] Budapest University of Technology and Economics, Műegyetem rkp. 3., H-1111 Budapest, Hungary.
[2] HUN-REN Wigner Research Center for Physics, 29–33 Konkoly–Thege Miklós Str., H-1121 Budapest, Hungary.
[3] ELTE Eötvös Loránd University, Institute of Physics, 1/A Pázmány Péter Sétány, H-1117 Budapest, Hungary.
[†] corresponding author

E-mail: gyulai.laszlo@wigner.hun-ren.hu, biro.gabor@wigner.hun-ren.hu, vertesi.robert@wigner.hun-ren.hu, barnafoldi.gergely@wigner.hun-ren.hu

3 July 2024

Abstract. We use open charm production to estimate how far we can see back in time in high-energy hadron-hadron collisions. We analyze the transverse momentum distributions of the identified D mesons from pp, p–Pb and A–A collisions at the ALICE and STAR experiments covering the energy range from $\sqrt{s_{\mathrm{NN}}} = 200$ GeV up to 7 TeV. Within a non-extensive statistical framework, the common Tsallis parameters for D mesons represent higher temperature and more degrees of freedom than that of light-flavour hadrons. Assuming Bjorken-expansion, the production of D mesons corresponds to a significantly earlier proper time, $\tau_{\mathrm{D}} = (0.18 \pm 0.06)\tau_{\mathrm{LF}}$.



The Hungarian Maffia…

So, thanks for giving me

the non-extensive pink glass!

It is more colorful and fun than
the ’standard thermodynamical’ one!

Happy 70th birthday & good health & more physics!