CFNS-SURGE Summer Workshop on the Physics of the Electron-Ion Collider

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Nonextensive description of charged particle production in pp collisions

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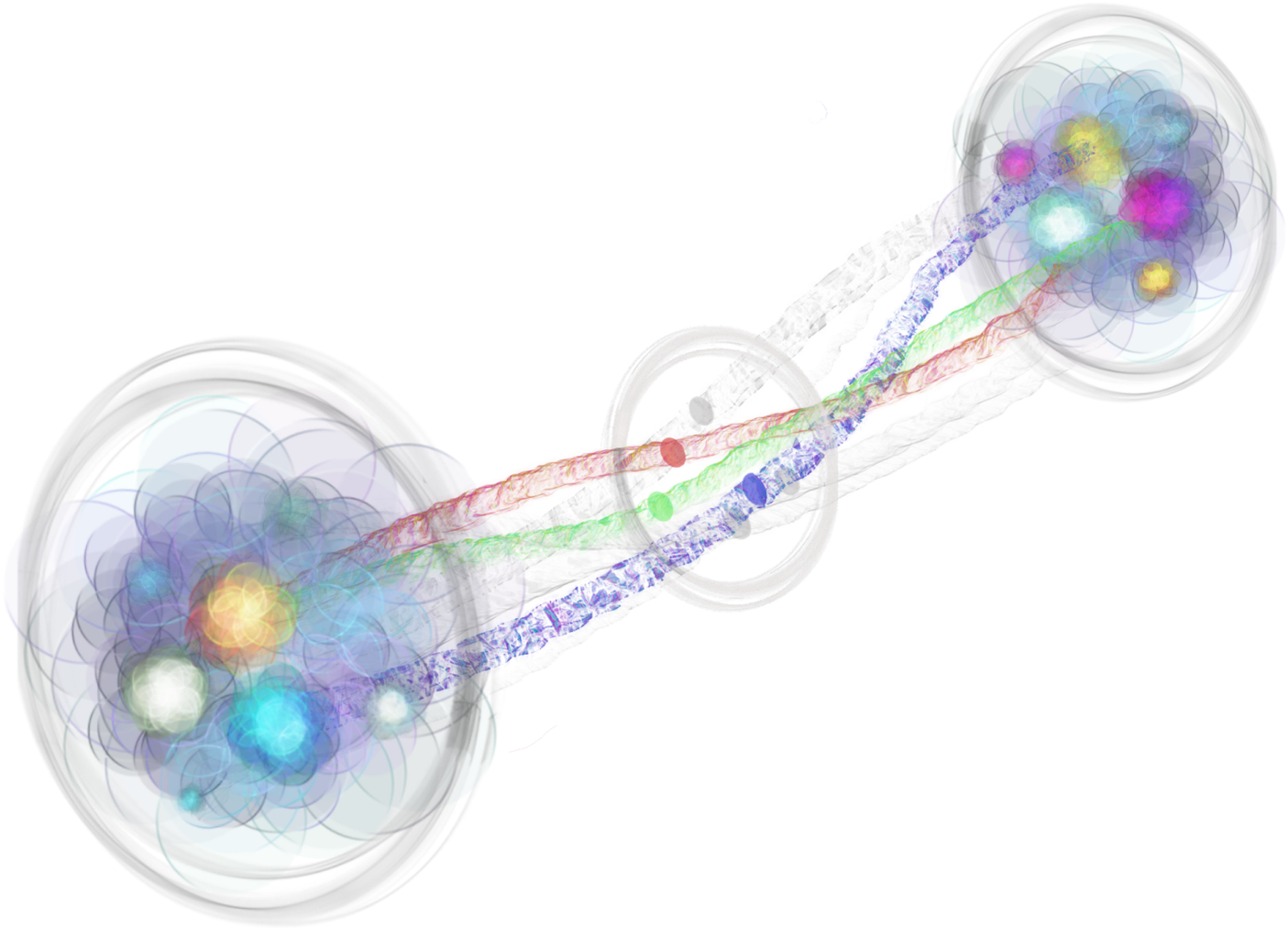
Particle production from Schwinger mechanism



$$\frac{dN}{dp_T^2} \sim \int_0^\infty \exp\left(-\frac{\pi p_T^2}{x^2}\right) P(x)dx$$

Schwinger Mechanism

String tension fluctuations

The Schwinger mechanism represents the probability of observing a particle with transverse momentum p_T produced by the fragmentation of strings with tension x^2.

Intensity of the color interaction

Schwinger J 1962 Phys. Rev. 128 2425 // Bialas A 1999 Phys. Lett. B 466 301

$$\frac{dN}{dp_T^2} \sim \int_0^\infty \exp\left(-\frac{\pi p_T^2}{x^2}\right) P(x)dx$$

Schwinger Mechanism

String tension fluctuations

Gaussian fluctuations $P(x) \sim \exp\left(-x^2/2\sigma^2\right)$

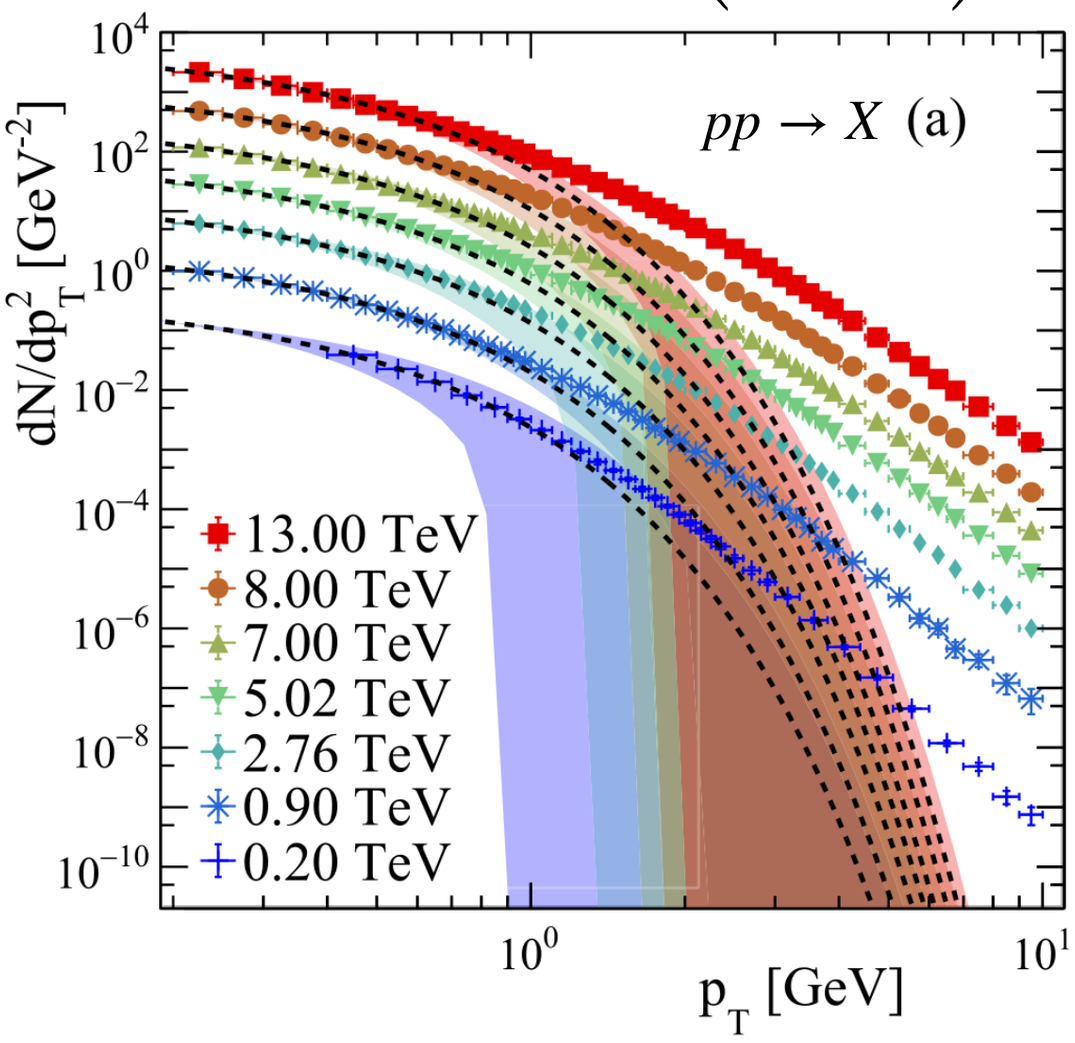
Thermal distribution $\frac{dN}{dp_T^2} \sim \exp\left(\frac{-p_T\sqrt{2\pi}}{\sigma}\right)$

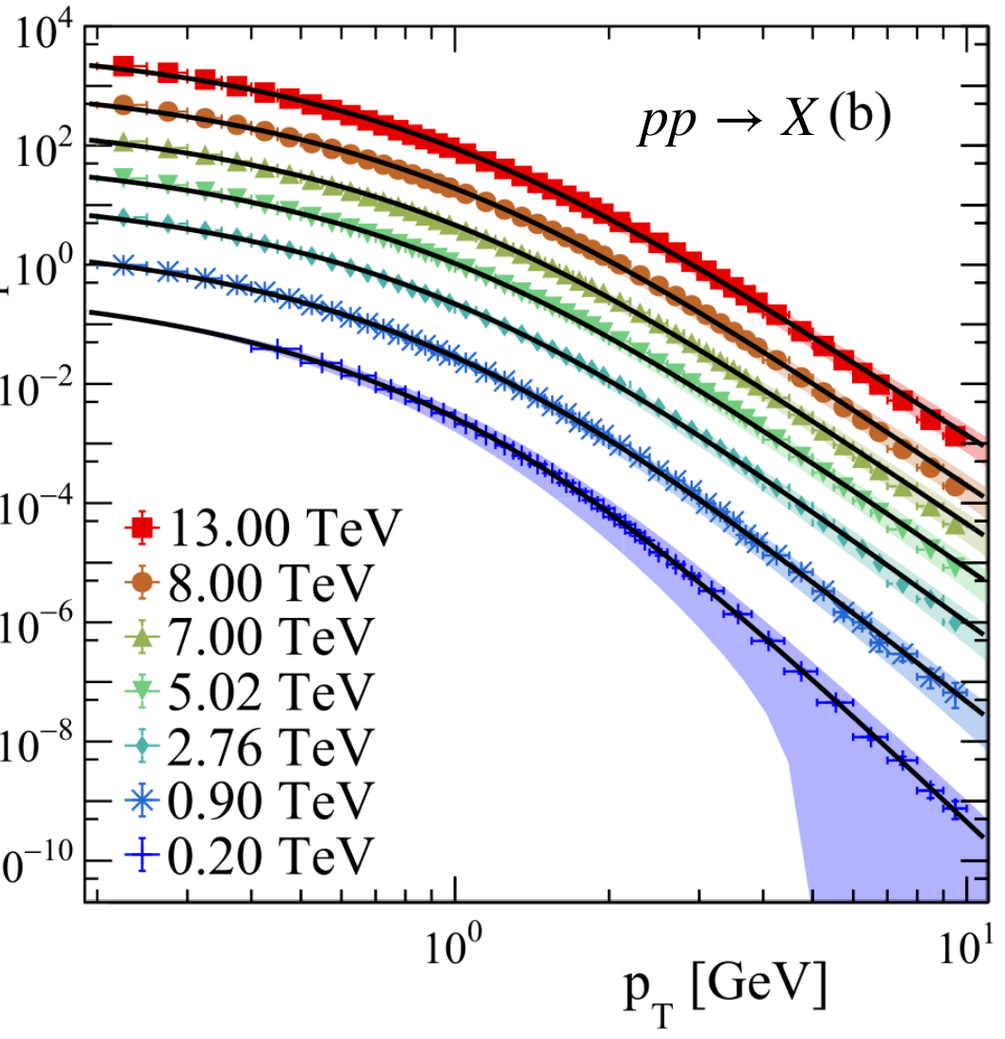
q-Gaussian fluctuations $P(x) \sim \left(1 + \frac{(q-1)x^2}{2\sigma^2}\right)^{\frac{1}{1-q}}$

Heavy tailed!

Tricomi's Function $\frac{dN}{dp_T^2} \sim U\left(\frac{1}{q-1} - \frac{1}{2}, \frac{1}{2}, \pi p_T^2 \frac{q-1}{2\sigma^2}\right)$

$1 < q < 1.5$





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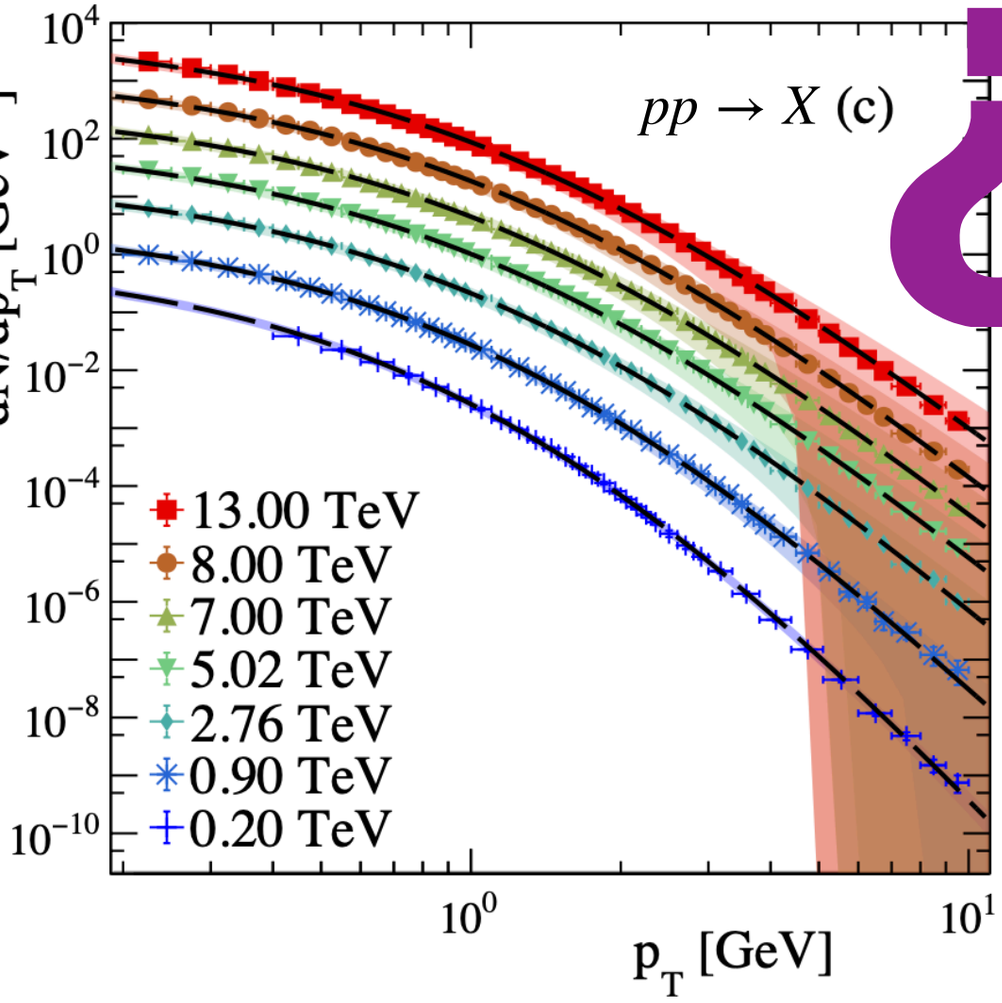
QCD-based Hagedorn function



¿ Hagedorn function $= \int_0^\infty \exp\left(-\frac{\pi p_T^2}{x^2}\right) P(x)dx$?

Schwinger Mechanism

String tension fluctuations

Is the Hagedorn function in agreement with the fragmentation model?

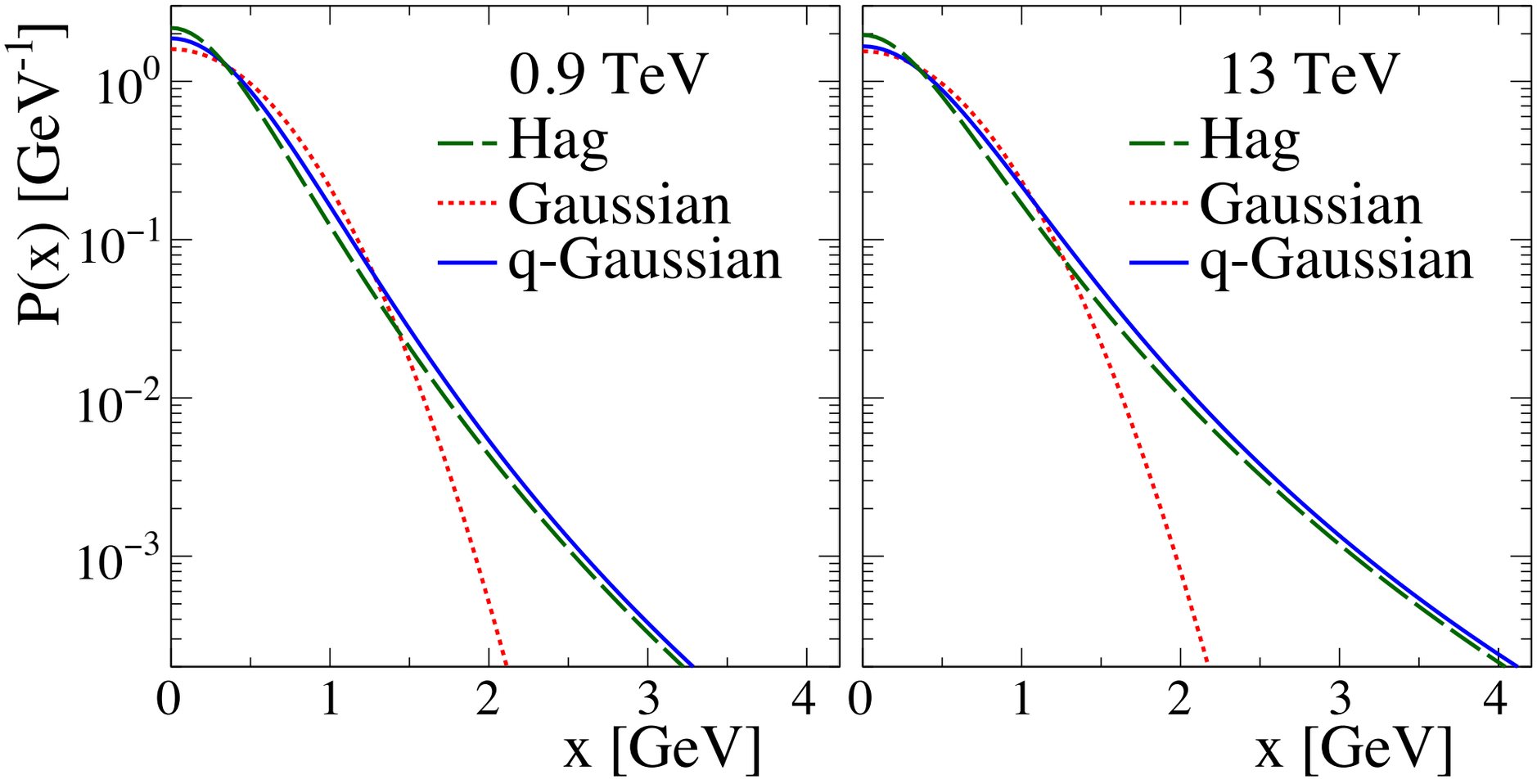
$$\left(\frac{p_0}{p_0+p_T}\right)^m = \int_0^\infty \exp\left(-\frac{\pi p_T^2}{x^2}\right) \frac{m p_0^m \pi^{\frac{m-1}{2}}}{x^{m+1}} U\left(\frac{m+1}{2}, \frac{1}{2}, \frac{\pi p_0^2}{x^2}\right) dx$$

String tension fluctuations $P(x)_{\text{Hag}}$ is a heavy-tailed distribution too !!

D. Rosales Herrera, et al 2024 *Phys. Rev. C*, *109*(3), 034915 // R. Hagedorn, Riv. Nuovo Cim. 6N10, 1 (1983)

String tension fluctuations

P_{qG} and P_{Hag} are phenomenologically equivalent



Heavy tailed distributions play an important role in the description of particle production !

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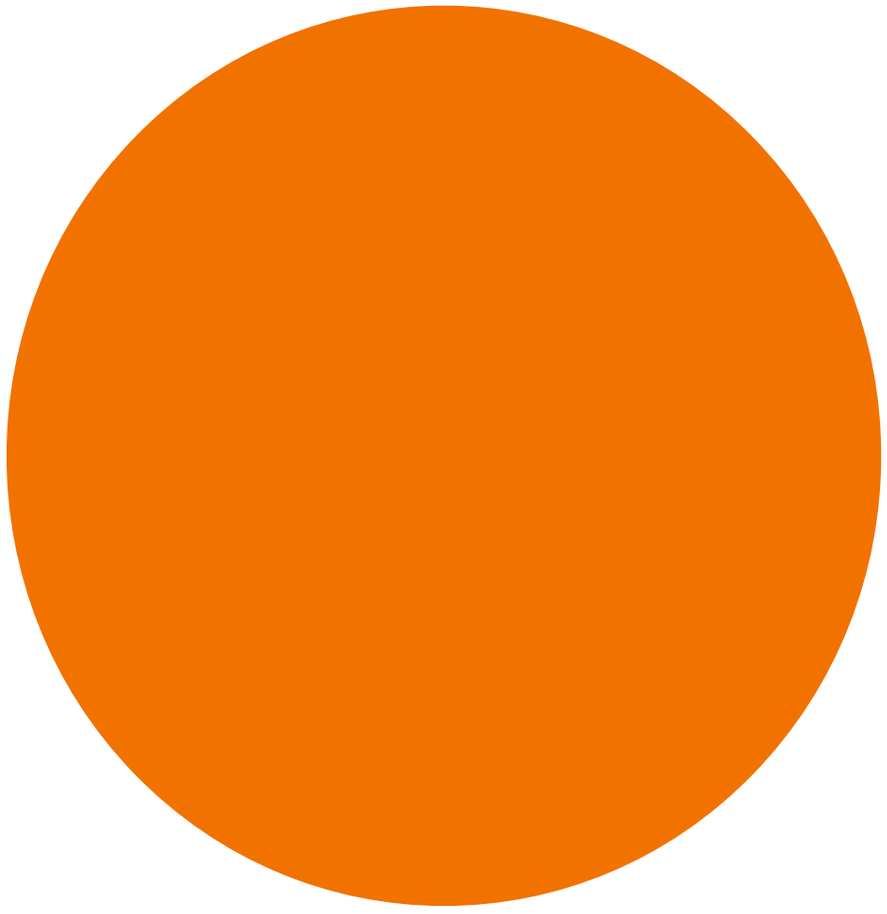
Temperature fluctuations

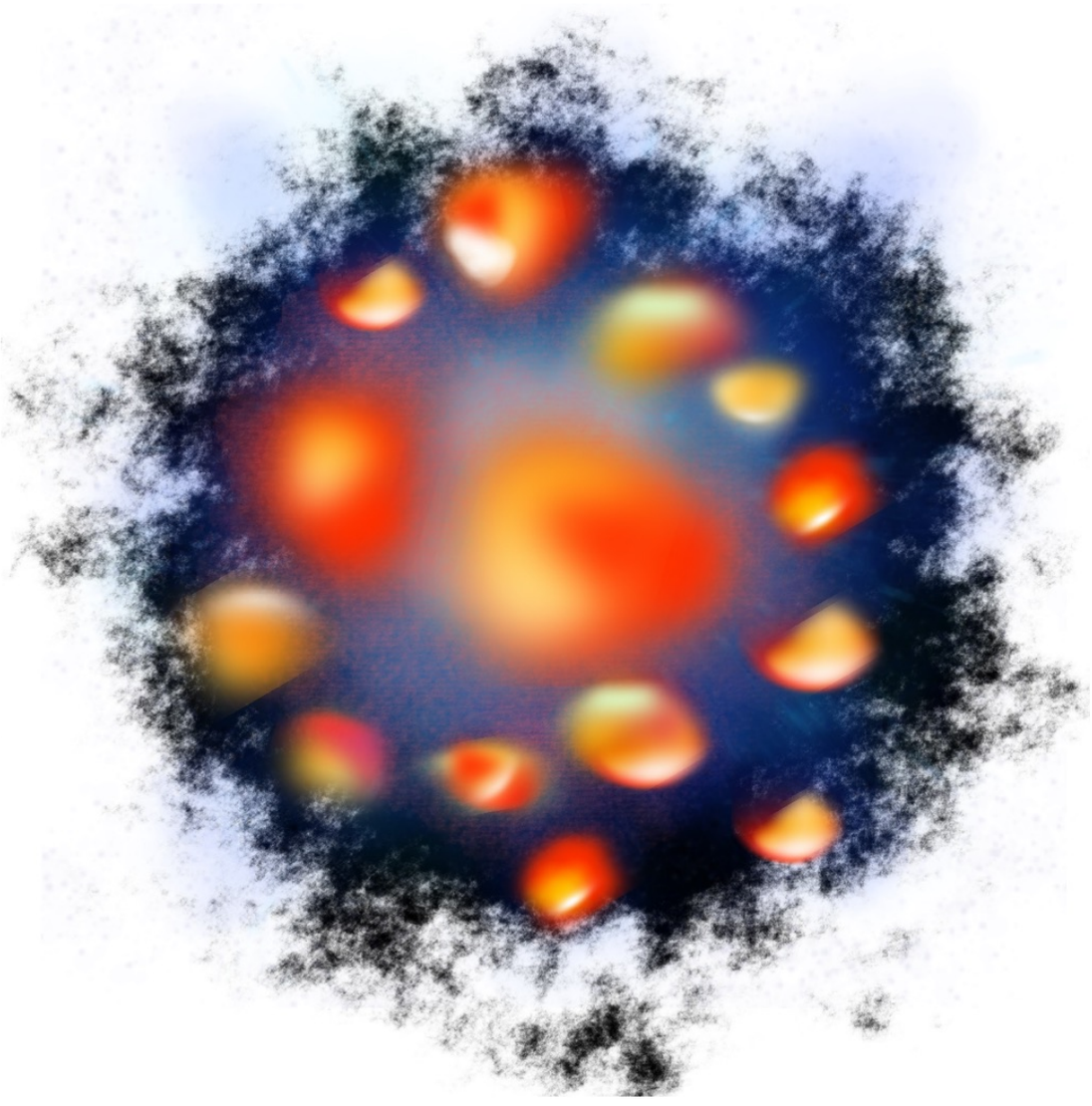
Gaussian fluctuations

$$\mathscr{T}_{th}(T) = \delta(T - T_{th})$$



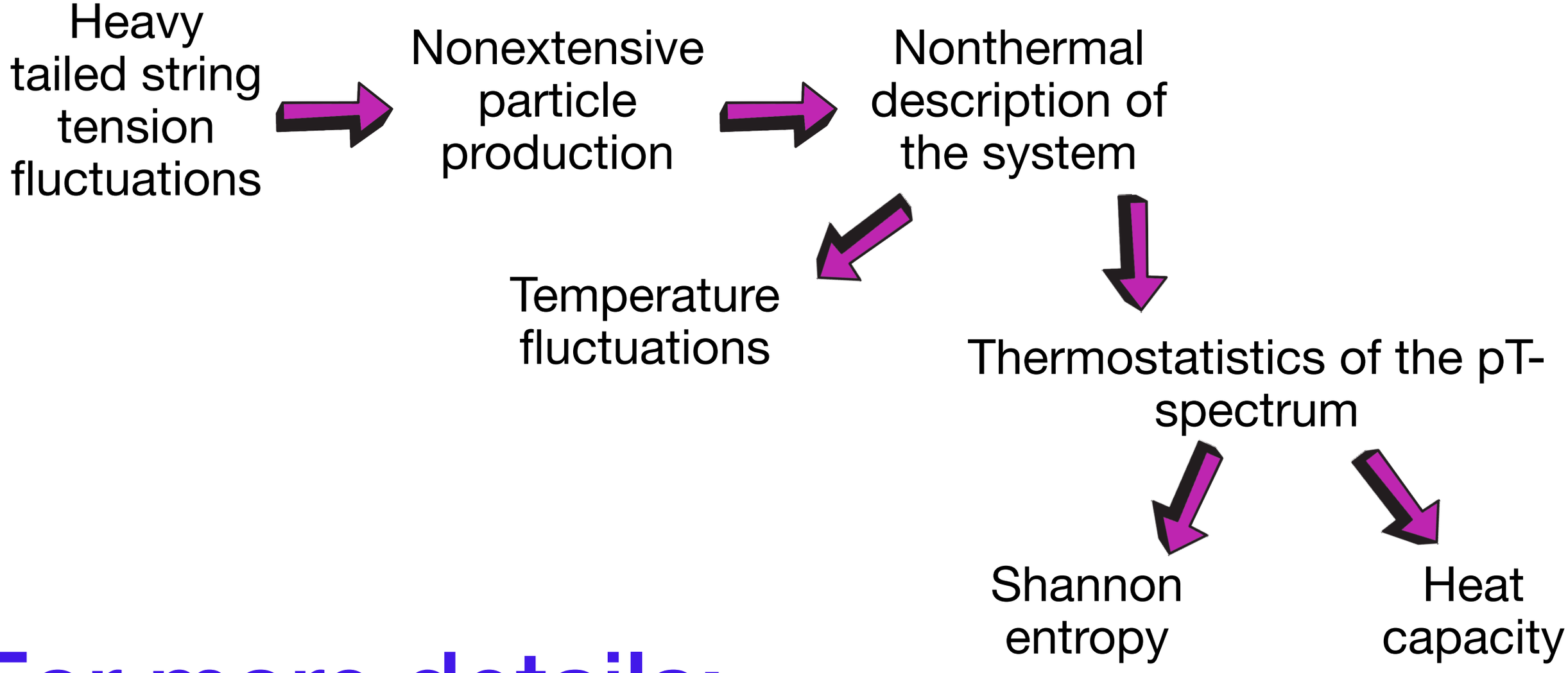
q-Gaussian fluctuations

$$\mathscr{T}_{U}(T) = \frac{2}{T^3}\Gamma\left(\frac{1}{T^2}, \frac{1}{q-1} - \frac{1}{2}, \frac{1}{4z_0}\right)$$



D. Rosales Herrera, et al, Phys. Rev. C 110, 015205 (2024).

Thank you



For more details:

[1] D. Rosales Herrera, et al, Phys. Rev. C 110, 015205 (2024)

[2] D. Rosales Herrera, et al, Phys. Rev. C 109, 034915 (2024)

[3] J. R. Alvarado García, et al, J. Phys. G: Nucl. Part. Phys. 50, 125105 (2023)

[4] J. E. Ramírez, et al, Eur. Phys. J. A 59, 250 (2023)