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Arxiv report

Long Range Azimuthal Correlation, Entanglement and Bell Inequality Violation by Spinning Gluons at the LHC

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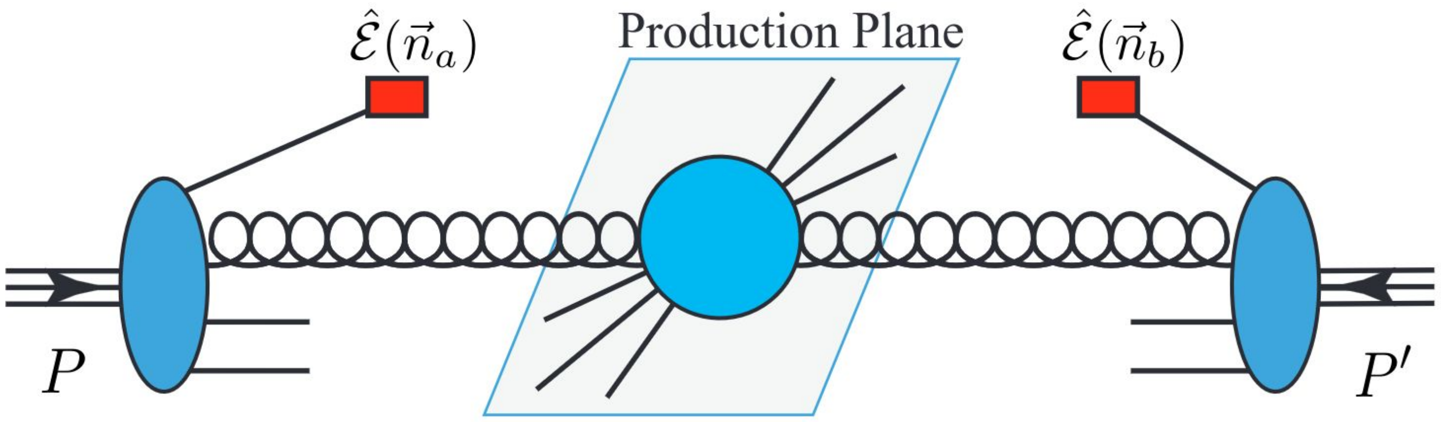
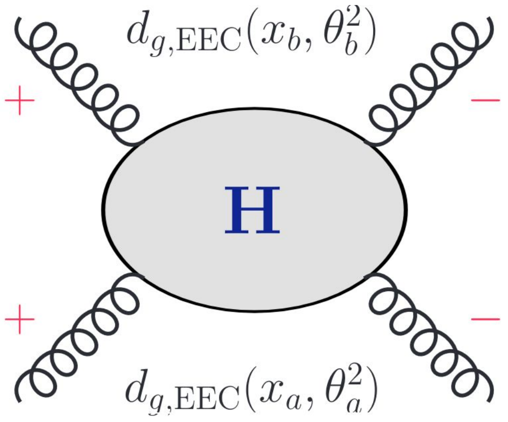
https://arxiv.org/pdf/2406.05880

- Introduction of Nucleon energy-energy correlator (NEEC) for H, t-pair from spinning gluons
- Measure energy flows in 2 arbitrary pixels on CAL with asymptotic energy flow operator
- θ_a, θ_b both small and in opposite directions => large rapidity difference -> long range correlation
- Long range cos(2ϕ) asymmetry from interference between double helicity-flip amplitudes in the scattering





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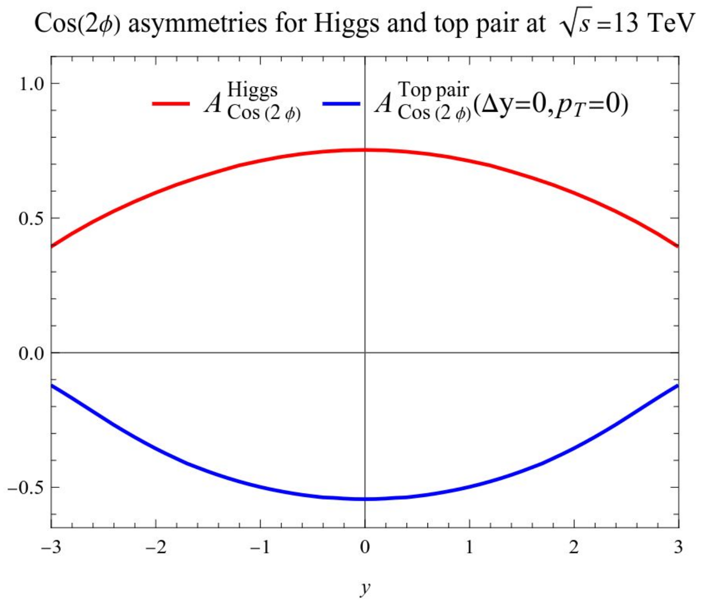
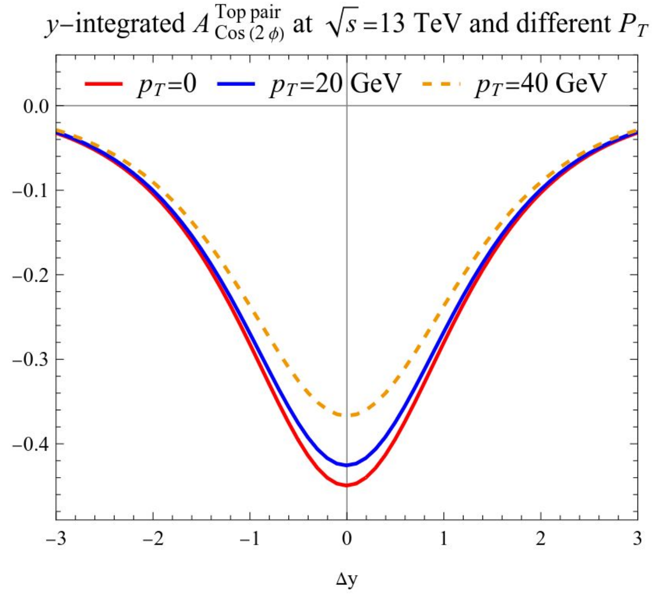
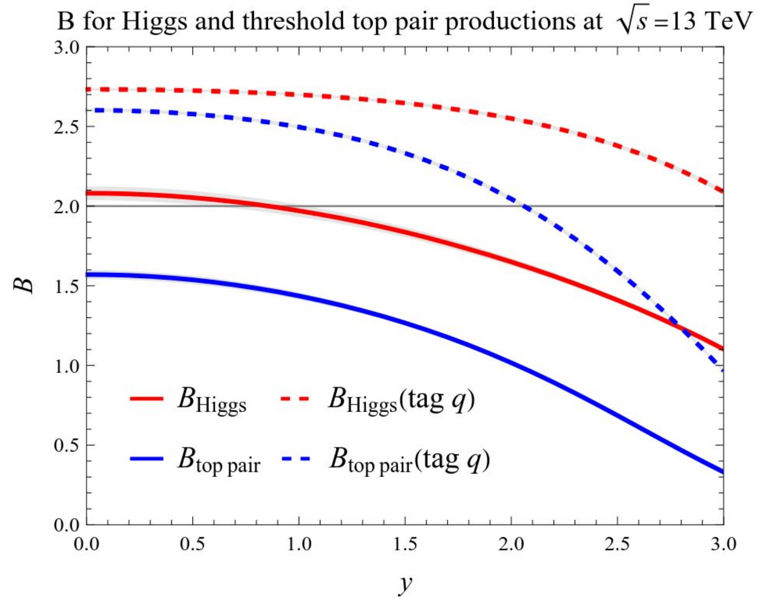
- Asymmetries different not the same for all processes, Δy and p_T
- Clauser-Horne-Shimony-Holt inequalit B ≤ 2 (equivalent to Bell’s)
- Full kinematics are not needed, just azimuthal angles of energy flow in forward detectors!

=> Measure fundamentals, Precision in SM (on H, tt and γγ) and probes for BSM!







Analytical approximations closed as desired to special functions

https://arxiv.org/pdf/2406.11947

- Method to construct global analytical expressions that approximate a function f over its entire range
- First fix asymptotic behaviour with two functions f_i,j and combine into initial structure f_s
- Middle range accuracy is controlled by adding additional terms that include additional degrees of freedom (DOF) in the form of coefficients that are determined by numerical minimization of resultant error
- local minimization gradient descent method, differential evolution algorithm
- Power series, Pade approximation are excellent candidates as DOF
- Global accuracy of approximation is p-norm of relative error

$$\lim_{x\to x_i} \frac{f(x)}{f_i(x)} = 1$$

$$\lim_{x\to x_f} \frac{f(x)}{f_f(x)} = 1$$

$$f_s(x) = g_i(x) f_i(x) + g_f(x) f_f(x)$$

$$\lim_{x\to x_i} \frac{f(x)}{f_s(x)} = \lim_{x\to x_f} \frac{f(x)}{f_s(x)} = 1$$

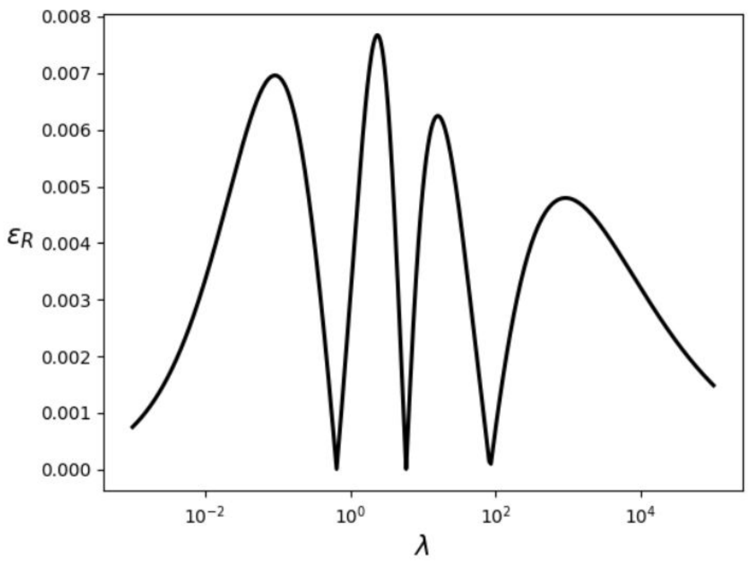
$$\|\varepsilon_R\|_p = \left(\int_{x_i}^{x_f} dx \left| \frac{\tilde{f}(x) - f(x)}{f(x)} \right|^p \right)^{\frac{1}{p}}$$

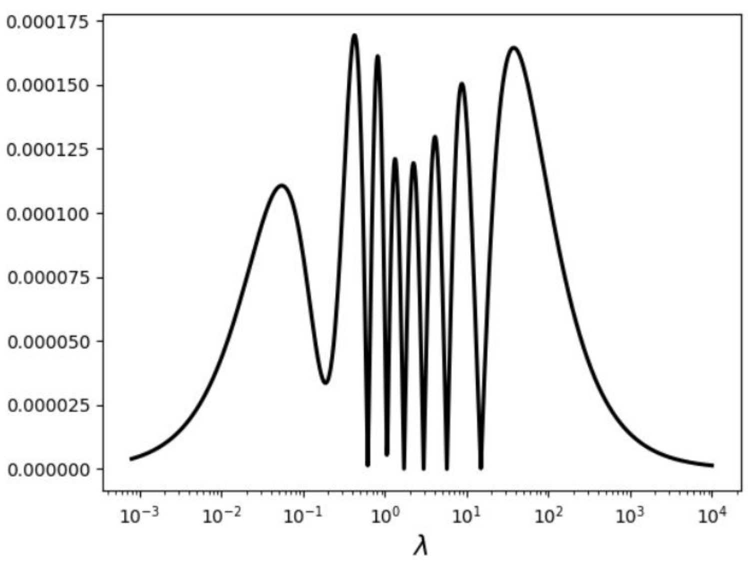
Fermi gas pressure

$$f(\lambda,\nu) = \int_1^\infty dx \frac{\left(x^2-1\right)^{\frac{3}{2}}}{e^{\lambda x-\nu}+1}$$

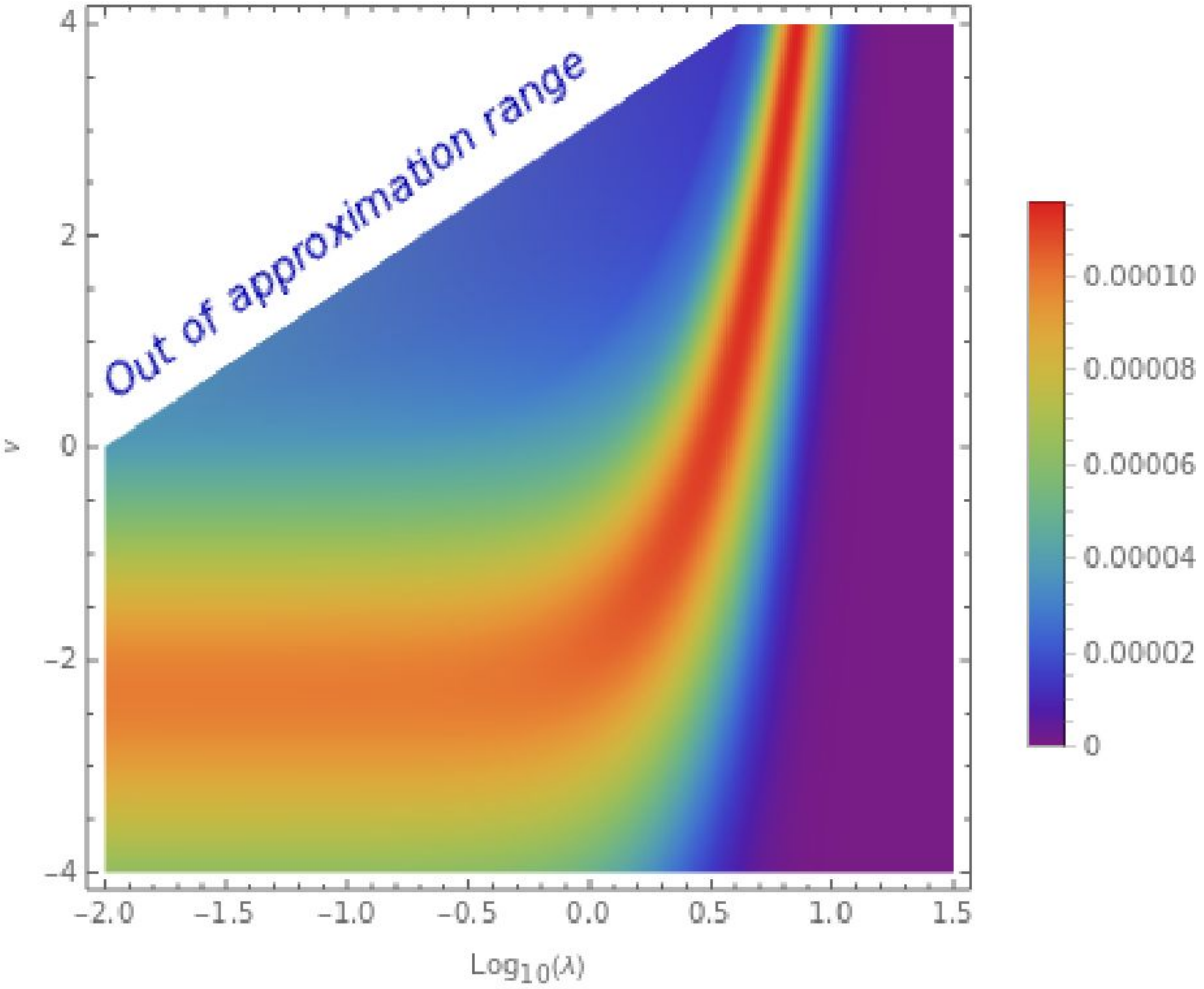
$$\tilde{f} = e^{-\lambda}\left(\frac{111.3}{\lambda^{3.05}} - \frac{108}{\lambda^{3.045}} + \frac{3\sqrt{2\pi}}{2\lambda^{2.5}} + \frac{7\pi^4}{120\lambda^4}\right)$$

$$\tilde{f} = \frac{e^{-\lambda}}{\lambda^4}\left(\frac{\frac{9\pi\lambda^8}{2} + 47.95\lambda^7 + 95.3\lambda^6 + 55\lambda^5 + 102.6\lambda^4 - 12\lambda^3 + 37\lambda^2 + 81.1\lambda + \frac{49\pi^8}{14400}}{\lambda^5 - 0.33\lambda^4 + 2.18\lambda^3 - 1.597\lambda^2 + 0.522\lambda + 1}\right)^{0.5}$$





$$\tilde{f} = \frac{1}{\lambda^2}\left(3e^{\nu}K_2(\lambda) - 0.8857e^{2.0411\nu}K_2(2.0411\lambda) + 1.0814e^{2.787\nu}K_2(2.787\lambda) - 0.7283e^{2.92\nu}K_2(2.92\lambda)\right)$$



An Efficient Approach to Regression Problems with Tensor Neural Networks (TNN)

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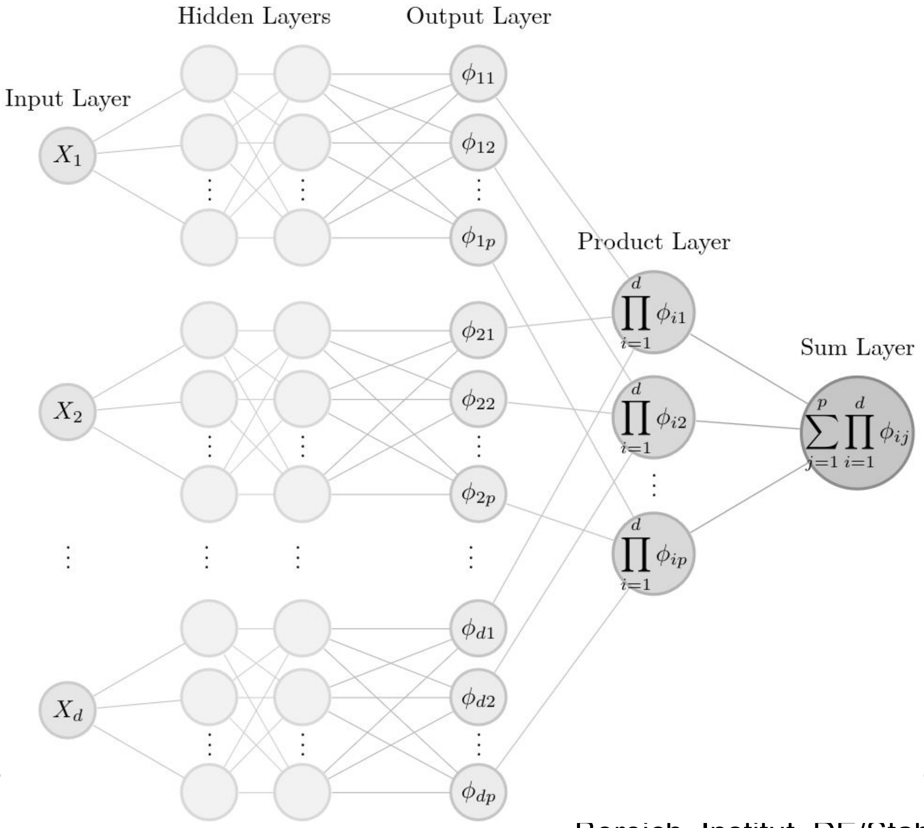
https://arxiv.org/pdf/2406.09694

- TNN to address nonparametric regression problems
- Integration of statistical regression and numerical integration into TNN framework
- efficiently performing high-dimensional integrations
- high-precision interpolations



$$f(x) = \sum_{i=1}^{8} sin(2\pi x_i), \quad x \in [0,1]^8$$

Table 2: Comparison of Model Performance

Model	Training MSE	Validation MSE	Testing MSE
FFN	1.7490E-03	1.7235E-03	2.1336E-03
RBN	2.1390E-04	1.9976E-03	1.8986E-03
TNN	2.9916E-05	3.8506E-05	4.3672E-05

$$f(x) = \prod_{i=1}^{8} e^{-x_i^2}, \quad x \in [0,1]^8$$

Table 4: Comparison of Model Performance

Model	Training MSE	Validation MSE	Testing MSE
FFN	3.6227E-06	1.3982E-05	2.0804E-05
RBN	5.2234E-08	9.2906E-07	1.3424E-06
TNN	7.5502E-07	7.7727E-07	1.2823E-06

Modeling of strength of concrete

Table 6: Comparison of Model Performance

Model	Training MSE	Validation	Testing MSE
FFN	2.7257E-03	3.4411E-03	3.9812E-03
RBN	1.7196E-03	4.2468E-03	5.1297E-03
TNN	3.1514E-03	2.7061E-03	3.4946E-03