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Recent developments in angular correlations of identified particles (experiment & theory)

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Angular ($\Delta\eta\Delta\varphi$) correlations of identified particles measured in ultrarelativistic proton-proton and heavy-ion collisions exhibit a number of features which depend on the collision system and particle type under consideration. Those features are produced by various mechanisms, such as (mini)jets, elliptic flow, resonance decays, and conservation laws. In addition, of particular importance are those related to the quantum statistics (QS) and final-state interactions (FSIs).

Latest measurements of $\Delta\eta\Delta\varphi$ correlations of identified particles from ALICE [1] and STAR [2] show differences in particle production between baryons and mesons. While the correlation functions for mesons exhibit the expected near-side ($(\Delta\eta,\Delta\varphi)\approx(0,0)$) peak dominated by effects of mini-jet fragmentation and are well reproduced by general-purpose Monte Carlo (MC) generators, the story is different for baryons. For pairs of particles of the same baryon number a surprising near-side anti-correlation structure is observed instead of a peak, implying that two such particles are rarely produced with similar momentum. Until recently, this effect has not been reproduced by any of the MC models, however, several developments on the theory side have been made since the publication of experimental results (i.e. [3,4]). The discrepancy poses fundamental questions on the production mechanism of baryons.

Moreover, in our recent work [5] we show how to unfold the QS and FSI contributions in angular correlation functions using momentum correlations (femtoscopy). In particular, we show how those effects modify the shape of the angular correlation function with emphasis on proton-proton pairs. Most importantly, specific structures in the near-side region of the two-baryon angular correlation function, namely a small enhancement in the middle of a depletion for proton-proton pairs is reproduced with the proposed unfolding procedure. However, the unfolding of the FSI and QS effects is not able to explain the wide anticorrelation effect at near-side observed by ALICE and STAR.

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[2] J. Adam et al. (STAR Collaboration), Phys. Rev. C 101, 014916 (2020), https://arxiv.org/abs/1906.09204
[3] L.Y. Zhang et al., Phys. Rev. C 98 (2018) 3, 034912, L.Y. Zhang et al., Phys. Lett. B 829 (2022) 137063
[4] N. Demazure, V. Gonzalez, F. Llanes-Estrada, https://arxiv.org/abs/2210.02358
[5] Ł. Graczykowski, M. Janik, Phys. Rev. C 104, 054909 (2021)

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