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Probing the QCD phase diagram with HBT femtoscopy

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The first observation of intensity correlation between bosons, namely photons was observed in the field of radio astronomy by Hanbury Brown and Twiss, hence such quantumstatistical correlations usually referred as HBT correlations. Quantumstatistical correlations were also observed in particle physics, firstly by Goldhaber, Goldhaber, Lee and Pais among same charged pions. They could explain the measured data by took into account for the Bose-Einstein symmetrization of the wave function of indistinguishable bosonic particles. Nowadays, HBT or Bose-Einstein correlations are widely used technique to measure the spatio-temporal properties of the particle emitting source but their importance are not solely given by their direct relation to the source size but their possible connections to underlying processes such as partially coherent particle production, in-medium mass modification or critical phenomena.

With limited statistics, the Gaussian shape of the correlation function was assumed but recent measurements have revealed a more detailed structure of the correlation functions. By employing Levy-type of correlation functions a new parameter, the Levy-index is introduced which could indicate several physical processes. It also gives statistically acceptable description of the measured data. In the special case, when the Levy-index is equal to 2 it restores the Gaussian distribution, when equal to 1, restores the Cauchy distribution. Interstitial values could be explained by anomalous diffusion, QCD jets, vicinity of the hypothetical critical point on the QCD phase diagram. These possibilities could mean motivation to perform precise HBT measurements to clarify the physical meaning of the Levy-index. Its possible relation to critical phenomena could make the measurements of the Levy-index a good tool to investigate the phase diagram of the strongly interacting matter. The precise measurements of the strength of the correlation, however, could give an insight to the particle production.

In my presentation I will review the theoretical background of the Levy HBT correlation measurements and then will give an overview results from BNL (PHENIX and STAR) and from CERN (CMS and NA61).

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