Fayoum University
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Final State Effects of Quantum Statistical Correlations in Ultra-Relativistic Collisions

Thesis

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By

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Master Thesis

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Abstract

Bose-Einstein correlation functions are an important tool in heavy ion collisions to discover the geometry of the emitting source and get information about its thermodynamical properties, and inner dynamics. and taking into account the modifications of those functions will be discussed in this study. BEC refers to the quantum-statistical correlations observed between identical particles (such as pions) produced in high-energy collisions. These correlations arise due to the indistinguishability of identical particles and their quantum mechanical behavior. In heavy-ion collisions, the dependence of the longitudinal dimension (denoted as p_{long}) on the average transverse momentum (k_T) and transverse mass (m_T) of the pion pair can be described using the Heisenberg uncertainty relations. The A-B effect is a quantum phenomenon related to the electromagnetic potential. Classically, there is no interpretation for this effect since the electromagnetic field strength vanishes outside a long the closed loop of the flux. However, the non-vanishing electromagnetic potential outside the loop leads to observable effects. A geometric interpretation of the A-B effect involves considering the equation of motion of a charged test particle in a combined gravitational and electromagnetic field. The resulting equation contains extra terms representing forces affecting the particle's acceleration, with the second term giving rise to the A-B effect. The Coulomb interaction describes the electrostatic force between charged particles.

In ultra-relativistic collisions, charged particles experience both the strong nuclear force (responsible for hadronization) and the electromagnetic Coulomb force. The Coulomb interaction modifies the momentum distribution of produced particles, affecting their correlations. As a result of these phenomena the time of flight needs some modifications to be taken into account to get the accurate time from the collision point to the detector, so the time shift and phase shift must described.

The thesis is coming in six chapters. Through the first chapter of the current thesis I introduce a background and highlight on the basic concepts of Aharonov-Bohm effect and historical overview. Details and descriptions of Bose-Einstein statistics with AB effect with wave function shift are mentioned in chapter two, then the third chapter contains the basic concepts of Core-Halo model with time evolution after ultra-relativistic collisions. In chapter four the calculation of Monte Carlo simulation from toy model to calculate the accurate time of flight for the traveled particles from the collision point to the detector is described. Chapter Five introduces the results from the model and MC simulation with a discussion. Finally our conclusion about AB phenomena with its modifications on particle wave function through RHIC experiments are given.