Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

A Search for Charm and Beauty in a Very Strange World

By

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The Relativistic Heavy Ion Collider (RHIC) was built to produce and study the extremely hot and dense phase of matter called Quark Gluon Plasma (QGP) in which the degrees of freedom are individual partons rather than composite hadrons. Since 2000, RHIC has collided various species of particles in order to disentangle and isolate the properties of the strongly interacting QGP: p+p to set a baseline, d+Au to establish a control experiment, Au+Au to definitively create the QGP, and Cu+Cu to bridge the gap between d+Au and Au+Au.

Electron-positron pairs are a particularly effective probe of the QGP because they carry no color charge. Therefore, once created, these leptons do not interact strongly with the medium. As a result, they retain characteristics of the full time evolution and dynamics of the system. There are many features of interest in the dielectron invariant mass spectrum. The low mass region ($m<1$ GeV/c^2) consists primarily of pairs from Dalitz decays of light hadrons and direct decays of vector mesons that can be modified by the medium, while the intermediate ($1<m<3$ GeV/c^2) and high ($4<m<8$ GeV/c^2) mass regions are dominated by pairs from mesons containing charm and beauty respectively.

Of the multitude of measurements that PHENIX has produced over the last decade, one of the more mysterious and intriguing is a large enhancement of pairs in the low mass region in central Au+Au collisions compared to the p+p reference. Current theories are unable to explain the origin of this excess and a lingering question within the field is whether the presence of "cold" nuclear matter in the initial state of the collision, independent of the formation of a QGP, could possibly account for this increased yield.

To answer this question, this thesis explores the dielectron spectra in d+Au collisions at $\sqrt{s_{NN}}$ =200GeV. The d+Au system contains the cold nuclear matter in question but cannot create the required energy density to form a QGP, making it an ideal place to explore these effects. In addition, the 2008 d+Au dataset contains the necessary luminosity to also dissect the high mass region of the spectrum, thereby illuminating the characteristics of heavy flavor production. These include measuring the production cross sections for charm and beauty (σ_{cc}, σ_{bb}) as well as testing the validity of next-to-leading order perturbative Quantum Chromodynamics (NLO pQCD).

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