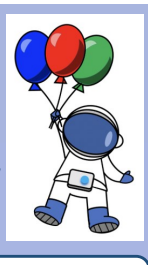
Di-Hadron Photoproduction in Au+Au Ultra-Peripheral Collisions at 200 GeV

Xin Wu (*for the STAR Collaboration*),
University of Science and Technology of China, Email: wuxinust@mail.ustc.edu.cn

QM 2023

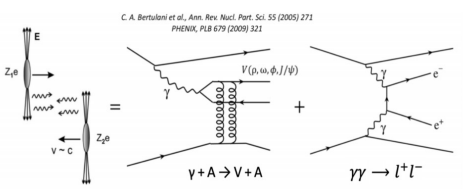


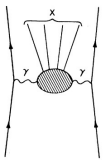
Abstract

Relativistic heavy-ion collisions generate extremely strong electromagnetic fields, providing an ideal environment to study the electromagnetic excitation of the vacuum. This poster shows the first measurements of baryon-antibaryon and meson-antimeson pair production from QED vacuum excitation in Au+Au ultra-peripheral collisions at $\sqrt{s_{NN}}$ = 200 GeV by the STAR experiment. These measurements will shed new lights on the understanding of the QED vacuum.

Motivation

- The ground state of quantum system is characterized by zero-point motion, and consequentially the creation and annihilation of virtual matter and antimatter particle pairs occur all the time in QED vacuum.
- An electromagnetic field which reaches the Schwinger limit would separate the virtual particle pairs. These virtual particle pairs will evolve to real particle pairs in a dynamic environment and be observed.
- The Breit-Wheeler process has been observed by STAR*, but higher excitation mode of QED vacuum from pure electromagnetic fields has never been measured.

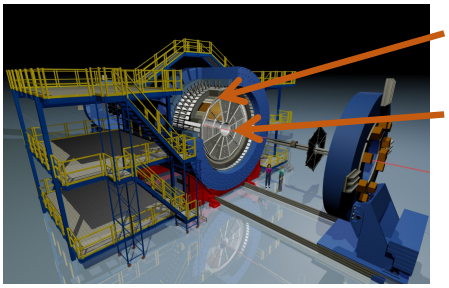




*J.Adam et al. (STAR), Phys.Rev.Lett. 121 (2018) 13, 132301

$\gamma\gamma \to h\bar{h}$?

The Solenoidal Tracker At RHIC (STAR)



Time of flight: particle identificatin

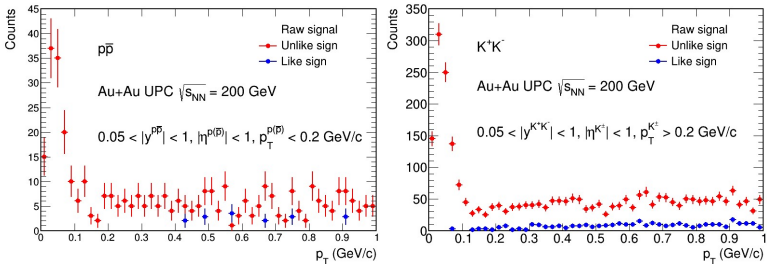
Time Projection Chamber: track reconstruction, particle identification

Zero-Degree Calorimeter: detect neutrons

Event Selection and Particle Identification

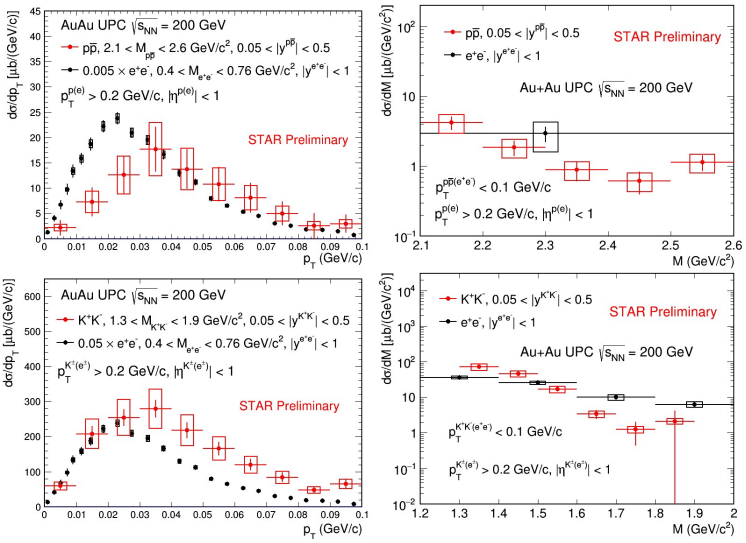
- Dataset: Au+Au at 200 GeV taken in 2010/2011
- Trigger: UPC-main (ZDC coincidence + BBC veto + bTOF activity)
- Luminosity: 1085.9 μb^{-1} (2010), 858 μb^{-1} (2011)
- Event selection: nPrimary = 2.
- PID: $\chi^2_{p\bar{p}}$ (or $\chi^2_{K^+K^-}$)<4 & $\chi^2_{\pi^+\pi^-}$>20 ($\chi^2_{12} = n\sigma_1^2 + n\sigma_2^2$)
- Pairs with |y|<0.05 are rejected to remove cosmic rays.

Raw Signals



- Significant pp̄ and K^+K^- signals are observed at p_T < 0.1 GeV/c.

Cross Section



- $\sigma_{AuAu\to AuAu p\bar{p}}$ = 0.83 ± 0.1 ± 0.24 μb, $\sigma_{AuAu\to AuAuK^+K^-}$ = 15 ± 0.58 ± 3.0 μb
- The pp̄ and K^+K^- pair production cross section are comparable to the BW process.
- The p_T shape is expected for different mass region.

Summary and Outlook

- The photo-induced K^+K^- and pp̄ process has been observed.
- Separate the photon-photon and photon-nucleus contribution in the future.
- p_T and invariant mass spectra will be compared to theory.

Supported in part by the U.S. DEPARTMENT OF ENERGY Office of Science

University of Science and Technology of China

The STAR Collaboration
https://drupal.star.bnl.gov/STAR/presentations