Charge balancing and the fall off of the ridge

Piotr Bożek and Wojtek Broniowski

Institute of Nuclear Physics Kraków

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Two-particle correlations

\[ C_2(\Delta \eta, \Delta \phi) = \frac{N_{\text{pairs}}^{\text{phys}}(\Delta \eta, \Delta \phi)}{N_{\text{pairs}}^{\text{mixed}}(\Delta \eta, \Delta \phi)} \]

flow correlations

\[ \frac{\Delta \rho}{\rho_{\text{ref}}} \]

STAR

J. Takahashi et al. (2009)
3 + 1-D viscous hydrodynamics

Au-Au 200GeV

first 3+1D visc. : B.Schenke et al.

IQCD + Hadron Gas

$\eta/s = 0.08(0.16)$
2-D correlations

(0.8 < p_T < 4 GeV - “unbiased”)

STAR data, 2007
2-D correlations

\[0.8 < p_T < 4 \text{ GeV} - \text{“unbiased”}\]

Unlike-sign

Like-sign

STAR data, 2007

No balancing
Charge balancing

local charge conservation

charge balance function

Bass et al. (2000)
2-D correlations

\[ R_2(\Delta \eta, \Delta \phi) = \frac{N_{\text{pairs}}^{\text{phys}}(\Delta \eta, \Delta \phi)}{N_{\text{pairs}}^{\text{mixed}}(\Delta \eta, \Delta \phi)} \]

\((0.8 < p_T < 4 \text{ GeV})\)

Here are the plots for **Unlike-sign** and **Like-sign**

**STAR data**

With balancing!

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2D balance functions

\[ B(\Delta \eta, \Delta \phi) = \frac{\langle N_{++} - N_{--} \rangle}{\langle N_+ \rangle} + \frac{\langle N_{--} - N_{++} \rangle}{\langle N_- \rangle} \]

\[ c = 0 - 5\% \]
2D balance functions

\[ B(\Delta \eta, \Delta \phi) = \frac{\langle N_{+-} - N_{++} \rangle}{\langle N_+ \rangle} + \frac{\langle N_{-+} - N_{--} \rangle}{\langle N_- \rangle} \]
\[ c = 0 - 5\% \]

big (direct balancing) \hspace{2cm} \text{small (resonance decays only)}

balancing \rightarrow \text{collimation}

important non-flow effect, a way to look at the data
Model Summary

(a) 30-40%, unbal.

(b) 30-40%, unbal.

(c) 30-40%, bal.

(d) 30-40%, bal.

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Balance functions in relative rapidity

Jeon & Pratt 2002, ...

charge balance function in $\Delta \eta$

comparison to the STAR data
solid: $T_f = 140$ MeV, dashed: $T_f = 150$ MeV
Non-flow effect on $v_n$

**Figure 1:**
- **Panel a)**
  - PHENIX $c=0-10\%$
  - STAR
  - $v_2$
  - $v_2 + \text{ch. balan.}$

- **Panel b)**
  - PHENIX $c=30-40\%$
  - STAR
  - $v_2$
  - $v_2 + \text{ch. balan.}$

**Figure 2:**
- **Panel a)**
  - STAR Data
  - $v^2_n[10^{-3}]$

- **Panel b)**
  - $v_2(LS)$
  - Hydro
  - Hydro + ch. balan. $\eta/s=0.16$

**Figure 3:**
- STAR Data
- Hydro
- Hydro + ch. balan. $\eta/s=0.16$

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Charge balancing and the fall off of the ridge
\( \nu_1 \) - parity violation observable

Transverse-momentum conservation lowers \( \nu_1^2 \equiv \langle \cos(\phi_1 - \phi_2) \rangle \)

Comparison to the STAR data

Pratt, Schlichting (2011), Bzdak, Koch, Liao (2011)
E-by-e hydro with charge balancing for 2-D correlation function

**Charge balancing** explains the shape of the same-side ridge - major **non-flow** effect

Charge balancing increases $v_n^2 \{2\}$ by a few % and splits the like-sign and unlike-sign case

Transverse-momentum conservation important for $v_1^2$, parity violation obs. semi-quantitative agreement

**Substract** charge conservation effects to look for early correlations