Charge balancing and the fall off of the ridge

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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

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

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

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

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

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

STAR data

**Unlike-sign**

**Like-sign**

With balancing!
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} 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.

Charge balancing and the fall off of the ridge
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 $v_n$

**Graphical Content:**
- Two plots illustrating the dependence of $v_2$ on $p_T$ for different centrality bins:
  - PHENIX c=0-10% and STAR data.
  - Hydro + charge balancing.
- A third plot showing $v_n^2$ for 0-5% centrality.
- An event-by-event analysis of $v_2$ with STAR Data.

**Textual Content:**
- "Charge balancing and the fall off of the ridge" by Piotr Bożek and Wojtek Broniowski.
$\nu_1$ - parity violation observable

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

comparison to the STAR data

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

Subtract charge conservation effects to look for early correlations