Influences of electromagnetic field characteristics on the CME and CMW measurements

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CME leads a vector current

\[ J = \frac{Qe}{2\pi} \mu_B B \]

CME signal – charge separation signal \( \Delta \gamma \propto (B^2 \cos^2 (\Psi_B - \Psi_{SP})) \)

CMW (CME+CSE) signal: v2 splitting of positive and negative charged particles (slope parameter \( \gamma \)) [1, 2].

**CME results: isobaric collisions**

Woods-Saxon form of spatial distribution of nucleons:

\[ \rho(r, \theta) = \rho_0 / (1 + \exp((r - R_0 - \beta_2 R_0 \gamma_2 (\theta))/\alpha)) \]

<table>
<thead>
<tr>
<th>Case</th>
<th>( R_0 )</th>
<th>( a )</th>
<th>( \beta_2 )</th>
<th>( \beta_4 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>5.13</td>
<td>0.46</td>
<td>0.13</td>
<td>0.00</td>
</tr>
<tr>
<td>Case 2</td>
<td>5.06</td>
<td>0.46</td>
<td>0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>Ru96</td>
<td>5.13</td>
<td>0.46</td>
<td>0.13</td>
<td>0.00</td>
</tr>
<tr>
<td>Zr96</td>
<td>5.06</td>
<td>0.46</td>
<td>0.18</td>
<td>0.00</td>
</tr>
</tbody>
</table>

\( \Psi_z \) is participant plane which is constructed by initial geometry of partons.

\( \Psi_z^{SP} \) is spectator plane which is constructed by spectator neutrons from one projectile [3].

In central and mid-central collisions, \( B^2 \cos^2 (\Psi_B - \Psi_z) \) are similar in the four cases but different in peripheral collisions.

\[ B^2 \cos^2 (\Psi_B - \Psi_z^{SP}) > B^2 \cos^2 (\Psi_B - \Psi_z) \]

For case 1, RR of \( B^2 \cos^2 (\Psi_B - \Psi_z) \) and \( B^2 \cos^2 (\Psi_B - \Psi_z^{SP}) \) are similar.

For case 2, RR of \( \Psi_z \) is larger than RR of \( \Psi_z^{SP} \).

\( \Psi_z^{SP} \) is expected to reflect much cleaner information about the CME signal.

**CMW results: \( E \cdot B \)**

A dipolar distribution of \( E \cdot B \) is observed in noncentral \( \text{Au}+\text{Au} \) collisions.

\[ \mathcal{J}_5 = \frac{Qe}{2\pi} \mu_B B \]

A dipolar \( E \cdot B \) in a magnetic field can lead to an electric quadrupole with the help of CME.

The density of \( E \cdot B \) is consistent with the centrality dependence of the slope parameter \( \gamma \) by STAR.

**CME in isobaric collisions**

a) Deformation difference causes some effects.

b) \( \Psi_z^{SP} \) has stronger correlation with \( \Psi_B \) than \( \Psi_z \).

c) \( \Delta \gamma \) w.r.t \( \Psi_z^{SP} \) reflects much cleaner information about the CME signal.

**CMW in \( \text{Au}+\text{Au} \)**

a) A dipolar \( E \cdot B \) is observed in noncentral \( \text{Au}+\text{Au} \) collisions.

b) It can result in an electric quadrupole without CMW \( \Rightarrow \) a new interpretation to the slope \( \gamma \) measured by STAR.

c) Source for other chiral anomalous effects?

**References**

