Non-identical particle femtoscopy in Pb—Pb collision at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE

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Non-identical femtoscopy

Source size \( (R) \) of the particle emitting system

Emission asymmetry \( (\mu = \langle \chi^{\text{light}} \rangle - \langle \chi^{\text{heavy}} \rangle) \) between the particles that form a pair, produced due to radial flow and thermalisation

\[ \Psi(r^*, k^*) \]

Pair Rest Frame (total momentum = 0)

\[ k^* = \frac{(p_1^* - p_2^*)}{2} = p_1^* \]

Pair relative momentum

Spherical harmonics representation of CF

\[ C(k^*) = \sum \left( C_{l,m}(k^*) Y_{l,m}(\theta_k, \phi_k) \right) \]

\[ k^* \text{ is decomposed into } k^*_{\text{out}}, k^*_{\text{side}}, k^*_{\text{long}} \]

\[ k^*_{\text{out}} = |k^*| \sin \theta_{k^*} \sin \phi_{k^*} \]

\[ k^*_{\text{side}} = |k^*| \sin \theta_{k^*} \cos \phi_{k^*} \]

\[ k^*_{\text{long}} = |k^*| \cos \theta_{k^*} \]

Source function: probability of emitting a particle pair at distance \( r^* \)

Pair interaction: includes final-state interactions (FSI) with \( k^* \) at distance \( r^* \)

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FSI (Coulomb and Strong)
- Attractive for unlike-sign pairs, repulsive for like-sign pairs
- Source size extraction

Pair-emission asymmetry extraction

Non-femtoscopic background (due to elliptic flow, residual correlations, etc.)

All four correlation functions (separately for $C_0$ and $\text{Re} C_1$) are parameterised together with $B$

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**Fit results (theoretical predictions) describe the background minimised correlation functions very well**

- $R_{\text{out}}$ and $\mu_{\text{out}}$ extracted for each centrality class (next slide)

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$R_{out}$ and $\mu_{out}$ as the function of $<dN_{ch}/d\eta>^{1/3}$ and $<m_T>$

- $R_{out}$ increases with $<dN_{ch}/d\eta>^{1/3}$ as no. of participants increase, agrees with the predictions from $(3+1)$D viscous hydrodynamics + THERMINATOR 2 for peripheral events
- $\mu_{out}$ always negative, implies pions are always emitted closer to the center of the source, confirms the existence of the radial flow, compared with the predictions using additional delay ($\Delta \tau$) in kaon emission [1, 2, 3]
- Consistent with results at 2.76 TeV (blue markers), no energy dependence observed

$R_{out}$ decreases with pair-$<m_T>$, presence of strong collective flow
- $\mu_{out}$ is lowest in smallest pair-$<m_T>$ bin in all centrality,
- Since $<x_{out}> \propto 1/(T/m_T)$, individual $<m_T>$ values for $\pi$ and $K$ that are forming pairs in each pair-$<m_T>$ bin are needed to understand the trend of $\mu_{out}$

\( \mu_{\text{out}} \) signals the presence of radial flow

- Pions are always emitted closer to the center of the source than kaons

- \( R_{\text{out}} \) increases with centrality and decreases with pair-\( \langle m_t \rangle \) due to the radial flow

...Thank you