Exploring origins for correlations between flow harmonics and transverse momentum in small collision systems

*Phys. Rev. C 103, 064906 (2021)*

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\( v_n - p_T \) correlation

- Event-by-event correlation of anisotropies (\( v_n^2 \)) and mean transverse momentum (\([p_T]\)) can provide information on the interplay of geometry and its transport

\[
\rho(v_n^2, [p_T]) = \frac{\text{cov}(v_n^2, [p_T])}{\sqrt{\text{Var}(v_n^2)} \sqrt{\text{Var}([p_T])}}
\]

\[
\text{cov}(v_n^2, [p_T]) = \text{Re} \left( \left\langle \sum_{a,c} e^{in(\phi_a - \phi_c)} ([p_T] - \langle [p_T] \rangle) \right\rangle \right)
\]

\[
\text{Var}(v_n^2) = v_n \{2\}^4 - v_n \{4\}^4 = \langle \text{corr}_n \{4\} \rangle - \langle \text{corr}_n \{2\} \rangle^2
\]

\[
\text{Var}(p_T) \approx c_k = \left\langle \frac{1}{N_{\text{pair}}} \sum_b \sum_{b' \neq b} (p_T, b - \langle [p_T] \rangle)(p_T, b' - \langle [p_T] \rangle) \right\rangle
\]
$v_n$–$p_T$ correlation searching for initial–state correlation

- Positive correlation only with initial–state momentum anisotropy
- Sign change with both initial–state and final–state interactions
- Negative correlation only with initial geometry or final–state momentum anisotropy
- Measuring the $v_n$–$p_T$ correlation at low multiplicity may provide information on initial–state momentum correlation

- Any other effects on the $v_n$–$p_T$ correlation at low multiplicity like non–flow?
$v_n-p_T$ correlation in PYTHIA

- Positive correlation at low multiplicity and sign change are seen in PYTHIA8 p+p including only non-flow effects

- Similar positive $v_n-p_T$ correlation in PYTHIA–Angantyr (non-flow effects) and Glasma (initial-momentum correlation)
$v_n - p_T$ correlation in AMPT

- Negative correlation in p+p at the entire multiplicity
- Comparable positive correlation in p+O and O+O between PYTHIA and AMPT
- Different from the ATLAS results
- Similar sign change is seen with the model including both initial and final-state correlations
Correlation between eccentricity and size of the overlap area with partons from string melting

- Positive correlation in p+p due to a large ellipticity with two strings and negative correlation and p+A and A+A at low multiplicity
  - Opposite to results from the MC-Glauber initial geometry
- Experimental results in p+p will help to further understand the initial geometry