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Measurement of four-particle cumulants and symmetric cumulants with subevent methods in small collision systems with the ATLAS detector

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Measurements of four-particle flow cumulants $c_n\{4\} = \langle v_n^4 \rangle - 2\langle v_n^2 \rangle^2$ for $n = 2$ and 3, and symmetric cumulants $SC(n,m) = \langle v_n^2 v_m^2 \rangle - \langle v_n^2 \rangle \langle v_m^2 \rangle$ for $(n,m) = (2,3)$ and $(2,4)$ are presented in pp, p+Pb and peripheral Pb+Pb collisions at various collision energies, aiming to probe the long-range collective nature of multi-particle production in small systems. Results are obtained using the standard cumulant method, as well as the two-subevent and three-subevent cumulant methods. Results from the standard method are found to be strongly biased by non-flow correlations as indicated by strong sensitivity to the chosen event class definition. A systematic reduction of non-flow effects is observed when using the two-subevent method and the results become independent of event class definition when the three-subevent method is used. The values of $v_n\{4\} = \sqrt[4]{-c_n\{4\}}$ are found to be constant over the range 40<N_{ch}<200 in pp collisions, providing direct evidence that multi-particle collectivity persists to low multiplicity. The measured $SC(n,m)$ shows an anti-correlation between v_2 and v_3, and a positive correlation between v_2 and v_4. The magnitude of $SC(n,m)$ is constant with N_{ch} in pp collisions, but increases with N_{ch} in p+Pb and Pb+Pb collisions. The normalized symmetric cumulants $SC(n,m)/\langle v_n^2 \rangle \langle v_m^2 \rangle$ are found to be independent of p_{T}, suggesting v_n-v_m correlations reflect the global properties of the event. These measurements provide further evidence for long-range multi-particle collectivity, and quantify the nature of its event-by-event fluctuations.

Content type

Experiment

Collaboration

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Centralised submission by Collaboration

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