Anisotropic flow

Heavy-ion collisions: initial state anisotropy → final state momentum anisotropy, a phenomenon called *anisotropic flow* [1]

- Magnitude is quantified by the $v_n$ coefficients in a Fourier series of the azimuthal distribution of produced particles [2]
- $v_2$, elliptic flow, $v_3$, triangular flow, $v_4$,... Constrain initial conditions, deconfined phase, particle production mechanisms

**Methods used to measure anisotropic flow**

\[
V_n = \left(\sum Q_i Q_j \right) \left(\sum Q_i Q_j \right)
\]

- Inclusive, $\pi$, $K$, $p$ measured with scalar product method [3]
- Particle of interest (POI) and references particles (RPs) separated by $|\Delta \eta| > 2$, to suppress non-flow
- $v_n$ of $\Lambda$, $K^0$, $\Xi$, and $\Omega$ measured using invariant mass method [4]

\[
v_n^{\text{inv}}(m_n) = v_n^{\text{unb}} N_n^{\text{unb}} (m_n) = v_n^{\text{unb}} N_n^{\text{unb}} (m_n)
\]

**Event Shape Engineering (ESE)**

- Select events with similar centralities and different shapes based on the event-by-event flow/eccentricity fluctuations [5]
- Flow vector $\rightarrow q$-distributions

$Q_n = \sum \cos (n \phi)$

$Q_n^{\text{unb}} = v_n^{\text{unb}} N_n^{\text{unb}}$ (i.e., ESE/unbiased: almost flat up to $p_T > 20$ GeV/$c$)

- Same source of flow fluctuations
- Small deviations for $p_T < 3$ GeV/$c$ (different ellipticity)

**$v_2(2, |\Delta \eta| > 2)(p_T)$ with $q_3$: 5-10%, 30-40% centrality**

- Mass ordering at low $p_T$, baryon-meson grouping at intermediate $p_T$
- $v_2$ anti-correlated with $q_3$
- $v_2^{\text{unb}}$: same source of flow fluctuations
- No dependence on particle species
- Weak sensitivity for central collisions

**CONCLUSIONS**

- $v_2^{\text{unb}}$: same trends as found in the unbiased results
- Mass ordering at low $p_T$, baryon-meson grouping at intermediate $p_T$
- $v_2$ anticorrelated with $q_3$ (i.e., $v_2$)
- $v_2^{\text{unb}}$: same source of flow fluctuations
- No dependence on particle species

**BIBLIOGRAPHY**

5. J. Schukraft et al, PLB 719, 394 (2013)