We discuss the generation of anisotropic flows $v_n$ for a fluid at fixed $\eta/s(T)$ by means of an event-by-event transport approach. Such an approach recovers the universal features of the ideal hydrodynamics. We discuss the effect of the $\eta/s$ and its temperature dependence on the build up of the $v_n(p_T)$ revealing that only in ultra-central collisions ($0$-0.2%) the $v_n(p_T)$ show the largest sensitivity to the $T$ dependence of $\eta/s$ in the QGP phase and this sensitivity increases with the order of the harmonic $n$. Moreover, the study of the correlations between the initial spatial anisotropies $\epsilon_n$ and the final flow coefficients $v_n$ show that at LHC energies there is more correlation than at RHIC energies. The degree of correlation increases from central to peripheral collisions, but only in ultra-central collisions at LHC, we find that the linear correlation coefficient $C(n,n)=1$ for $n=2, ..., 5$.

1 - Transport approach: viscous corrections

$$ p^n \frac{\partial}{\partial x} f(x,p) = C_{22} $$

We evaluate viscous corrections to transverse momentum spectra and anisotropic flow by solving numerically a relativistic Boltzmann equation.

In the limit $\sigma \to \infty$, a generic observable $f(q)$ can be expanded in powers of $1/\sigma$.

We evaluate the ideal hydrodynamics limit $f_0^{\epsilon}$, $v_2^{\epsilon}$ and the viscous corrections $\delta f$ and $\delta v_n$ solving the Relativistic Boltzmann equation for large values of the cross section $\sigma$.

2 - Transport approach: fixing $\eta/s(T)$

To fix locally $\eta/s$ we need to know $\eta/s(0,M,T) \xrightarrow{\text{Chapman-Enskog approximation}} \eta/s$.

Chapman-Enskog approximation

$$ \frac{d\phi_n}{d\epsilon_n} = \int d\epsilon f_0^{\epsilon}(\epsilon_n, p_n) - \frac{1}{15} \frac{1}{\sigma_n} g_n(p_n) $$

Chapman-Enskog is a good approximation already at 1st order $3\%$ ($\approx 3\%$ at 2nd order)

Simulating a fixed $\eta/s$

Instead of focusing on specific microscopic calculations we fixed the total cross section in order to have the wanted $\eta/s$.

$\sigma$ is evaluated in each cell of the coordinate space of our grid during the dynamics.

3 - Effects of $\eta/s(T)$ on the $v_n(p_T)$

- Different $v_n$ can probes different values of $\eta/s(T)$ during the expansion of the fireball.
- $v_n(p_T)$ at RHIC is more sensitive to the value of $\eta/s$ at low temperature.
- $v_n(p_T)$ and $v_2(p_T)$ are more sensitive to the value of $\eta/s$ than the $v_3(p_T)$.
- At LHC energies $v_n(p_T)$ is more sensitive to the value of $\eta/s$ in the QGP phase.

At LHC energies:

- At low $p_T$, $v_2(p_T) \approx p_T^2$. At higher $p_T$, $v_2$ saturates while $v_3$ for $n>3$ increase linearly with $p_T$.
- In ultra-central collisions the $v_2(p_T)$ have a stronger sensitivity to the $T$ dependence of $\eta/s$ in the QGP phase.
- The sensitivity to the $T$ dependence of $\eta/s$ increases with the order of the harmonic $n$.

4 - Correlations between $v_n$ and $\epsilon_n$

A measure of the linear correlation is given by the linear correlation coefficient:

$$ C_{\eta/s,n} = \int \frac{d^3x}{(2\pi)^3} f(x,p) = \epsilon_n \cdot v_n $$

$C_{\eta/s,n}$ is a decreasing function with the impact parameter.

- At LHC there is a stronger correlation between $v_n$ and $\epsilon_n$ than at RHIC for all $n$.
- For ultra-central collisions $v_n$ are strongly correlated to $\epsilon_n$ $C_{\eta/s,n}/p_T = v_n = \epsilon_n$ for $n=2,3,4$.

5 - Outlook

- To study the role of the Equation of State on the anisotropic flows $v_n(p_T)$ and the viscous corrections $\delta v_n$.
- To include the hadronization by coalescence.