Sub-nucleon geometry and multiparticle cumulants including $c_2\{4\}$ in $p + p$ collisions

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Developed Versions of the String Melting AMPT

1. New quark coalescence model.
2. Improved heavy quark productions.
4. Sub-nucleon geometry of the proton which consists of 3 constituent quarks.

Normal AMPT includes 1-3.
3-quark AMPT includes 1-4.
In normal AMPT, $c_2\{2\}$ for 0.3 mb and 3 mb are close to the data.

In 3-quark AMPT, $c_2\{2\}$ for 3 mb is close to the data.

In normal AMPT, $c_2\{4\} < 0$ at $N_{ch} > 32$ for 0.3 mb.

In 3-quark AMPT, $c_2\{4\}$ results have a similar multiplicity dependence as the data.

$c_2\{4\}$ has a non-monotonous dependence on $\sigma$. 

arXiv:2112.01232
Various $p_T$ Selections of $c_2\{4\}$

- The model results show the same qualitative behavior as data.
- $c_2\{4\}$ magnitudes from AMPT are often quite different from data.
- $c_2\{4\}$ and its sign-changed location depend sensitively on the sub-nucleon geometry for proton.

arXiv:2112.01232

Xinli Zhao @ QM2022
c_2\{4\} in normal AMPT and 3-quark AMPT produce negative values at high multiplicities.

c_2\{2\} and c_2\{4\} depend strongly on σ and the dependences at high multiplicities are non-monotonous.

AMPT results with a constant σ can’t well reproduce the ATLAS c_2\{2\} and c_2\{4\} data.

3-quark AMPT results are in better agreements with the experimental data than the normal AMPT. This indicates the importance of including the sub-nucleon geometry of the proton in studies of multiparticle cumulants in p + p collisions.