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A Quasiparticle Transport Explanation for Collectivity in the Smallest of Collision Systems ($p+p$ and e^+e^-)

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Experimental evidence suggests that collectivity in asymmetric small systems (p, d, ^{3}He+A) is directly related to the initial collision geometry. Therefore, a compelling question is whether the same argument can be extended to p+p, and even e^+e^- collisions. We have modified A-Multiphase-Transport-Model (AMPT) to include the constituent quark structure of the proton. We find with very modest parton-parton cross sections a good description of the triangular and elliptic flow coefficients measured by ATLAS and CMS in p+p collisions, as a function of multiplicity and transverse momentum. We assess the non-flow separation techniques used by these experiments, by implementing their exact methods and comparing the result with the true flow relative to initial geometry in the model. The default AMPT model imposes formation times for partons which are much shorter than their respective de Broglie wavelength, at odds with a central assumption of semi-classical kinetic theory. This challenges the idea of modeling the QGP as well-defined quasi-particles undergoing Boltzmann evolution. We explore the impact on collectivity of enforcing a minimum de Broglie wavelength criterion, and find that it is significant for these smallest of systems. Lastly, we explore the minimal requirements for collectivity within this transport framework to determine whether the multiplicity and geometry of e^+e^- collisions is sufficient to generate experimentally verifiable signals.

Content type

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