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Exploring the mechanisms generating the directed flow in relativistic nuclear collisions

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The quark-gluon plasma (QGP) is intensively studied since decades in Heavy-Ion Collisions (HICs) at high energy and recently also in high-multiplicity events of relativistic proton-nucleus collisions. Both collision systems are characterized by the presence of very intense electromagnetic fields, which attain their maximal strength in the early stage and interplay with the strong vorticity induced in the plasma by the large angular momentum of the colliding nuclei. A promising observable influenced by these phenomena is the particle directed flow v_1. We discuss the v_1 of light hadrons and heavy mesons in large and small colliding systems by means of relativistic transport simulations. We show that in HICs the magnitude of the v_1 of light particles keeps trace of the vorticity in the system, whereas the very large v_1 of neutral D mesons is due to the longitudinal asymmetry between bulk matter and charm quarks and to the large non-perturbative interaction of heavy quarks in QGP. The splitting of v_1 for D^0 and $\overline{D}^0$ is also much larger than the one observed for light particles, mainly due the early formation time of heavy quarks. However, standard electromagnetic profile with constant conductivity is not able to account for the huge splitting observed at LHC energy. In proton-nucleus collisions the generated electric field is comparable to the magnetic field since the beginning, due to the different number of protons in the colliding nuclei. Moreover, the particle rapidity distributions are strongly asymmetric inside the overlap region due to the different size of the incoming nuclei. We present our results on p+Au collisions at top RHIC energy, showing how the electromagnetic field leads to a sizeable splitting in the v_1 of pions and kaons and that this is mainly generated in the deconfined phase.

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