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QUARK GLUON PLASMA IN AN EARLY PHASE OF THE UNIVERSE AND IN THE LABORATORY

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Abstract. A few microseconds after the birth of the Universe (Big Bang), the Universe was filled with the matter consisting of colored quarks and gluons (particles which constitute hadrons), called quark gluon plasma (QGP) (Shuryak 2017). That primordial QGP lasts for about a few μs until the Universe cooled down and expanded enough that colored quarks had to confine within the colorless new formed hadrons. In high-energy nuclear collisions, where a high baryon density, or a high temperature could be achieved, small pieces of the QGP can be recreated. Such created QGP undergoes an explosion, called the Little Bang. In spite of its small size (about $1000 fm^3$) and short duration (a few fm/c, where c is the speed of light), the QGP is well described by relativistic hydrodynamics. Even more, small perturbations on top of the explosion could be also well described by relativistic hydrodynamics. In high-energy nucleus-nucleus collisions which have been performed at the Relativistic Heavy Ion Collider (RHIC) and at the Large Hadron Collider (LHC), the QGP was artificially created with extremely high temperature and the baryon density close to zero (Chatrchyan et al. 2014, Khachatryan et al. 2015, Sirunyan et al. 2017). On the other side, at future experiments as NICA (Dubna), J-PARC HI (Tokai) and CBM (Darmstadt) will explore the region of temperature vs baryo-chemical potential $(T - \mu_B)$ phase diagram at smaller temeperatures and high baryon densities. This will enable to investigate a new domain of quantum-chromodynamic matter created in such collisions. We briefly discuss about some aspects of the QGP formation and its properties.

References

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