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COULD QUARK GLUON PLASMA BE A SOURCE OF SUPER HIGH ENERGY COSMIC RAYS?

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ABSTRACT

It is widely discussed that the dense and/or hot quark matter– quark-gluon plasma can be formed in the center of some massive stars, for example as a result of supernova explosion, and could lead to the neutron stars formation and formation of the Quark Stars. We support that parton collective behavior could lead to formation of coherent parton system likes "Mini" Color Glass Condensate. It means parton collective behavior and interactions in hot and dense matter ,in the quark-gluon plasma could lead to increase locally the density of the matter due to for example parton percolation (decreasing the volume) and fast growth of the number of gluons (increasing the energy) and something likes "Mini" Color Glass Condensate could be formed. The "Mini" Color Glass Condensate might formed in the centre of the stars and be a source of super high energy hadrons-super high energy cosmic rays.

Keywords: *quark stars, quark-gluon plasma*

Cosmic rays can provide us an important information on appearance and evolution of the Universe. Since super high energy particle beams (greater than $10^{17\text{-}18}$ *eV*) are not available in ground-based laboratories, super high energy cosmic rays are the only resource to study interactions of the particles in this energy domain. The source of super high energy cosmic are still unknown [1], moreover, we don't even know whether their origin is galactic or extragalactic. The flux of cosmic rays with energy up to $\sim 10^{10}$ *eV* is mainly attributed to solar cosmic rays, intermediate energies (up to $\sim 10^{15}$ *eV*) to galactic cosmic rays, and highest energies (greater than 10^{15} *eV*) to extragalactic cosmic rays. The electromagnetic fields generated by some massive stars are considered as plausible sources for the super high energy cosmic rays [2], however, some theoretical predictions show that these fields could be too weak to accelerate particles to energies of order 10^{15} *eV*.

The talk focuses on one of the possible sources of the super high energy cosmic particles and proposes the Quark Gluon Plasma (QGP) is formed in the centre of some super massive starsas a possible source of the super high energy hadrons - super high energy cosmic rays.

Azimuthal anisotropy observed experimentally at *RHIC* and *LHC* shows a collective behavior, which is likely to be formed at an early, parton, stage of the space-time evolution of the produced hot and dense matter [3]. The anisotropy indicates that matter under extreme conditions behaves as a nearly ideal liquid rather than an ideal gas of quarks and gluons. Scaling behavior of $v_2$vsp_T [4] gives a possibility to assume that the collective behavior of the partons defines the dynamics of the expansion in the longitudinal plane namely (see Fig.1, Number of quark (n_q) scaled v_2 as a function of scaled p_T . All data are from 200 GeV Au+Au minimum bias collisions. The dot-dashed-line is thescaled result of the fit to $K_0^S$and Λ.)

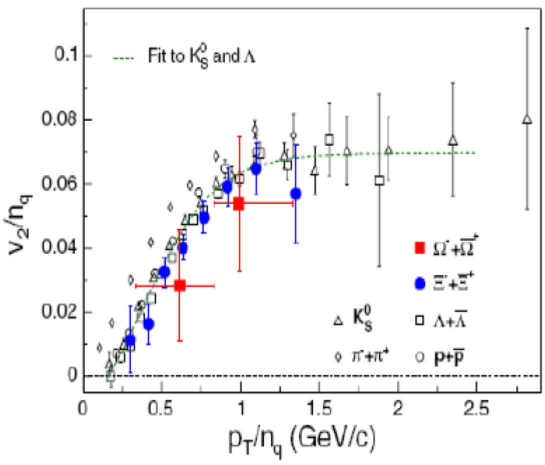

Fig. 1

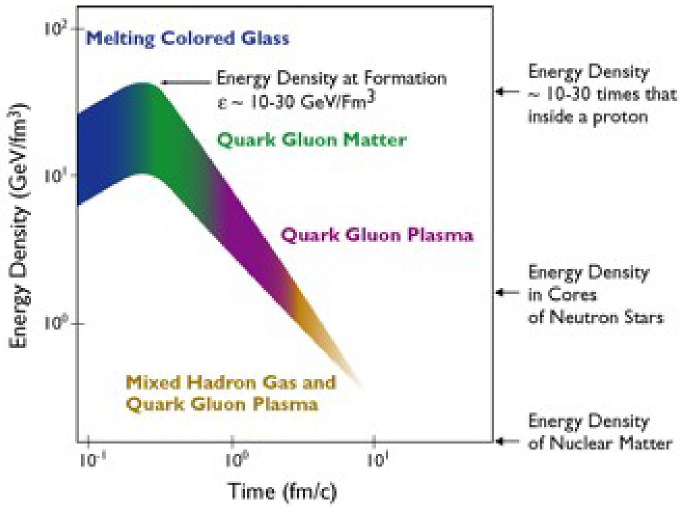

Fig.2

The first measurement of elliptic flow of charged particles in *Pb-Pb* collisionsat the center of mass energy per nucleon pair $\sqrt{s_{NN}}= 2.76\ A\ GeV$ [5], with the *ALICE* detector, demonstrated that the $v_2(p_t)$ does notchange within uncertainties from the $\sqrt{s_{NN}} = 200\ GeV$ to *2.76 TeV*. *ALICE LHC* data demonstrated that values of the $v_2$increase with energy.

We support that above mentioned parton collective behavior could lead to formation of coherent parton system likes “Mini” Color Glass Condensate (M CGC). It means parton collective behavior and interactions in hot and dense matter ,in the QGP could lead to increase locally the density of the matter due to for example parton percolation (decreasing the volume) [6] and fast growth of the number of gluons (increasing the energy) and something likes M CGC could be formed [7] (Fig.2)

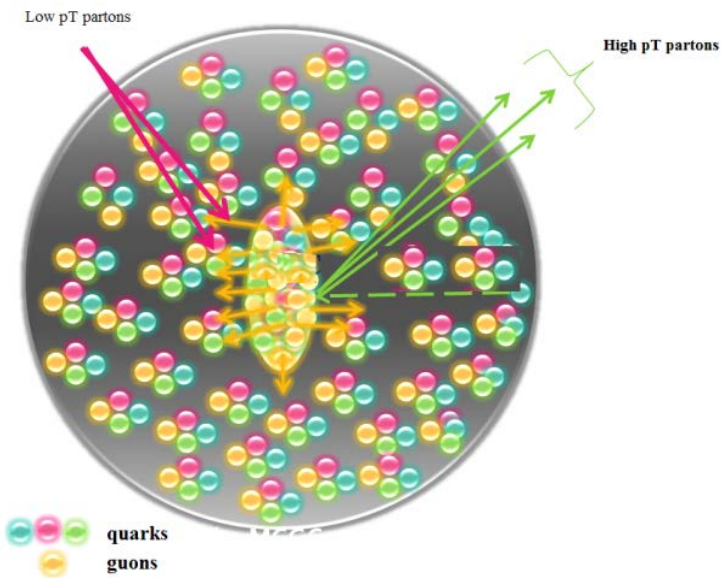

Fig.3 shows schematically the coherent prompt parton production by collected parton system. As a result of coherent interaction with collected partons(s) within the M CGC could be emitted the partons with limited high-transfer energy and hadronized. The energy of the hadrons would depend on the parameters of the system and limited by the total energy of the mini M CGC only – could be obtained from the parton Coherent Tube Model (CTM) [8].

It is widely discussed that the dense and/or hot quark matter– QGP can be formed in the center of some massive stars, for example as a result of supernova explosion, and could lead to the neutron stars formation [9] and formation of the Quark Stars [10]. The M CGC might formed in the centre of the stars and be a source ofsuper high energy hadrons -super high energy cosmic rays.

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