Contribution ID : **886**
Type : **Oral talk**

Second look to the Polyakov Loop Nambu-Jona-Lasinio model at finite baryonic density

Friday, 9 October 2020 11:15 (15)

We revisit the Polyakov Loop coupled Nambu-Jona-Lasinio model that maintains the Polyakov loop dynamics at zero temperature, which is the most interesting for astrophysical applications. For this purpose we re-examine potential for the deconfinement order parameter at finite baryonic densities. Secondly, and the most important, we explicitly demonstrate that naive modification of this potential at any temperature is formally equivalent to assigning a baryonic charge to gluons. We develop a general formulation of the present model which is free of the discussed defect and is normalized to asymptotic of the QCD equation of state given by $\mathcal{O}(^2)$ perturbative results. We also demonstrate that incorporation of the Polyakov loop dynamics to the present model sizably stiffens the quark matter equation of state supporting an existence of heavy compact stars with quark cores.

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Session Classification : Astroparticle Physics

Track Classification : Astroparticle physics