Quark-hadron matter with strangeness

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Many theoretical calculations and lattice QCD simulations have shown that the deconfinement transition at high-density area is of first-order. Then the Gibbs conditions gives rise to various structured mixed phase. The structured mixed phase consisting of the quark and hadron phases, which expected in the core region of hybrid stars, has been numerically studied with the Coulomb screening effect and the surface effect [1]. Consequently the equation of state shows a similar behavior to that given by the Maxwell construction. Therefore, the Maxwell construction effectively gain the physical meaning again with two or more chemical potentials. Then the mixed phase region is restricted to a narrow region by the surface effect and the charge screening effect. We also could see that there are not large region of the mixed phase but narrow region of the mixed phase and larger quark phase in the core region of hybrid stars.

Although the strangeness degree of freedom should appear in the nuclear matter at the high density region before it begins the deconfinement phase transition, however, the hadronic phase has been treated as the nuclear matter in the former study [1]. On the other hand, nowadays many theoretical calculations have tried to include the strangeness degree of freedom in each matter [2, 3], and tried to describe both matters from a unified model [4]. However the phase transition between the hyperonic and strange quark matter is not clearly understood.

In this work we have tried to include the strangeness degree of freedom in both the hadronic and quark matter phases. In the point of this view, we have considered to describe both matters from the one model with incorporating the MIT bag [5]. With using the Gibbs condition to describe the phase transition, we can show the phase diagram which is explicitly showing the strangeness degree of freedom. As the Gibbs conditions show that the mixed phase consisting of quark and nuclear matters exist in a density region, we may see the mixed phase consisting of hyperonic and the strange quark matters in some density region(Fig. 1).

We can apply these results in the study of the inner core region of hybrid stars and the hadronization of the relativistic nucleus-nucleus collisions.

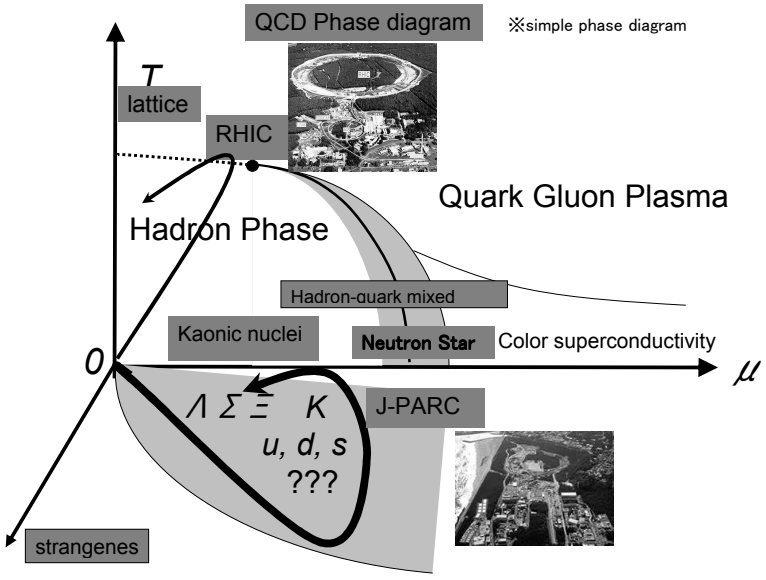

Figure 1: 3-dimensional phase diagram would show new phases?

References

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