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Hadron-Quark Crossover as a Possible Resolution of Hyperon Crisis in Massive Neutron Stars

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Recent observations of two solar-mass neutron stars
bring a serious conflict between the stiff equation of state (EOS)
required from the observations and the soft EOS
with hyperons required from theory.
We call this problem the “Hyperon Crisis”.

We propose a possible resolution of this problem
from the point of view of the smooth crossover
between the hadronic matter with hyperons and
the strongly interacting (2+1)-flavor quark matter
at around 3 times the normal nuclear matter density.
The sound velocity is found to increase in the crossover region, which
leads to a stiff EOS and hence to two solar-mass neutron stars
with reasonable radius of about 11-12 km [1,2].
Our idea is in sharp contrast to the conventional approach
of the first-order hadron-quark transition where
the EOS always becomes soft.

The above conclusion is robust in the sense that
the qualitative results do not depend on the different choices of
hadronic EOS nor the different ways of interpolation
between the hadronic EOS and quark EOS.
Also, we found that the three-body
forces acting among nucleons and hyperons play
essential role for the onset density of strangeness
mixing and the cooling of neutron stars, while
the effect of the color superconductivity does
not affect the above conclusion.

Our analyses strongly indicate the necessity of
strongly interacting quark matter inside
massive neutron stars.

[1] K. Masuda, T. Hatsuda and T. Takatsuka, ApJ 764, 12 (2013)

[2] K. Masuda, T. Hatsuda and T. Takatsuka, PTEP 073D01 (2013)

On behalf of collaboration:

None

Primary author: Mr MASUDA, Kota (Univ. of Tokyo / RIKEN)

Co-authors: Prof. TAKATSUKA, Tatsuyuki (RIKEN); Prof. HATSUDA, Tetsuo (RIKEN)

Presenter: Mr MASUDA, Kota (Univ. of Tokyo / RIKEN)

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