QUARK MATTER 2015
Sep. 27 – Oct. 3, 2015 Kobe, Japan

Contribution ID: **88** Type: **Contributed talk**

Phenomenological QCD equations of state for massive neutron stars

Wednesday 30 September 2015 10:00 (20 minutes)

We construct an equation of state for massive neutron stars based on QCD phenomenology, with special attention to the behavior at density larger than twice of saturation density. Our primary purpose is to delineate the relevant ingredients of equations of state that simultaneously have the required stiffness and satisfy constraints from thermodynamics and causality. We construct the equations of state following the 3-window description proposed by Masuda-Hatsuda-Takatsuka: at low density, we use the APR equation of state; at high density we use the NJL model with supplemental vector and diquark interactions that are inferred from the hadron spectroscopy and nuclear physics; at intermediate density we interpolate the low and high density equations of state. The 3-window approach allows us to consider a class of quark equations of state which have been implicitly omitted in the conventional hybrid construction. In particular, quark matter equation of state can be stiff in this approach. We will argue how the neutrons star mass-radius curves can be related to the microscopic effects in the QCD dynamics.

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Session Classification: Quark Matter in Astrophysics

Track Classification: Quark Matter in Astrophysics