Hadron-quark phase transition in the quark-meson coupling model

Supervisor： Hong Shen

Reporter： Min Ju

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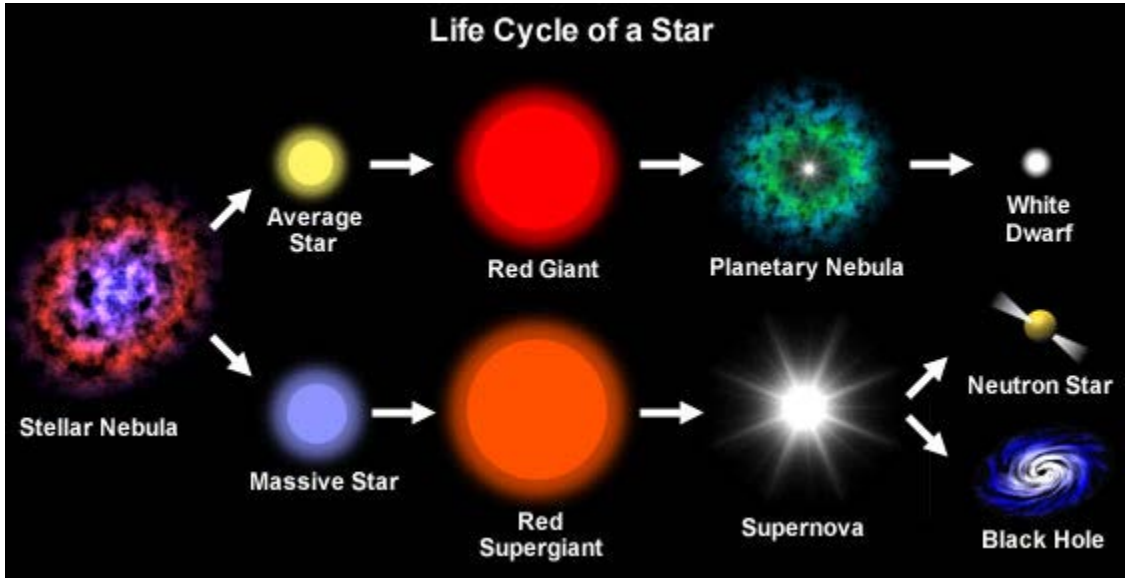
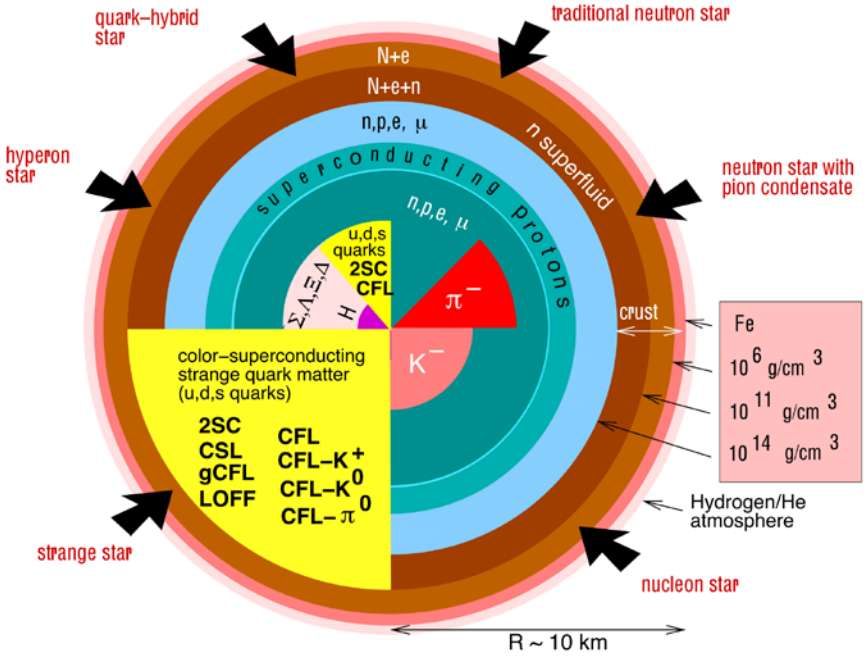
Introduction





http://www.seasky.org/celestial-objects/stars.html
http://www.physics.sdsu.edu/fweber/

Model

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Hadron Matter
QMC model.

$$\begin{aligned}\mathcal{L} = & \sum_{b=n,p} \bar{\psi}_b \left[i\gamma_\mu \partial^\mu - M_N^* - g_\omega \gamma_0 \omega - \frac{g_\rho}{2} \gamma_0 \tau_3 \rho \right] \psi_b \\ & - \frac{1}{2} m_\sigma^2 \sigma^2 + \frac{1}{2} m_\omega^2 \omega^2 + \Lambda_\nu (g_\omega^2 \omega^2)(g_\rho^2 \rho^2) \\ & + \sum_{l=e,\mu} \bar{\psi}_l [i\gamma_\mu \partial^\mu - m_l] \psi_l .\end{aligned}$$

Quark Matter
bag model

$$\begin{aligned}\varepsilon = & \sum_{f=u,d,s} \frac{N_c \cdot \gamma}{16\pi^2} \left\{ \left(2\mu_f^2 - {m_f}^2\right) k_f \mu_f - {m_f}^4 ln \left(\frac{k_f + \mu_f}{m_f} \right) \right\} \\ & + \sum_{l=e,\mu} \frac{1}{8\pi^2} \left\{ 2k_F^l {E_F^l}^3 - {m_l}^2 k_F^l E_F^l - {m_l}^4 ln \left(\frac{k_F^l + E_F^l}{m_l} \right) \right\} + B, \\ P = & \sum_{f=u,d,s} \frac{N_c \cdot \gamma}{24\pi^2} \left\{ \left({\mu_f}^2 - 2.5{m_f}^2\right) k_f \mu_f + 1.5{m_f}^4 ln \left(\frac{k_f + \mu_f}{m_f} \right) \right\} \\ & + \frac{1}{3} \sum_{l=e,\mu} \frac{1}{8\pi^2} \left\{ (2{k_F^l}^3 - 3{m_l}^2 k_F^l) E_F^l + 3{m_l}^4 ln \frac{k_F^l + E_F^l}{m_l} \right\} - B.\end{aligned}$$

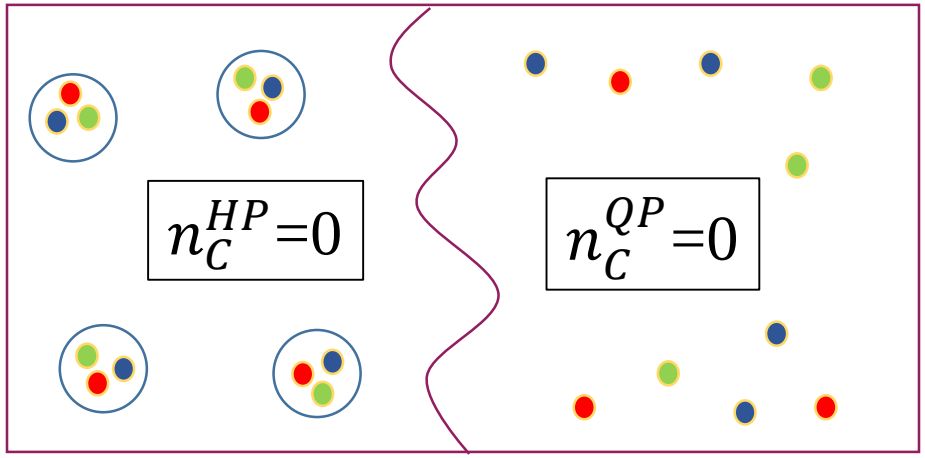
Model

Maxwell Construction

$$T^H = T^Q$$

$$\mu_{\mathrm{b}}^H = \mu_{\mathrm{b}}^Q$$

$$P^H = P^Q$$

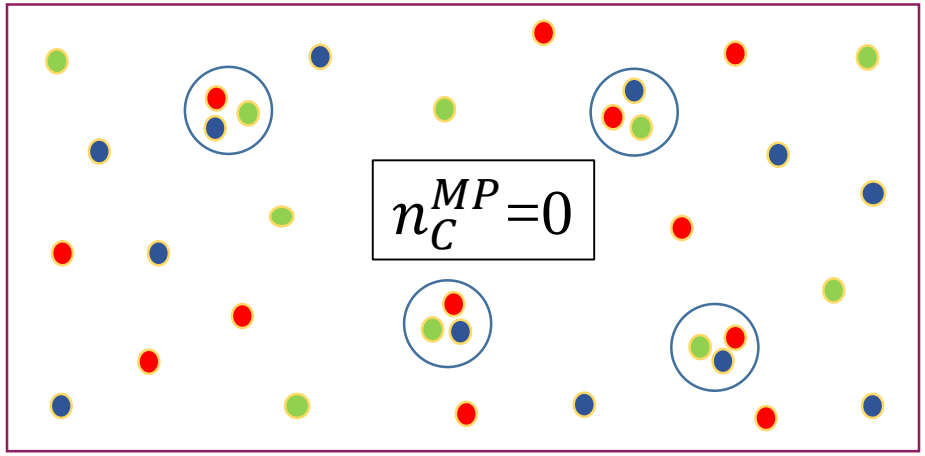


Gibbs Construction

$$T^H = T^Q$$

$$\mu_{\mathrm{b}}^H = \mu_{\mathrm{b}}^Q,\ \ \mu_{\mathrm{e}}^H = \mu_e^Q$$

$$P^H = P^Q$$



RESULTS

Table I: Parameter set used in the calculation.

$m_{u,d}$ (MeV)	m_s (MeV)	$B^{1/4}$ (MeV)	Z_0	g_σ^q	g_ω^q	g_ρ^q	Λ_ν
5.5	150.0	210.854	4.00506	5.9895	3.0018	11.2026	0.0844

Table II: Nuclear matter properties obtained with the QMC model.

Model	ρ_0 (fm^{-3})	E_0 (MeV)	K (MeV)	$E_{\rm sym}$ (MeV)	L (MeV)
QMC	0.15	-16.30	294.20	31.00	40.00

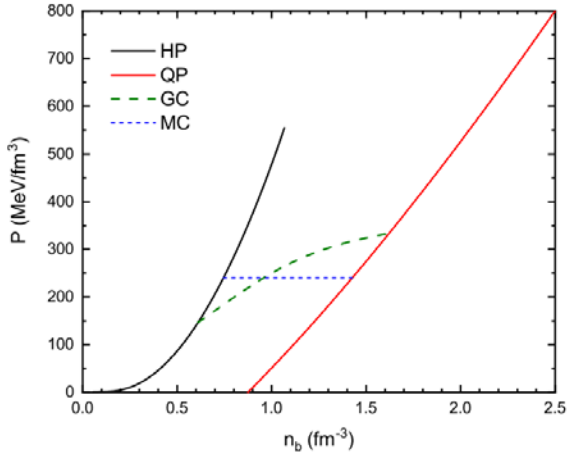


Fig 2: Pressure as a function of the baryon density n_b.

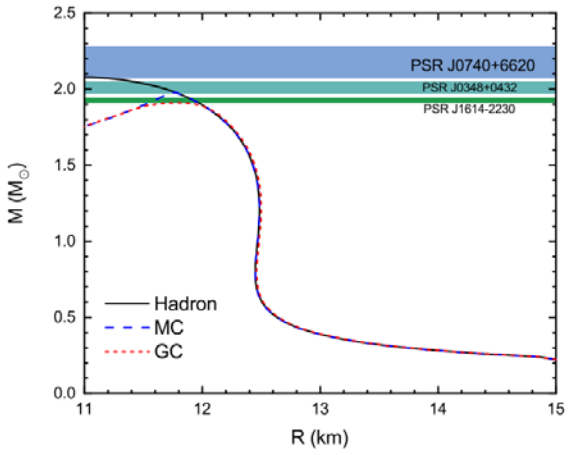


Fig 3: Mass-radius relations of neutron stars obtained using the QMC model.

Thank you very much for your attention!