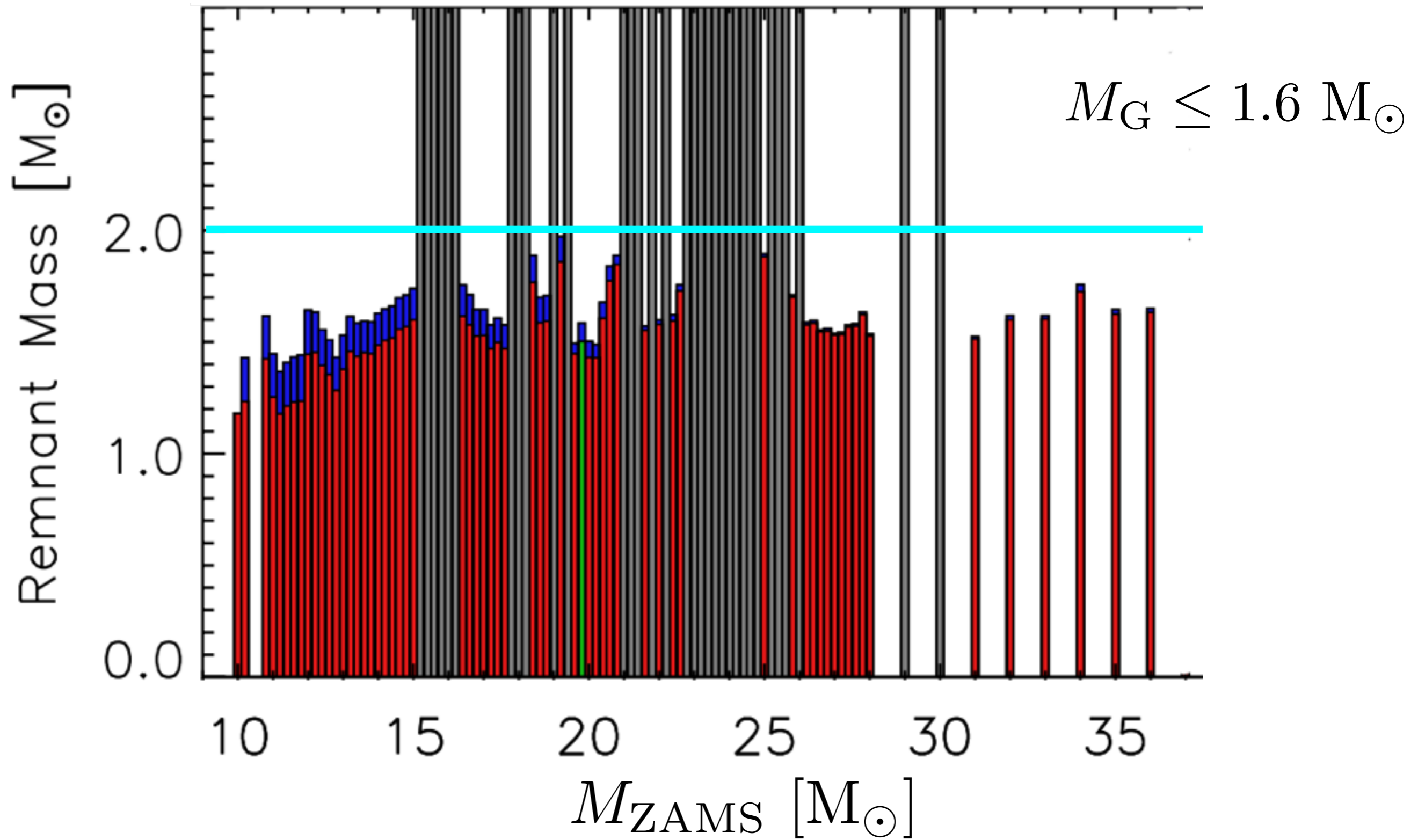


**Quark matter in neutron
stars ?**

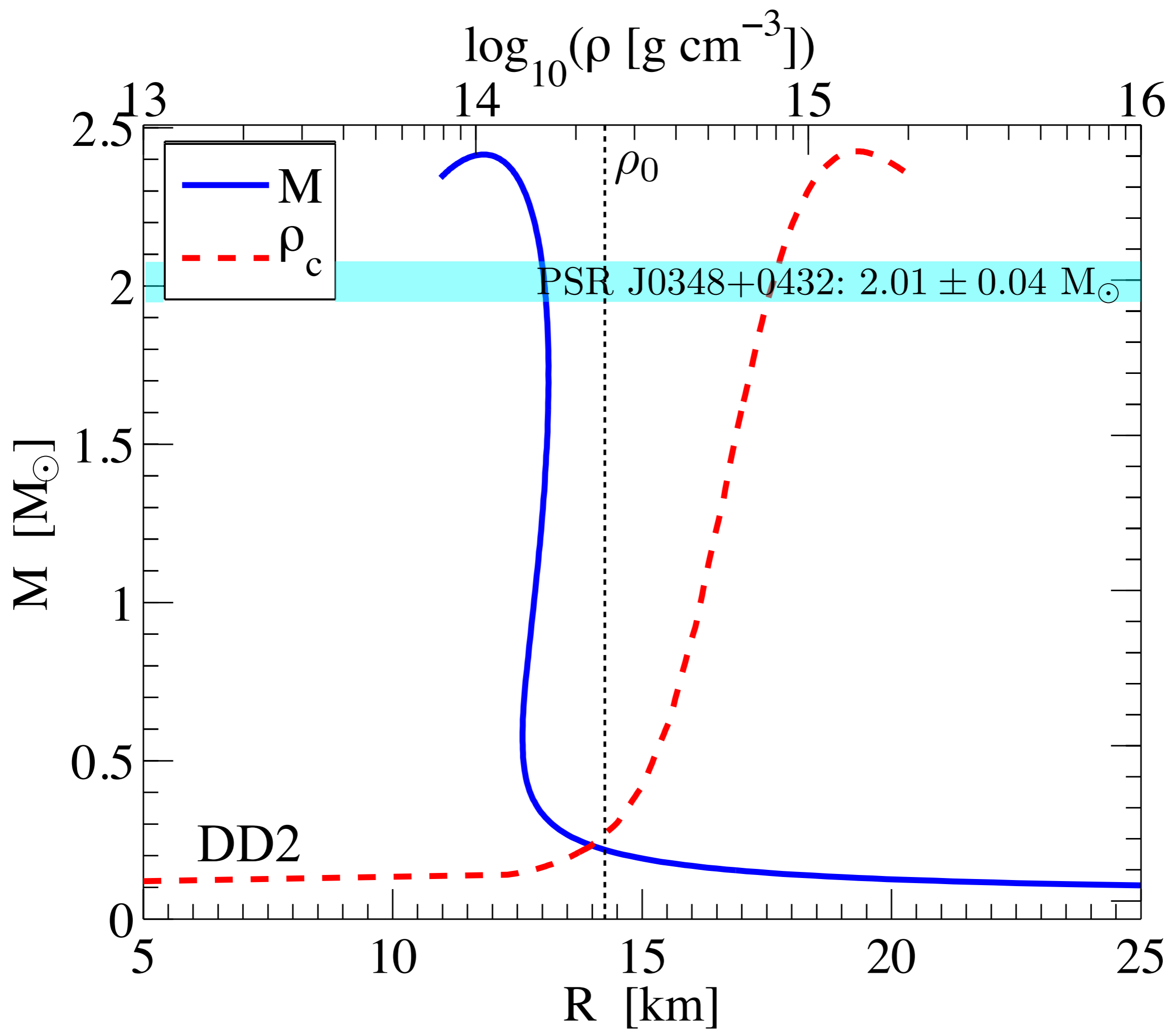
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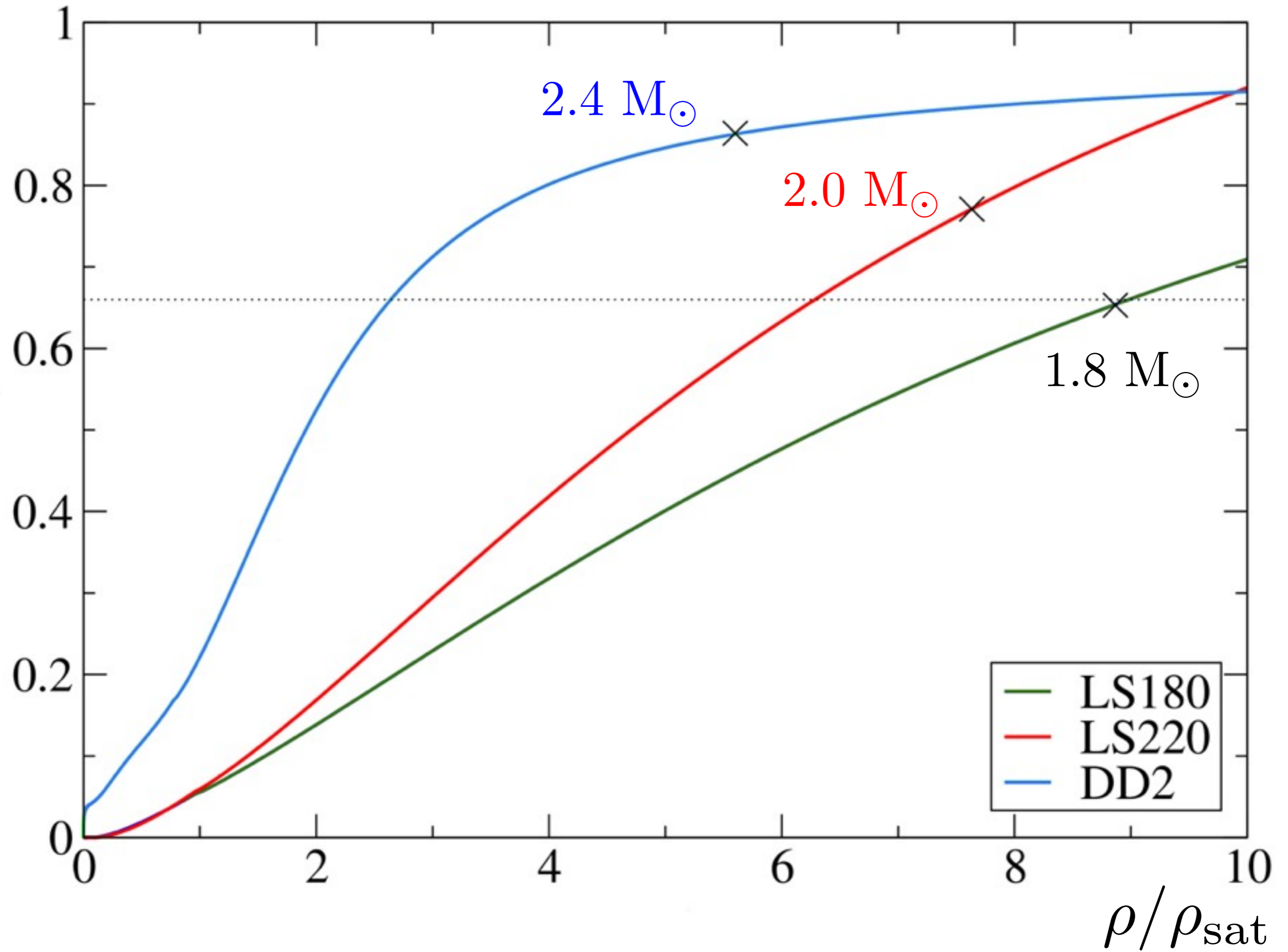
**on the origin of massive
neutron stars**

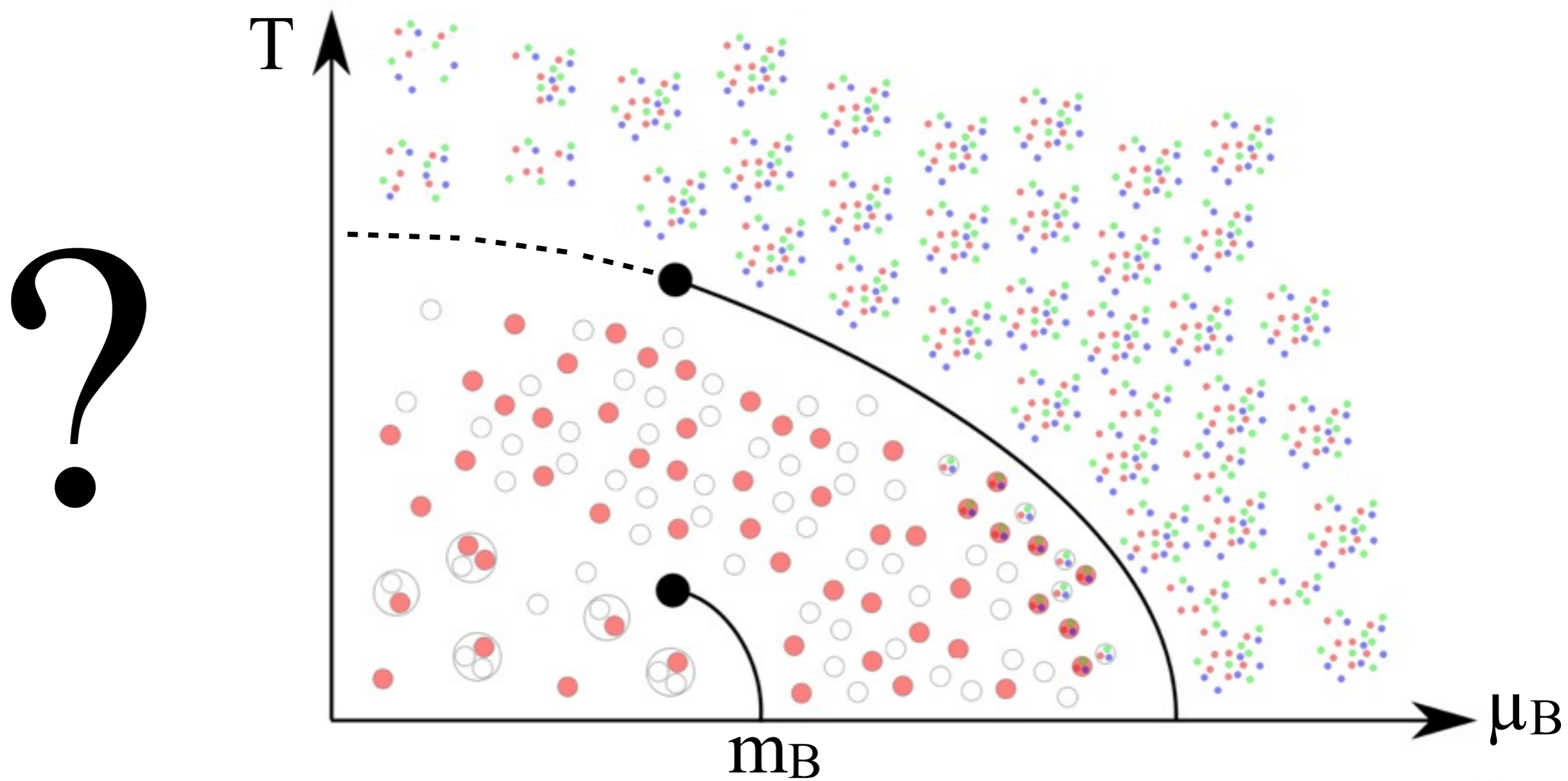
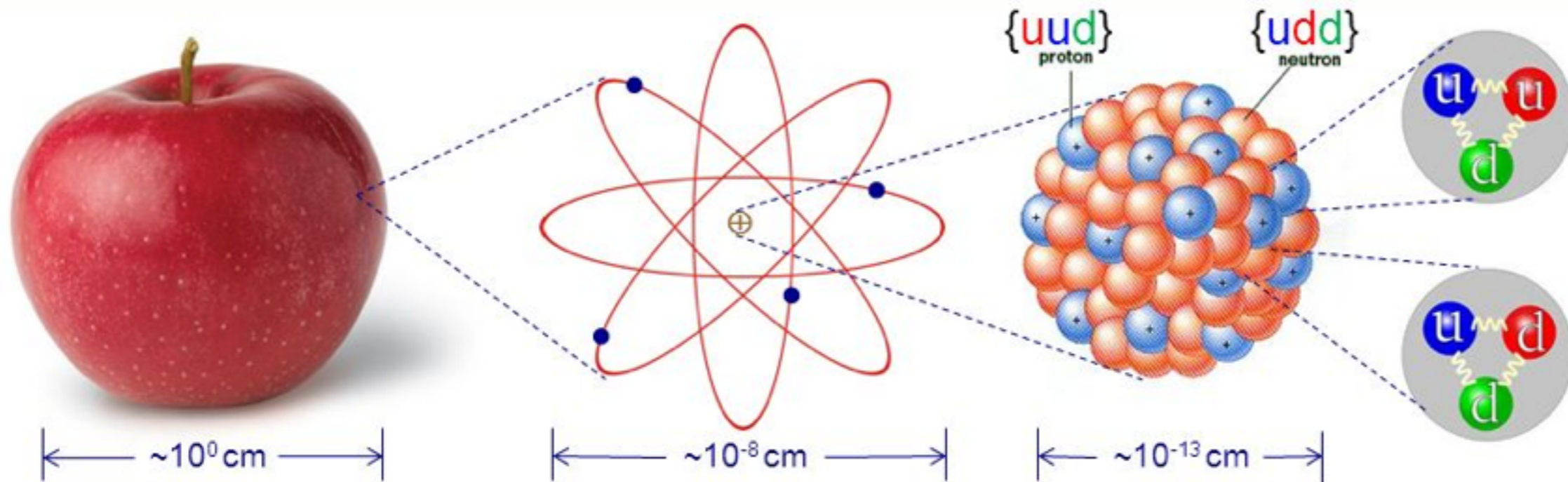


ApJ 757, 69 (2012)

ApJ 821, 38 (2016)



$(cs/c)^2$ 



$\alpha_s(Q)$

0.3

0.2

0.1

1

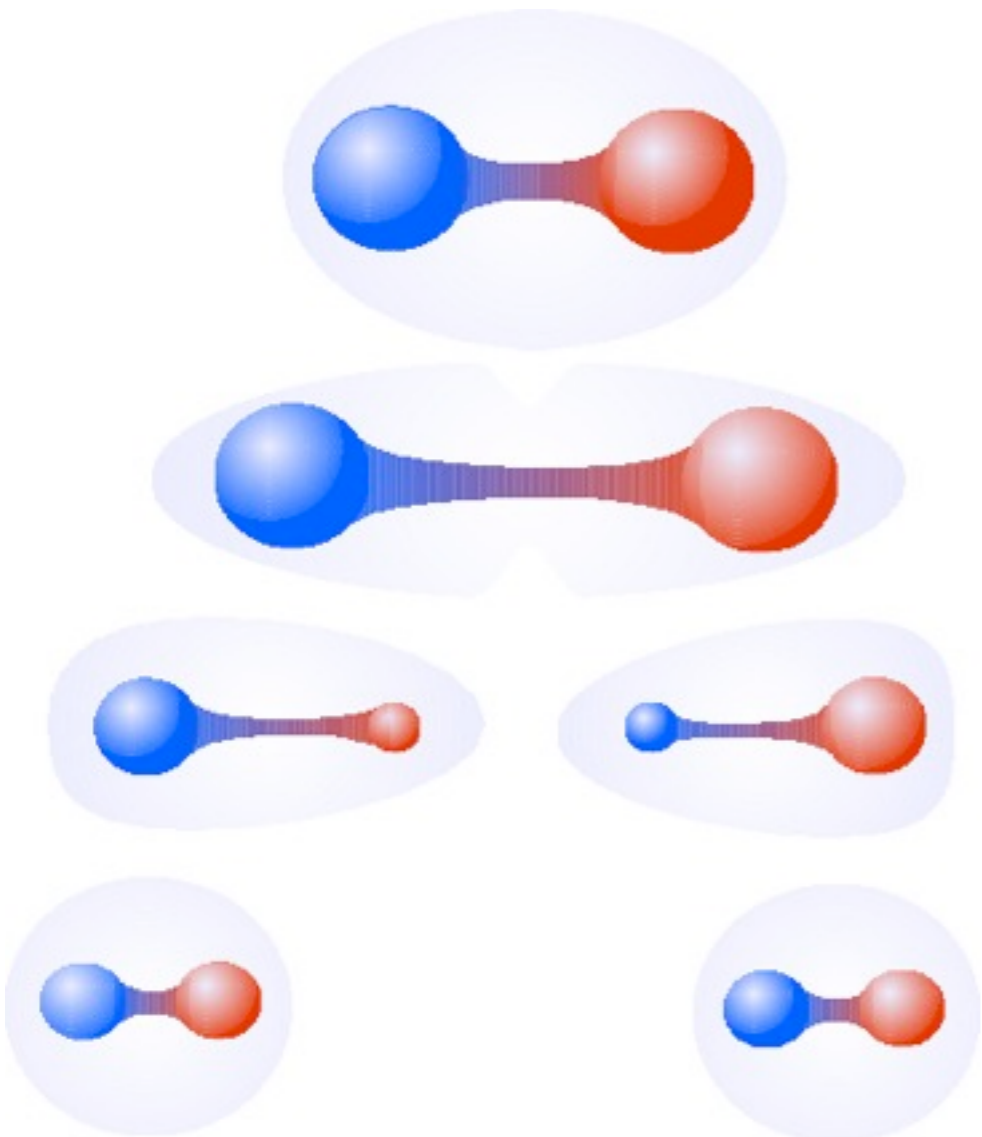
10

Q [GeV]

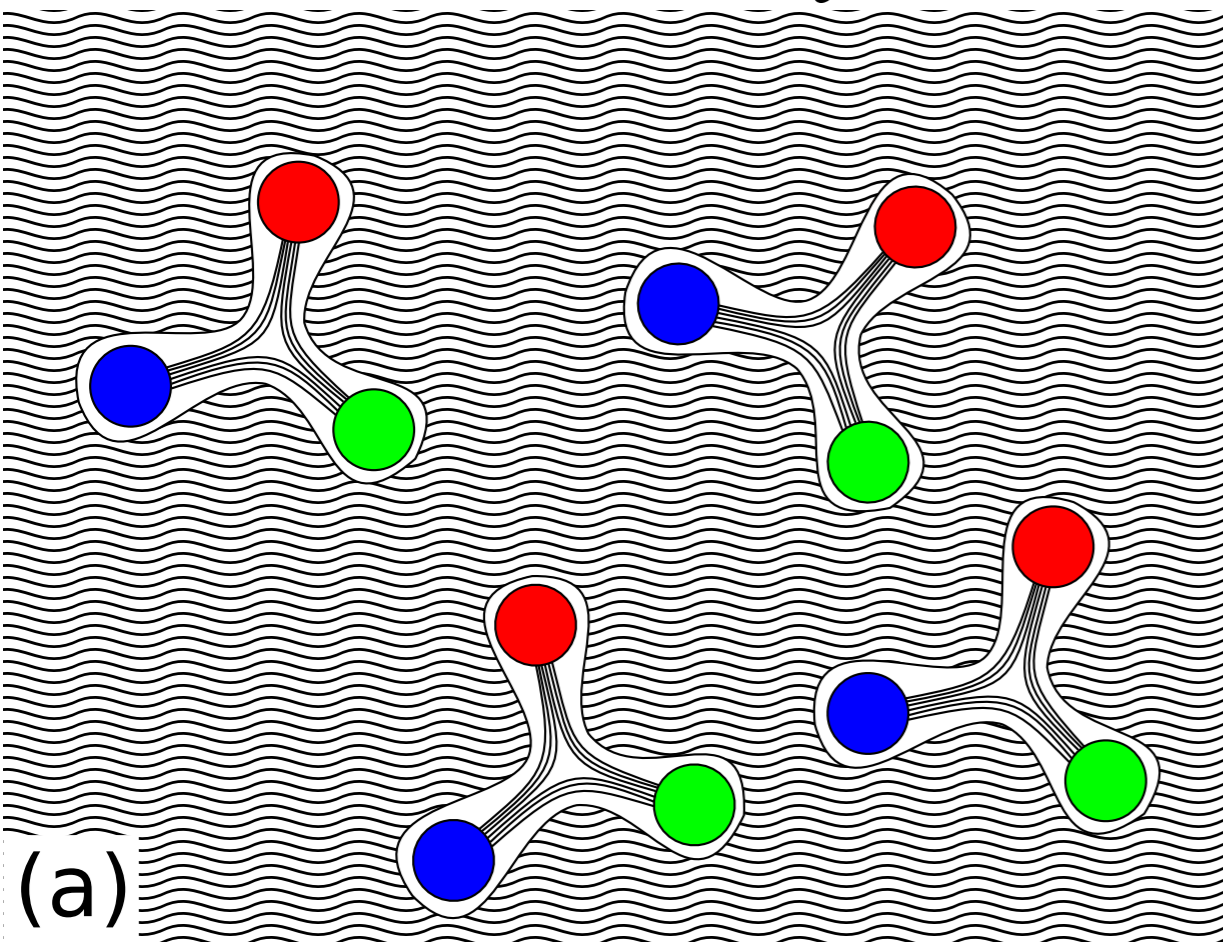
100

1000

- ▼ τ decays (N³LO)
- ⊠ Lattice QCD (NNLO)
- △ DIS jets (NLO)
- Heavy Quarkonia (NLO)
- e^+e^- jets & shapes (res. NNLO)
- Z pole fit (N³LO)
- ▽ $p\bar{p} \rightarrow$ jets (NLO)



low density



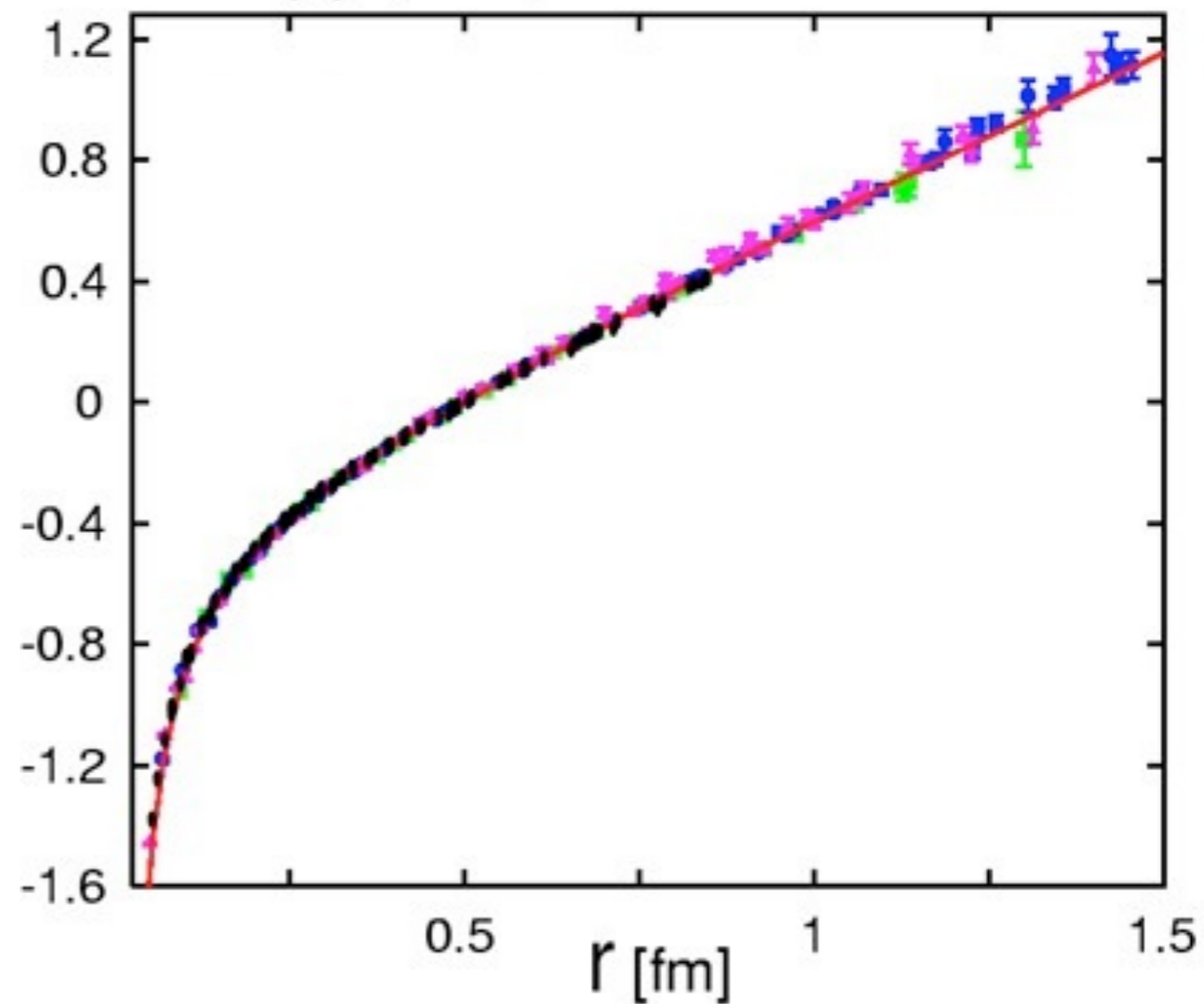
$$D = D_0$$

Dual-Meissner effect

NPA 536, 669 (1992)

PRD 96, 056024 (2017)

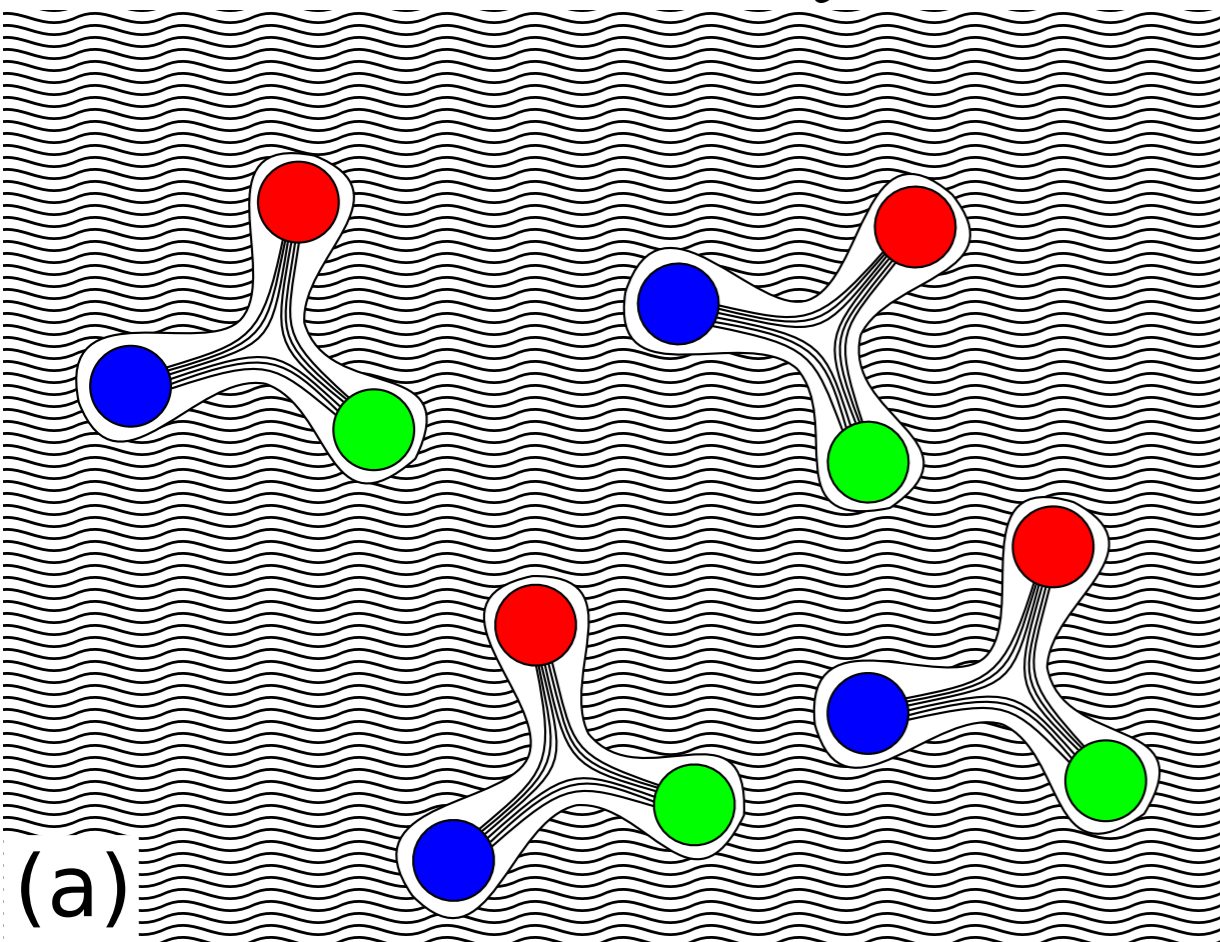
$V_{Q\bar{Q}}(r)$ [GeV]



$$V_{Q\bar{Q}}(r) \propto D_0 r - \frac{A}{r}$$

$$D_0 = 1 \text{ GeV fm}^{-1}$$

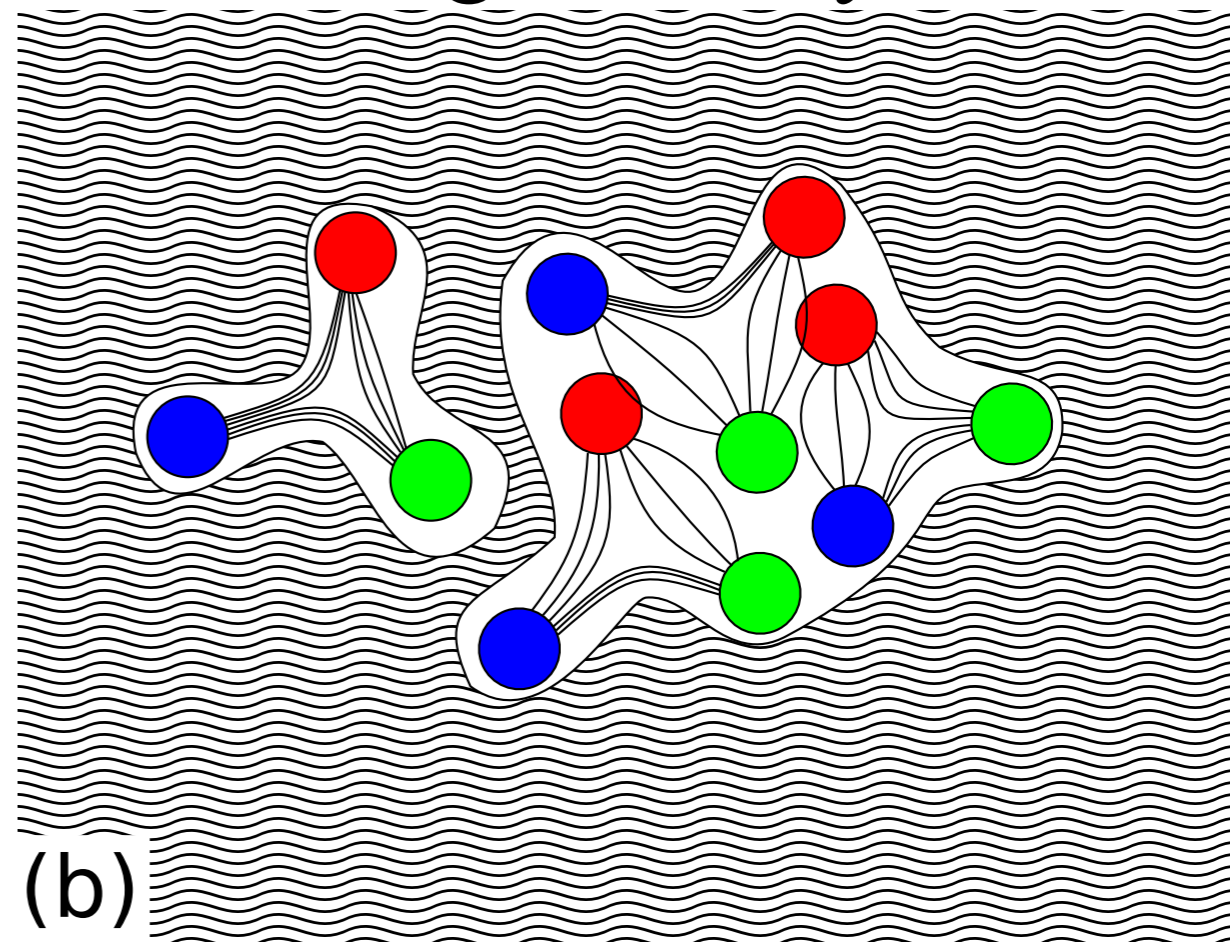
low density



(a)

$$D = D_0$$

high density



(b)

$$D(\rho) = D_0 \Phi(\rho)$$

$$\Phi(\rho) = \exp \left\{ -\alpha (\rho - \rho_0)^2 \right\}$$

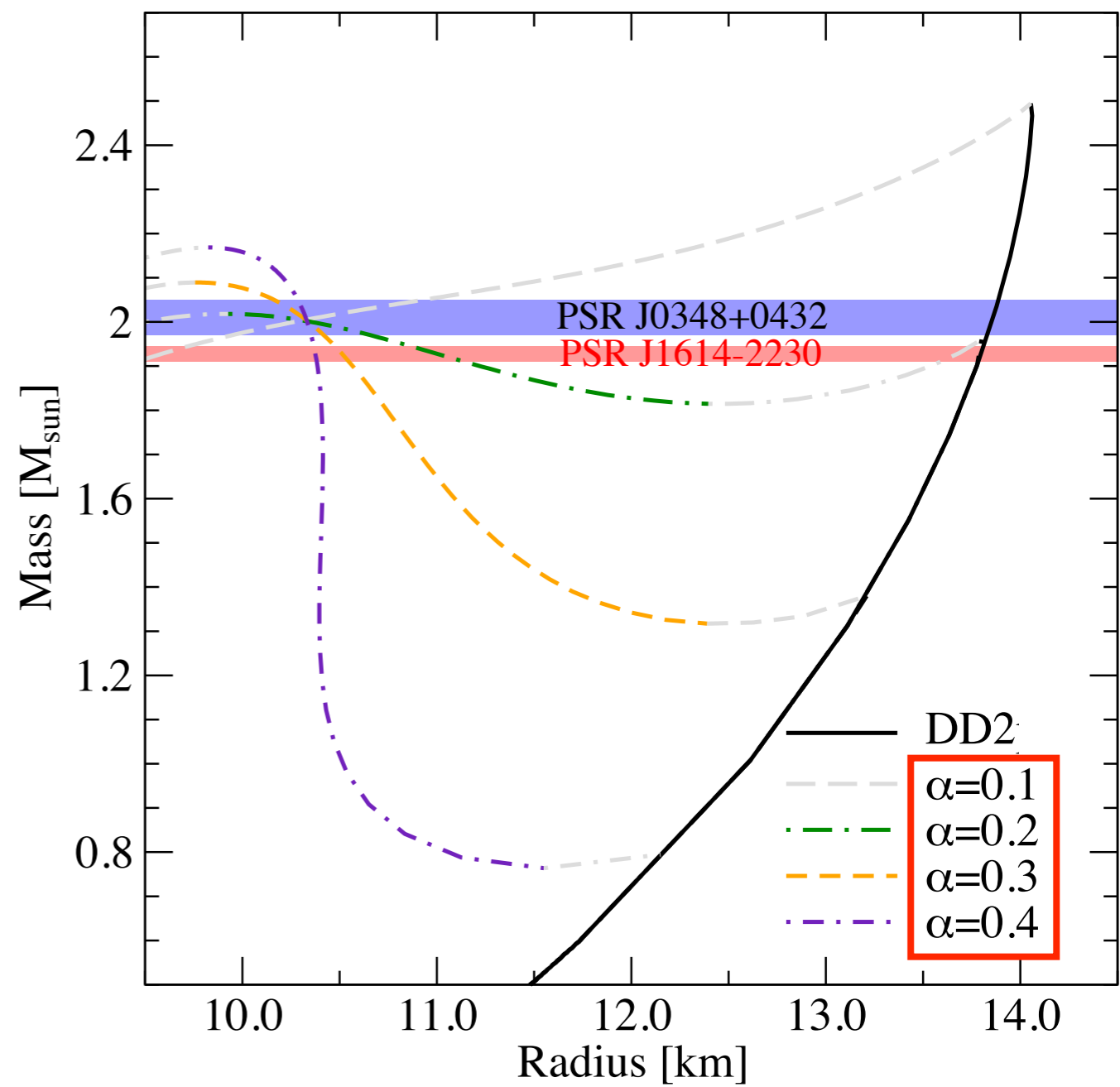
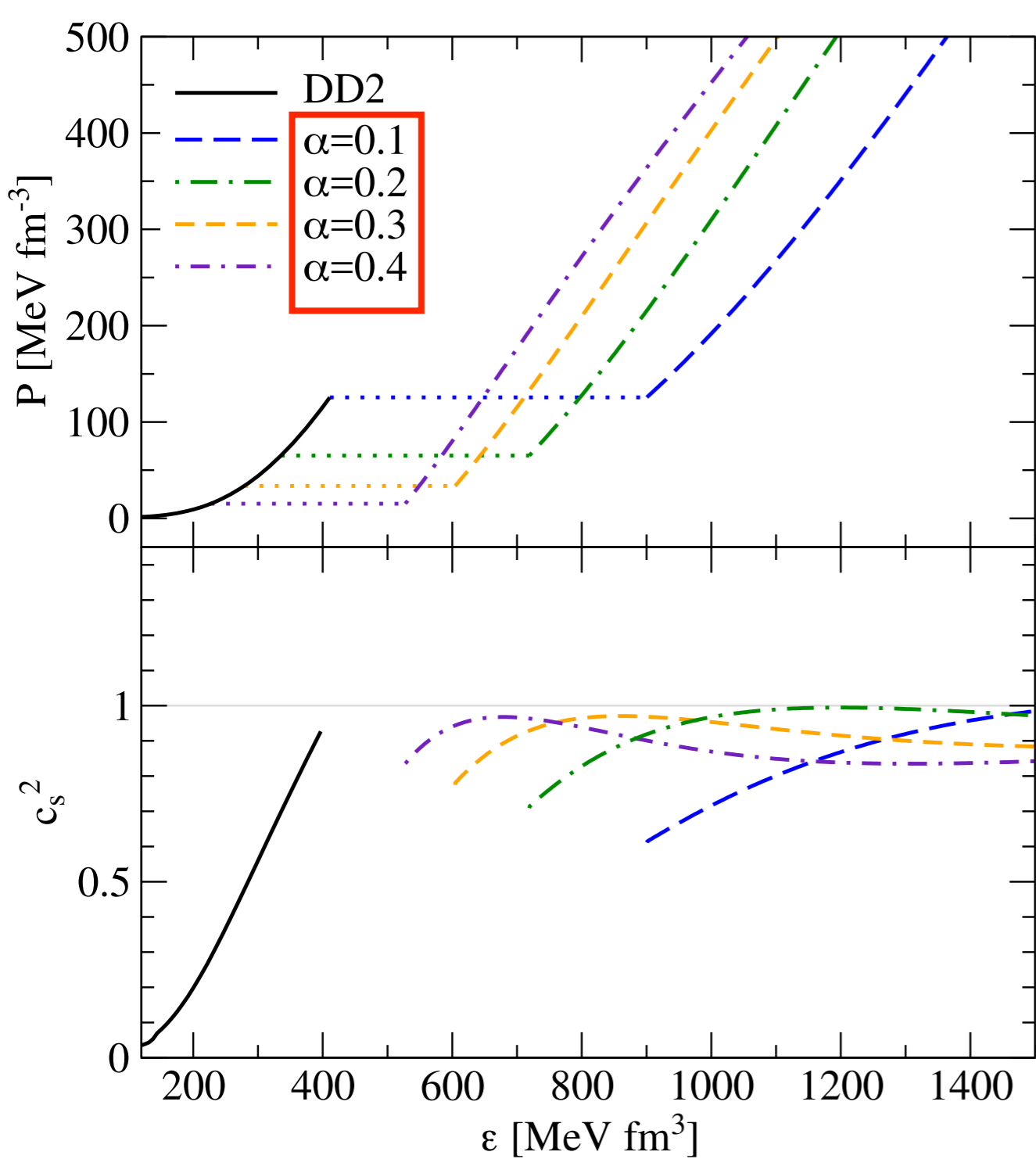
repulsive vector interaction:

$$\mu^* = \mu - a \rho - \mathcal{O}(\rho^3)$$

NPA 536, 669 (1992)

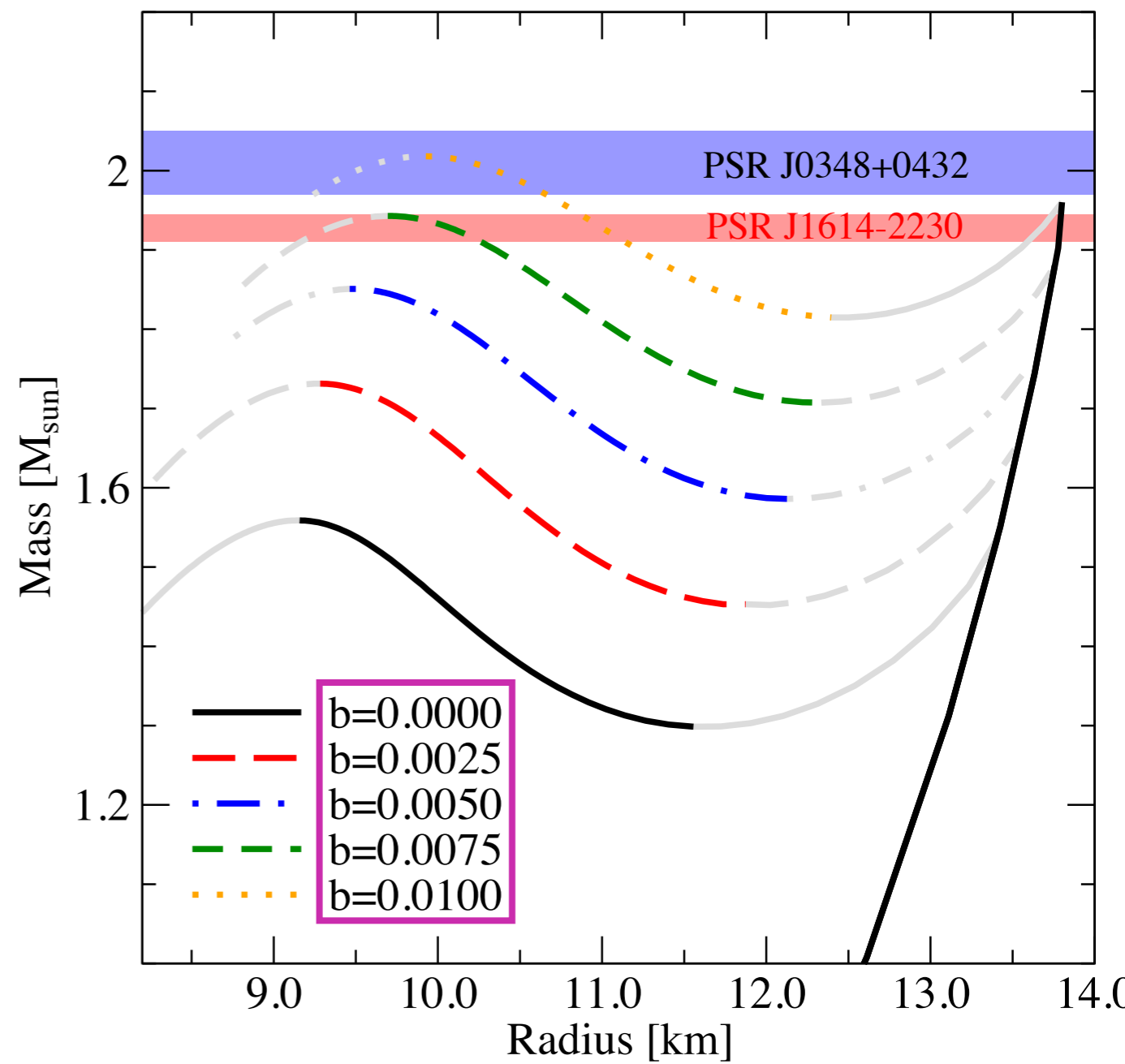
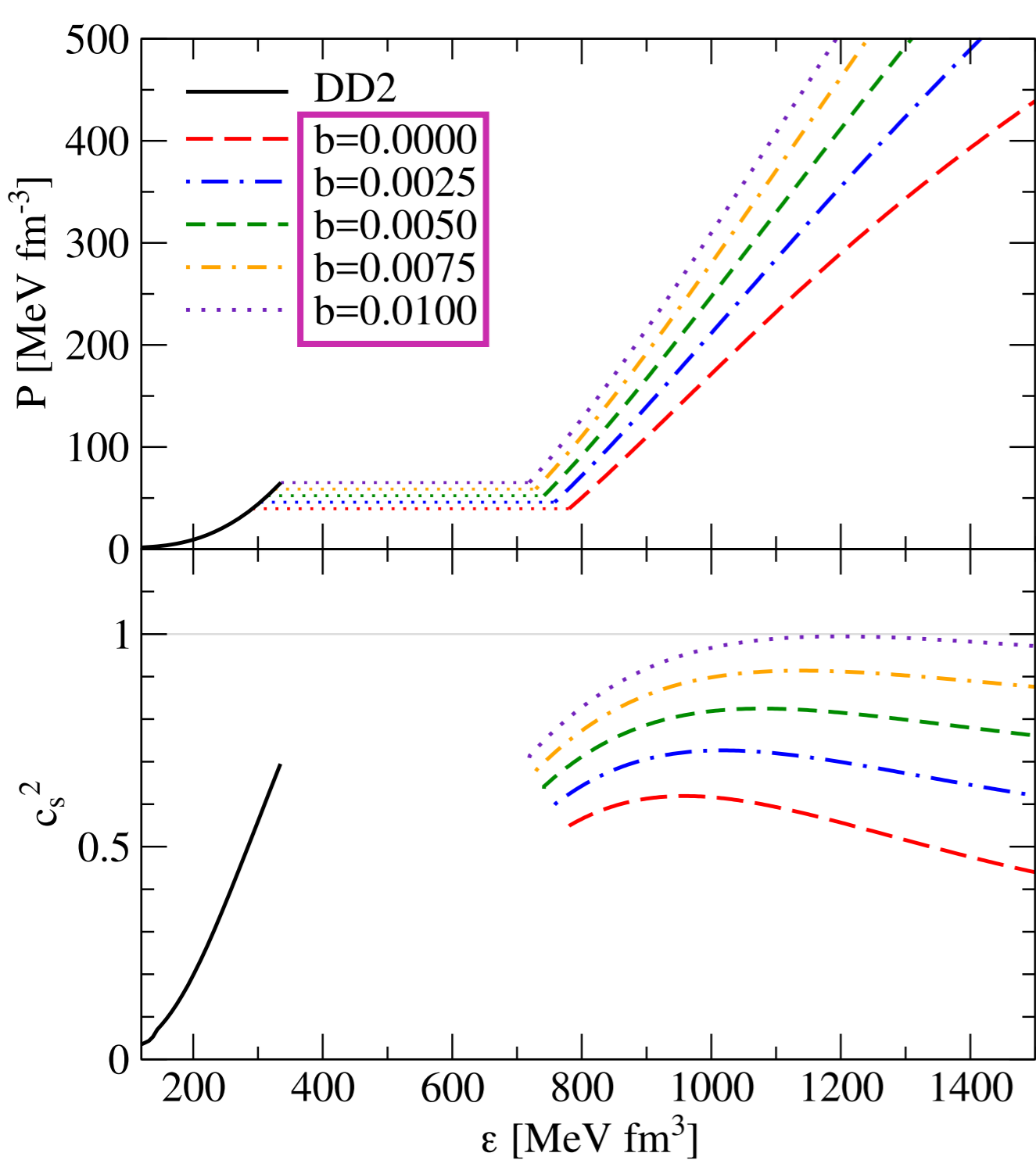
PRD 96, 056024 (2017)

A&A 577, 40 (2015)



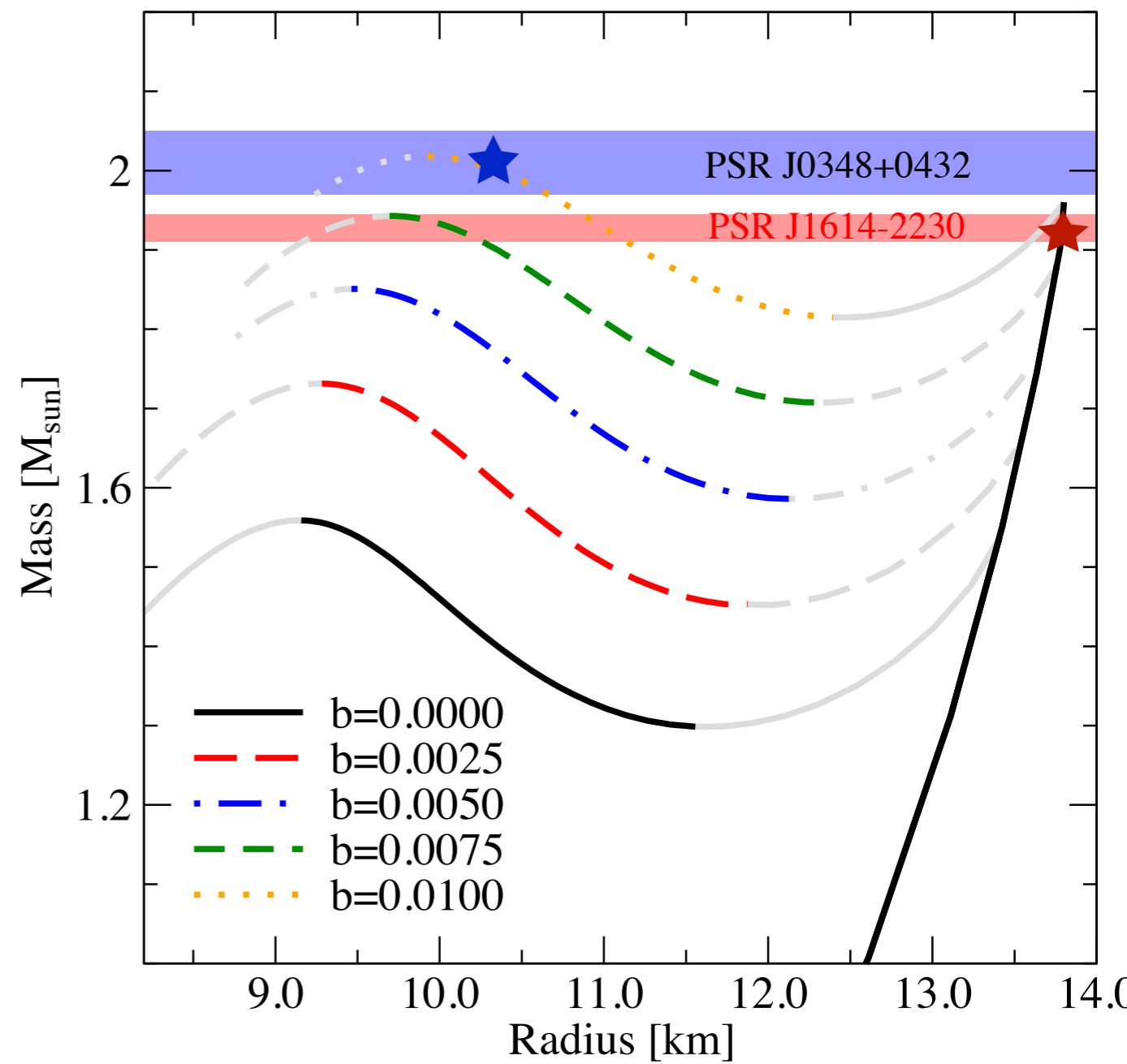
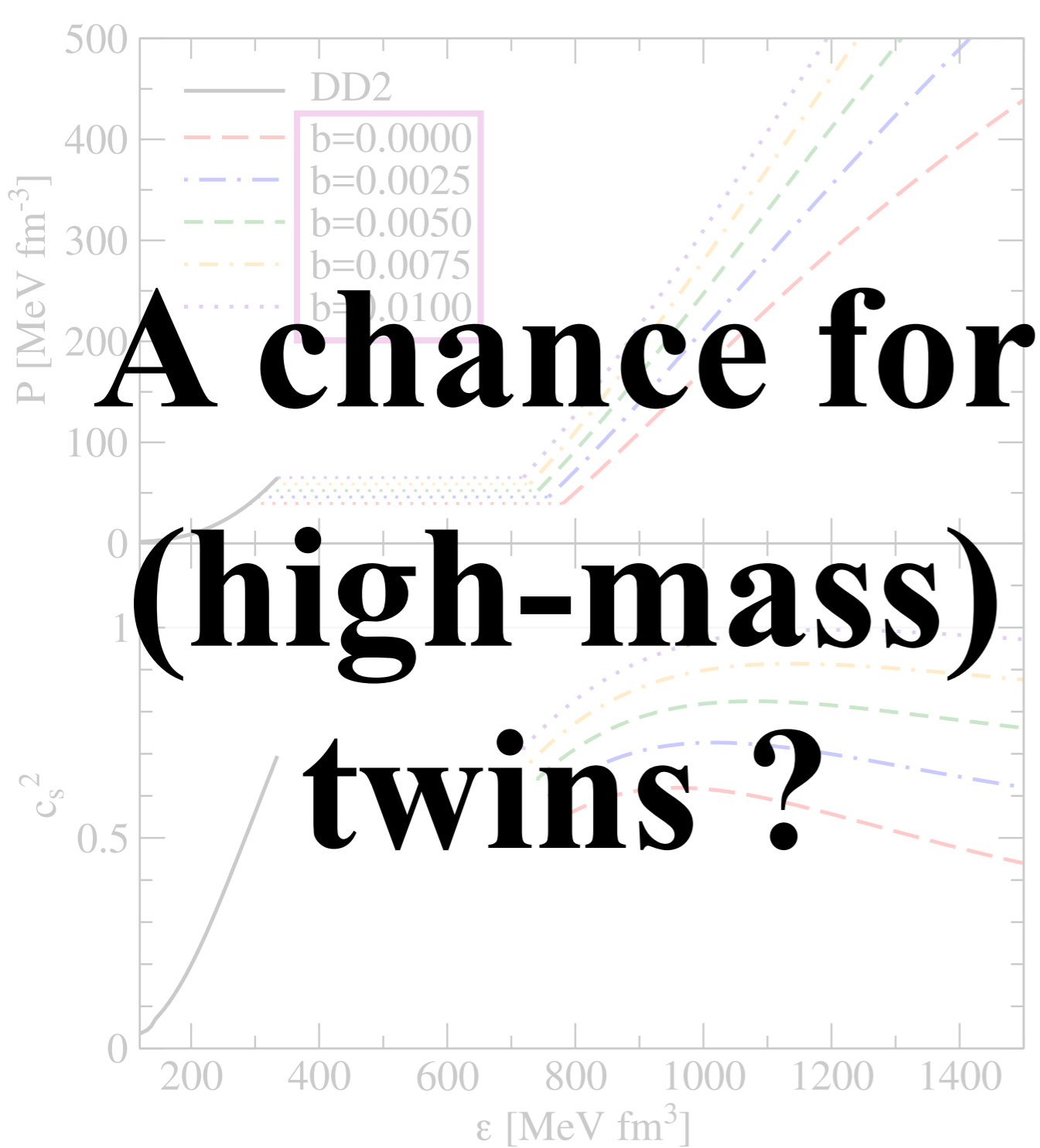
$$D(\rho) = D_0 \Phi(\rho)$$

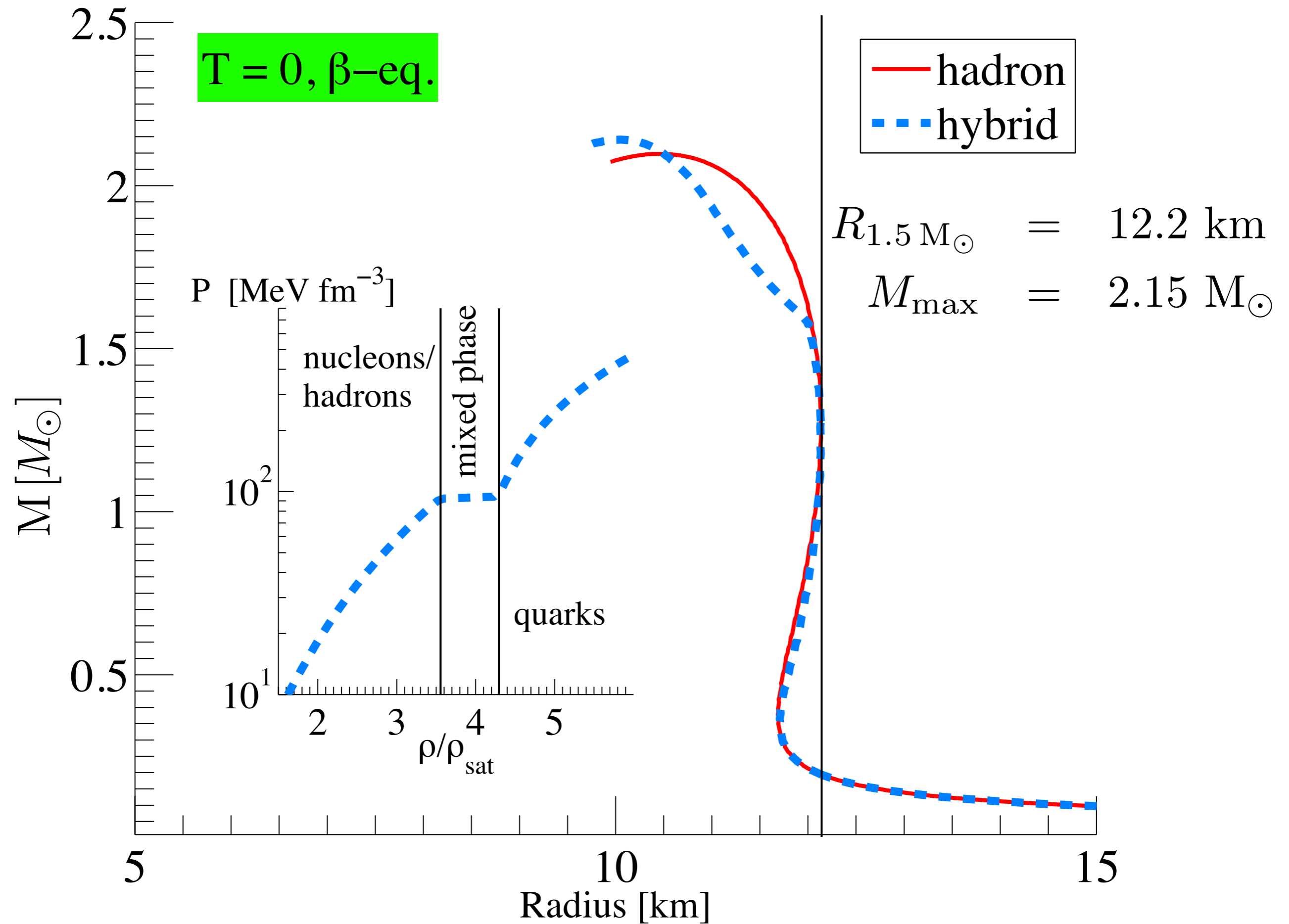
$$\Phi(\rho) = \exp \left\{ -\alpha (\rho - \rho_0)^2 \right\}$$

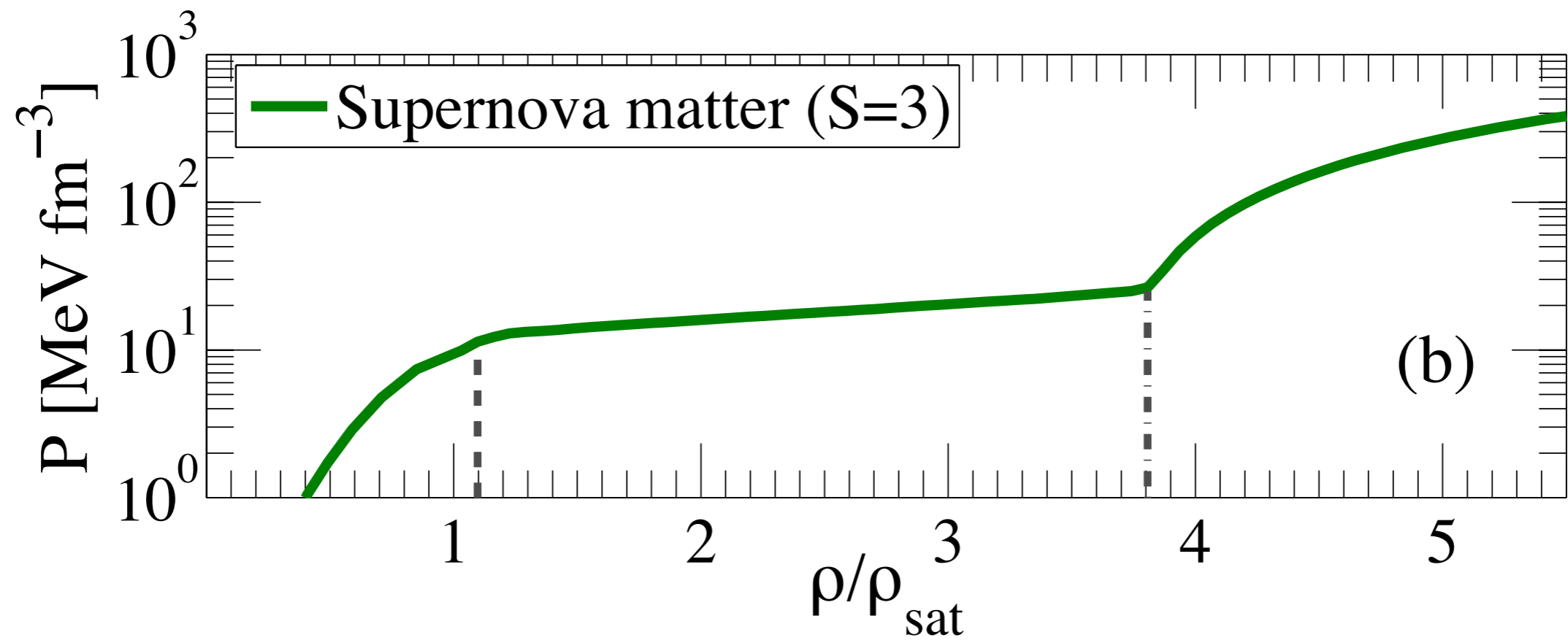
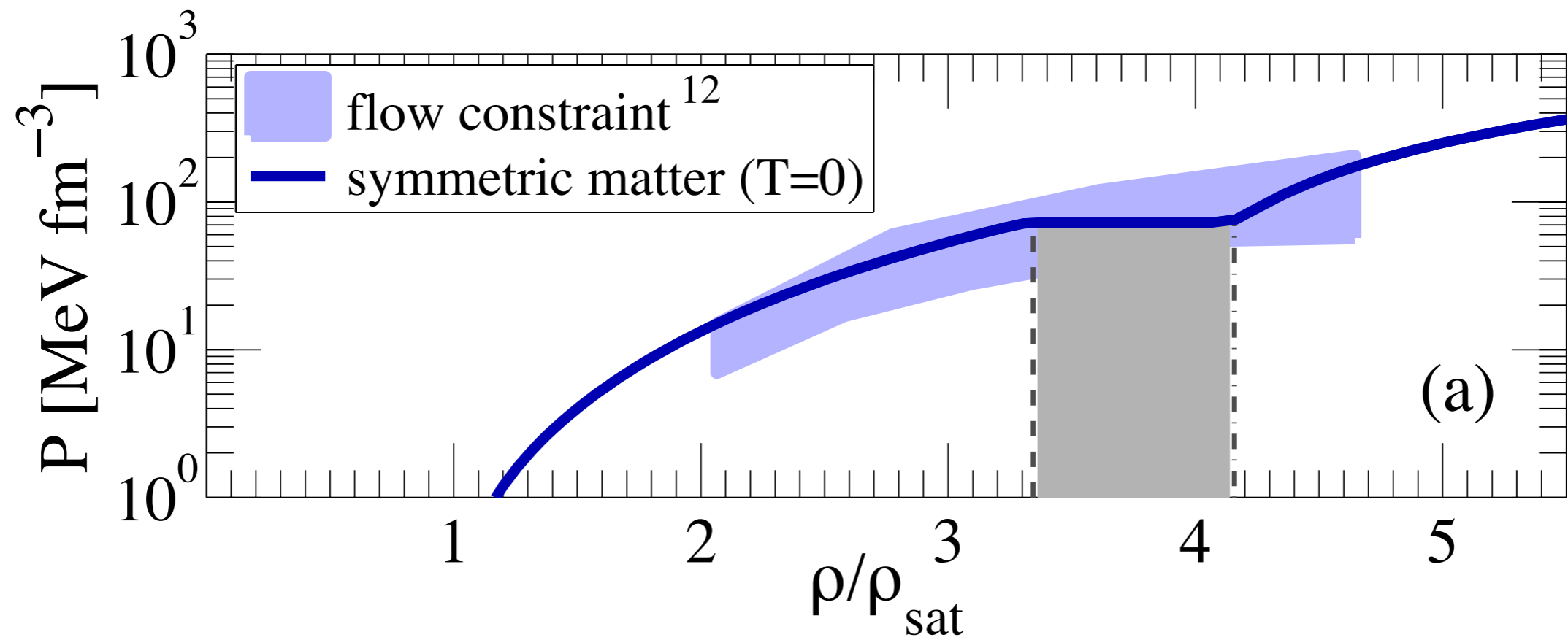


repulsive vector interaction:

$$\mu^* = \mu - a\rho - \mathcal{O}(\rho^3)$$







T/T_c

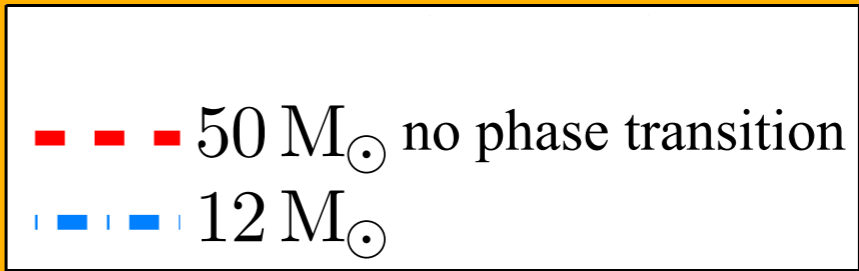
c

1

QGP

quark-hadron
mixed phase

black-hole
formation



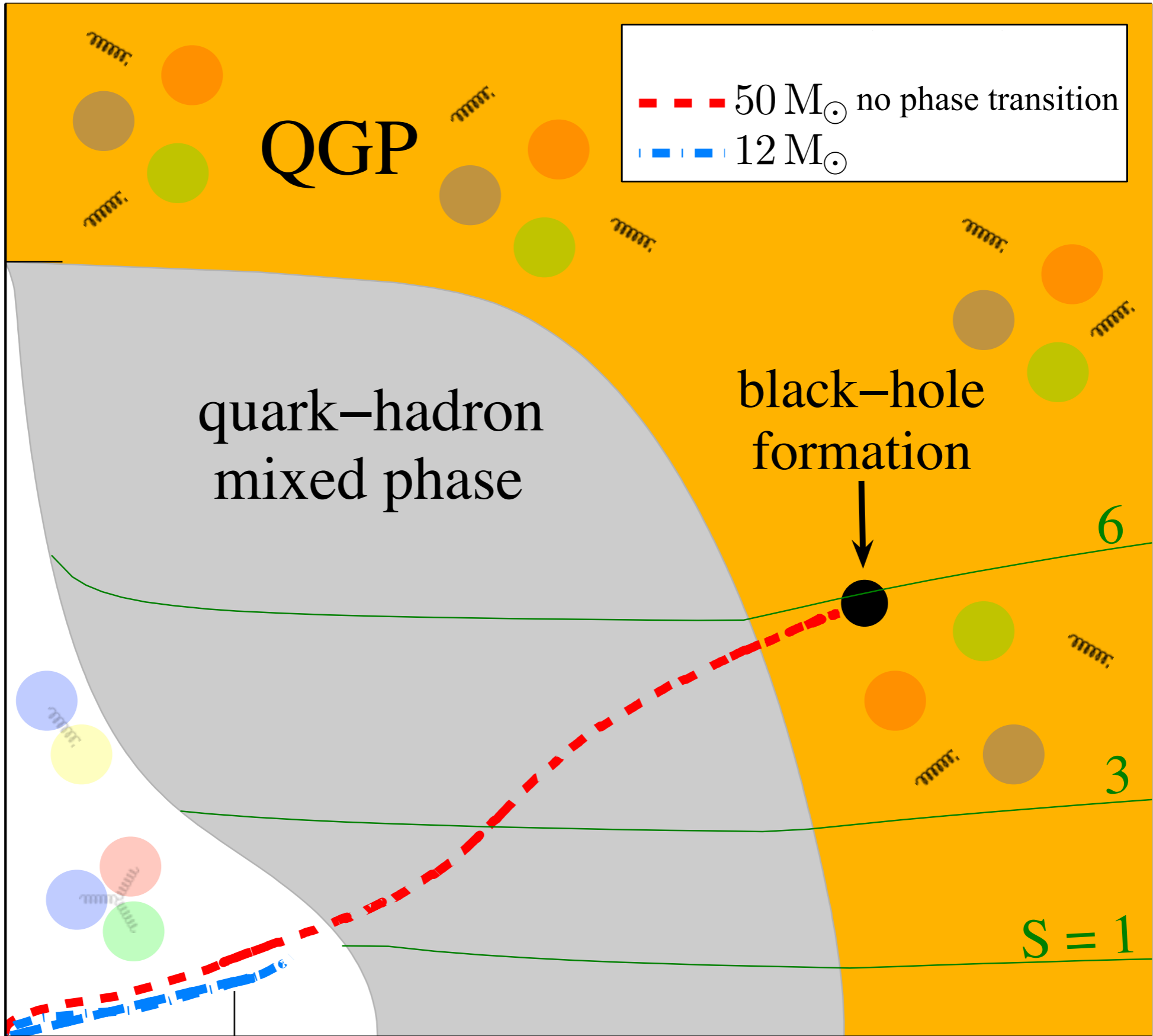
6

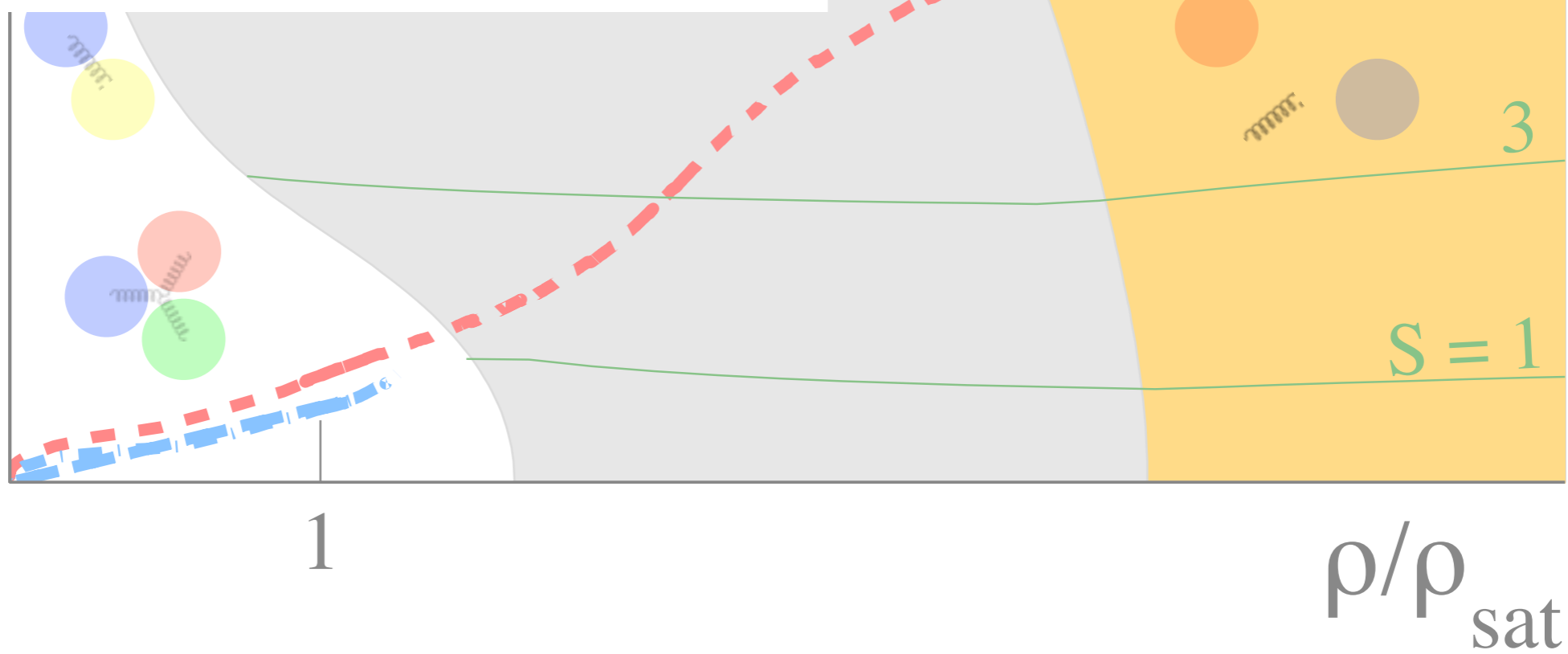
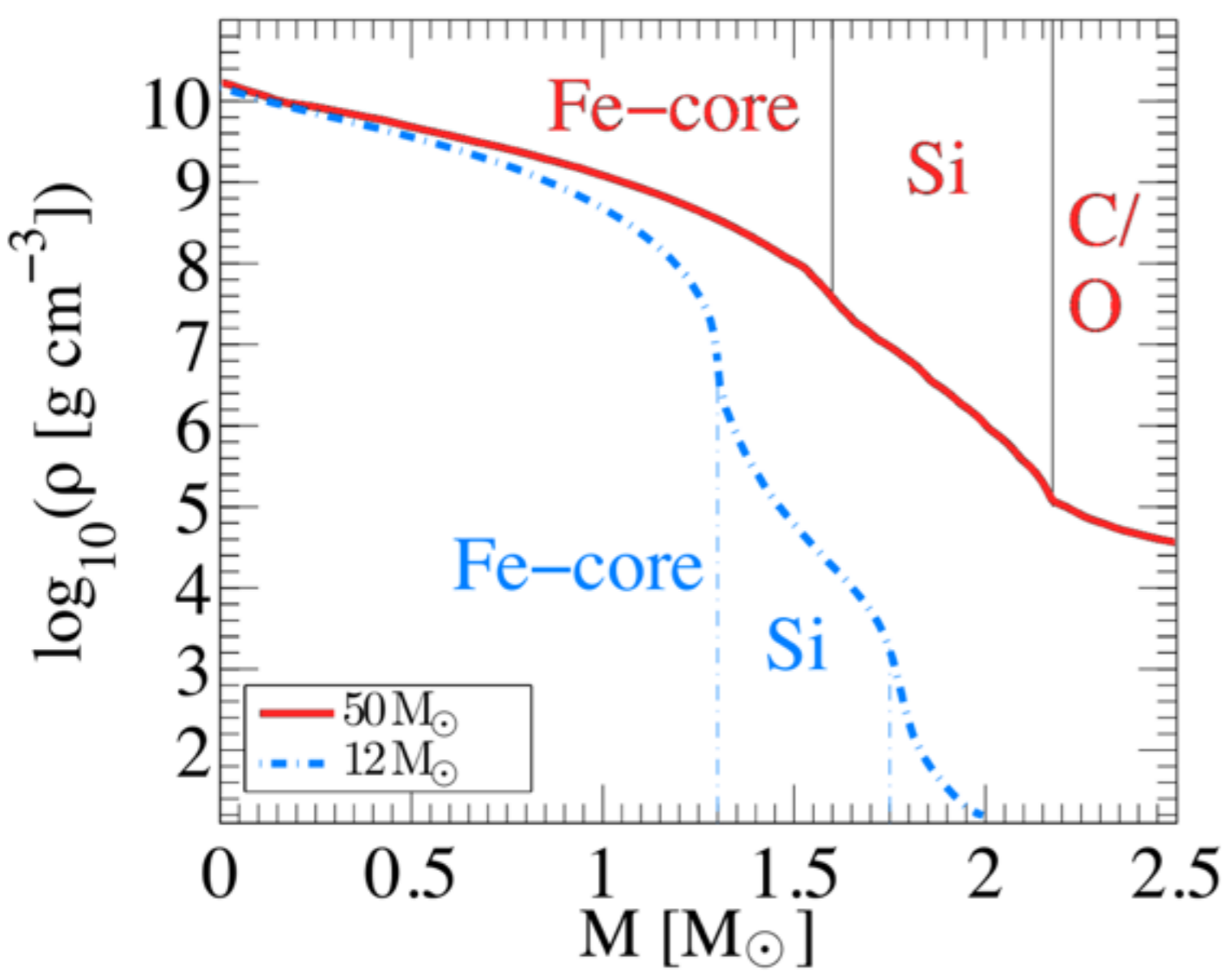
3

$S = 1$

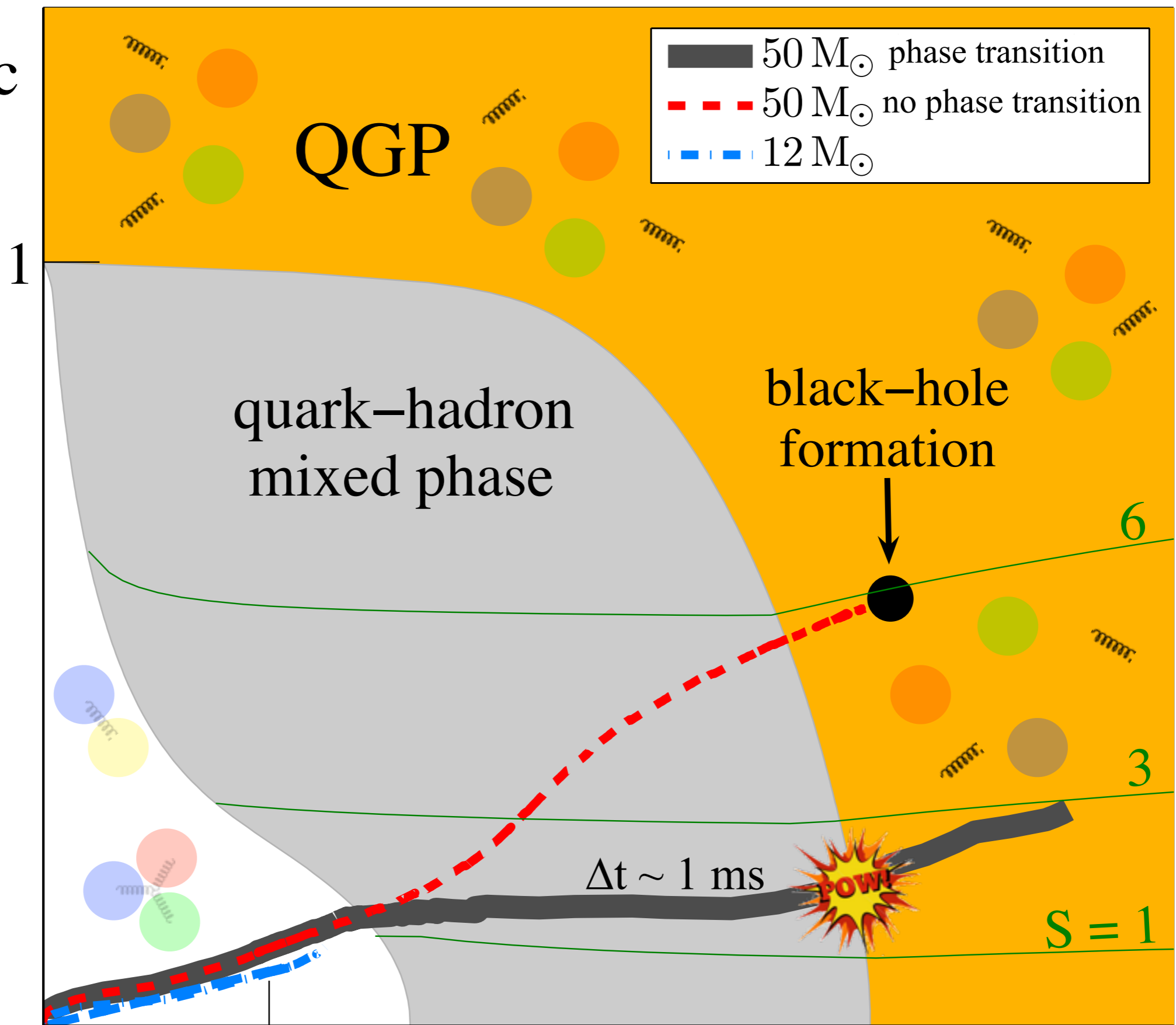
1

ρ/ρ_{sat}



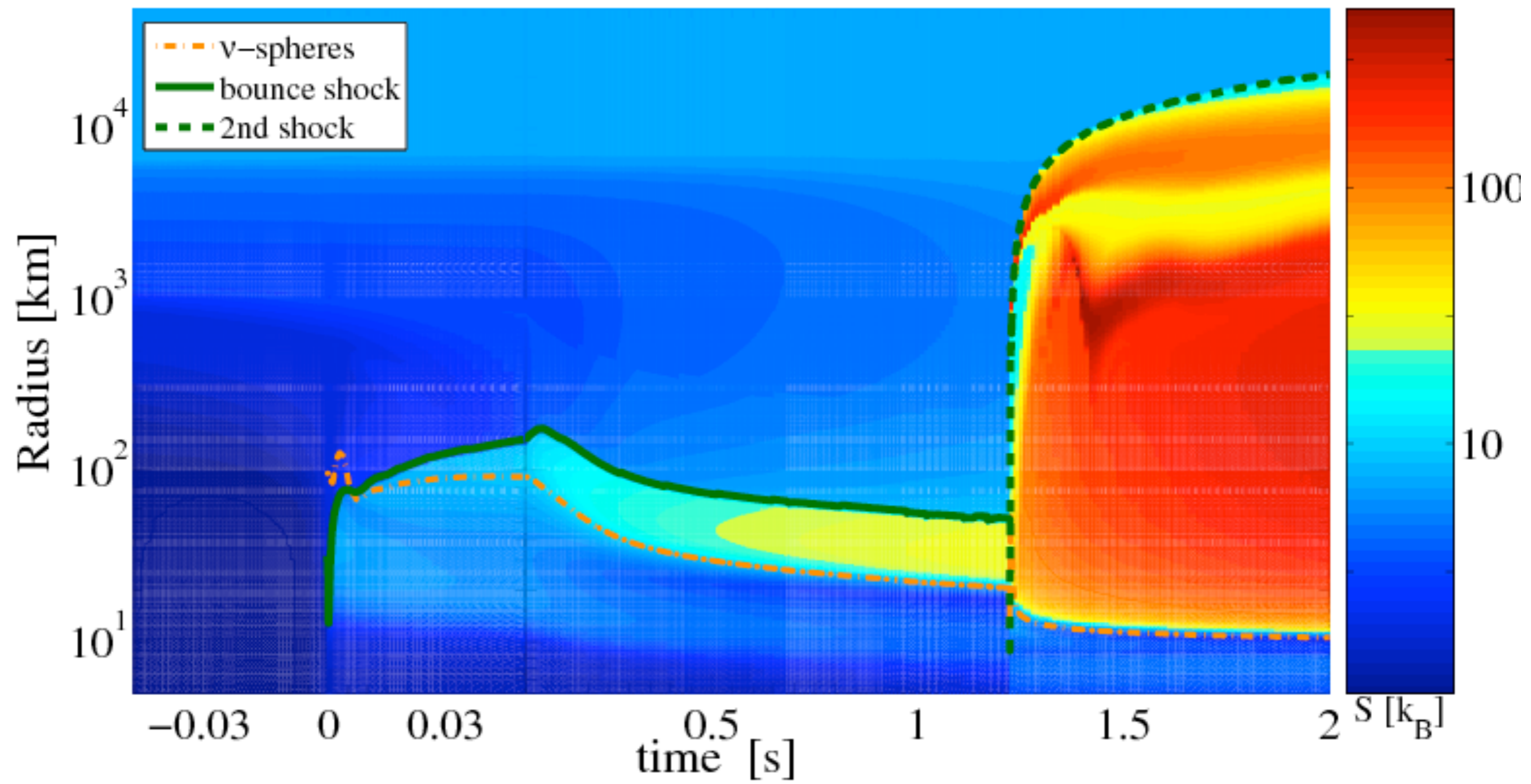


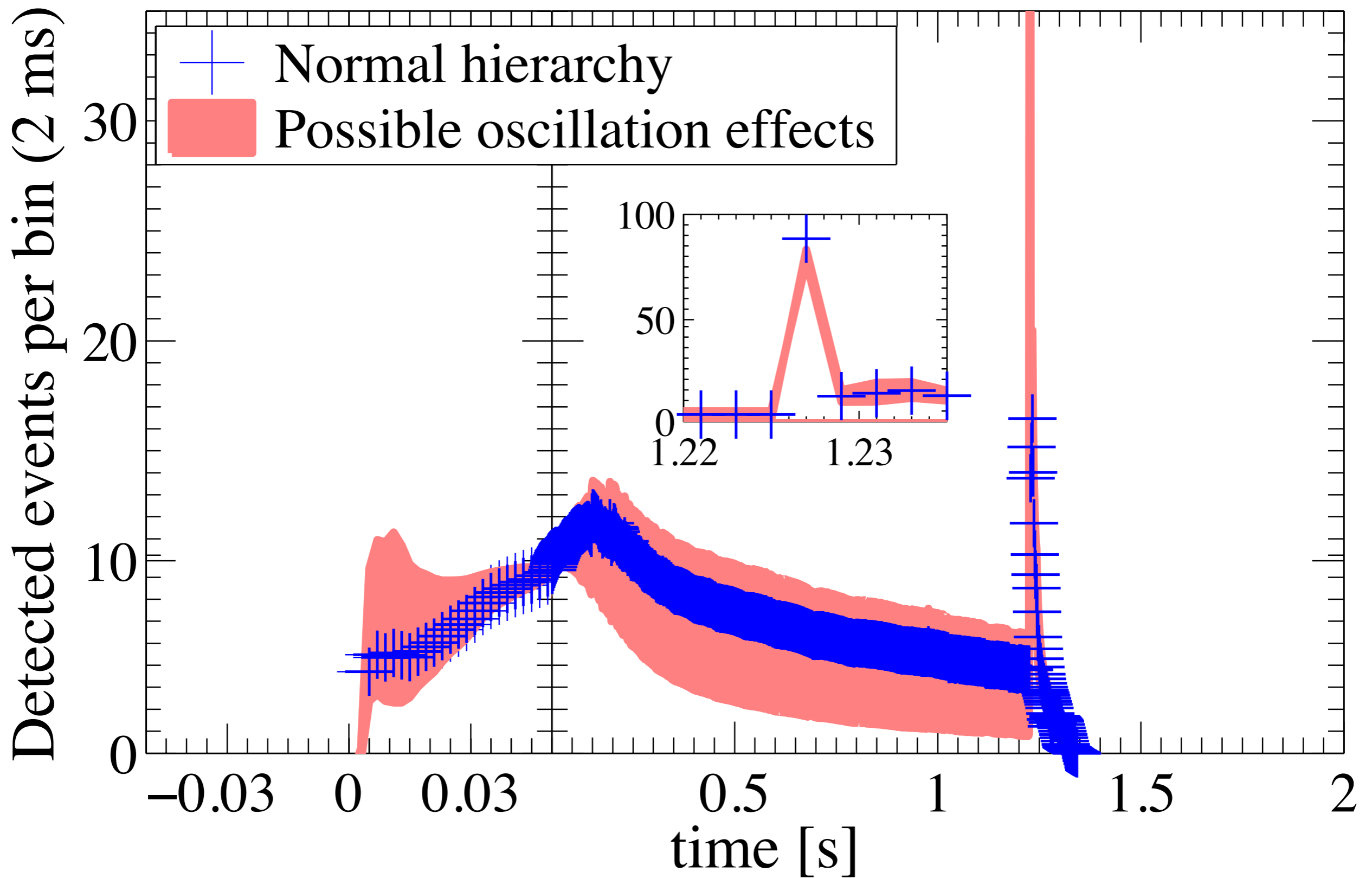
T/T_c



1

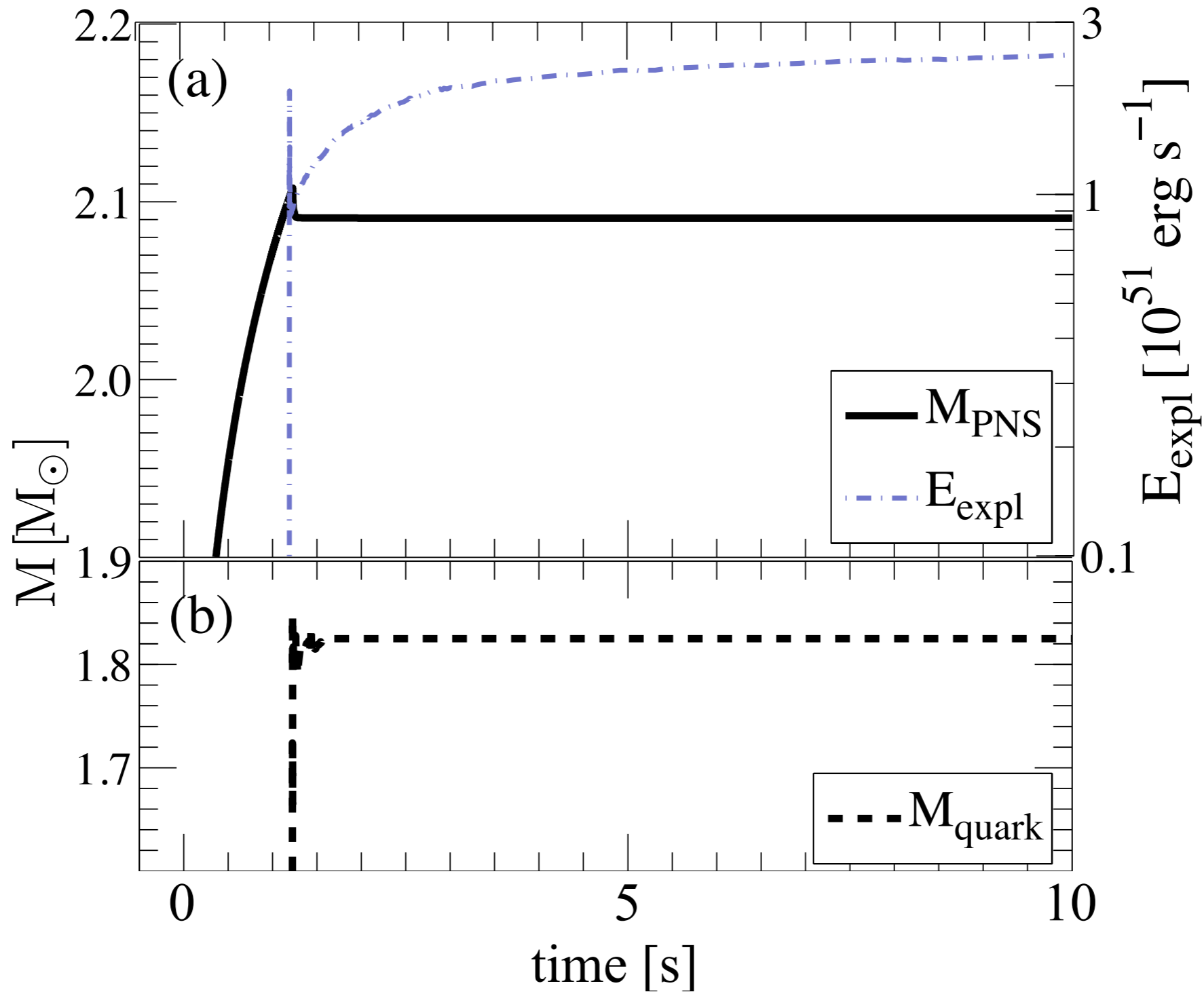
ρ/ρ_{sat}





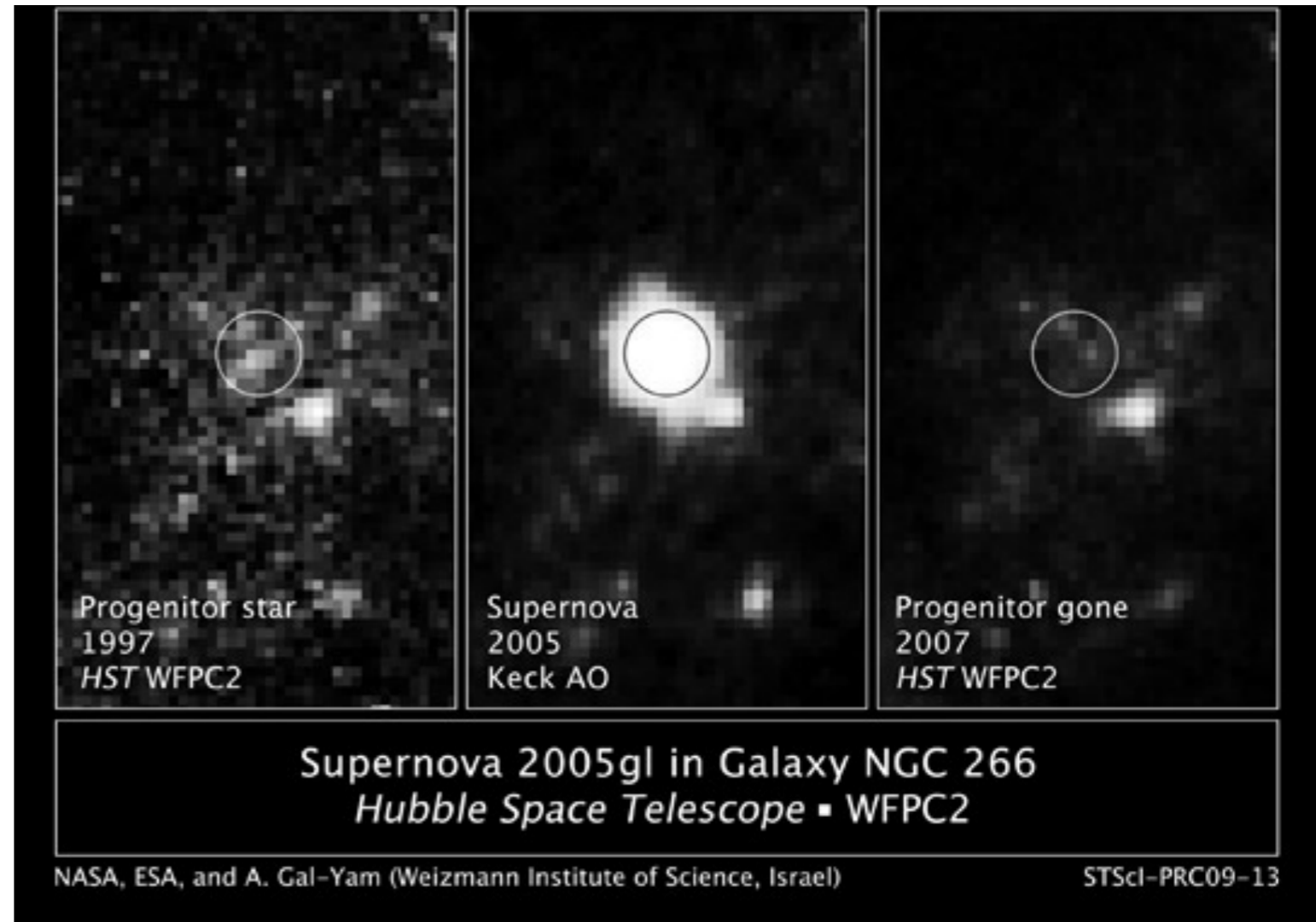
$$E_{\text{expl}} = 3 \times 10^{51} \text{ erg s}^{-1}$$

$$M_{\text{NS}} \simeq 2 M_{\odot}$$



A novel road to explosions of very massive stars $\gtrsim 40 - 50 M_{\odot}$

“The progenitor was so bright that it probably belonged to a class of stars called Luminous Blue Variables (LBVs)”



Remnants: massive neutron stars $\sim 2 M_{\odot}$

Thanks for your attention

In collaboration with:

N. U. Bastian
D. Blaschke
T. Klähn
S. Typel
M. R. Wu