East Asia Joint Workshop on Fields and Strings 2018
@ KIAS

QUARK MATTER & NEUTRON STAR FROM ADS/QCD AND THE APPLICATION TO GRAVITATIONAL WAVES".

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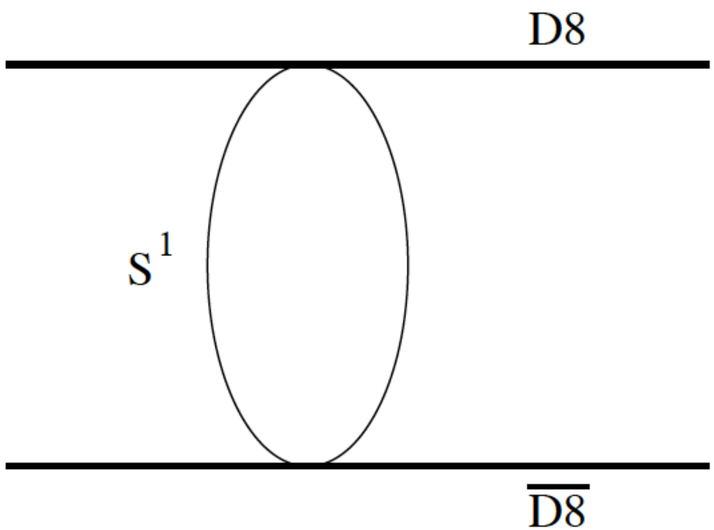
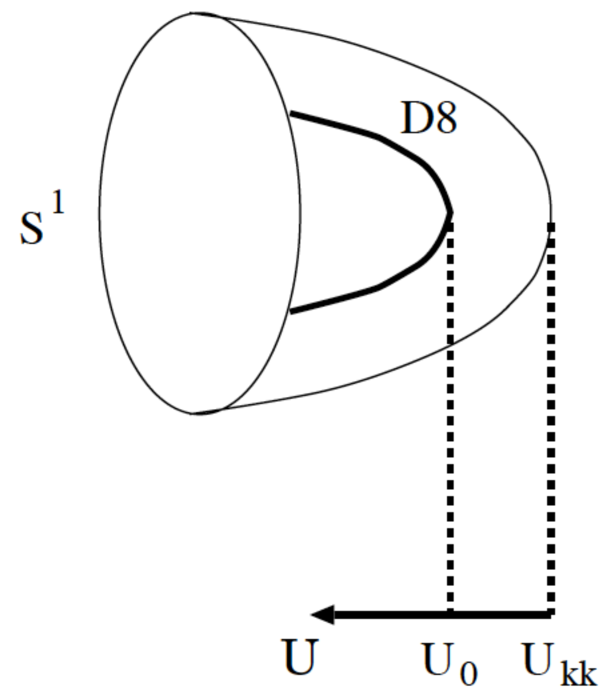
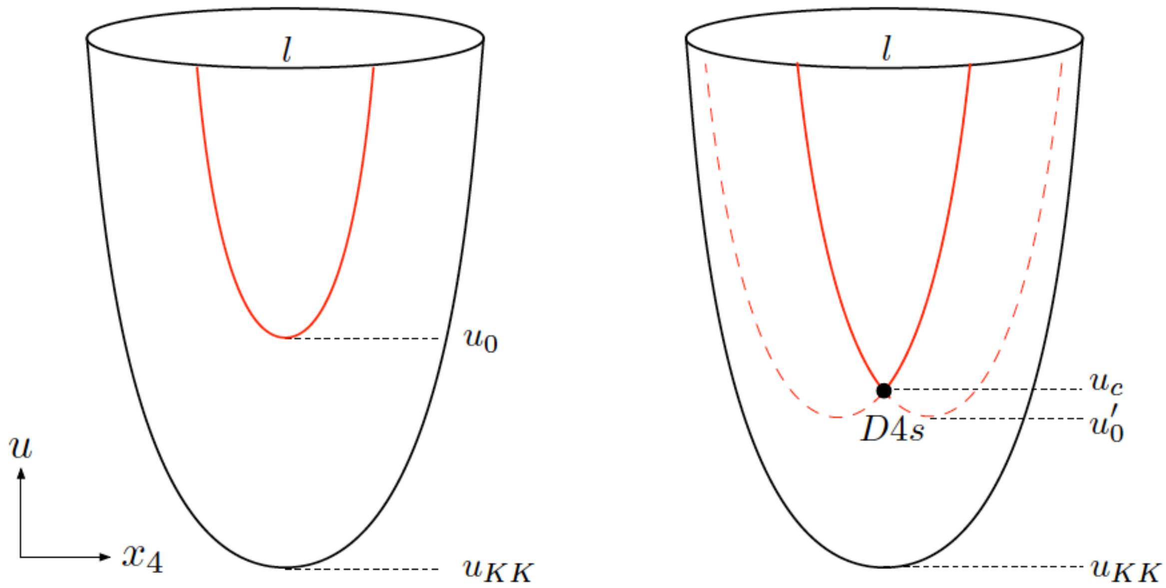
In collaboration with **Feng-Li Lin, Takayuki Hirayama, Ling-Wei Luo**

Sakai-Sugimoto model

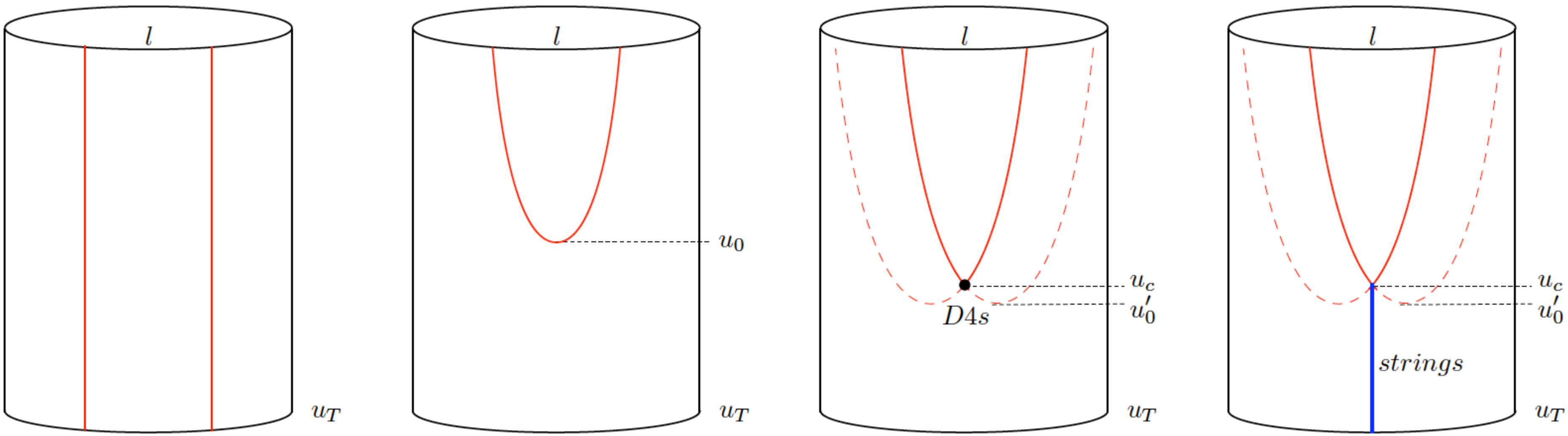




hep-th/0412141



O. Bergman, G. Lifschytz and M. Lippert, 0708.0326



O. Bergman, G. Lifschytz and M. Lippert, 0708.0326

HOLOGRAPHIC NUCLEAR MATTERS

$$S[a_0, x_4; A_\mu(m_i)] := \mathcal{N}\frac{V}{T}\int_{u_c}^{\infty} du\mathcal{L} = S_{DBI} + S_{CS}$$

$$\mathcal{N} := \frac{N_c \lambda_{YM}^3}{12(2\pi)^5} M_{KK}^4$$

$$\frac{T}{V}\mathcal{N}^{-1} S_{CS} = -n_I \int_{u_c}^{\infty} a_(u) q(u) = -n_I \mu + \int_{u_c}^{\infty} n_I \, a'(u) Q(u) du$$

$$\Omega[T,\mu;n_I,m_i,k] = \frac{T}{V} S|_{\text{on-shell}}$$

$$\frac{\ell}{2} = \int_{u_c}^{\infty} du\ x_4'(u)$$

$$\frac{\partial \Omega}{\partial n_I} = \frac{\partial \Omega}{\partial m_i} = 0$$

$$f_T = 1 - \frac{u_T^3}{u^3}$$

Equation of state (EOS)

$$p = -\Omega$$

$$\epsilon = \Omega + n_I \mu + T s,$$

$$s := -\frac{\partial \Omega}{\partial T}\Big|_{\mu}$$

$$\epsilon = \epsilon[p; T].$$

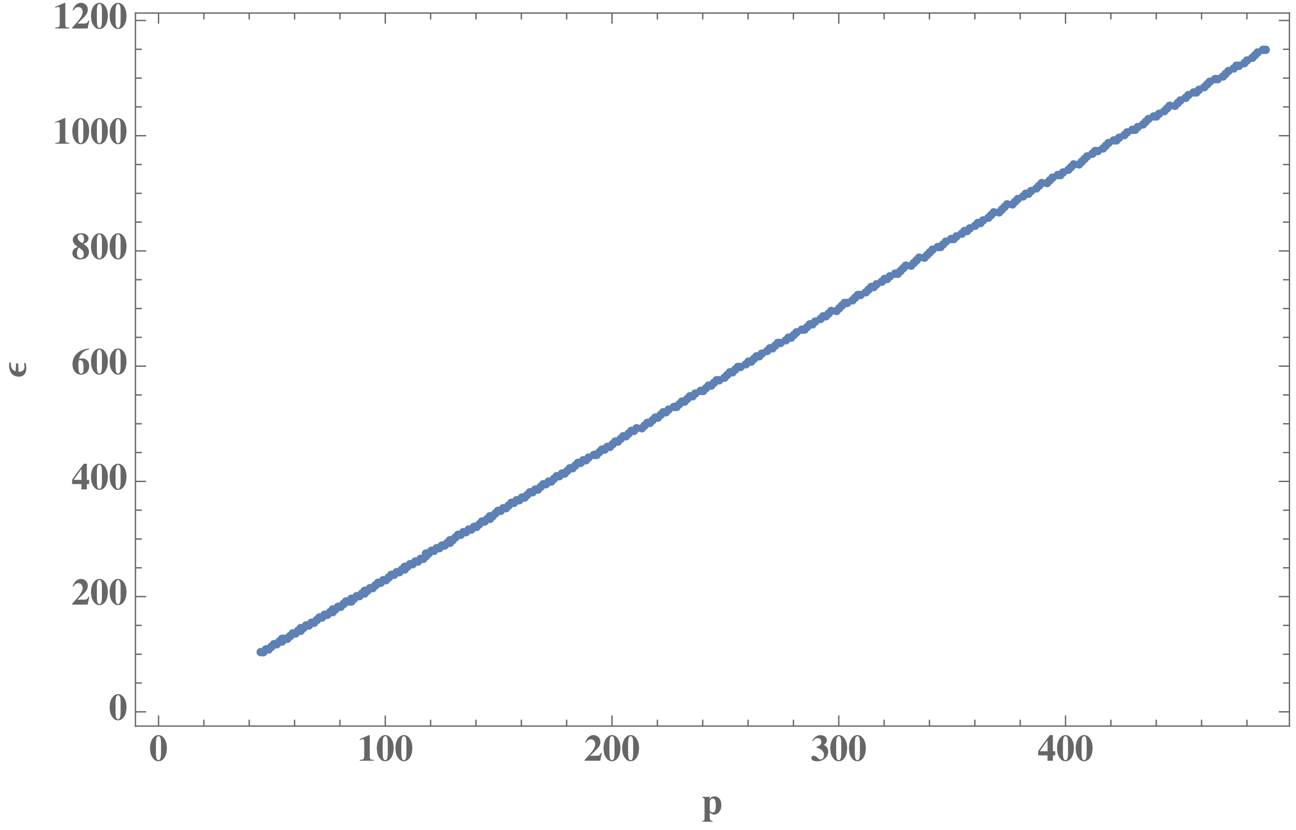
$$\mathcal{L} = \mathcal{L}_0 + n_I \left[\frac{u}{3}\sqrt{f_T(u)} - \hat{a}_0(u)\right] \delta(u - u_c)$$

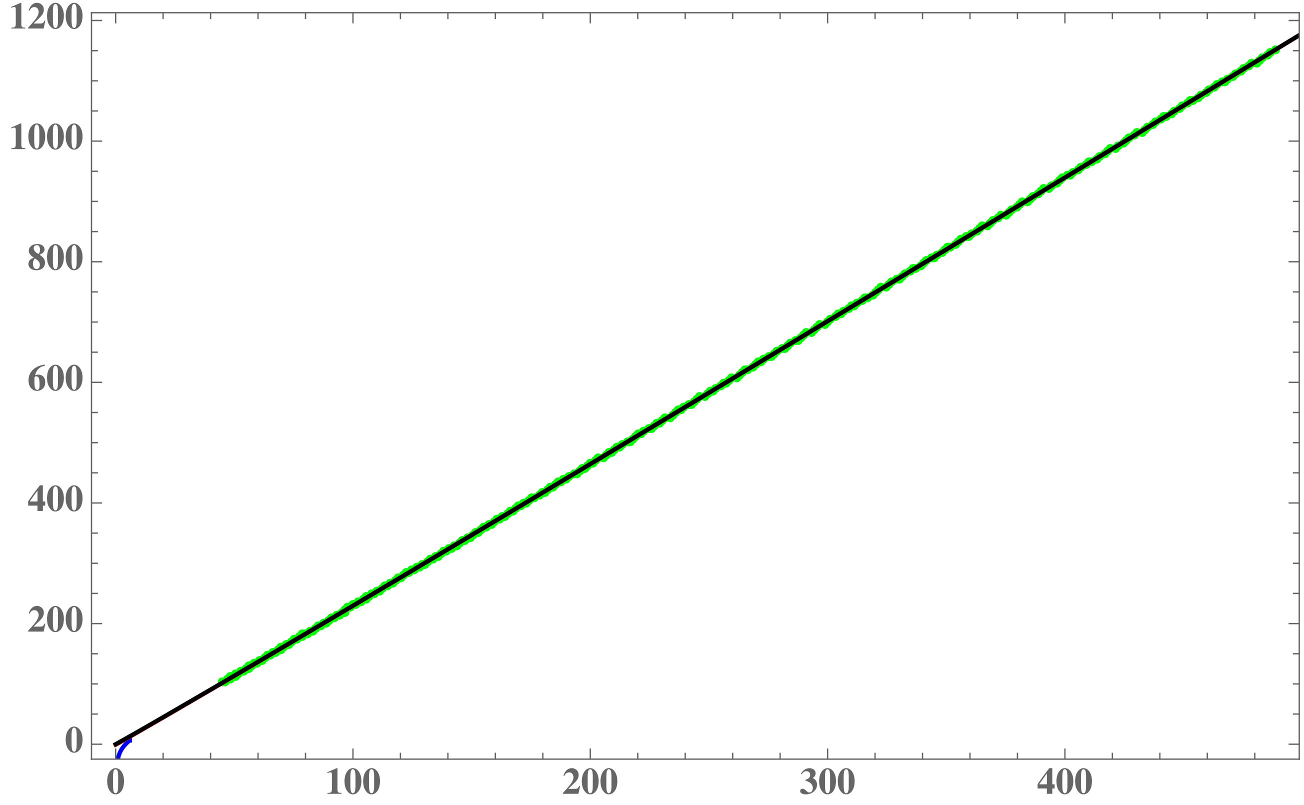
$$\frac{\ell}{2} = k \int_{u_c}^{\infty} \frac{du}{u^{3/2}\sqrt{f_T(u)}\sqrt{g(u)}}\,, \qquad \mu - \hat{a}_0(u_c) = n_I \int_{u_c}^{\infty} du\, \frac{u^{3/2}\sqrt{f_T(u)}}{\sqrt{g(u)}}$$

$$\Omega_{\text{pointlike}} = \mathcal{N} \int_{u_c}^{\infty} du\, u^5 \frac{u^{3/2}\sqrt{f_T(u)}}{\sqrt{g(u)}}$$

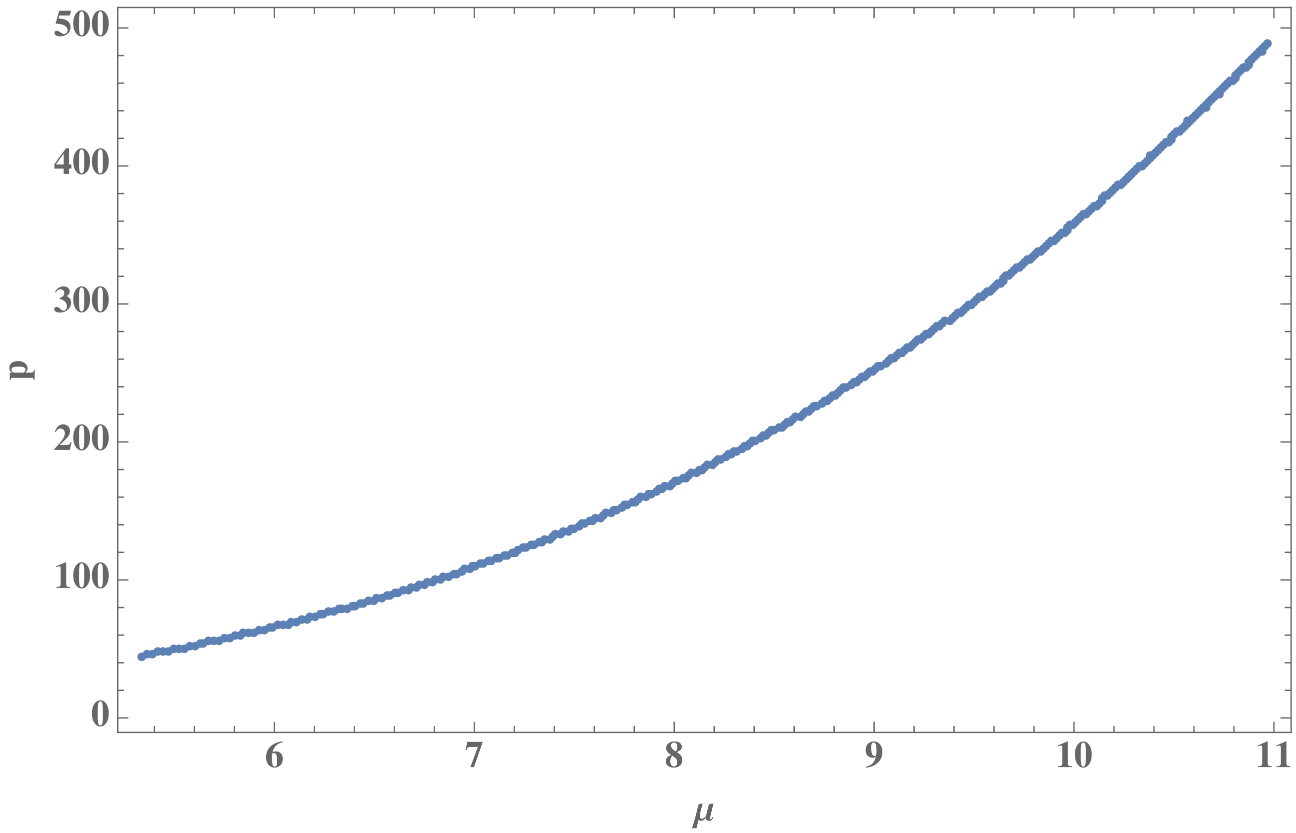
S. w. Li, A. Schmitt and Q. Wang, 1505.04886

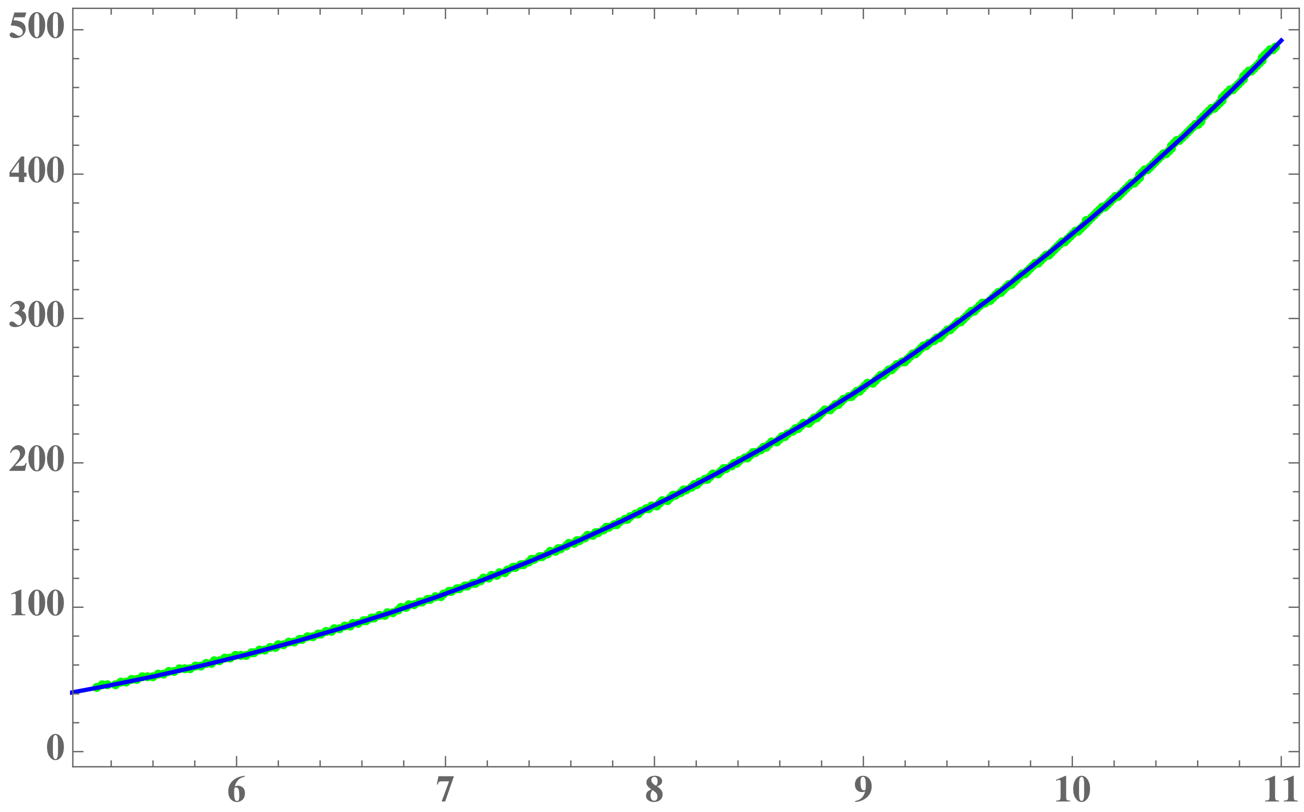
$$\epsilon_{QCD} = \kappa p_{QCD}^{\gamma}$$



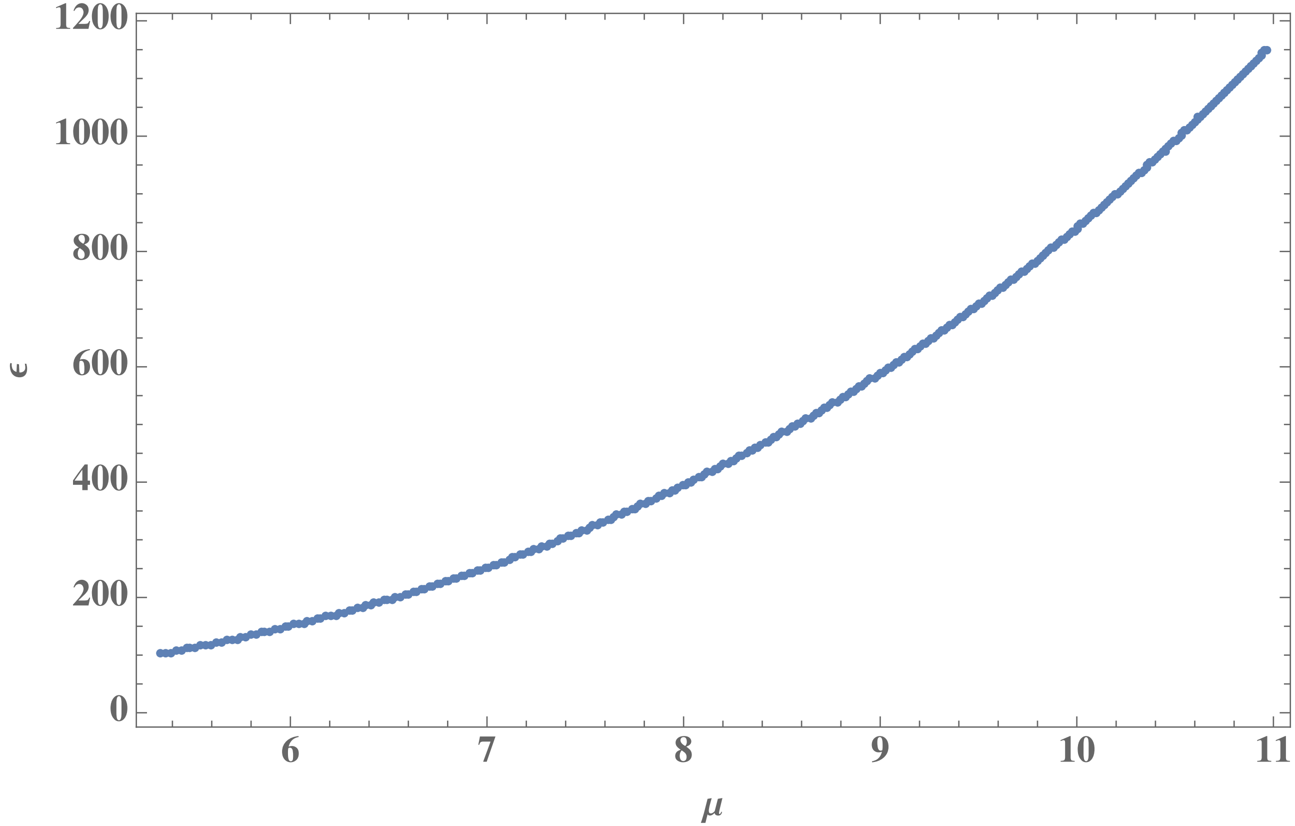


{κ1 → 2.13149, γ1 → 1.01621}


500
400
300
200
100
0
p
6
7
8
9
10
11
μ



{κ4 → 0.167495, γ4 → 3.3306}



1200
1000
800
600
400
200
0
ϵ
6
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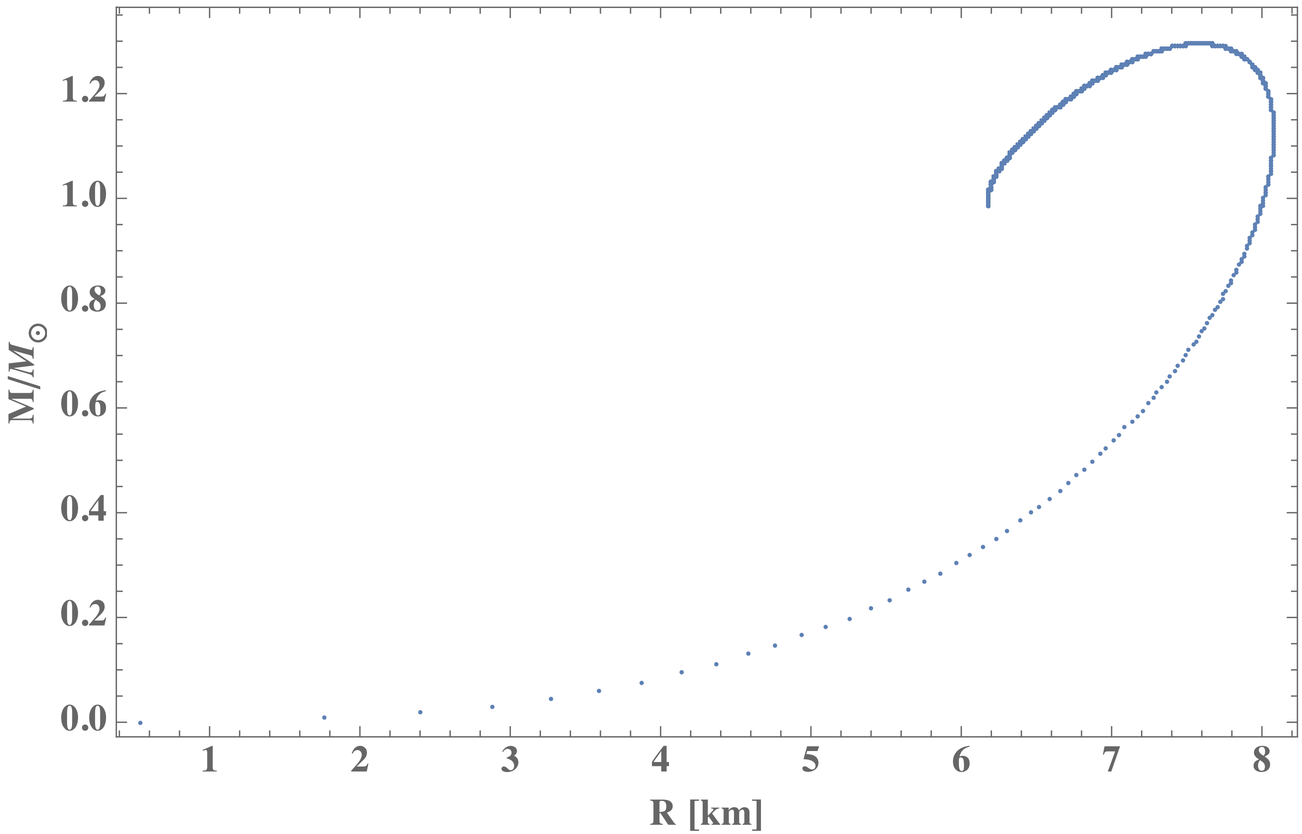
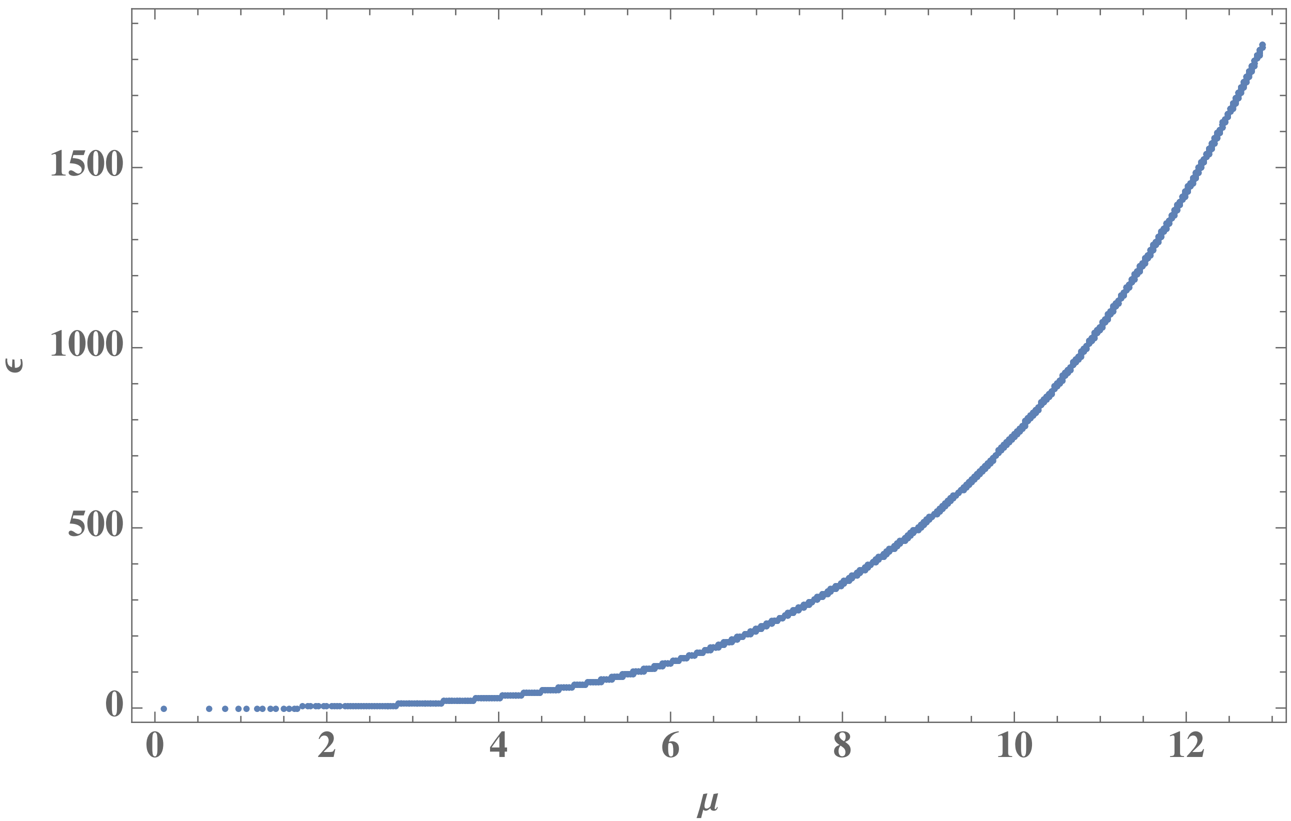
8
9
10
11
μ

Tolman-Oppenheimer-Volko
(TOV) equation

$$\epsilon_{TOV} = (1.79316 \times 10^{-5} \times \ell^7)^{1-\gamma} \kappa \, p_{TOV}^{\gamma}$$





1500
1000
500
0
ϵ
0
2
4
6
8
10
12
μ

```
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 Plot[-2/7*x^(7/2)*(Gamma[3./10.] Gamma[6./5.]/Sqrt[Pi])^(-5/2), {x, 0, 1000}, PlotStyle → Blue],
 Plot[-5.4*10^-3, {x, 0, 1000}, PlotStyle → Black]]
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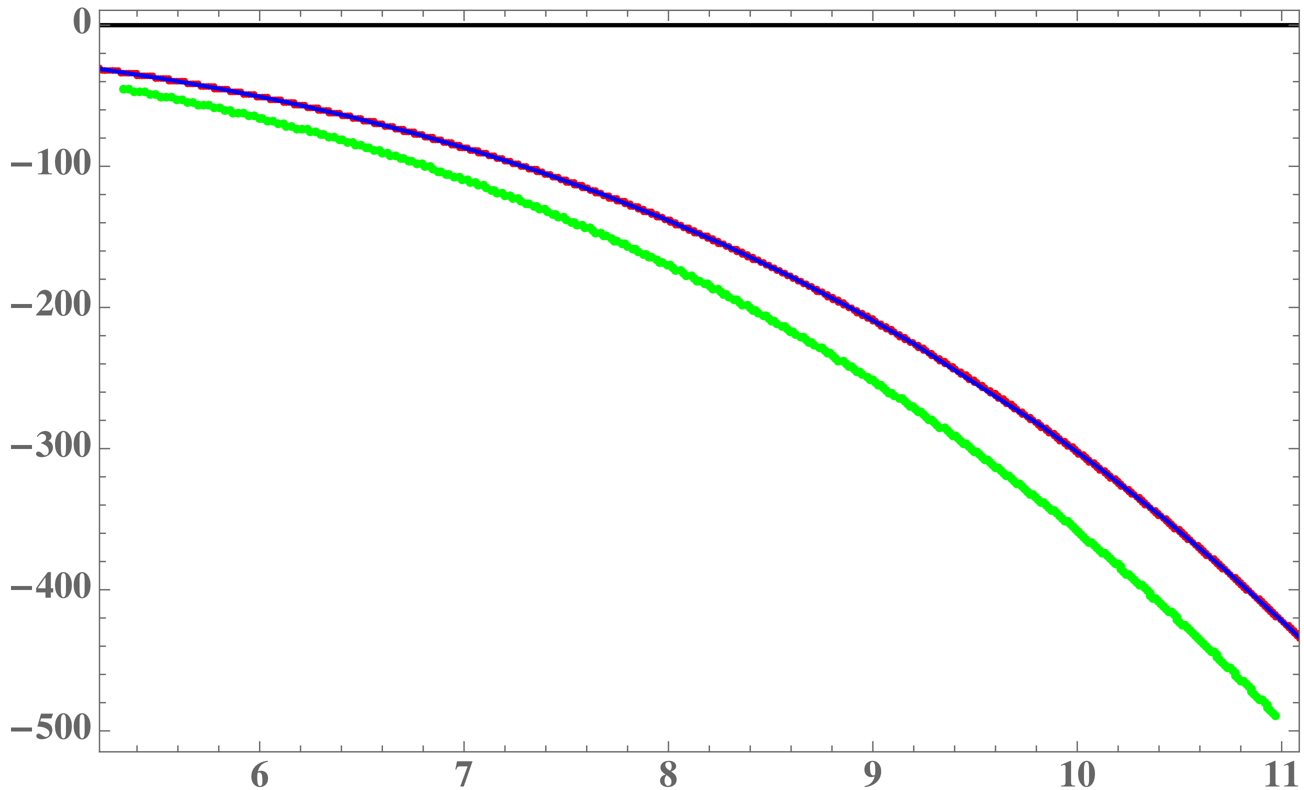

$$n_I = \ell^{-5}\mathcal{N}^{3/4} n_{QCD} = 0.12\, \ell^{-5} n_{QCD} n_0$$

$$n_{QCD} \simeq 40\ell^5 \text{ to } 80\ell^5. \qquad p_{QCD} \simeq 55\ell^7 \text{ to } 550\ell^7$$

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$n_{QCD} \simeq 40\ell^5$ to $80\ell^5$. $\quad p_{QCD} \simeq 55\ell^7$ to $550\ell^7$