Project 3

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1 Lane-Emden Equation

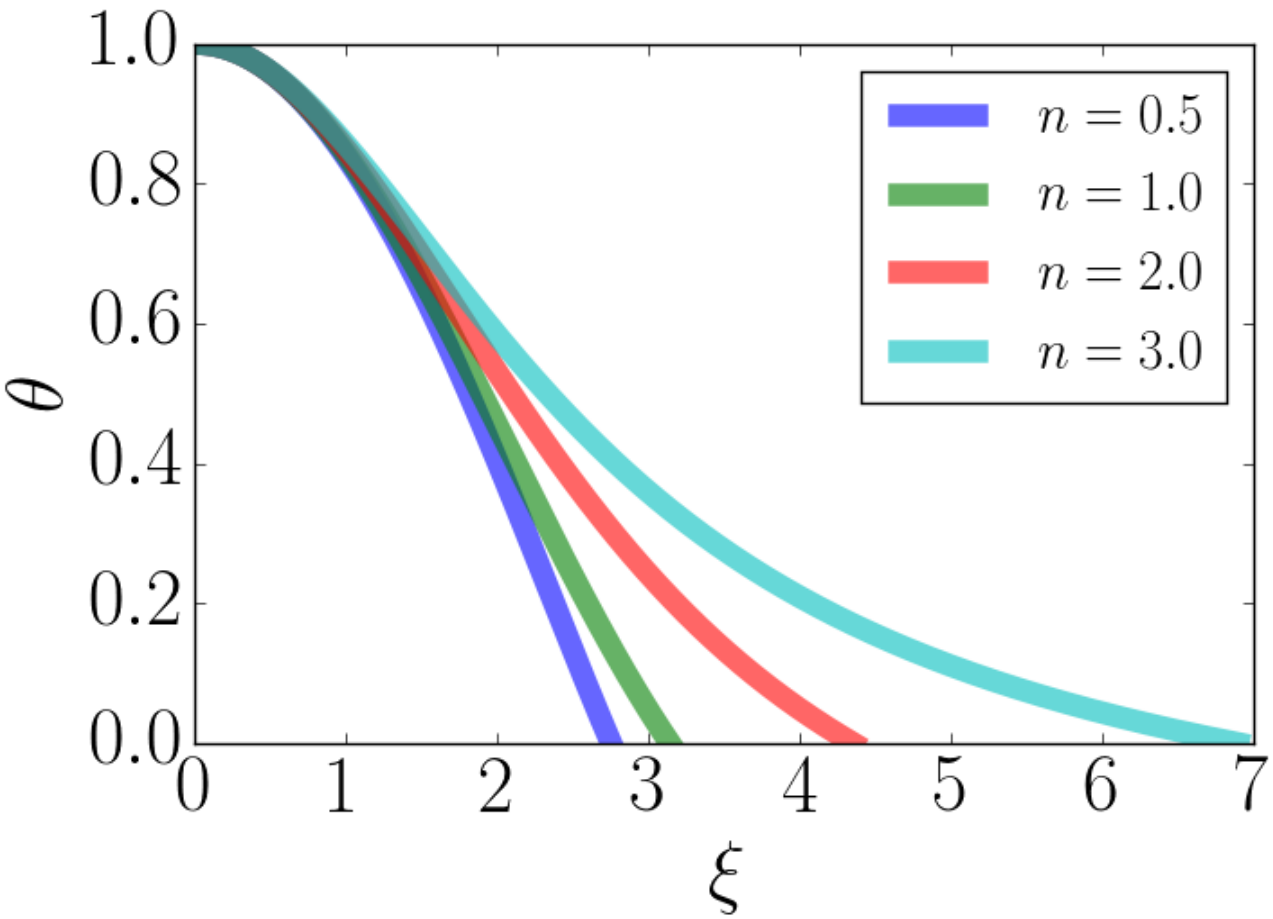


Figure 1: Lane-Emden for $n = 0.5, 1, 2, 3$

2 Dimensionless Quantities

n	$\hat{M}$	Ξ	$-(\frac{d\theta}{d\xi})_{\xi=\Xi}$	$\hat{\Omega}$	$\hat{I}$
0.5	47.5911	2.7528	0.4999	1.7268	0.1764
1	39.4651	3.1419	0.3182	2.0003	0.2612
2	30.2913	4.3537	0.1271	2.8059	0.5792
3	25.3594	6.8999	0.0423	4.4188	1.5481

Table 1: Dimensionless Quantities for different models

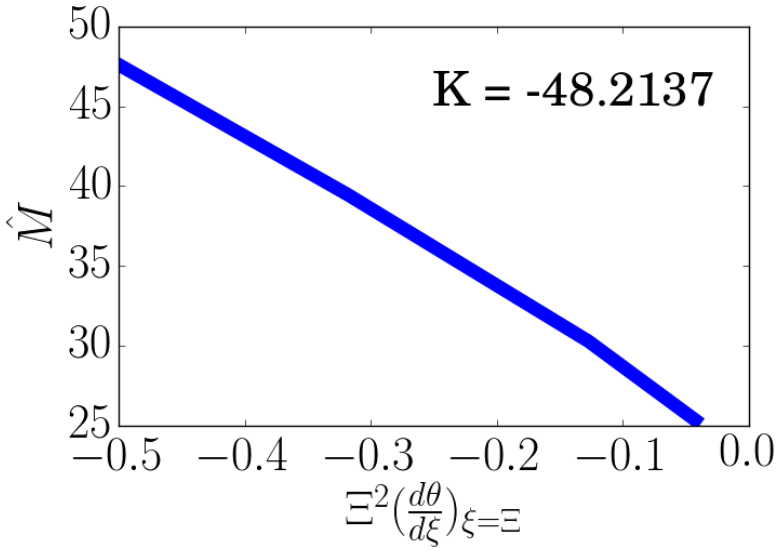


Figure 2: Constant K from the slope

3 Central Pressure of Sun

Using cgs units:

$$\begin{aligned} G &= 6.674e-8\frac{cm^3}{gs} \\ R &= 695.8e8cm \\ M &= 1.989e33g \\ \hat{M} &= 25.3594 \\ \alpha &= 1.0084e11 \\ \rho_c &= \frac{M}{\alpha^3 \hat{M}} \\ &= 0.07648 \\ \kappa &= \alpha^2 \frac{4\pi G}{n+1} \frac{1}{\rho_c^{(1-n)/n}} \\ &= 1.9200e14 \\ P_c &= 1.2473e17 \end{aligned}$$

P_c from the $n = 3$ model is more than half the expected value.

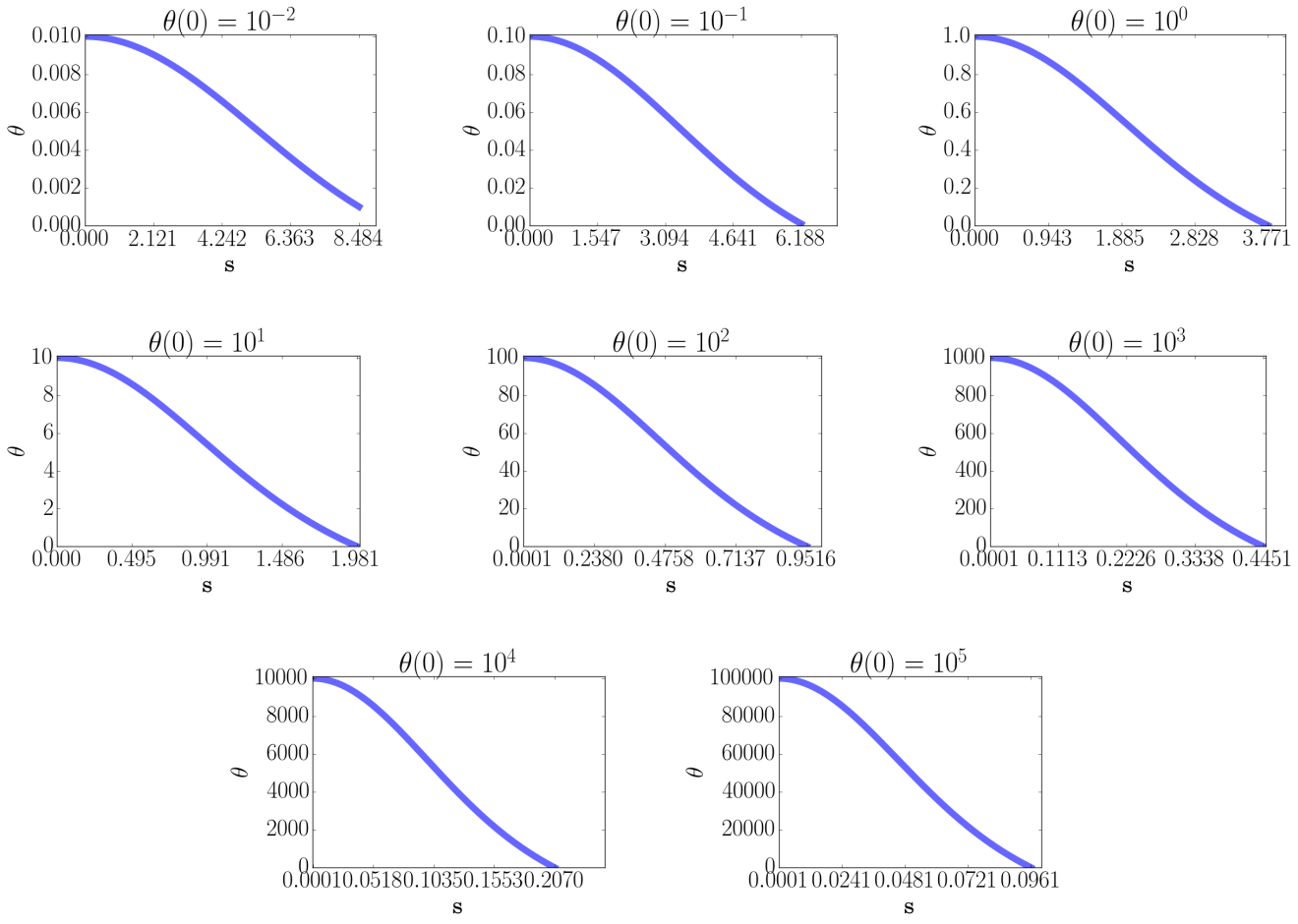
4 White Dwarfs

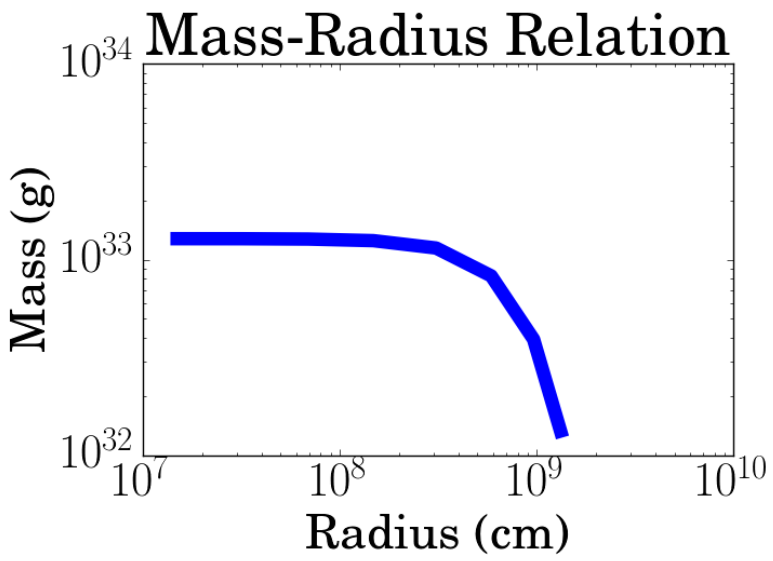
Defining $G(\theta)$ as:

$$G(\theta) \equiv \frac{\theta^{-1/3}(4\theta^{2/3}+5)}{3(\theta^{2/3}+1)^{3/2}}$$

We can solve:

$$\theta'' G(\theta) + \frac{2}{s} G'(\theta)(\theta')^2 + \theta = 0$$


$\theta(0) = 10^{-2}$
0.010
0.008
0.006
0.004
0.002
0.000
θ
0.000 2.121 4.242 6.363 8.484
s
$\theta(0) = 10^{-1}$
0.10
0.08
0.06
0.04
0.02
0.00
θ
0.000 1.547 3.094 4.641 6.188
s
$\theta(0) = 10^{0}$
1.0
0.8
0.6
0.4
0.2
0.0
θ
0.000 0.943 1.885 2.828 3.771
s
$\theta(0) = 10^{1}$
10
8
6
4
2
0
θ
0.000 0.495 0.991 1.486 1.981
s
$\theta(0) = 10^{2}$
100
80
60
40
20
0
θ
0.0001 0.2380 0.4758 0.7137 0.9516
s
$\theta(0) = 10^{3}$
1000
800
600
400
200
0
θ
0.0001 0.1113 0.2226 0.3338 0.4451
s
$\theta(0) = 10^{4}$
10000
8000
6000
4000
2000
0
θ
0.00010.05180.10350.15530.2070
s
$\theta(0) = 10^{5}$
100000
80000
60000
40000
20000
0
θ
0.0001 0.0241 0.0481 0.0721 0.0961
s


Mass-Radius Relation
10^{34}
10^{33}
10^{32}
Mass (g)
10^{7}
10^{8}
10^{9}
10^{10}
Radius (cm)