

The role of non-unified equations of state in the modelisation of macroscopic parameters of Neutron Stars

Lami Suleiman

Subject of [Suleiman, Fortin, Zdunik, Haensel 2021] and [Suleiman+2021] in prep.

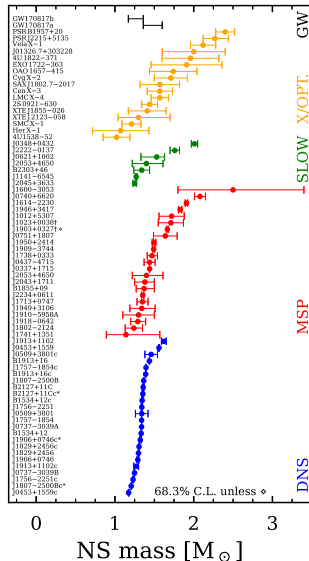
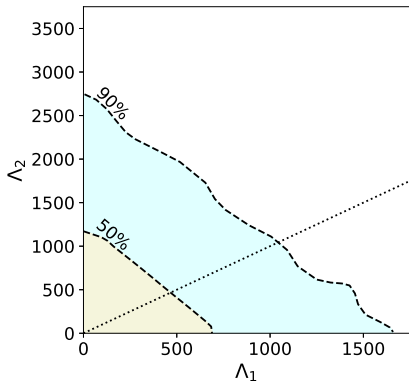
Cinquième Assemblée Générale du GdR Ondes Gravitationnelles



Exploring high density physics with Neutron Star observations

Observed macroscopic parameters of Neutron Stars (NS):

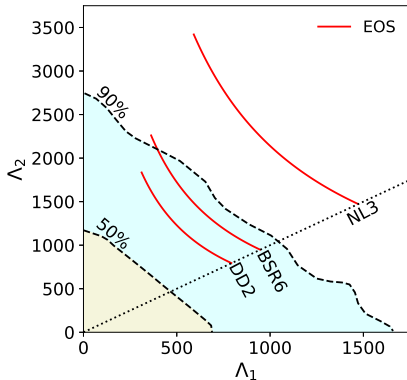
- Total mass: $M \simeq 1 - 2M_{\odot}$
- Total radius: $R \simeq [9 - 15] \text{ kms}$
NICER telescope $\rightarrow (M; R)$
- Tidal deformability Λ : GW170817



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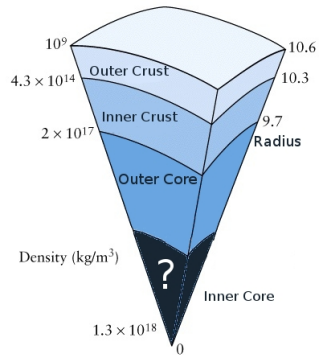
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Typical density at the core of NS:
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Hydrodynamics equations = bridge

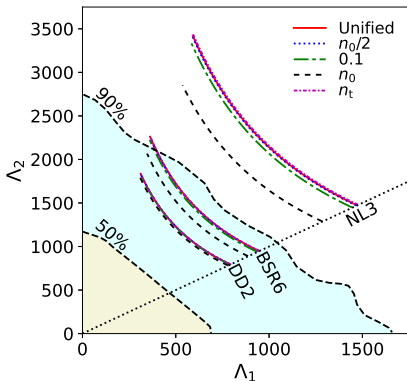
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- Output: M, R, Λ (+I, Q)



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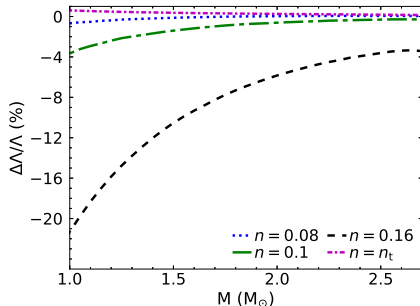


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EoS construction : **say no to non-unified**

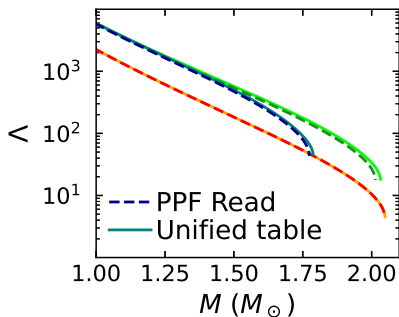


Non-unified models found in analytical expressions

EoS usually given in tables (P, ρ, ϵ)

Analytical form of the EoS
= quite handy !

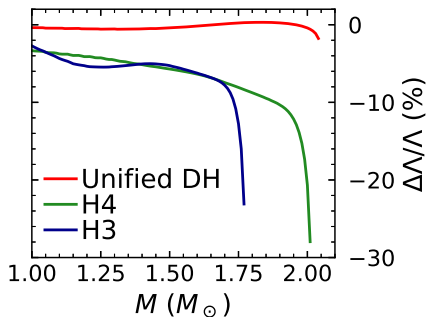
Fit the table with small number of parameters



Some existing fits:

- Spectral: [Lindbloom 2010]
- Piecewise polytropic: [Read+ 2009]

If constructed in non-unified way:
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EoS	M_{\max}	Δ	$R_{M_{\max}}$	Δ	$I_{1.338}$	Δ	$L_{M_{\max}}$	Δ
BSR6	2.430	-0.21	12.13	-0.24	1.677	0.02	836.16	0.01
NL3	2.773	-0.16	13.29	-0.23	1.898	-0.16	1297.27	-0.48
DD2 Y	1.996	0.02	11.38	0.72	1.592	-0.11	694.86	-0.50
DD2 B0	1.997	0.11	12.47	0.51	1.593	-0.17	698.15	-0.73

- Using non-unified EoS results in error in the modelisation of macroscopic parameters
- Non-unified EoS are hidden in:
 - universal relations
 - analytical representation of tabulated EoS
- Soon will be provided piecewise polytropic fits for $\simeq 60$ EoS, RMF, Skyrme, hybrid, hyperons.