

# Hempel–Schaffner-Bielich/DD2

## EoS Submission Details

EoS name	Hempel–Schaffner-Bielich/DD2
category	hadronic
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## Abstract

This hadronic EOS table is calculated with the statistical model with excluded volume and interactions of Hempel and Schaffner-Bielich (HS) [1] with RMF interactions DD2 [2]. Contributions of neutrons, anti-neutrons, protons, anti-protons, electrons, positrons, photons, and nuclei are included. For the masses of nuclei, FRDM [3] was used. The details of the underlying EOS model can be found in Ref. [1], where the TMA interactions were used. The manual from the web page <http://phys-merger.physik.unibas.ch/~hempel/eos.html> gives further information about the table. On this web page, also routines are available which allow to determine the abundances of all nuclei for all conditions. Applications of HS EOS for various different RMF interactions in supernova simulations can be found in Refs. [4,5].

### **References to the original work**

1. M. Hempel and J. Schaffner-Bielich, Nucl. Phys. A 837 (2010) 210.
2. S. Typel, G. Röpke, T. Klähn, D. Blaschke, and H.H. Wolter, Phys. Rev. C 81 (2010) 015803.
3. P. Möller, J.R. Nix, and K.-L. Kratz, Atomic Data and Nuclear Data Tables 66 (1997) 131.

### **Further references**

4. M. Hempel, T. Fischer, J. Schaffner-Bielich, and M. Liebendörfer, Astrophys. J. 748 (2012) 70.
5. A.W. Steiner, M. Hempel, and T. Fischer, Astrophys.J. 774 (2013) 17.

## Nuclear Matter Properties<sup>1</sup>

	Quantity	Unit	
$n_S$	saturation density in symmetric matter	$\text{fm}^{-3}$	0.1491
$E_0$	binding energy per baryon at saturation	MeV	16.02
$K$	incompressibility	MeV	242.7
$K'$	skewness	MeV	168.7
$J$	symmetry energy	MeV	31.67
$L$	symmetry energy slope parameter	MeV	55.03
$K_{sym}$	symmetry incompressibility	MeV	-93.2

## Neutron Star Properties<sup>1</sup>

	Quantity	Unit	
$M_{max}$	maximum mass	$M_{sun}$	2.42
$M_{DU,e}$	mass at DUrca threshold (1/9) w/o $\mu^-$	$M_{sun}$	-
$R_{M_{max}}$	radius at maximum NS mass	km	11.9
$R_{1.4}$	radius at 1.4 $M_{sun}$ NS mass	km	13.2

## eos.thermo

eos.thermo and the three grid defining files are ComPOSE standard data files and by definition available. eos.thermo does not necessarily provide all possible data.

```
table dimension          3
table type               1
total number of grid points 1584360
```

Range and density (#) of the grid parameters:

	Quantity	Unit	min	max	#
T	Temperature	MeV	0.1E+00	0.15848932E+03	81
$n_b$	Baryon Nr Density	$\text{fm}^{-3}$	0.1E-11	0.1E+02	326
$Y_q$	Charge Fraction		0.10000000E-01	0.60000000E+00	60

T,  $n_b$ , and  $Y_q$  are stored in eos.t, eos.nb, and eos.yq, respectively.

<sup>1</sup>0-values indicate, that the corresponding data is not provided.

### Further Available Data Files

Files and quantities listed in the following are provided beyond CompOSE's core requirements as outlined in Sec.4.2. of the CompOSE manual.

**eos.compo** : available

index	particle
0	$e^-$
10	n
11	p
4002	${}^2_4\text{He}$
3002	${}^2_3\text{He}$
3001	${}^1_3\text{H}$
2001	${}^1_2\text{H}$
	- end of table -

The listed particle number fractions are net fractions, i.e., they are given by the difference between the corresponding particle and anti-particle fractions. Further particle sets are defined.

index	description
999	Average fraction, mass and proton number for all nuclei not listed above
	- end of table -

**eos.micro** : available

index	quantity	particle
10041	Dirac effective mass divided by particle mass $m_i^D/m_i$	n
11041	Dirac effective mass divided by particle mass $m_i^D/m_i$	p
10051	relativistic vector self-energy $V_i$	n
11051	relativistic vector self-energy $V_i$	p
	- end of table -	