

Hempel–Schaffner-Bielich/DD2

EoS Submission Details

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|---------------------|------------------------------|
| 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, 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 (2012), arXiv:1207.2184.

Nuclear Matter Properties¹

| | Quantity | Unit | |
|-----------|---|------------------|--------|
| n_S | saturation density in symmetric matter | 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 Properties¹

| | Quantity | Unit | |
|---------------|---|------------------|-------|
| M_{max} | maximum mass | M_{sun} | 2.42 |
| $M_{DU,e}$ | mass at DUrca threshold (1/9) w/o μ^- | M_{sun} | - |
| $R_{M_{max}}$ | radius at maximum NS mass | km | 11.90 |
| $R_{1.4}$ | radius at 1.4 M_{sun} NS mass | km | 13.2 |

¹0-values indicate, that the corresponding data is not provided.

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 | 0.10000000E+00 | 0.15848932E+03 | 81 |
| n_b | Baryon Nr Density | fm^{-3} | 0.10000000E-11 | 0.10000000E+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.

additional quantities in eos.thermo

none defined

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

The listed particle number fractions of protons and neutrons are net fractions, i.e., they are given by the difference between the corresponding particle and anti-particle number density.

Further particle sets are defined. One set of quadruples for an average "heavy" nucleus, see Table 7.2 of the manual.

| index | description |
|-------|--|
| 999 | group of all other considered nuclei which are not listed above (averaged) |
| | - 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 |
| | - end of table - | |

Description of Phases

Fill this part briefly, in particular if several phases occur. In this latter case characterize the transition(s).

PHASE INDEX #1:

NSE phase, i.e., a mixture of nuclei and nucleons

PHASE INDEX #3:

pure RMF, i.e., only nucleons

PHASE INDEX #2:

Maxwell transition region between phase 1 and 3, assuming local charge neutrality and locally fixed Y_e .