RB(BBSk4), NSE

EoS Submission Details

EoS name	RB(BBSk4), NSE
category	Hadronic
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Abstract

This table contains the EOS by Raduta and Beznogov (RB) [1] computed using the BBSk4 interaction. BBSk4 belongs to the family of Brussels extended Skyrme interactions and was generated within a Bayesian inference of the dense matter EOS [2]. BBSk4 belongs to the run 1 of Ref. [2] and features extreme behaviors of $p_{\rm th}(n)$; its thermal properties are discussed in Ref. [3]. The model includes nucleons, a distribution of nuclei, photons, electrons and positrons. For densities lower than n_S and temperatures lower than the limiting temperature for Coulomb instabilities (T_{lim}), the extended nuclear statistical equilibrium (NSE) approach of Ref. [1] is employed. For $T \geq T_{lim}$ and/or $n \geq n_{tr}$, where n_{tr} is the transition density to homogenous matter, nuclear matter is homogeneous. We consider that $T_{lim} = 2/3T_C$, where T_C represents the critical temperature for the liquid-gas phase transition of homogeneous symmetric nuclear matter. The pool of NSE nuclei consists of nuclei present in AME2020 [4] and DZ10 [5] tables, from where the values of binding energies are taken. The internal partition function is computed using a back-shifted Fermi gas parametrization [6]. The Coulomb interaction between nuclei and electrons and among electrons is estimated within the Wigner-Seits approximation. Interactions between nuclei and with the unbound nucleons are accounted for within the excluded volume approximation.

References to the original work

1. A. R. Raduta and M. V. Beznogov, Astron.Astrophys. 701 (2025) A143.
2. M. V. Beznogov and A. R. Raduta, Phys. Rev. C 110, 035805 (2024).
3. A. R. Raduta and M. V. Beznogov, arXiv:2509.23910.
4. M. Wang, W. J. Huang, F. G. Kondev, G. Audi, and S. Naimi, Chin. Phys. C 45, 030003 (2021).

5. J. Duflo and A. P. Zuker, Phys. Rev. C 52, R23 (1995).

6. T. von Egidy and D. Bucurescu, Phys. Rev. C 72, 044311 (2005), [Erratum: Phys.Rev.C 73, 049901 (2006)].

Nuclear Matter Properties[1]

	Quantity	Unit	
n_S	saturation density in symmetric matter	fm^{-3}	0.164
E_0	binding energy per baryon at saturation	MeV	−15.71
K	incompressibility	MeV	248
K'	skewness	MeV	369
J	symmetry energy	MeV	30.1
L	symmetry energy slope parameter	MeV	56.8
K_{sym}	symmetry incompressibility	MeV	−55
T_C	critical temperature for the liquid-gas phase transition in symmetric matter	MeV	19.38

Neutron Star Properties[1]

	Quantity	Unit	
M_{max}	maximum mass	M_{sun}	2.14
$M_{DU,e}$	mass at DUrca threshold with μ^-	M_{sun}	1.34
$R_{M_{max}}$	radius at maximum NS mass	km	10.64
$R_{1.4}$	radius at 1.4 M_{sun} NS mass	km	12.40
$\tilde{\Lambda}$	tidal deformability for GW170817 at a mass ratio of $q = 0.8$		501

eos.thermo

eos.thermo and the three grid defining files are CompOSE standard data files and by definition available.

additional quantities in eos.thermo

none defined

[1] 0-values indicate, that the corresponding data is not provided.

table dimension	3
table type	1
total number of grid points	2029200

Range and density (#) of the grid parameters:

	Quantity	Unit	min	max	#
T	Temperature	MeV	0.1	100	76
n_b	Baryon Nr Density	fm^{-3}	10^{-12}	0.87096359	445
Y_q	Charge Fraction		0.01	0.6	60

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

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
2001	^{2}H
3001	^{3}H
4001	^{4}H
5001	^{5}H
6001	^{6}H
7001	^{7}H
3002	^{3}He
4002	^{4}He
5002	^{5}He
6002	^{6}He
7002	^{7}He
8002	^{8}He
9002	^{9}He
10002	^{10}He
11002	^{11}He
12002	^{12}He
13002	^{13}He
14002	^{14}He
	- continued on next page -

index	quantity
	- end of table -

further particle sets are defined. Two sets of quadruples are present, one for an average "heavy" nucleus ($A \geq 20$) and one for an average "light" nucleus ($Z \geq 3$ and $A < 20$), see Table 13 of the manual.

index	description
999	average "heavy" nucleus
998	average "light" nucleus
	- end of table -

eos.micro: available

index	quantity	particle
10040	Landau effective mass divided by the particle mass m_i^L/m_i	n
11040	Landau effective mass divided by the particle mass m_i^L/m_i	p
10050	mean field interaction potential of the particle U_i	n
11050	mean field interaction potential of the particle U_i	p
	- end of table -	

Description of Nuclear Phases

PHASE INDEX #2: NSE phase, i.e., a mixture of nuclei and nucleons

PHASE INDEX #1: homogeneous nuclear matter treated within the non-relativistic mean field model

PHASE INDEX #3: smooth matching between phase 2 and phase 1, assuming local charge neutrality and locally fixed Y_e

eos.mr: available

The file contains central baryonic particle number density (in fm^{-3}), neutron star radius (in km), neutron star gravitational mass (in M_{sun}), neutron star baryonic mass (in M_{sun}), and tidal deformability (dimensionless). It corresponds to the zero-temperature EoS.