Raduta-Gulminelli EoS with full nuclear distribution and SLy4

EoS Submission Details

EoS name	Raduta-Gulminelli EoS with full nuclear distribution and SLy4
category	nuclear
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Abstract

This EoS table corresponds to the extended NSE model proposed in Refs. [1,2] where excluded volume effects between nuclear clusters and unbound nucleons are implemented via energy shifts of clusters binding energies. For nuclei for which experimental masses are known, the mass tables of Audi el al. [3] are used. Then, up to the drip lines, evaluated masses of the 10-parameter model by Duflo and Zuker (DZ10) [4] are employed. Beyond drip lines, nuclear binding energies are described according to the Liquid Drop Model like parametrization of Ref. [5], corresponding to SLy4 [6]. This expression is modified in two respects. First, a phenomenological pairing term, $\Delta(A) = \pm 12/A$, where $+(-)$ corresponds to even-even (odd-odd) nuclei, is added. Then, two correction terms are included such as to smoothly match, for each isotopic chain, the liquid-drop predictions with the limiting values of DZ10. The allowed mass range of clusters is $2 \leq A \leq 300$. Unbound nucleons are modelled within the standard density functional theory [7] model. The Skyrme SLy4 [6] effective interaction is used.

References to the original work

1. *Unified treatment of sub-saturation stellar matter at zero and finite temperature*, F. Gulminelli, Ad. R. Raduta, Phys. Rev. C 92 (2015) 055803.

2. *Nuclear Statistical Equilibrium Equation of State for Core Collapse*, Ad. R. Raduta and F. Gulminelli, arXiv: 2018

Further References

3. *The Ame2012 atomic mass evaluation*, G. Audi, M. Wang, A. H. Wapstra, F. G. Kondev, M. MacCormick, X. Xu, and B. Pfeiffer, Chin. Phys. C 36 (2012) 1287; *The Ame2012 atomic mass evaluation*, M. Wang, G. Audi, A. H. Wapstra, F. G. Kondev, M. MacCormick, X. Xu, and B. Pfeiffer, Chin. Phys. C 36 (2012) 1603; http : //amdc . impcas . ac.Cn/evaluation/data2012/data/nubase. mas12.

4. *Microscopic mass formulas*, J. Duflo and A. P. Zuker, Phys. Rev. C 52 (1995) R23.

5. *Symmetry energy I: Semi-infinite matter*, P. Danielewicz and J. Lee, Nucl. Phys. A 818 (2009) 36.

6. *A Skyrme parametrization from subnuclear to neutron star densities Part II. Nuclei far from stabilities*, E. Chabanat, P. Bonche, P. Haensel, J. Meyer, and R. Schaeffer, Nucl. Phys. A 635 (1998) 231.

7. *Many-body methods at finite temperature*, D. Vautherin, Adv. Nucl. Phys. 22 (1996) 123.

Nuclear Matter Properties[1]

	Quantity	Unit	
n_S	saturation density in symmetric matter	fm^{-3}	0.159
E_0	binding energy per baryon at saturation	MeV	15.97
K	incompressibility	MeV	230.0
K'	skewness	MeV	-363.11
J	symmetry energy	MeV	32.04
L	symmetry energy slope parameter	MeV	46.00
K_{sym}	symmetry incompressibility	MeV	-119.73

Neutron Star Properties[1]

	Quantity	Unit	
M_{max}	maximum mass	$M_{\rm sun}$	2.075
$M_{DU,e}$	mass at DUrca threshold (1/9) w/o μ^-	$M_{\rm sun}$	0
$R_{M_{max}}$	radius at maximum NS mass	km	10.09
$R_{1.4}$	radius at 1.4 $M_{\rm sun}$ NS mass	km	11.86
$\tilde{\Lambda}$	tidal deformability GW170817 at $q = M_1/M_2 = 0.8$		396

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	1024240

Range and density (#) of the grid parameters:

	Quantity	Unit	min	max	#
T	Temperature	MeV	0.1	50.00	124
n_b	Baryon Nr Density	fm^{-3}	1.0E-12	1.50	140
Y_q	Charge Fraction		0.01	0.60	59

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

[1] 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
10	n
11	p
2001	^{2}H
3001	^{3}H
3002	^{3}He
4002	α-particle
	- end of table -

further particle sets are defined as quadruples representing an average heavy nucleus ($A \geq 20$) and average light nuclei ($2 \leq A < 20$).

index	description
1	Average mass number, proton number and fraction for light nuclei ($2 \leq A < 20$)
2	Average mass number, proton number and fraction for heavy nuclei ($A \geq 20$)
	- end of table -

eos.compo.long lists, in addition to particle fractions of neutrons and protons, the relative abundances $n(A, Z)/n_B$ of at maximum $N_{max} = 500$ nuclides whose multiplicities per unit volume are greater or equal to $f_{lim} Y_{max}$, where Y_{max} is the multiplicity per unit volume of the most probable nucleus with $A \geq 2$. For f_{lim}, over complementary domains, two values are used: 10^{-5} and 10^{-8}. Note that, because of excluded volume effects, $n_n + n_p + \sum_{A,Z} An(A, Z) \neq n_B$, $n_p + \sum_{A,Z} Zn(A, Z) \neq Y_p n_B$.