SRO version of SLy4, SNA

EoS Submission Details

EoS name	SRO version of SLy4, SNA
category	Hadronic
submitted by	André da Silva Schneider
affiliation	Stockholm University
e-mail contact	andre.schneider@astro.su.se
sheet creation date	August 5, 2019

Abstract

This table contains the EoS by Schneider, Roberts, and Ott (SRO) [1] computed using the SLy4 Skyrme parametrization [2]. The nuclear interaction is an effective non-relativistic Skyrme type model without momentum dependence generalized from the seminal work of Lattimer and Swesty [3]. The model includes nucleons, which are treated as non-relativistic particles; α-particles, modeled as hard spheres of volume $v_\alpha = 24\text{fm}^{-3}$ forming an ideal Boltzmann gas; and photos, electrons, and positrons, all treated as thermally equilibrated non-interacting relativistic gases. At low densities and temperatures nucleons may cluster into heavy nuclei computed within the single nuclues approximation (SNA). In the SNA, one representative nucleus or, more generally, a high-density structure such as a pasta phase, is determined from equilibrium conditions within a spherical Wigner-Seitz cell, including surface, Coulomb, and translational energy corrections using a liquid-drop model for the surface corrections. The Wigner-Seitz cell is charge neutral, and heavy nuclei are surrounded by a gas of free nucleons, α-particles, photons, electrons and positrons. Interactions between the outside gas and the nuclei are taken into account through an excluded volume. At high densities and temperatures heavy nuclei or the pasta phases dissolve in favor of homogeneous nuclear matter. The configuration of matter and the balance between the different phases is given by the thermodynamically most favorable state, that is, the one that minimizes the Helmholtz free energy of the system and, thus, guarantees thermodynamic consistency of the EoS. Unlike Ref. [3], transitions from inhomogeneous to bulk nuclear matter are first order and simply chosen from the phase which minimizes the Helmholtz free energy. Further details can be found in Refs. [1, 3]. A link to additional information which includes our open-source SROEOS code and many pre-computed tables for different Skyrme parametrizations found in the literature are found in the webpage `https://stellarcollapse.org/SROEOS`. Tables where a transition from the SNA treatment to one considering 3 335 nuclei in nuclear statistical equilibrium (NSE) are also available.

References to the original work

1. A.S. Schneider, L. Roberts, C.D. Ott, Phys.Rev. C96, 065802 (2017)

Further References

2. E. Chabanat, P. Bonche, P. Haensel, J. Meyer, and R. Schaeffer, Nucl. Phys. A 635, 231 (1998).

3. J. M. Lattimer and F. D. Swesty, Nucl. Phys. A 535, 331 (1991).

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
K'	skewness	MeV	363
J	symmetry energy	MeV	32.04
L	symmetry energy slope parameter	MeV	46
K_{sym}	symmetry incompressibility	MeV	-120

Neutron Star Properties[1]

	Quantity	Unit	
M_{max}	maximum mass	M_{sun}	2.05
$M_{DU,e}$	mass at DUrca threshold (1/9) w/o μ^-	M_{sun}	0
$R_{M_{max}}$	radius at maximum NS mass	km	10.0
$R_{1.4}$	radius at 1.4 M_{sun} NS mass	km	11.7
$\tilde{\Lambda}$	tidal deformability GW170817 at $q = M_1/M_2 = 0.8$		343

eos.thermo

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

table dimension	3
table type	1
total number of grid points	4206378

Range and density (#) of the grid parameters:

	Quantity	Unit	min	max	#
T	Temperature	MeV	0.001	251.2	163
n_b	Baryon Nr Density	fm^{-3}	6.3e-13	6.3	391
Y_q	Charge Fraction		0.005	0.655	66

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
0	e
10	n
11	p
4002	^{4}He
	- end of table -

One set of quadruples for a unique average heavy nucleus is present.

eos.micro : available

index	particle
11040	effective mass of protons divided by proton mass m_p^*/m_p
10040	effective mass of neutrons divided by neutron mass m_n^*/m_n
11050	U_p proton mean field interaction potential
10050	U_n neutron mean field interaction potential
	- end of table -