Hadronic chiral mean field model with crust

EoS Submission Details

EoS name	Hadronic chiral mean field model with crust
category	Hadronic
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Abstract

The $SU(3)$ Chiral Mean Field (CMF) model can be used to describe several systems, among which are the interior of neutron and proto-neutron stars. More specifically it is a non-linear realization of the sigma model which includes pseudo- scalar mesons as the angular parameters for the chiral transformation. It includes nucleons and hyperons as degrees of freedom (and in some cases free leptons). The model reproduces standard nuclear physical constraints as well as astrophysical ones, such as massive neutron stars. Within the model, baryons are mediated by vector-isoscalar, vector-isovector, scalar-isoscalar, and scalar-isovector mesons (including strange quark-antiquark states). At low densities and/or temperatures, the nuclear liquid-gas first-order phase transition is reproduced. At high densities and/or temperatures, chiral symmetry is restored, which can be seen in a reduction of the effective baryon masses. The present EoS table is for cold chemically-equilibrated neutron stars.

For the present version, the crust EoS by Gulminelli and Raduta [4] has been added at low densities employing the effective interaction Rs proposed by Friedrich and Reinhard [5] and the cluster energy functionals from Danielewicz and Lee [6].

References to the original work

1. V. Dexheimer and S. Schramm, *Proto-Neutron and Neutron Stars in a Chiral $SU(3)$ Model*, Astrophys. J. 683, 943 (2008).

2. T. Schurhoff, S. Schramm and V. Dexheimer, *Neutron stars with small radii - the role of Delta resonances*, Astrophys. J. 724, L74 (2010).

3. V. Dexheimer, R. Negreiros and S. Schramm, *Reconciling Nuclear and Astrophysical Constraints*, Phys. Rev. C 92, no. 1, 012801 (2015).

Further References

4. F. Gulminelli and Ad. R. Raduta, Phys. Rev. C 92, 055803 (2015)
5. J. Friedrich and P.-G. Reinhard, Phys. Rev. C 33, 335 (1986)
6. P. Danielewicz et J. Lee, Nucl. Phys. A818, 36 (2009)

Nuclear Matter Properties[1]

	Quantity	Unit	
n_S	saturation density in symmetric matter	fm^{-3}	0.15
E_0	binding energy per baryon at saturation	MeV	16.
K	incompressibility	MeV	300
K'	skewness	MeV	0
J	symmetry energy	MeV	30
L	symmetry energy slope parameter	MeV	88
K_{sym}	symmetry incompressibility	MeV	0
U_Λ	Λ-potential at saturation	MeV	- 28
U_Σ	Σ-potential at saturation	MeV	6
U_Ξ	Ξ-potential at saturation	MeV	- 18

Critial point for liquid gas phase transition: $T_c = 16.4$ MeV, $n_c = 0.05\text{fm}^{-3}$, $\mu_c = 910$ MeV.

Neutron Star Properties[1]

	Quantity	Unit	
M_{max}	maximum mass	M_{sun}	2.1
$M_{DU,e}$	mass at DUrca threshold (1/9) w/o μ^-	M_{sun}	0
$R_{M_{max}}$	radius at maximum NS mass	km	12.
$R_{1.4}$	radius at 1.4 M_{sun} NS mass	km	0

eos.thermo

eos.thermo and the three grid defining files are CompOSE standard data files and by definition available. eos.thermo provides in addition to the mandatory entries the scaled enthalpy per baryon, $\mathcal{H}/m_B - 1$, the strangeness number density, $\sum_i S_i n_i$ in fm^{-3}, and the sum over the number density of baryons in fm^{-3}.

table dimension	1
table type	1
total number of grid points	1191

Range and density (#) of the grid parameters:
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.

	Quantity	Unit	min	max	#
T	Temperature	MeV	0	0	1
n_b	Baryon Nr Density	fm^{-3}	1.e-7	3.03	1191
Y_q	Charge Fraction		0	0	1

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
1	μ
10	n
11	p
100	Λ
110	Σ^-
111	Σ^0
112	Σ^+
120	Ξ^-
121	Ξ^0
500	u
501	d
502	s
	- end of table -

In addition one quadruple representing one heavy nucleus is available.

The phase index is defined as 1 (bulk hadronic matter) or 4 (heavy nuclei present).