

Hadronic chiral mean field model

EoS Submission Details

EoS name	Hadronic chiral mean field model
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.

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).
4. V. Dexheimer, *Tabulated Neutron Star Equations of State Modelled within the Chiral Mean Field Model*, *Publications of the Astronomical Society of Australia* 34 (2017).

Nuclear Matter Properties¹

	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

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

Neutron Star Properties¹

	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 $1.4 M_{\text{sun}}$ 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	301

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

Range and density (#) of the grid parameters:

	Quantity	Unit	min	max	#
T	Temperature	MeV	0	0	1
n_b	Baryon Nr Density	fm^{-3}	0.03	3.03	301
Y_q	Charge Fraction		0	0	1

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