EoS name: CMF hadronic (#1) for general purpose with electrons
Category: Hadronic
Submitted by: Veronica Dexheimer
Affiliation: Kent State University, OH USA
E-mail contact: vdexheim@kent.edu
Sheet creation date: Mar 15, 2021(same table as from old Jun-22, 2017 sheet)

Abstract:

The relativistic SU(3) Chiral Mean Field (CMF) model was the first model developed with the intent of describing 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. Depending on the choice of degrees of freedom, it can include nucleons, hyperons, spin 3/2 (Delta) baryons, light quarks, free leptons and mesons. The model reproduces standard nuclear physical constraints, as well as astrophysical ones, such as massive neutron stars. The quark sector of the model was fitted to reproduce lattice QCD results at zero and small densities. The model results were found to be in agreement with perturbative QCD for the relevant astrophysical regime.

Within the model, baryons and quarks 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, and, if the quarks are included in the model, deconfinement takes place. Here, we present two different kinds of EoS. The first one is for cold chemically-equilibrated neutron stars. The second one is for matter out of equilibrium, such as the one created in particle collisions, supernova explosions and neutron star mergers, in which case we vary not only the density, but also the temperature and electric charge fraction.

References to the original work:

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

V. Dexheimer and S. Schramm, A Novel Approach to Model Hybrid Stars, Phys.Rev.C **81** (2010) 045201.

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

V. Dexheimer, R.O. Gomes, T. Klähn, S. Han, M. Salinas, GW190814 as a massive rapidly rotating neutron star with exotic degrees of freedom, Phys.Rev.C **103** (2021) 2.

<u>Nuclear Matter Properties:</u>

saturation density n_B= 0.15 fm^{-3}
binding energy per nucleon at saturation E/A-M_B= -16 MeV
incompressibility at saturation K= 300 MeV
symmetry energy at saturation E_{sym}= 30 MeV
symmetry energy slope at saturation L= 88 MeV

hyperon potentials at saturation U_Λ=-28 MeV, U_Σ=5 MeV, U_Ξ=-18 MeV

critical point for liquid gas phase transition T_C=16.4 MeV, n_C=0.05 fm^{-3}, μ_C=910 MeV

<u>Neutron Star Properties:</u>

maximum mass M= 2.07 M_{Sun} (Rs crust)
radius of maximum mass star R= 11.88 km (Rs crust)
radius of 1.4 M_{Sun} star R= 13.57 km (Rs crust)
dimensionless tidal deformability of 1.4 M_{Sun} star Λ= 889 (Rs crust)
Urca process threshold density $n_{B\,Urca}$= 0.31 fm^{-3}

<u>Tables for Supernova/Neutron-Star Merger Simulations:</u>

The 5 tables described in the following are CompOSE standard data files.

eos.thermo
table dimension: 2
total number of grid points: 1 316 574
total number of lines: 1 316 575 (first line contains extra information)
grid parameters: charge fraction (from 0 to 0.53 with steps of 0.01), temperature (from 0 to 160 MeV with steps of 2 MeV), baryon number density (from 0.01 to 3.01 fm^{-3} with steps of 0.01 fm^{-3})
the n_B values are stored in file eos.nb
the T values are stored in file eos.t
the Y_q values are stored in file eos.yq
the 2 extra columns contain the scaled enthalpy per baryon $(\varepsilon+P)/(n_B\,m_B)-1$ and the strangeness number density, which is the particle sum over $(S_i n_i)$ in fm^{-3}

eos.compo
table dimension: 2
total number of grid points: 1 316 574
total number of lines: 1 316 574

grid parameters: charge fraction (from 0 to 0.53 with steps of 0.01), temperature (from 0 to 160 MeV with steps of 2 MeV), baryon number density (from 0.01 to 3.01 fm^{-3} with steps of 0.01 fm^{-3})

the n_B values are stored in file eos.nb

the T values are stored in file eos.t

the Y_q values are stored in file eos.yq

the phase index is defined as 1 (hadronic matter)

we provide 13 particle pairs

eos.nb

table dimension: 1

total number of grid points: 301

total number of lines: 303 (first two lines contain extra information)

grid values: baryon number density (from 0.01 to 3.01 fm^{-3} with steps of 0.01 fm^{-3})

eos.t

table dimension: 1

total number of grid points: 81

total number of lines: 83 (first two lines contain extra information)

grid values: temperature (from 0 to 160 MeV with steps of 2 MeV)

eos.yq

table dimension: 1

total number of grid points: 54

total number of lines: 56 (first two lines contain extra information)

grid values: charge fraction (from 0 to 0.53 with steps of 0.01)