

# CLDM-NRMM-BSK14-FS4

## EoS Submission Details

|                     |                     |
|---------------------|---------------------|
| EoS name            | GMSR(BSK14)         |
| category            | nucleonic/unified   |
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| sheet creation date | November 17, 2021   |

## Abstract

This table corresponds to the unified EoS of cold catalyzed nuclear matter at  $\beta$ -equilibrium by G. Grams, J. Margueron, R. Somasundaram and S. Reddy [1]. The crust is model with a compressible liquid drop model (CLDM) with Coulomb, surface and curvature terms, the crust model is named finite size 4 (FS4). The considered effective interaction is given by the non-relativistic (NR) meta-model (MM) adjusted to reproduce BSK14. The lowest order nuclear empirical parameters are defined at  $n_{\text{sat}}$  ( $E, L/n, K$ ), while the higher order ones ( $K', Z$ ) are define from a fit of symmetric matter (SM) and neutron matter (NM) up to  $10n_{\text{sat}}$ . See Ref. [1].

## References to the original work

1. G. Grams, J. Margueron, R. Somasundaram and S. Reddy. Submitted to EPJA Special Issue on “ComPOSE: a repository for Neutron Star Equations of State and Transport Properties” (2021)

## Nuclear Matter Properties<sup>1</sup>

|           | Quantity                                | Unit             |        |
|-----------|---|------------------|--------|
| $n_S$     | saturation density in symmetric matter  | $\text{fm}^{-3}$ | 0.159  |
| $E_0$     | binding energy per baryon at saturation | MeV              | -15.9  |
| $K$       | incompressibility                       | MeV              | 239.0  |
| $K'$      | skewness                                | MeV              | 88.0   |
| $J$       | symmetry energy                         | MeV              | 30.0   |
| $L$       | symmetry energy slope parameter         | MeV              | 43.9   |
| $K_{sym}$ | symmetry incompressibility              | MeV              | -152.0 |

## Neutron Star Properties<sup>1</sup>

|                   | Quantity  | Unit             |       |
|-------------------|---|------------------|-------|
| $M_{max}$         | maximum mass  | $M_{\text{sun}}$ | 1.92  |
| $M_{DU,e}$        | mass at DUrca threshold (1/9) w/o $\mu^-$                     | $M_{\text{sun}}$ | 0     |
| $R_{M_{max}}$     | radius at maximum NS mass                                     | km               | 9.30  |
| $R_{1.4}$         | radius at 1.4 $M_{\text{sun}}$ NS mass                        | km               | 11.23 |
| $\tilde{\Lambda}$ | tidal deformability for GW170817 at a mass ratio of $q = 1.0$ |                  | 209   |

## eos.thermo

eos.thermo and the three grid defining files are ComPOSE standard data files and by definition available. We provide all standard quantities of eos.thermo in ComPOSE, i.e., pressure, internal energy, baryon, charge and electron chemical potentials. We provide tree additional quantities: (i) the sound speed  $(v_s/c)^2$ , (ii) the symmetry energy defined as the difference between pure neutron matter (NM) and symmetric matter (SM)  $e_{sym} = e_{NM} - e_{SM}$  [MeV] and (iii) the symmetry energy defined as the second derivative of the energy per particle with respect to the asymmetry  $e_{sym,2} = (1/2)(\partial^2 e / \partial \delta^2)$  [MeV] where  $\delta = (n_n - n_p)/(n_n + n_p)$ . The sound speed is computed in the crust and core consistently. The symmetry energies  $e_{sym}$  and  $e_{sym,2}$  are computed at infinity nuclear matter. The purpose of the sound speed is to check causality, which is not guaranteed in non-relativistic models while the purpose of the symmetry energy is to check a possible bending down to negative values at high densities ( $> 4 n_{\text{sat}}$ ), a common feature of Skyrme models. When  $e_{sym} < 0$  the electron fraction goes to zero. More details of quantities can be found in Ref. [1].

<sup>1</sup>0-values indicate, that the corresponding data is not provided.

table dimension                    1  
table type                            1  
total number of grid points    445

Range and density (#) of the grid parameters:

|       | Quantity          | Unit             | min                  | max   | #   |
|-------|-------------------|------------------|----------------------|-------|-----|
| T     | Temperature       | MeV              | 0                    | 0     | 1   |
| $n_b$ | Baryon Nr Density | $\text{fm}^{-3}$ | $1.0 \times 10^{-7}$ | 1.6   | 445 |
| $Y_q$ | Charge Fraction   |                  | 0.0                  | 0.442 | 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         |
|-------|------------------|
| 10    | n                |
| 11    | p                |
| 0     | $e^-$            |
| 1     | $\mu^-$          |
|       | - end of table - |

One set of quadruple for an unique heavy nucleus. See section of 4.2.3 CompOSE manual.

### Description of phases

PHASE INDEX #4: heavy nucleus present

PHASE INDEX #3: homogeneous matter