# QHC21 $A_\chi$

## EoS Submission Details

| | |
|---|---|
| EoS name | QHC21 $A_\chi$ |
| category | hybrid |
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| sheet creation date | December 18, 2021 |

## Abstract

This table corresponds to the zero temperature and $\beta$-equilibrium unified EoS by Kojo et al. [1]. The EoS are divided into four distinct domains: the crust, nuclear liquid, hadron-quark crossover, and quark matter domains. For each domain we assign an equation of state as

| | | |
|---|---|---|
| Crust | Togashi [2] | $[10^{-9}n_0 \leq n_B \leq 0.5n_0]$ |
| Nuclear liquid | $N^3LO$ ChEFT [3] | $[0.5n_0 \leq n_B \leq 1.5n_0]$ |
| Crossover | QHC21 $A_\chi$ [1] | $[1.5n_0 \leq n_B \leq 3.5n_0]$ |
| Quark matter | QHC21 $A_\chi$ [1] | $[3.5n_0 \leq n_B \leq 10n_0]$ |

The quark matter EoS (including up-, down-, and strange-quarks) in the QHC21 was calculated using the NJL model within the mean field approximation. As variable parameters, we choose $g_V$ and $H$ which quantify the strength of the repulsive density-density interaction and the attractive paring-interaction between quarks, respectively. For QHC21$A_\chi$, we consider $(g_V, H)/G = (1.00, 1.50)$ [$A_\chi$] which are compatible with the hadron physics. The QHC21 satisfies the empirical constraints from neutron stars as well as the causality and thermodynamic consistency.

## References to the original work

1. T. Kojo, G. Baym, and T. Hatsuda,
"*QHC21 equation of state of neutron star matter – in light of 2021 NICER data*,"
arXiv: 2111.11919, `https://arxiv.org/pdf/2111.11919.pdf`

2. H. Togashi, K. Nakazato, Y. Takehara, S. Yamamuro, H. Suzuki, and M. Takano,
*"Nuclear equation of state for core-collapse supernova simulations with realistic nuclear forces,"* Nucl. Phys. A 961, 78 (2017),
`https://doi.org/10.1016/j.nuclphysa.2017.02.010`

3. C. Drischler, S. Han, J.M. Lattimer, M. Prakash, S. Reddy, and T. Zhao,
*"Limiting masses and radii of neutron stars and their implications,"*
Phys. Rev. C **103**, 045808, `https://doi.org/10.1103/PhysRevC.103.045808`

## Nuclear Matter Properties[1]

| | Quantity | Unit | |
|---|---|---|---|
| $n_S$ | saturation density in symmetric matter | $\mathrm{fm}^{-3}$ | 0.17 |
| $E_0$ | binding energy per baryon at saturation | MeV | 14.3 |
| $K$ | incompressibility | MeV | 260.0 |
| $K'$ | skewness | MeV | 0 |
| $J$ | symmetry energy | MeV | 31.7 |
| $L$ | symmetry energy slope parameter | MeV | 59.8 |
| $K_{sym}$ | symmetry incompressibility | MeV | 0 |
| $U_\Lambda$ | $\Lambda$-potential at saturation | MeV | 0 |
| $U_\Sigma$ | $\Sigma$-potential at saturation | MeV | 0 |
| $U_\Xi$ | $\Xi$-potential at saturation | MeV | 0 |

## Neutron Star Properties[1]

| | Quantity | Unit | |
|---|---|---|---|
| $M_{max}$ | maximum mass | $\mathrm{M}_{sun}$ | 2.19 |
| $M_{DU,e}$ | mass at DUrca threshold (1/9) w/o $\mu^-$ | $\mathrm{M}_{sun}$ | 0 |
| $R_{M_{max}}$ | radius at maximum NS mass | km | 11.7 |
| $R_{1.4}$ | radius at 1.4 $\mathrm{M}_{sun}$ NS mass | km | 12.4 |
| $\tilde{\Lambda}$ | tidal deformability for GW170817 at a mass ratio of $q = 0.8$ | | 0 |

## eos.thermo

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

| | |
|---|---|
| table dimension | 1 |
| table type | 1 |
| total number of grid points | 805 |

[1] 0-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 | $fm^{-3}$ | 7.59E-011 | 1.49 | 805 |
| $Y_q$ | 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.

**e**os.compo : not available

| index | particle |
|---|---|
| 0 | e |
| | - end of table - |