# APR(APR) with unified crust

## EoS Submission Details

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|---|---|
| EoS name | APR(APR) with unified crust |
| category | Hadronic |
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| sheet creation date | March 18, 2025 |

## Abstract

This table represents the zero temperature and $\beta$-equilibrium EoS by Akmal, Pandharipande and Ravenhall using variational techniques [1], interaction $A18+\delta v+UIX*$. The transition to the pion condensed phase at high densities is modelled via an inhomogeneous mixed phase with a Gibbs construction, see chapter 5.12 of [2]. The crust has been reconstructed in a thermodynamically consistent and unified way using the CUTER tool [3,4], see [4] for details.

## References to the original work

1. A. Akmal, V.R. Pandharipande and D.G. Ravenhall, Phys. Rev. C 58 (1998) 1804.
2. P. Haensel, A.Y. Potekhin, D.G. Yakovlev, Neutron Stars 1: Equation of State and Structure, Springer, New York (2007).
3. P.J. Davis, *et al*, Astron. Astrophys. 687, 44 (2024).
4. P.J. Davis *et al*, Eur. Phys. J. A (2025).

## Nuclear Matter Properties[1]

| | Quantity | Unit | |
|---|---|---|---|
| $n_S$ | saturation density in symmetric matter | $\mathrm{fm}^{-3}$ | 0.16 |
| $E_0$ | binding energy per baryon at saturation | MeV | 16.0 |
| $K$ | incompressibility | MeV | 266.0 |
| $K'$ | skewness | MeV | – |
| $J$ | symmetry energy | MeV | 32.6 |
| $L$ | symmetry energy slope parameter | MeV | 57.6 |
| $K_{sym}$ | symmetry incompressibility | MeV | – |

## 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 $\mu^-$ | $\mathrm{M}_{sun}$ | – |
| $R_{M_{max}}$ | radius at maximum NS mass | km | 9.94 |
| $R_{1.4}$ | radius at 1.4 $\mathrm{M}_{sun}$ NS mass | km | 11.37 |
| $\tilde{\Lambda}$ | tidal deformability for a NS with $M = 1.4\mathrm{M}_{sun}$ | 246 | |

## 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 | 1833 |

[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 | $fm^{-3}$ | 1.e-11 | 1.34 | 1833 |
| $Y_q$ | Charge Fraction | | 0 | 0 | 1 |

T, $n_b$, and $Y_q$ are stored in eos.t, eos.nb, and eos.yq, respectively.