

# Explanation of Equation of State Tables

Here we describe the physical quantities provided in the tables for the equation of state, eos\_80.dat and eosb\_80.dat. One should download the gzip compressed files eos\_80.dat.gz and or eosb\_80.dat.gz and use gunzip to decompress them. [For example gunzip eos\_80.dat.gz will create eos\_80.dat which is 1.9GB.] References include: G. Shen, C. J. Horowitz, S. Teige, arXiv:1006.0489 and Phys. Rev. C **82**, 015806 (2010).

There are 16 items in each row. In eosb\_80.dat, only the contribution from baryons is taken into account for items 4,5,6. In eos\_80.dat, the contributions from electrons, positrons, and photons are also included.

Table 1: Range of temperatures, densities and proton fractions in the EOS table.

Parameter	minimum	maximum	number of grid points
$T$ [MeV]	0, $10^{-0.8}$	$10^{1.9}$	218
$\log_{10}(n_B)$ [ $\text{fm}^{-3}$ ]	-8.0	0.2	657
$Y_p$	0, 0.05	0.56	$1(Y_p=0)+52$

1. Temperature  $T$  [MeV]. The range of temperature is from  $T = 0, 10^{-0.8}$  to  $10^{1.9}$  MeV. In eosb\_80.dat and eos\_80.dat, the log10 step for grid point in temperature is 0.0125 for nonzero temperatures.
2. Proton fraction  $Y_p$ . The range of proton fraction is  $0, 0.05 \sim 0.56$ . The step in proton fraction is 0.01.
3. Baryon number density  $n$  [ $\text{fm}^{-3}$ ]. The range of density is from  $10^{-8}$  to  $10^{0.2} \text{ fm}^{-3}$ . In eosb\_80.dat and eos\_80.dat, the log10 step for grid points in density is 0.0125.
4. Free energy per baryon  $F$  [MeV], which has subtracted the free nucleon mass 939 MeV.
5. Pressure  $P$  [MeV/ $\text{fm}^3$ ].
6. Entropy per baryon  $S$  [ $k_B$ ].
7. Chemical potential for neutrons  $\mu_n$  [MeV]. The value is relative to the nucleon mass 939 MeV.
8. Chemical potential for protons  $\mu_p$  [MeV]. The value is relative to the nucleon mass.
9. Chemical potential for electrons  $\mu_e$  [MeV]. The value is the physical value including the electron mass.
10. Average mass number  $\bar{A}$  of heavy nuclei, which exclude alpha particles.
11. Average proton number  $\bar{Z}$  of heavy nuclei, which exclude alpha particles.

12. Mass fraction of free neutrons.
13. Mass fraction of free protons.
14. Mass fraction of alpha particles.
15. Mass fraction of heavy nuclei, which exclude alpha particles.
16. Effective nucleon mass  $M^*$  [MeV]. In uniform matter it is obtained from RMF theory. For virial gas and non-uniform matter, it is chosen to be the free nucleon mass.

### **Sample Fortran Program readeos.f**

The Fortran program readeos.f includes a very short main program that calls the subroutine load\_table, to read eos\_80.dat or eosb\_80.dat, and then calls the subroutine readeos with inputs  $T$  (in MeV), proton fraction  $Y_p$ , and density  $n$  (in  $\text{fm}^{-3}$ ). The subroutine readeos uses trilinear interpolation (in  $T$ ,  $Y_p$ , and  $n$ ) to return the above 16 values plus the internal energy per baryon (in MeV) and the chemical potential for electron neutrinos in chemical equilibrium (in MeV). Note that one needs to call load\_table only once and then one can call readeos many times. For further details please see the comments in readeos.f.