

CompOSE - CompStar Online Supernovae Equations Of State

Stefan Typel for the CompOSE core team



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**Neutron Stars: the equation of state,
superconductivity/superfluidity
and transport coefficients
(PHAROS WG1+WG2 meeting)**

**University of Coimbra, Portugal
September 26 – 28, 2018**

CompOSE core team:

Chikako Ishizuka (Tokyo Institute of Technology, Japan)

Thomas Klähn (California State University Long Beach, USA)

Micaela Oertel (LUTH, Observatoire de Paris, France)

Stefan Typel (Technische Universität Darmstadt and GSI, Germany)

web support:

Marco Mancini (LUTH, Observatoire de Paris, France)



Main Features



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-
- ▶ **free-access website (compose.obspm.fr)**
 - ▶ hosted at LUTH, Observatoire de Paris, Meudon



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 - ▶ thermodynamic properties, chemical composition, microscopic quantities
 - ▶ tabulation in temperature, baryon density and hadronic charge fraction
 - ▶ very flexible data format

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- ▶ **handling of EoS data**
 - ▶ software for extraction, interpolation and calculation of additional quantities
 - ▶ online generation of EoS tables (access restricted)
 - ▶ different output formats

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 - ▶ different output formats
- ▶ **documentation**
 - ▶ manual and 'how-to' instructions
 - ▶ bibliography of EoS publications
 - ▶ links to related projects



- ▶ **presently available types of tables**
 - ▶ 3-dimensional
 - ▶ general purpose EoS (59 data sets)
 - ▶ 2-dimensional
 - ▶ zero-temperature EoS (5 data sets)
 - ▶ neutron matter EoS (26 data sets)
 - ▶ 1-dimensional
 - ▶ cold β -equilibrated matter EoS (30 data sets)

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▶ EoS files

- ▶ parameters (temperature, baryon density and hadronic charge fraction):
`eos.t`, `eos.nb`, `eos.yq`
- ▶ EoS data: `eos.thermo`, `eos.compo*`, `eos.micro*` (*: optional)
- ▶ information on EoS model in data sheet: `eos.pdf`
- ▶ collection of files available as `eos.zip`

- ▶ **discretization grid** (`eos.t`, `eos.nb`, `eos.yq`)
in temperature T , baryon density n_b , and hadronic charge fraction Y_q
⇒ indices i_T, i_{nb}, i_{Y_q}

Data Format of EoS Files

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► **thermodynamic quantities:** (eos.thermo)

$$i_T \quad i_{nb} \quad i_{Y_q} \quad \frac{\rho}{n_b} \quad \frac{s}{n_b} \quad \frac{\mu_b}{m_n} - 1 \quad \frac{\mu_q}{m_n} \quad \frac{\mu_l}{m_n} \quad \frac{f}{n_b m_n} - 1 \quad \frac{e}{n_b m_n} - 1 \quad N_{\text{add}} \quad q_1 \dots q_{N_{\text{add}}}$$

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- ▶ **chemical composition:** (`eos.compo`, optional)

$i_T \quad i_{nb} \quad i_{Y_q} \quad l_{\text{phase}} \quad N_{\text{pairs}} \quad l_1 \quad Y_1 \dots \quad l_{N_{\text{pairs}}} \quad Y_{N_{\text{pairs}}}$
 $N_{\text{quad}} \quad l_1 \quad A_{l_1}^{\text{av}} \quad Z_{l_1}^{\text{av}} \quad Y_{l_1}^{\text{av}} \dots \quad l_{N_{\text{quad}}} \quad A_{N_{\text{quad}}}^{\text{av}} \quad Z_{N_{\text{quad}}}^{\text{av}} \quad Y_{N_{\text{quad}}}^{\text{av}}$

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indices I_{phase}, I_n define thermodynamic phase and particle type

▶ **microscopic properties:** (`eos.micro`, optional)

$i_T \quad i_{n_b} \quad i_{Y_q} \quad N_{\text{qty}} \quad K_1 \quad q_{K_1} \dots K_{N_{\text{qty}}} \quad q_{K_{N_{\text{qty}}}}$

index K_n defines particle type and quantity q_{K_n}



▶ software

- ▶ FORTRAN code, version 2.17, 2018/09/07
(`compose.f90`, `composemodules.f90`, `out_to_json.f90`, `Makefile`)
- ▶ 'file version' (needs input files provided by the user)
- ▶ new 'terminal version' (default), simple interaction with user
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▶ output files

- ▶ EoS table: `eos.table`
- ▶ additional information: `eos.report`
- ▶ input for neutron star calculations (if possible): `eos.beta`



▶ **web interface**

- ▶ access restricted \Rightarrow registration required
- ▶ generation of EoS tables (in preparation)
- ▶ graphical representation of EoS etc.
(merger with EOSDB website of Chikako Ishizuka, in planning)



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▶ **LORENE library**

- ▶ cold neutron star EoS can be used as direct input for Nrotstar code
 \Rightarrow properties of rotating neutron stars



▶ manual

- ▶ detailed information on file formats, tabulation scheme, interpolation, . . .
- ▶ version 1.00 published (75 pages)
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- ▶ contact CompOSE core team by sending email to `develop.compose@obspm.fr`
- ▶ details on preparation of files and transmission will be clarified



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- ▶ full access to all services with password



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- ▶ dependence on other variables?
- ▶ choice of other primary variables?
- ▶ output for constant entropy per baryon implemented recently
- ▶ additional data (e.g. transport properties)?



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- ▶ **other suggestions?**