MESA Stellar Model Format

MESA-format files store data describing a stellar model in an ASCII text file. There are a number of variants of this format, which can be distinguished by the initial header line.

Version 0.01

The first line of version-0.01 MESA files is a header with the following columns:

Column	Variable	Datatype	Definition
1	n	integer	Number of grid points
2	M_*	real	Stellar mass (g)
3	R_*	real	Stellar radius (cm)
4	L_*	real	Stellar luminosity ($\mathrm{erg\,s^{-1}}$)

The subsequent n lines contain the model data, one line per grid point extending from the center to the surface, with the following columns:

Column	Name	Datatype	Definition
1	k	integer	Grid point index ($k = 1, \ldots, n$)
2	r	real	Radius (cm)
3	w	real	$M_r/(M_* - M_r)$
4	L_r	real	Luminosity ($\mathrm{erg\,s^{-1}}$)
5	P	real	Total pressure ($\mathrm{dyn\,cm^{-2}}$)
6	T	real	Temperature (K)
7	ρ	real	Density ($\mathrm{g\,cm^{-3}}$)
8	∇	real	$\mathrm{d}\ln T/\mathrm{d}\ln p$
9	N^2	real	Brunt-Väisälä frequency squared ($\mathrm{s^{-2}}$)
10	c_V	real	Specific heat at constant volume ($\mathrm{erg\,g^{-1}\,K^{-1}}$)
11	c_P	real	Specific heat at constant pressure ($\mathrm{erg\,g^{-1}\,K^{-1}}$)
12	χ_T	real	$(\partial \ln P/\partial \ln T)_\rho$
13	χ_ρ	real	$(\partial \ln P/\partial \ln \rho)_T$
14	κ	real	Opacity ($\mathrm{cm^2\,g^{-1}}$)
15	κ_T	real	$(\partial \ln \kappa/\partial \ln T)_\rho$
16	κ_ρ	real	$(\partial \ln \kappa/\partial \ln \rho)_T$
17	ϵ	real	Energy generation/loss rate ($\mathrm{erg\,s^{-1}\,g^{-1}}$)
18	$\epsilon\,\epsilon_T$	real	$(\partial \epsilon/\partial \ln T)_\rho$ ($\mathrm{erg\,s^{-1}\,g^{-1}}$)
19	$\epsilon\,\epsilon_\rho$	real	$(\partial \epsilon/\partial \ln \rho)_T$ ($\mathrm{erg\,s^{-1}\,g^{-1}}$)

Version 0.19

The first line of version-0.19 MESA files is a header with the following columns:

Column	Variable	Datatype	Definition
1	n	integer	Number of grid points
2	M_*	real	Stellar mass (g)
3	R_*	real	Stellar radius (cm)
4	L_*	real	Stellar luminosity ($\mathrm{erg\,s^{-1}}$)
5	19	integer	Version number $\times 100$

The subsequent n lines contain the model data, one line per grid point extending from the center to the surface, with the following columns:

Column	Name	Datatype	Definition
1	k	integer	Grid point index ($k = 1, \ldots, n$)
2	r	real	Radius (cm)
3	w	real	$M_r/(M_* - M_r)$
4	L_r	real	Luminosity ($\mathrm{erg\,s^{-1}}$)
5	P	real	Total pressure ($\mathrm{dyn\,cm^{-2}}$)
6	T	real	Temperature (K)
7	ρ	real	Density ($\mathrm{g\,cm^{-3}}$)
8	∇	real	$\mathrm{d}\ln T/\mathrm{d}\ln p$
9	N^2	real	Brunt-Väisälä frequency squared ($\mathrm{s^{-2}}$)
10	Γ_1	real	$(\partial \ln P/\partial \ln \rho)_{\mathrm{ad}}$
11	∇_{ad}	real	$(\mathrm{d}\ln T/\mathrm{d}\ln P)_{\mathrm{ad}}$
12	δ	real	$-(\partial \ln \rho/\partial \ln T)_P$
13	κ	real	Opacity ($\mathrm{cm^2\,g^{-1}}$)
14	κ_T	real	$(\partial \ln \kappa/\partial \ln T)_\rho$
15	κ_ρ	real	$(\partial \ln \kappa/\partial \ln \rho)_T$
16	ϵ	real	Energy generation/loss rate ($\mathrm{erg\,}s^{-1}\,\mathrm{g^{-1}}$)
17	$\epsilon\,\epsilon_T$	real	$(\partial\epsilon/\partial \ln T)_\rho$ ($\mathrm{erg\,}s^{-1}\,\mathrm{g^{-1}}$)
18	$\epsilon\,\epsilon_\rho$	real	$(\partial\epsilon/\partial \ln \rho)_T$ ($\mathrm{erg\,}s^{-1}\,\mathrm{g^{-1}}$)
19	Ω_{rot}	real	Rotation angular velocity ($\mathrm{rad\,s^{-1}}$)

Version 1.00

The first line of version-1.00 MESA files is a header with the following columns:

Column	Variable	Datatype	Definition
1	n	integer	Number of grid points
2	M_*	real	Stellar mass (g)
3	R_*	real	Stellar radius (cm)
4	L_*	real	Stellar luminosity ($\mathrm{erg\,s^{-1}}$)
5	100	integer	Version number $\times 100$

The subsequent n lines contain the model data, one line per grid point extending from the center to the surface, with the following columns:

Note that the definitions of columns 14 and 15 are slightly different than in previous versions.

Column	Name	Datatype	Definition
1	k	integer	Grid point index ($k = 1, \ldots, n$)
2	r	real	Radius (cm)
3	M_r	real	Interior mass (g)
4	L_r	real	Luminosity ($\mathrm{erg\,s^{-1}}$)
5	P	real	Total pressure ($\mathrm{dyn\,cm^{-2}}$)
6	T	real	Temperature (K)
7	ρ	real	Density ($\mathrm{g\,cm^{-3}}$)
8	∇	real	$\mathrm{d}\ln T/\mathrm{d}\ln p$
9	N^2	real	Brunt-Väisälä frequency squared ($\mathrm{s^{-2}}$)
10	Γ_1	real	$(\partial \ln P/\partial \ln \rho)_{\mathrm{ad}}$
11	∇_{ad}	real	$(\mathrm{d}\ln T/\mathrm{d}\ln P)_{\mathrm{ad}}$
12	δ	real	$-(\partial \ln \rho/\partial \ln T)_P$
13	κ	real	Opacity ($\mathrm{cm^2\,g^{-1}}$)
14	$\kappa\,\kappa_T$	real	$(\partial\kappa/\partial \ln T)_\rho$ ($\mathrm{cm^2\,g^{-1}}$)
15	$\kappa\,\kappa_\rho$	real	$(\partial\kappa/\partial \ln \rho)_T$ ($\mathrm{cm^2\,g^{-1}}$)
16	ϵ	real	Energy generation/loss rate ($\mathrm{erg\,}s^{-1}\,\mathrm{g^{-1}}$)
17	$\epsilon\,\epsilon_T$	real	$(\partial\epsilon/\partial \ln T)_\rho$ ($\mathrm{erg\,}s^{-1}\,\mathrm{g^{-1}}$)
18	$\epsilon\,\epsilon_\rho$	real	$(\partial\epsilon/\partial \ln \rho)_T$ ($\mathrm{erg\,}s^{-1}\,\mathrm{g^{-1}}$)
19	Ω_{rot}	real	Rotation angular velocity ($\mathrm{rad\,s^{-1}}$)