

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 (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 ($k = 1, \dots, n$)
2	r	real	Radius (cm)
3	w	real	$M_r/(M_* - M_r)$
4	L_r	real	Luminosity (erg s^{-1})
5	P	real	Total pressure (dyn cm^{-2})
6	T	real	Temperature (K)
7	ρ	real	Density (g cm^{-3})
8	∇	real	$d \ln T / d \ln p$
9	N^2	real	Brunt-Väisälä frequency squared (s^{-2})
10	c_V	real	Specific heat at constant volume ($\text{erg g}^{-1} \text{K}^{-1}$)
11	c_P	real	Specific heat at constant pressure ($\text{erg g}^{-1} \text{K}^{-1}$)
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 ($\text{cm}^2 \text{g}^{-1}$)
15	κ_T	real	$(\partial \ln \kappa / \partial \ln T)_\rho$
16	κ_ρ	real	$(\partial \ln \kappa / \partial \ln \rho)_T$
17	$\epsilon_{\text{nuc}} + \epsilon_{\text{grav}}$	real	Total energy generation/loss rate ($\text{erg s}^{-1} \text{g}^{-1}$)
18	$\epsilon_{\text{nuc}} \epsilon_{\text{nuc},T}$	real	$\epsilon_{\text{nuc}} (\partial \ln \epsilon_{\text{nuc}} / \partial \ln T)_\rho$ ($\text{erg s}^{-1} \text{g}^{-1}$)
19	$\epsilon_{\text{nuc}} \epsilon_{\text{nuc},\rho}$	real	$\epsilon_{\text{nuc}} (\partial \ln \epsilon_{\text{nuc}} / \partial \ln \rho)_T$ ($\text{erg s}^{-1} \text{g}^{-1}$)

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 (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 ($k = 1, \dots, n$)
2	r	real	Radius (cm)
3	w	real	$M_r / (M_* - M_r)$
4	L_r	real	Luminosity (erg s^{-1})
5	P	real	Total pressure (dyn cm^{-2})
6	T	real	Temperature (K)
7	ρ	real	Density (g cm^{-3})
8	∇	real	$d \ln T / d \ln p$
9	N^2	real	Brunt-Väisälä frequency squared (s^{-2})
10	Γ_1	real	$(\partial \ln P / \partial \ln \rho)_{\text{ad}}$
11	∇_{ad}	real	$(d \ln T / d \ln P)_{\text{ad}}$
12	δ	real	$-(\partial \ln \rho / \partial \ln T)_P$
13	κ	real	Opacity ($\text{cm}^2 \text{g}^{-1}$)
14	κ_T	real	$(\partial \ln \kappa / \partial \ln T)_\rho$
15	κ_ρ	real	$(\partial \ln \kappa / \partial \ln \rho)_T$
16	$\epsilon_{\text{nuc}} + \epsilon_{\text{grav}}$	real	Total energy generation/loss rate ($\text{erg s}^{-1} \text{g}^{-1}$)
17	$\epsilon_{\text{nuc}} \epsilon_{\text{nuc},T}$	real	$\epsilon_{\text{nuc}} (\partial \ln \epsilon_{\text{nuc}} / \partial \ln T)_\rho$ ($\text{erg s}^{-1} \text{g}^{-1}$)
18	$\epsilon_{\text{nuc}} \epsilon_{\text{nuc},\rho}$	real	$\epsilon_{\text{nuc}} (\partial \ln \epsilon_{\text{nuc}} / \partial \ln \rho)_T$ ($\text{erg s}^{-1} \text{g}^{-1}$)
19	Ω_{rot}	real	Rotation angular velocity (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 (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:

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

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

Version 1.01

The first line of version-1.01 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 (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:

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

Note that column 16 is now the nuclear energy generation rate ϵ_{nuc} , rather than the total (nuclear plus gravitational) generation rate $\epsilon_{\text{nuc}} + \epsilon_{\text{grav}}$ used in previous versions.