Stellar Structure Equations

As given in lecture:

As used in a stellar evolution code:

[Lagrangian (mass) coordinates]

1. $\frac{dM}{dr} = \rho 4\pi r^2$ $\qquad$ $\frac{dr}{dM} = \frac{1}{\rho 4\pi r^2}$

2. $\frac{dP}{dr} = -g\rho$ $\qquad$ $\frac{dP}{dM} = -\frac{g}{4\pi r^2} = -\frac{GM}{4\pi r^4}$

3. $\frac{dL}{dr} = (\varepsilon - T\,ds/dt)\rho 4\pi r^2$ $\qquad$ $\frac{dL}{dM} = \varepsilon - T\,ds/dt$

4. $\begin{cases} \frac{dT}{dr} = \frac{-3\kappa\rho L}{64\pi\sigma r^2 T^3} & \text{radiative} \qquad \frac{dT}{dM} = \frac{-3\kappa L}{256\pi^2\sigma r^4 T^3} \\ \frac{dT}{dr} = \left(1-\frac{1}{\gamma}\right)\frac{T}{P}\frac{dP}{dr} & \text{convective} \qquad \frac{dT}{dM} = \left(1-1/\gamma\right)\frac{T}{P}\frac{dP}{dM} \end{cases}$

⇑

Enclosed mass is the independent variable