```
Clear["Global`*"]
Msun = 2 × 10^33;
Mdotsol = (Msun / (3.15 × 10^7))
G = 6.67 × 10^-8;
c = 3 × 10^10;
σ = 5.67 × 10^-5;
kb = 1.38 × 10^-16;
mp = 1.67 × 10^-24;
Tc = 8 × 10^4 μ0^(1/5) μe^-1/5 r3^(-9/10) M7^-1/5 α0.3^-1/5 fT^1/5 (ṁ / ϵ0.1)^(2/5) κ̂^1/5 ;
LEdd = 4 π G (M7 / (0.4 μe κ̂)) c 10^7 Msun;
ṀEdd = LEdd / (c^2 ϵ0.1 0.1);
Ṁ = ṁ ṀEdd;
Rs = 2 G (M7 / c^2) 10^7 Msun;
(Ṁ / (3 π (kb Tc)/(μ0 mp) 0.3 α0.3)) (G M7 10^7 Msun / (r3^3 (10^3 Rs)^3))^(1/2) // Simplify[#, Assumptions → {M7 > 0, r3 > 0}] &
```

$$6.34921 \times 10^{25}$$

$$\frac{169\,123.\ \mu 0^{4/5} \left(\frac{\dot{m}}{\epsilon_{0.1}}\right)^{3/5}}{\mu e^{4/5}\ \hat{\kappa}^{6/5} \left(\frac{r3^3\ f_T}{M_7}\right)^{1/5}\ \alpha_{0.3}^{4/5}}$$

```
Clear[Tc]
```

$$\rho c\, kb\, \frac{Tc}{\mu 0\, mp} /. \{\mu 0 \to 0.615,\ Tc \to 10^5,\ \rho c \to 1.5 \times 10^{-8}\}$$

$$4\, \sigma\, Tc^4 / (3\, c) /. \{Tc \to 10^5\}$$

$$cs = \sqrt{\gamma \left(4\, \sigma\, Tc^4 / (3\, c\, \rho c)\right)}$$

$$H = \frac{Mdot}{3\, \pi\, \Sigma\, cs\, \alpha} /. \{\mu 0 \to 0.615,\ Tc \to 10^5,\ \Sigma \to 90\,000,\ Mdot \to 1.40 \times 10^{24},\ \alpha \to 0.3,\ \gamma \to 4/3\}$$

$$rul = \left(Solve\left[\frac{90\,000}{2\, H} == \rho c,\ \rho c\right]\right)[[3]]$$

$$\rho c\, kb\, \frac{Tc}{\mu 0\, mp} /. \{\mu 0 \to 0.615,\ Tc \to 10^5,\ \rho c \to 1.5 \times 10^{-8}\}$$

$$4\, \sigma\, Tc^4 / (3\, c) /. rul /. Tc \to 10^5$$

$$\frac{H}{cs} /. rul /. \{\mu 0 \to 0.615,\ Tc \to 10^5,\ \Sigma \to 90\,000,\ Mdot \to 1.40 \times 10^{24},\ \alpha \to 0.3,\ \gamma \to 4/3\}$$

```
(*H/cs/.rul

    2 π/Sqrt[G M/R^3]/.{M→M7 10^7 Msun, R→200 Rs, M7→1}*)
```

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$$5.01996 \times 10^{-8} \sqrt{\frac{Tc^4\, \gamma}{\rho c}}$$

$$\frac{9.49125 \times 10^{15}}{\sqrt{\frac{1}{\rho c}}}$$

$$\{\rho c \to 2.82223 \times 10^{-8}\}$$

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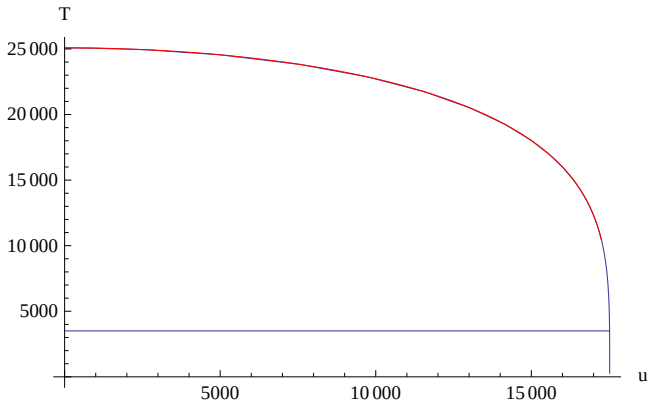
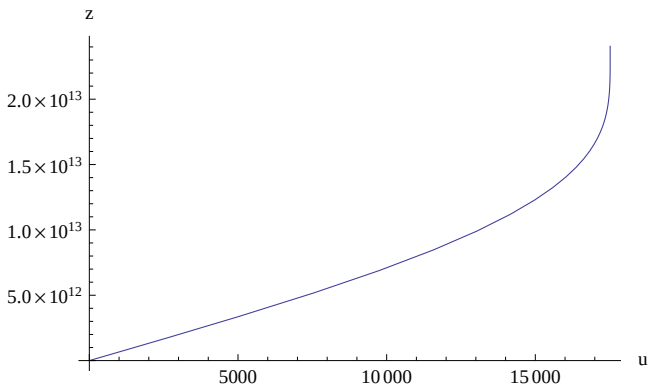
```
(*Example of a particular profile*)
M = 10^7 Msun;
μe = 1;
μ0 = 0.615;
κes = 0.4 μe;
(*Import profile and extract physical parameters*)
MyFile = "profile-35035-0.1-1000";
MyFileP = StringSplit[MyFile, "-"] // #[[2 ;;]] &;
MyFileP = ToExpression /@ MyFileP;
Σ = MyFileP[[1]];
Ṁ = MyFileP[[2]] 10 × 4 π G M / (c κes);
R = MyFileP[[3]] 2 G M / c^2;
(*Kinematic viscosity*)
ν = Ṁ / (3 π Σ);
(*Keplerian angular velocity*)
Ω = Sqrt[G M / R^3];
(*Central sound speed*)
cs0 = Sqrt[kb Tc / (μ0 mp)]

Teff = ((9/8 ν Σ) Ω^2 / σ)^0.25;
Tss[Tc_, u_, Σ_] := Tc (1 - 4 (u/Σ)^2)^(1/4);
(*Finding the points which bracket the effective temperature*)
tlow = (Position[profile[[All, 4]], x_ /; x < Teff])[[1]];
thigh = (Position[profile[[All, 4]], x_ /; x > Teff])[[-1]];
Extract[profile[[All, 1]], {thigh, tlow}]
Print["u*=", Σ/2 Sqrt[1 - 8 / ((3 / 2) κes Σ)]]

profile = Import[NotebookDirectory[] <> MyFile, "Table"];
u0 = profile[[All, 1]] // Min;
umax = profile[[All, 1]] // Max;
Tc = profile[[1, 4]];
t1 = Show[{profile[[All, {1, 4}]]} // ListLinePlot[#, PlotRange → All] &,
   Plot[Teff, {u, u0, umax}], PlotRange → All, AxesLabel → {"u", "T"}, AxesOrigin → {0, 0}];
t2 = Plot[Tss[Tc, u, Σ], {u, 0, umax}, PlotStyle → Directive[Red]];
Show[t1, t2]
{profile[[All, {1, 2}]]} // ListLinePlot[#, AxesLabel → {"u", "z"}, PlotRange → All] &
{profile[[All, {1, 3}]]} // ListLinePlot[#, AxesLabel → {"u", "ρ"}, PlotRange → All] &
profile[[All, {2, 4}]] //
 ListLinePlot[#, PlotRange → All, AxesOrigin → {0, 0}, PlotRange → All] &
(profile[[All, 6]] - profile[[All, 7]]) // ListLinePlot[#, AxesOrigin → {0, 0}] &
```

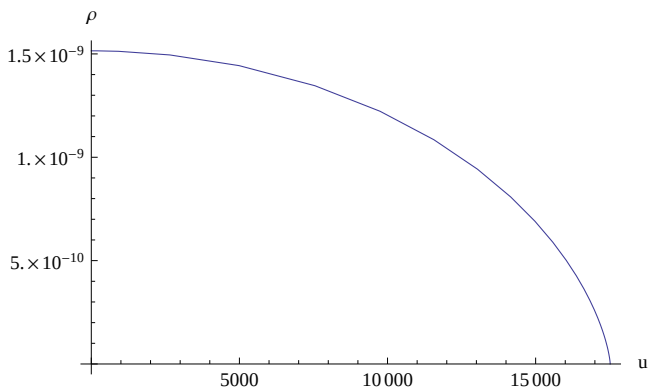
1.83576×10^6

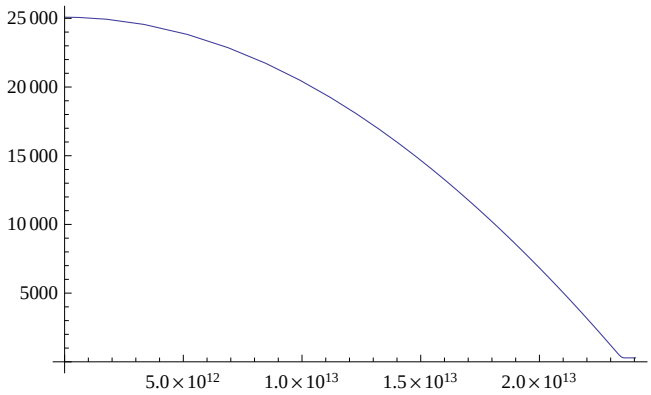
{17 514., 17 514.}

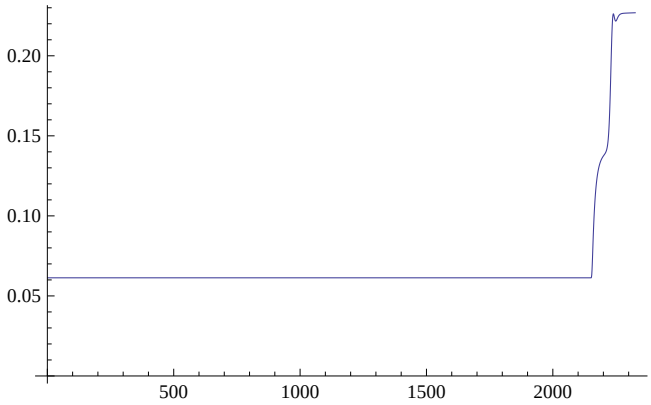
u* = 17 514.2












```
profile[[All, 3]] profile[[All, 4]]^(-7/2) // ListLogPlot
```