

$$P^2 = \left( \frac{4\pi^2}{GM} \right)^3$$

$$\text{Incoming energy} = \left( \frac{L_*}{4\pi a^2} \right) \pi R^2$$

$$\text{Outgoing energy} = (\sigma T^4) 4\pi R^2$$

$$\left( \frac{L_*}{4\pi a^2} \right) \pi R^2 = (\sigma T^4) 4\pi R^2$$

$$T^4 = \frac{L_*}{16\pi a^2 \sigma}$$

$$\frac{T_b}{T_{\text{Earth}}} = \left( \frac{0.00155/1.0}{(0.05/1.0)^2} \right)^{1/4}$$

$$= 0.89$$