\[ P = 13 \text{ days} \]
\[ a = 7 \text{ million miles} \]
\[ D = 20 \text{ light years} \]
\[ m = 10.5 \]

\[ 13 \text{ days} = 3 \times 10^{-2} \text{ yr} \]
\[ 7 \times 10^6 \text{ miles} = 10^2 \text{ km} = 10^8 \text{ m} \]
\[ = 7 \times 10^{-2} \text{ AU} \]
\[ a^3 = P^2 M \quad \Rightarrow \quad \text{solve mass} \]
\[ \frac{\left(7 \times 10^{-2}\right)^3}{\left(3 \times 10^{-2}\right)^2} = \frac{350 \times 10^{-6}}{10 \times 10^{-4}} \]
\[ = 35 \times 10^{-2} = .35 = \frac{1}{3} \]
\[ D = 20 \text{ ly} \]

\[ n = 6 \text{ parsecs} \]

\[ m - M = 5 \log \left( \frac{D}{10 \text{ pc}} \right) \]

\[ = 5 \log \left( 2 \times 3 \times 10^9 \right) \]

\[ = 5 \left[ \log (2) + \log (3) \right] \]

\[ = 5 \log (10^9) \]

\[ = 5 \times 3 = 15 \]

\[ 10.5 - M = -1 \]

\[ M = 11.5 \]

\[ \frac{-0.4 (M - M_0)}{10} = b \times 10^{-6} \]

\[ -0.4 (11.5 - 5) \]

\[ = 10^{\frac{-2}{3}} 6.5 \]

\[ = 10^{-2.6} \]
\frac{k_e}{b_0} = 10^4 \times 10^{-3} = 2.5 \times 10^{-5}
Open Yale courses

\[ a \approx 10^{-2} \]

\[ 10^{-2} \leq 10^{2} \]

\[ \text{push Umer} \]

\[ g_{out} = 0 \]

also - no shrinking

*Structure*

Life: complexity

We exist

**Another fact**

"epochs"

\[ 25 \text{ m} \times \text{cm} \]

\[ 2 \text{ nm} \]

\[ 0 \text{ cm} \]

\[ x \]

\[ a_0 \]
\[ R_s = \frac{2GM}{C^2} \]

if \( G \) bigger
if \( C \) smaller

\( R_s \) would be bigger

if \( R_s > R_{\text{white dwarf}} \)

All stars end as black holes

No Carbon (or anything other than H, He)

---

Properties of carbon

it would disappear

if a fire shock wave hit

was slightly different
DRASTIC FINE TUNING
of natural constants
prerequisite for life

ANTHROPIC PRINCIPLE
The fact that life exists or
important for understanding
basic physics/cosmology

Why do G, c, λ ....
have the values they do

1) accident

2) life "created" on purpose
   \rightarrow religious
   \rightarrow "Strong Anthropic Principle"
Uiverse MUST have life

3) MULTIVERSE
   many universes with different sets of physical laws

   Generate many universes
   1) beyond "cosmic horizon"
   2) other dimensions (string theory)

   evolutionary argument
   new universes from
   from old ones
   (black holes)

   => favor universes that produce lots of black holes