

Assume the value of the *actual* Hubble constant is 69 km/s Mpc.

1. What do those weird units mean: km/(s Mpc)?

What we're really talking about is the recession speed of galaxies at a given distance: km/s at a given # of megaparsecs away from us. The speed is due to the expansion of the intervening space, so we're saying that each Mpc of space is growing 69 km larger with every passing second. (A Mpc is a million parsecs, or about 3.2 million light years.)

2. Calculate the age of the universe, assuming the Hubble constant has always had the same value. (This will involve some unit conversion because of the weird units. 1 parsec = 3.09×10^{16} meters.)

Same deal as before, only now the distance units won't cancel until we convert them to the same units. (This looks more complicated than it really is, because I've tried to write out the steps in excruciating detail in case you've missed a step.)

The units are written as a simple ratio: $H_0 = \frac{\text{rise}}{\text{run}} = 69 \frac{\frac{\text{km}}{\text{s}}}{\text{Mpc}} = 69 \frac{\frac{\text{km}}{\text{s}}}{\frac{\text{Mpc}}{1}} = 69 \frac{\text{km}}{\text{s}} \times \frac{1}{\text{Mpc}} = \frac{69 \text{ km}}{\text{s Mpc}}$

Now flip over the Hubble constant to give the age, then convert the kilometers and the Mpc each to meters, so the final units are (s*m)/m and the meters will go away, leaving the age

in seconds: $\text{age} = \frac{1}{H_0} = \frac{1}{69} \frac{\text{s Mpc}}{\text{km}} \times \frac{1 \text{ km}}{1000 \text{ m}} \times \frac{10^6 \text{ pc}}{1 \text{ Mpc}} \times \frac{3.09 \times 10^{16} \text{ m}}{1 \text{ pc}} = \frac{3.09 \times 10^{22}}{69000} \text{ s} = 4.48 \times 10^{17} \text{ s}$

Lastly, convert seconds to years to see if the answer you got seems reasonable.

$$\text{age} = 4.48 \times 10^{17} \text{ s} \times \frac{1 \text{ hr}}{3600 \text{ s}} \times \frac{1 \text{ day}}{24 \text{ hrs}} \times \frac{1 \text{ yr}}{365.25 \text{ days}} = 1.42 \times 10^{10} \text{ yrs} = 14.2 \text{ Gyrs}$$

3. Once we have measured the Hubble constant, we can use it to determine distances to other galaxies. What measurement would we need to make to find the distance to a distant galaxy using the Hubble Law?

We need the galaxy's recession velocity, so we take a spectrum and measure the Doppler shift of one or more spectral lines. Having this, we find where on the Hubble Law line the galaxy must land, and read the galaxy's distance off the graph.