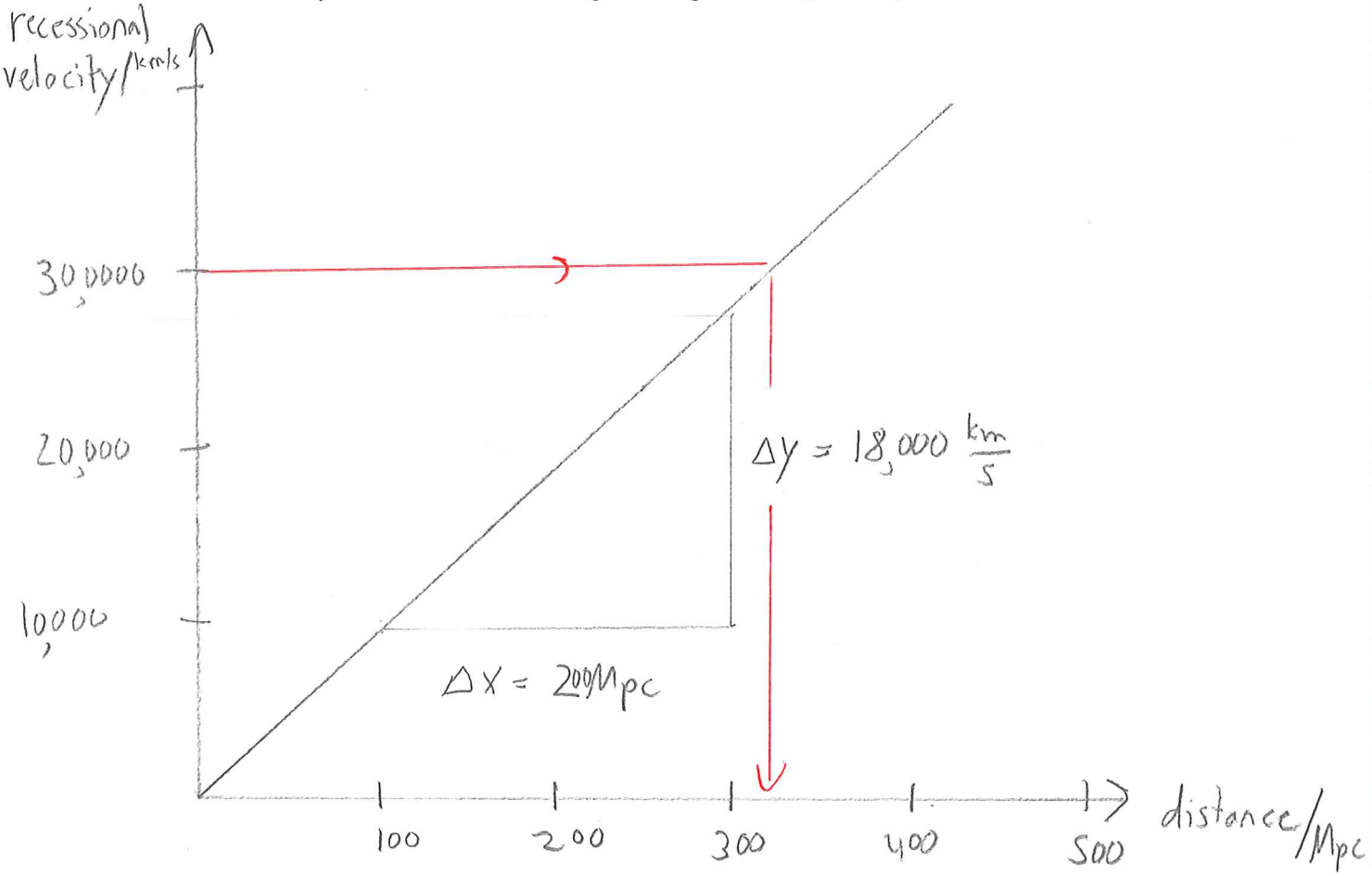
INST 2403 Activity

Hubble's Law

Hubble's law relates the recessional velocity of galaxies (how fast they move away from us) to their distance from us. It was discovered by Edwin Hubble in the late 1920ies by correlating the redshift of spectral lines of galaxies with their distances as determined by the Cepheid period-luminosity relation. Hubble's law states that there is a direct proportionality between recessional velocity and distance, i.e. the graph of velocity versus distance is a straight line with a constant slope, the so-called Hubble constant H_0.

1. Draw a Hubble plot by putting an appropriate straight line into a two-dimensional coordinate system. Should the line go through the origin? Explain.



Yes, line goes through origin because something close to us does not recede.

2. Now label the axes and commit to some scale. Typical scales are tens of thousands of km/s on the vertical and a few megaparsecs (1 Mpc = 3.26 million lightyears) on the horizontal axis.

hundred

3. Calculate your Hubble constant.

slope is $m = \frac{\Delta y}{\Delta x} = \frac{18{,}000 \text{ km/s}}{200 \text{ Mpc}} = 90 \frac{\text{km/s}}{\text{Mpc}} \equiv H_0$

4. Pick an example showing how the Hubble plot works: How can you get from the velocity of a galaxy to its distance?

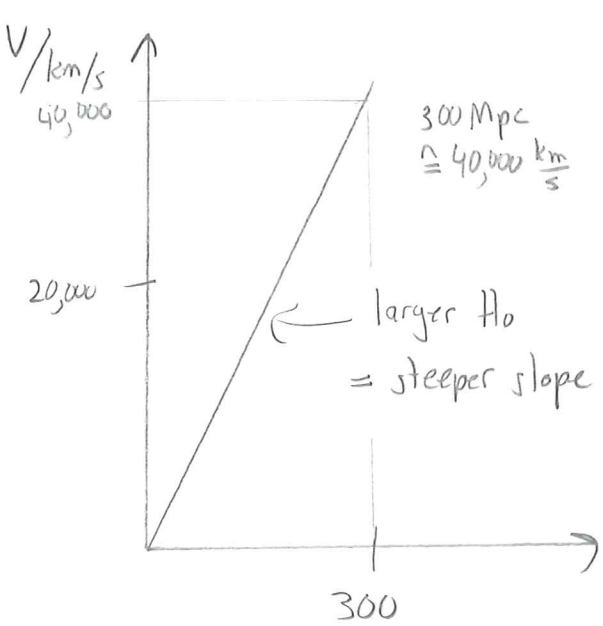
$V = H_0 d$ or $d = \frac{V}{H_0}$

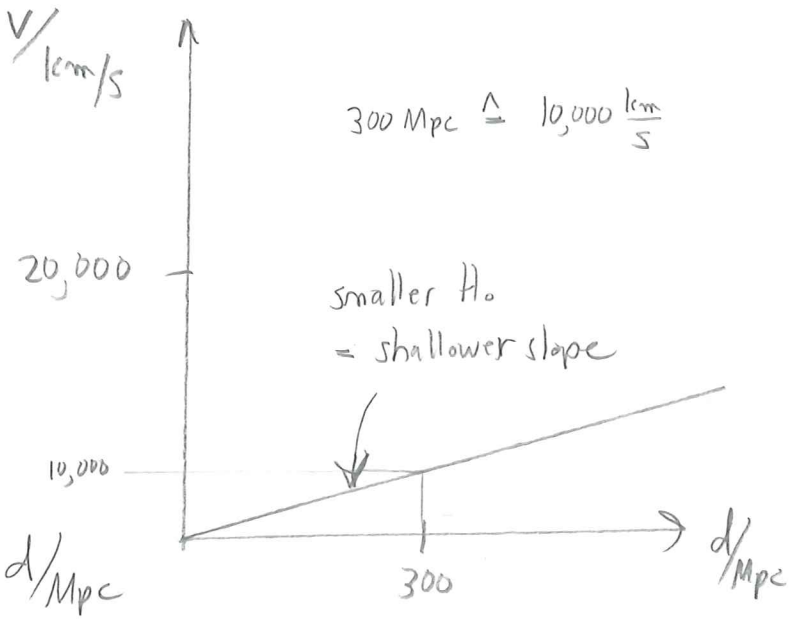
Say $V = 20{,}000 \text{ km/s} \Rightarrow d = \frac{20000 \text{ km/s}}{75 \text{ km/s}} \text{ Mpc} \approx 320 \text{ Mpc}$ (see graph)

5. How did Hubble get from measuring redshifts to determining the recessional velocity of galaxies?

Redshift is the shift of spectral lines (dark lines) to longer wavelength. This shift in wavelength is proportional to the (recessional) velocity of the galaxy.

6. Draw two other Hubble plots: one with a larger Hubble constant, and one with a smaller Hubble constant.





7. What is different about these "universes"?

The universe with larger Ho is expanding faster and therefore younger.