The following people have participated in creating these solutions: Nicolaas E. Groeneboom, Magnus Pedersen Lohne, Karl R. Leikanger *NOTE: There might be errors in the solution. If you find something which doens't look right, please let me know.*

Partial solutions to problems: Lecture 11-12

Problem 1

Here, $\theta = 1'' = 1/60/60/360 \cdot 2\pi = 4.8 \cdot 10^{-6}$ radians. The distance between the two observations is $r = 2AU$, such that the distance to the star is $d = (r/2)/\theta = 1pc$. Naturally, a parsec is **defined** as the parallax angle of an arc second, so $d = 1/1'' = 1parsec$.

Problem 2

As in 7.1, $\theta = r/d = 2au/4.22ly = 7.5 \cdot 10^{-6}$ radians. The parallax angle half of this, or or $\theta \approx 0.77''$.

Problem 3

We use that

$$m - M = 5log_{10}(\frac{r}{10pc})$$

and solve for the radius r:

$$r = 10pc \cdot 10^{\frac{m-M}{5}}$$

When "plotting" (that is, manually inserting) the observed apparent magnitudes of the stars in the cluster into the Hertzsprung-Russel diagram, we note that the difference between the two magnitudes (absolute and apparent) are about $\delta m = 5$. Thus,

$$r = 10pc \cdot 10^{\frac{5}{5}} = 100pc$$

Problem 4

Supernovae type Ia always has an absolute magnitude of $M = -19.3 \pm 0.3$. If we observe a supernovae type Ia with apparent magnitude $m = 20$, we can use

$$r = 10pc \cdot 10^{\frac{m-M}{5}}$$

to give an upper and lower estimate:

$$r_{min} = 10pc \cdot 10^{\frac{20+19.0}{5}} \approx 630Mpc$$

$$r_{max} = 10pc \cdot 10^{\frac{20+19.6}{5}} \approx 832Mpc$$

Problem 5

Hubble's law states that the velocity of a distant object is proportional to its distance: $v = H_0 r$. The velocity can be measured from the shift of wavelength : $v = c \cdot (\lambda - \lambda_0)/\lambda_0$. Inserting and solving for r, we obtain

$$r = c\frac{\lambda - \lambda_0}{\lambda_0} \cdot \frac{1}{H_0}$$

Using that $H_0 \approx 71km/s/Mpc$, we find

$$r = 3 \cdot 10^8 \frac{29.7 - 21.2}{21.2} \cdot \frac{1}{71 \cdot 10^3} 1 \cdot 10^6 pc \approx 1.7Gpc$$

Problem 6

We start off by the optical-depth-modified version of

$$m - M = 5log_{10}(\frac{r}{10pc}) + 1.086\tau$$

such that when solving for the distance r:

$$r = 10pc \cdot 10^{\frac{m-M-1.086\tau}{5}}$$

For $\tau = 0.2$, we obtain the distance $r \approx 90pc$.

Problem 7

Same formula gives an error of 285Mpc.