Homework 1 Solutions
Astro 2 Spring 2013

Jared Brooks
Department of Physics: University of California, Santa Barbara
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24.34 (a) You would expect to find Type II Cepheids in globular clusters because globular clusters contain Population II stars. You would expect to find Type I Cepheids in the disks of spiral galaxies because that is where Population I stars are found.

(b) From Figure 19-19 we see that Type I Cepheids are more luminous than Type II Cepheids. Therefore, Hubble underestimated the luminosity of the Cepheids in M31, which caused him to underestimate the distance to M31.

24.37 (a) In 4 months a maser traveling at 1000 km/s will travel

\[
\frac{1000 \text{ km}}{1 \text{ s}} \times 4 \text{ mo} \times \frac{30 \text{ d}}{1 \text{ mo}} \times \frac{24 \text{ h}}{1 \text{ d}} \times \frac{3600 \text{ s}}{1 \text{ h}} = 1.04 \times 10^{10} \text{ km}
\]

\[
= 1.04 \times 10^{10} \text{ km} \times \frac{1 \text{ AU}}{1.496 \times 10^{8} \text{ km}} = 69 \text{ AU}
\]

(b) Using the small angle formula from Box 1-1, the distance to the galaxy is

\[
d = \frac{206.265D}{\alpha} = \frac{(206.265)(1.04 \times 10^{10} \text{ km})}{1 \times 10^{-5} \text{ arcsec}}
\]

\[
= 2.15 \times 10^{20} \text{ km}
\]

\[
d = 2.15 \times 10^{20} \text{ km} \times \frac{1 \times 10^{6} \text{ ly}}{9.46 \times 10^{18} \text{ km}} = 23 \text{ Mly}
\]

\[
= 23 \times 10^{6} \text{ ly} \times \frac{1 \text{ pc}}{3.26 \text{ ly}} \times \frac{1 \text{ Mpc}}{10^{6} \text{ pc}} = 7 \text{ Mpc}
\]
24.41  (a) We must use the relativistic formula:

\[
\frac{v}{c} = \frac{(z + 1)^2 - 1}{(z + 1) + 1} = \frac{(5.34 + 1)^2 - 1}{(5.34 + 1) + 1} = .951
\]

Then \(v = .95c = 2.85 \times 10^5 \text{ km/s.}\)

(b) The low z formula would give \(v = 5.34c\), which is a huge error.

(c) Using the Hubble Law,

\[
d = \frac{v}{H_0} = \frac{2.85 \times 10^5 \text{ km/s}}{73 \text{ km/s/Mpc}}
\]

\[= 3904 \text{ Mpc} = 12.73 \text{ billion light years}\]