Aydan Schultz — Mock Exam Problem

1) M33 is one of the nearest galaxies to the Milky Way, but just how close is it? Given its equatorial ($\alpha = 01:33:50.9$, $\delta = +30:39:36.6$) and galactic coordinates ($l = 133.6°$, $b = -31.3°$)

a) i) Convert the RA and Dec of M33 to degrees

ii) Explain why we should or should not be worried about the Milky Way's gas/dust interfering with our view of M33?

b) Explain qualitatively why we can't reliably use parallax to measure the distance to M33.

c) Instead, we'll look at a variable star from M33. Given an apparent magnitude $m_V = 19.1$ and a period of 47 days, find

i) The star's absolute magnitude M_V

ii) The distance to the star in kpc

d) Explain quantitatively why parallax can't be reliably used to measure the distance to M33.

Solutions:

a) i. $\alpha = 1h + \frac{33}{60}h + \frac{50.9}{3600}h = 1.56h$

$$1.56h \times \frac{15^\circ}{1h} = \boxed{23.5^\circ = \alpha}$$

$$\delta = 30^\circ + \frac{39}{60}^\circ + \frac{36.6}{3600}^\circ = \boxed{30.7^\circ = \delta}$$

ii. The galactic latitude ($b = -31.3^\circ$) is large enough to say that M33 is far enough from the plane of the Milky Way in order for it to be relatively easy to observe.

b) M33 is outside our own galaxy. Its large distance would correspond to a parallax angle far too small for any of our instruments to reliably detect.

c) i. $M_V = -2.678 \log_{10}(P) - 1.00$

$$M_V = -2.678 \log(47) - 1.00$$
$$\boxed{M_V = -5.5}$$

ii. $m_V - M_V = 5\log(d) - 5$

$$19.1 - (-5.5) = 5\log[d\,(\text{in pc})] - 5$$
$$\Rightarrow d = 8.32 \times 10^5 \text{ pc}$$
$$\simeq \boxed{830 \text{ kpc}}$$

d) $\pi = \frac{1}{d(\text{pc})} = \frac{1}{830000 \text{ pc}} = 1.2 \,\mu\text{as}$

Far too small; Gaia had a max "good" $\pi \simeq 0.2$ mas, or max "good" $d = 5000$ pc