

Planning Observations - Exercise Sheet

Observational Astronomy

1 Selecting Objects

1.1 Target Coordinates

Find the coordinates (RA and dec), in the equatorial system, the apparent magnitude, and the apparent size (in arcseconds) for all of the target objects¹.

Object Name	Right Ascension	Declination	Magnitude	Apparent Size (arcsec)
Andromeda Galaxy (M31)				
Ring Nebula (M57)				
Blue Snowball (NGC 7662)				
NGC 869				
NGC 884				
Ptolemy's Cluster (M7)				
M47				
Orion Nebula (M42)				
M15				

1.2 Sidereal Time vs. Solar Time

Explain why a sidereal day is 4 minutes shorter than a solar day. A diagram may help you visualize it.

¹Note: This is a hypothetical set of observations, but treat it as though you were going to follow through with them anyway.

1.3 Object Visibility: Declination Angle

Which of the objects on the list are high enough on the celestial sphere to be visible from Troy, given that the latitude of Troy is $+42.73^\circ\text{N}$? Justify your answers.

1.4 Target Visibility: Right Ascension

For the targets visible from our declination, determine which ones will be of the correct right ascension to be high enough in the sky at the intended observing date and time. You will need Troy's longitude, which is 73.68°W . You will need to calculate the sidereal time for a specific day and time, so take a convenient day (October 15 is good) and time (somewhere between 7:00pm and 10:00pm). Write down the date and time used, and what the sidereal time will be at your chosen observation time.

Date of Observation:

Time of Observation:

Local Sidereal Time for this Observation:

How far from the zenith will each object be at that time?

Object Name	Hours from Zenith
Andromeda Galaxy	
Ring Nebula	
Blue Snowball	
NGC 869	
NGC 884	
Ptolemy's Cluster	
M47	
Orion Nebula	
M15	

Which of your target objects will be visible at that time? Briefly justify yourself.

2 Calculating Exposure Times

To calculate necessary exposure time, you will first need to determine the rate that photons are hitting the CCD from the source (N_{star}). Calculate this value for each visible object and insert all of them into the table.

Write down your work for one object of your choice, then do all the rest of the calculations in a spreadsheet to make life easier.

2.1 N_{star}

Calculate the optical efficiency (ϵ), where ϵ is the square of the ratio of the diameters of the secondary mirror and the primary mirror. The secondary mirror is 4 inches in diameter, while the primary is 16 inches.

Using the equation given in the handout, calculate the value of N_{star} for the current object.

2.2 N_{sky}

Use the same procedure that you used for N_{star} to calculate the rate of electrons being produced in the CCD by the sky background (N_{sky}):
(Assume a given sky brightness of 16 magnitudes.)

2.3 n_{pix}

Given the values:

$$\begin{aligned} S &= \text{apparentsize(arcsec)} \\ \theta &= 0.23\text{arcsec} \cdot \text{pixel}^{-1} \end{aligned}$$

obtain a value for the number of pixels, n_{pix} , of the CCD that are 'on' the object:

2.4 Exposure Time

Using the equation given for exposure time based on signal-to-noise ratio, the values you just calculated for N_{star} and N_{sky} , calculate the necessary exposure times to acquire the images with S/N ratios of 100 and 1000:

Object Name	Calculated N_{star}	Calculated N_{sky}	t (for S/N = 100)	t (for S/N = 1000)
Andromeda Galaxy				
Ring Nebula				
Blue Snowball				
NGC 869				
NGC 884				
Ptolemy's Cluster				
M47				
Orion Nebula				
M15				