DARA Unit 1

Workshop 1

1. The theoretical angular resolution of a single reflecting telescope is given by

$$\theta = \frac{1.2\lambda}{D} \text{ radians}$$

where D is the diameter of the telescope and λ is the operating wavelength. There are

$$\frac{360}{2\pi} \times 60 \times 60 = 206265 \text{ arcseconds in a radian}$$

Evaluate the theoretical resolution in arcseconds for some well-known telescopes that cover a range of different wavelengths. E.g. the largest ground-based optical and radio telescopes and examples of space-based telescopes.

Table 1: Angular resolutions of world leading telescopes.

Telescope	Comment	Diameter	Operating λ	Resolution
				(arcsec)

2. Arrays of more than one telescope can operate together as an interferometer. The resolution is then determined by the separation of the telescopes or baseline, b, rather than the size of the individual telescopes.

$$\theta \approx \frac{\lambda}{b} \text{ radians}$$

Evaluate the resolution for some arrays of telescopes. E.g. world's leading arrays working at radio, millimetre and near-infrared wavelengths.

Table 2: Angular resolutions of world leading arrays of telescopes.

Telescope	Longest Baseline b	Operating λ	Resolution (arcsec)

3. The angular size of an object is given by

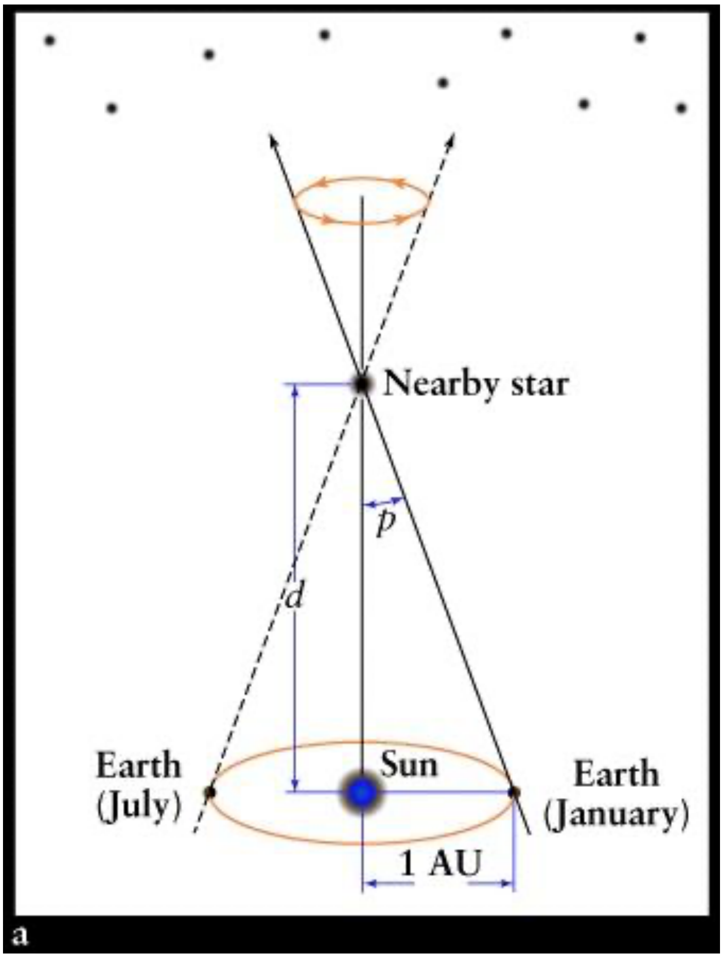
$$\theta = \frac{l}{d}\ \text{radians} = 206265\frac{l}{d}\ \text{arcseconds}$$

where l is the size of the object and d is the distance of the object (and they have to be in the same units). Evaluate the angular sizes in arcseconds of some common objects and compare to the angular resolutions you computed in 2 to find out which telescopes and wavelengths can resolve these objects.

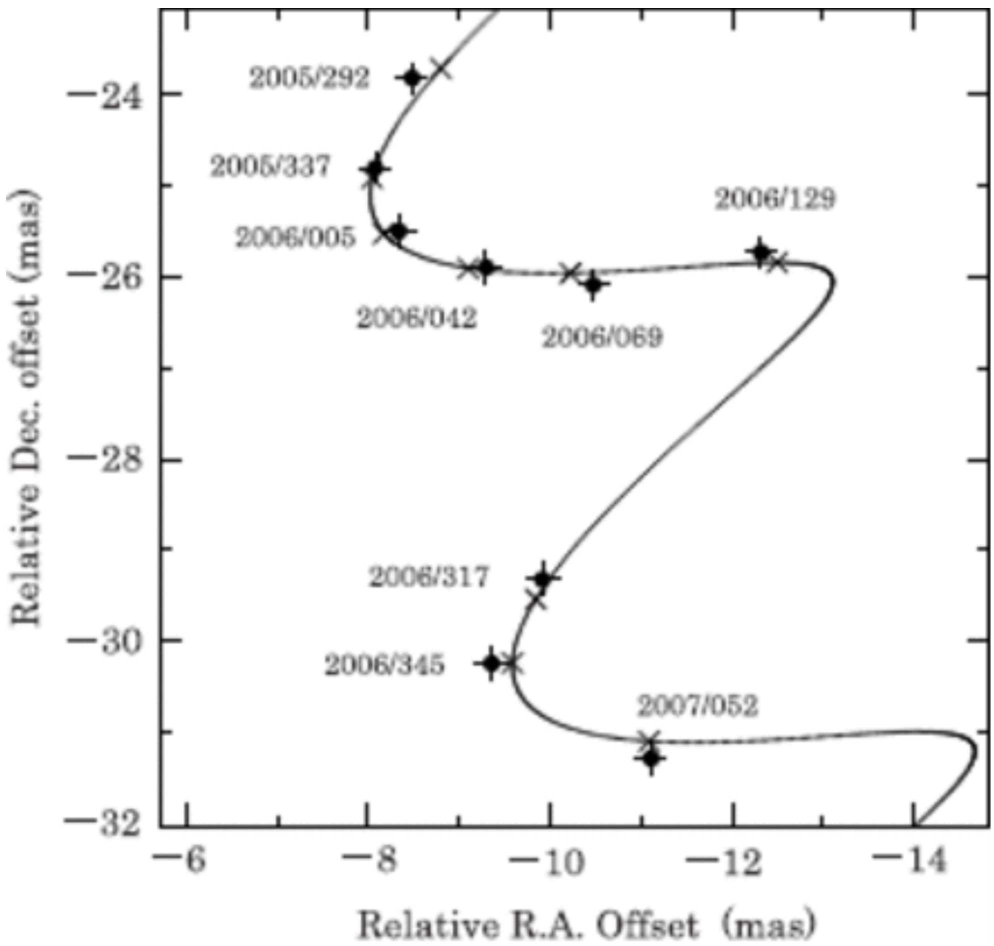
Table 3: Angular sizes of a selection of objects.

Object	Distance	Physical size	Angular size (arcsec)	Comment
Sun				
Moon				
Nearest star (α Cen)				
Nearest galaxy (M 31)				
Separate stars in nearest galaxy				
Distant galaxy				

4. Use the geometry in the diagram below to determine how many metres are in a parsec. (Note that you can use small angle approximations since the angle p is small.) Compare this to 1 light-year.



5. The diagram below shows the motion of a particular type of radio source originating from an evolved star called S Crateris. The radio emission is from a very strong spectral line called a water maser at around 22 GHz. The accurate positions of the maser 'spot' were taken with radio VLBI observations using the VERA array with a maximum baseline of 2300 km. The positions at different epochs labelled with year and day number are shown in the diagram below. The scale of the axes are in milli-arcseconds (mas). The motion is due to a combination of parallax and proper motion. Inspect the diagram to identify the direction of the proper motion and the amplitude of the oscillations due to parallax. Use these data to estimate both the distance of the star and the velocity of its proper motion across the sky.



6. The rest frequency of the maser spectral line above is 22.23508 GHz, but the line was actually observed at a frequency of 22.23256 GHz. Evaluate further what this tells us about the motion of the maser.