

Angular Measurements from Drawings

COMPUTING DISTANCES AND LINEAR SIZES OR SEPARATIONS USING ANGLES

Introduction

Many times during the semester, you will be computing angles, either from drawings or from drift timings. One of the reasons you want to measure angles is to compute either the distance to the object or the physical size of the object. (If there were two objects, and you measured the angle between them, you would compute the separation between the objects instead of the size.)

We have all observed that the angular (i.e. apparent) size of an object changes as the object gets further away. Things look bigger (angularly) when closer, and they look smaller when further. Similarly, bigger objects look bigger than smaller objects, if both are at the same distance. So, the angular size of an object (or angular separation between two objects) depends on both the distance and the size/separation.

You will need to know or measure 2 of the 3 quantities below, and you will use a formula to compute the 3rd.

<u>Single object</u>	<u>Two objects</u>
Angular size	Angular separation
Distance to object	Distance to both objects from Earth
Physical/linear size	Physical/linear separation between the two objects

Method

A formula that mathematically relates the angular size to the true physical size is:

$$\text{Angle (in units of radians)} = (\text{true size}) \div (\text{distance}).$$

To **convert arcseconds into radians**, divide by 206265.

Radians conversion example: 20 arcseconds is: $20 \div 206265 = 0.0000969$ radians (or 9.69×10^{-5} radians, sometimes written as 9.69E-05 or 9.69^{-05} on calculators)

Note, to use this formula, the units of “true size” and “distance” must be the same. For example, don’t use miles for one and kilometers for another; use miles (or km) for both. There are 1.609 km in one mile.

Full example: Let’s say you observe that it takes 5.3 seconds for the telescope to drift from one object to another, and you are told this object is 30 million miles from Earth. You are asked to compute how far apart these two objects are.

- 1) You need an angle, and you have the distance.
- 2) Compute angle via drift time: $5.3 \text{ seconds} * 15 \text{ arcseconds per time second} = 79.5 \text{ arcsec}$.
- 3) Convert this angle from arcseconds to radians: $79.5 \text{ arcsec} \div 206265 \text{ radians/arcsec} = 0.000385 = 3.85 \times 10^{-4}$ radians.
- 4) Using the formula above, we have:

Angle (in units of radians)	= (true separation) \div (distance to Earth).
3.85×10^{-4} radians	= (true separation) \div 30,000,000 miles
- 5) Solving for the true separation gives us a separation distance of 11,600 miles by:

$$(\text{true separation}) = 3.85 \times 10^{-4} \text{ radians} * 30,000,000 \text{ miles} = 11,600 \text{ miles}$$