

DRIFT TIMING

Introduction

Drift timing is one method used to determine angular sizes and separations. The idea is to leave the telescope stationary, and let the Earth's rotation naturally move the sky above the stationary scope. In the telescope, this will give the appearance that objects are drifting across the field of view. If accurate times are recorded, accurate angles can be deduced.

Earth's rotation rate

We know that it takes approximately 24 hours for stars to circle around the celestial pole once. (It actually takes stars 23 hours and 56 minutes to complete one revolution, but we'll round up to 24 hrs) Note, however, the Sun takes 24 hours, on average because the Earth's revolution around the Sun is an extra motion that adds 4 minutes.

This daily circular motion causes some objects to go below ground in the west (which we call "setting") and then to reappear later above ground in the east (which we call "rising").

We also know that stars on the celestial equator travel 360° during those 24 hours. This means that stars near the celestial equator travel 15° per hour (360° in 24 hrs = 15° per hour).

$$15^\circ \text{ per hour} \times 24 \text{ hours per day} = 360^\circ \text{ per day}$$

Stars farther from the celestial equator (where $\delta = 0^\circ$) and closer to the north celestial pole (i.e. near Polaris, where $\delta = 90^\circ$) travel less than 360° because their circles are smaller.

[Refer also to the "Astronomy Vocabulary," page **Error! Bookmark not defined.** for information related to the material below.]

Angular sizes

Since many angles in astronomy are much smaller than one degree, astronomers divide up one degree into 60 smaller parts called arcminutes. The symbol for one arcminute is $1'$. This means that $1/60^{\text{th}}$ of a degree is equal to $1'$. Similarly, we divide 1 arcminute into 60 parts called arcseconds. The symbol for one arcsecond is $1''$.

Stars on the celestial equator ($\delta = 0^\circ$) move 15° in one hour, which is equivalent to $15'$ in one minute, and $15''$ in one second.

Drift timing method

To do drift timing measurements, you need to measure how long it takes your object to cross the desired distance. In the Field-of-view (FOV) lab, page **Error! Bookmark not defined.**, the desired distance will be the diameter of what you can see in the eyepiece. In other labs, the desired distance will be from one edge of the object to the other edge, or from the center of one object to the center of another.

Start by aligning the object in the center of your field of view and then move it eastward to the desired edge. (In the FOV lab, this edge will be outside the eyepiece, for other labs it will be the edge or center of a visible object.) Once your star is at the desired edge, turn off your telescope motor and start timing. Stop timing when the other edge is crossed. Then quickly turn the motor back on so that you do not lose track of your star. Repeat each measurement 3 times and record each trial.

Drift Timing

Sample calculation: One of your FOV measurements reads 04:25.96. This equates to 4m 25.96 sec or 4 min x 60 sec/min = 240sec, + 25.96 sec = 265.96sec for a star to cross the FOV. Stars travel 15" in each second, so the drift angle is 265.96sec x 15"/sec = 3989.4" (3989.4 arcsec). This is equivalent to 3989.4/60 = 66.49 arcmin and also equivalent to 3989.4/3600 = 66.49/60 = 1.108 deg. For reference, the Sun and Moon are about half a degree across.

Comparison to drawings

In some labs, you should compare angular sizes you get via the drift method to angular sizes you get assuming you drew things to scale. (See page **Error! Bookmark not defined.**)

Errors

There are several sources of error associated with this drift timing measurement technique. Some of these errors can be reduced by repeating the trial several times and taking an average, which is why you will perform three trials.

One of your perpetual tasks in this class is to try to figure out what parts of an experiment are error prone and how big of an error this introduces. So, I will give you only one example of an error, and I will give a rough estimate for how important it is. You should think about other sources of error, and try to quantify them in your writings.

Humans have a reaction time. Sometimes this reaction time can be reduced by anticipating an event's completion. For example, if you are alert, you can probably move your finger from one place on the stopwatch to another in about 0.15 seconds. If you anticipate the need to move your finger, perhaps you will hit the button 0.05 seconds ahead of or after the actual event. I leave the actual numbers for you to DETERMINE EXPERIMENTALLY.

Rounding

Don't forget to round your angular size calculations according to the "rounding" handout.

Field of view measurements

On this handout, copy your value for the field of view for each of the eyepieces.

Eyepiece (number of mm) #1) _____ #2) _____ #3) _____
F.O.V. in *arcminutes* #1) _____ #2) _____ #3) _____

Once you record these numbers, you will want to use the same telescope and eyepieces. Record that information below too. (We have different eyepieces in each box set.)

Telescope number: _____ Eyepiece #1 brand & type _____
Eyepiece #2 brand & type _____ Eyepiece #3 brand & type _____