

Using Star Trails to Measure the Sidereal Day

Key Stage 4

Topics covered: Earth's rotation, night sky photography, angles, arcs

The stars rotate around the north and south celestial poles – these are points in the sky above the north and south poles of the Earth. The star Polaris marks out the north celestial pole. The stars Dubhe and Merak in the Plough point to Polaris making it easy to find in the night sky.



Credit: Peter Michaud (Gemini Observatory), AURA, NSF

Stars take **23 hours 56 minutes and 4 seconds** to make one complete revolution around a celestial pole – this is the time it takes the Earth to rotate once around its axis and it's called the **sidereal day**.

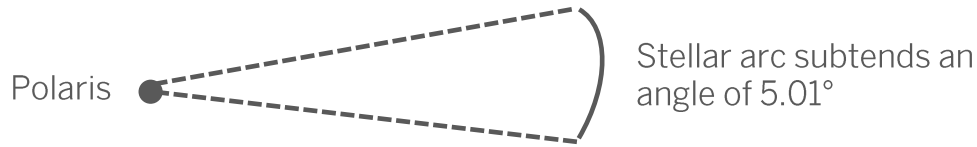
Activity

Take long-exposure photographs of the circumpolar stars around Polaris or the south celestial pole and use them to determine the length of the sidereal day.

You will need a compact bridge or DSLR camera for this and you may need to spend some time adjusting the settings to get the best images (see our how-to guides below). You will need a long exposure to get large stellar arcs that can be easily measured however light pollution will swamp the CCD within a 3 minute exposure unless you are in a very dark region – aim for the countryside away from city lights. A series of short exposures can be stacked to produce a long exposure image using image stacking software (see links below). The software also allows the user to select and deselect images to go into the final stacked image, therefore improving clarity of images.

An example of how to calculate the sidereal day:

An image gives star trails that subtend an angle of 5.01° at the pole star (see diagram below). The exposure time was 20 minutes.



If it takes 20 minutes for the star to move through 5.01° , the time it takes to move through 360° is equivalent to the sidereal day:
 $(360/5.01) \times 20 \text{ mins} = 1437 \text{ minutes or } 23\text{h } 57\text{m}.$

Longer exposures and stellar trails will allow more accurate measurements of the angle and thus a value for the sidereal day.

For advice on photographing star trails and observing the night sky, go to: www.rmg.co.uk/discover/astronomy-photographer-competition/how-to-guides/star-trails

For free downloadable image stacking software go to:
www.startrails.de (PC)
www.astronomie.be/registax/ (PC)
lynkeos.sourceforge.net/ (Mac)

To locate the Plough use www.stellarium.org or alternatively download an app for your mobile: [http://downloads.bbc.co.uk/tv/guides/BBC Stargazing Live 2012 Mobile App guides.pdf](http://downloads.bbc.co.uk/tv/guides/BBC_Stargazing_Live_2012_Mobile_App_guides.pdf)

Astronomy Photographer of the Year

Here at the Royal Observatory Greenwich we love space and want to see your photos of the night sky. Submit your favourite photos to our competition and you may become Astronomy Photographer of the Year.
www.rmg.co.uk/see-do/astrophotography-season-2015