Smaller Eclipses

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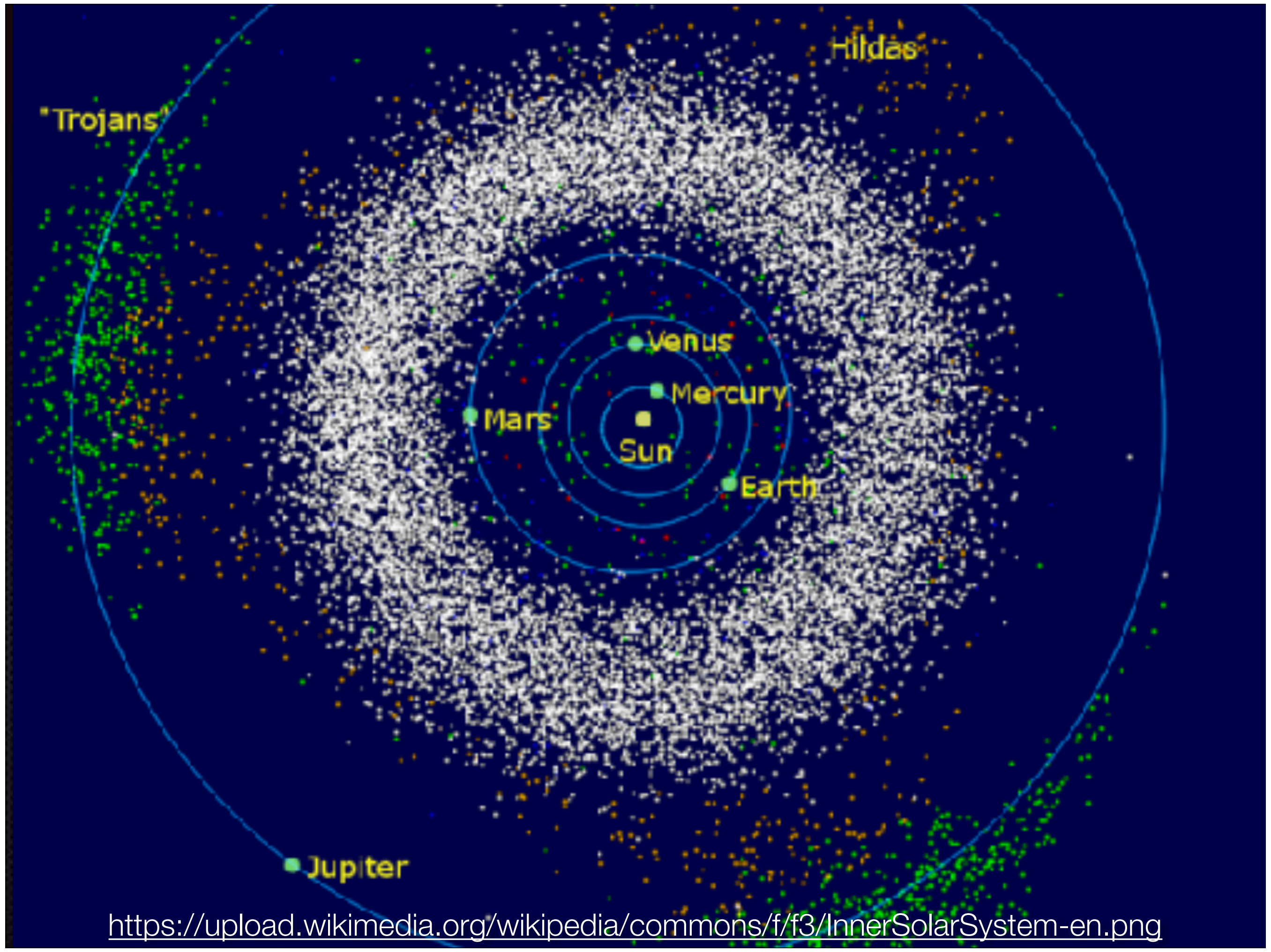
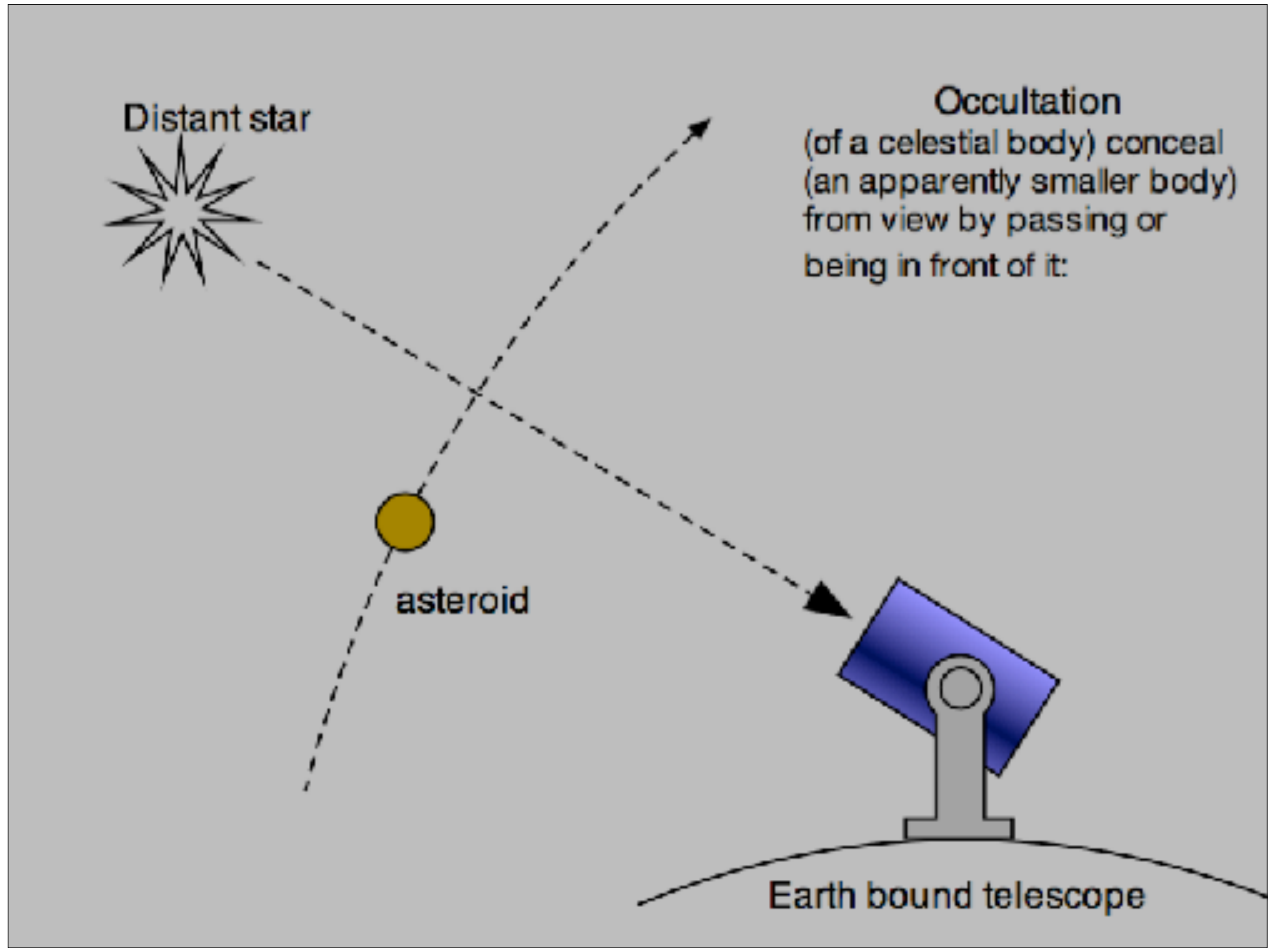
Most stargazing folk know about eclipses. They might just be the most well known stargazing event around.
And most folk know that you have to go to where the eclipse is visible, because it only happens across a small part of the earth's surface.

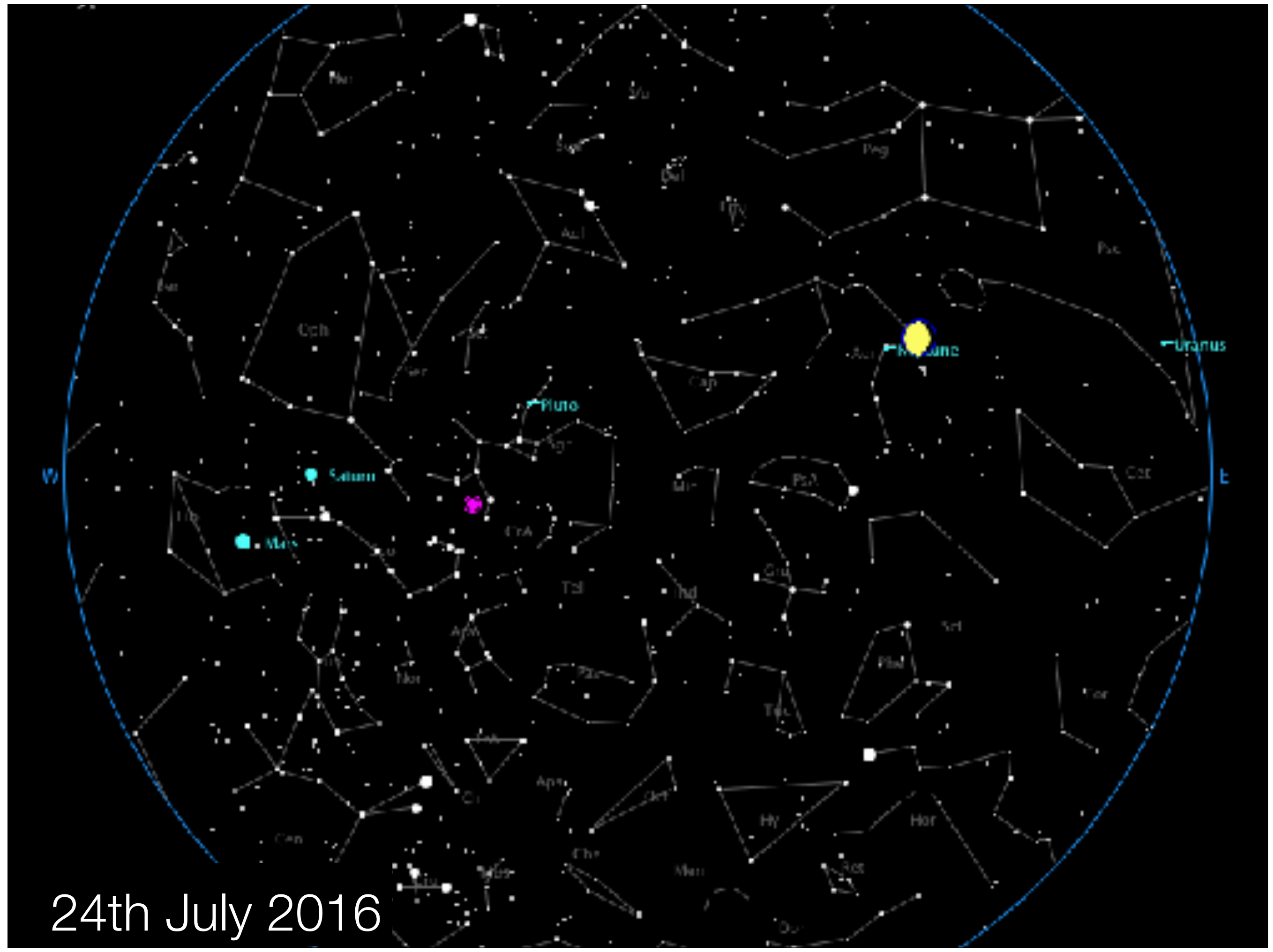


It turns out there are lots of little eclipses happening all the time, because there are lots of asteroids and minor planets and moons in our solar system

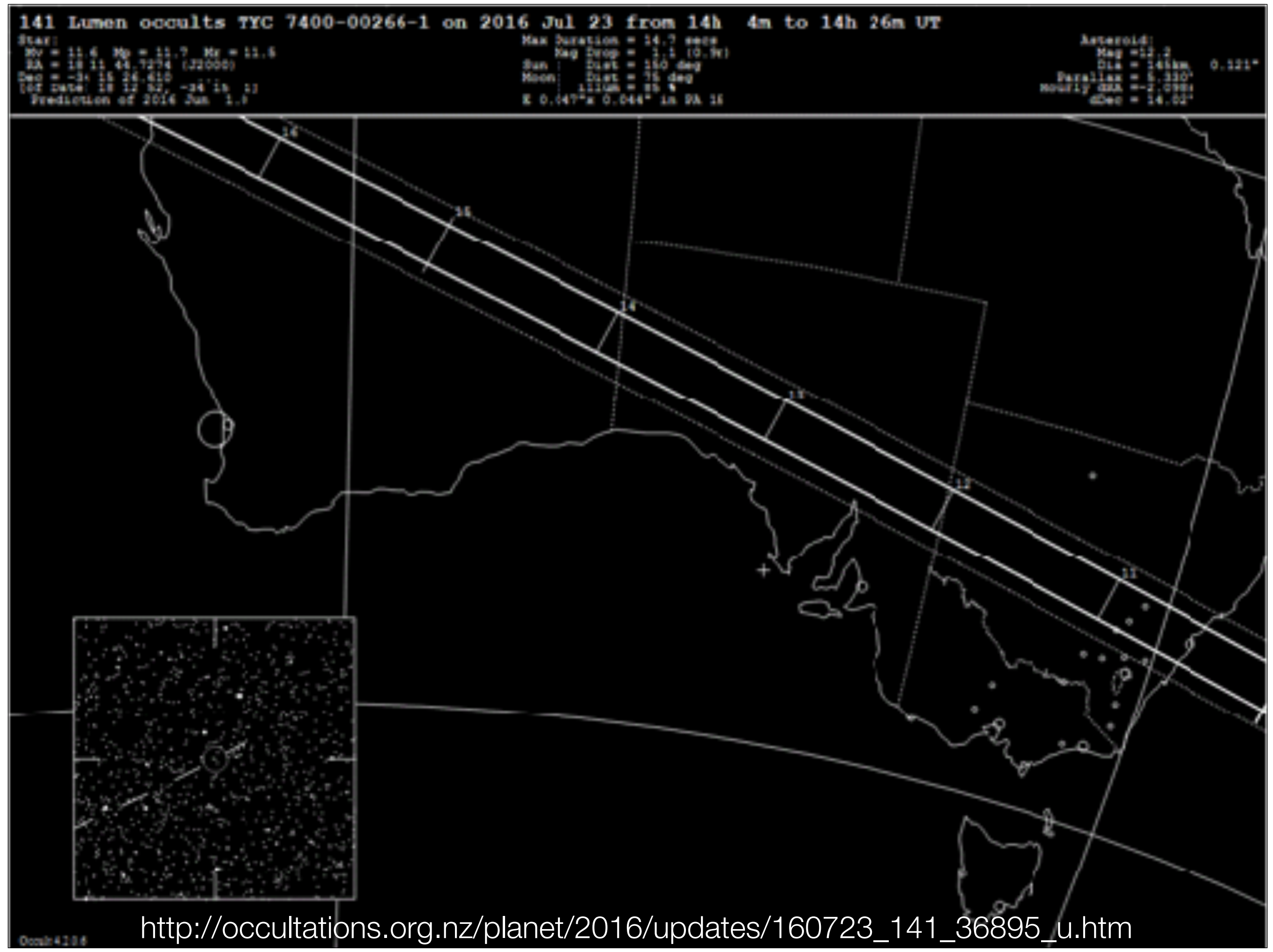
and there are lots of stars that we can see at night.



These mini-eclipses are called occultations. They are both beautiful and useful, because they give astronomers a chance to have a closer look at faraway objects in our solar system without actually going there.

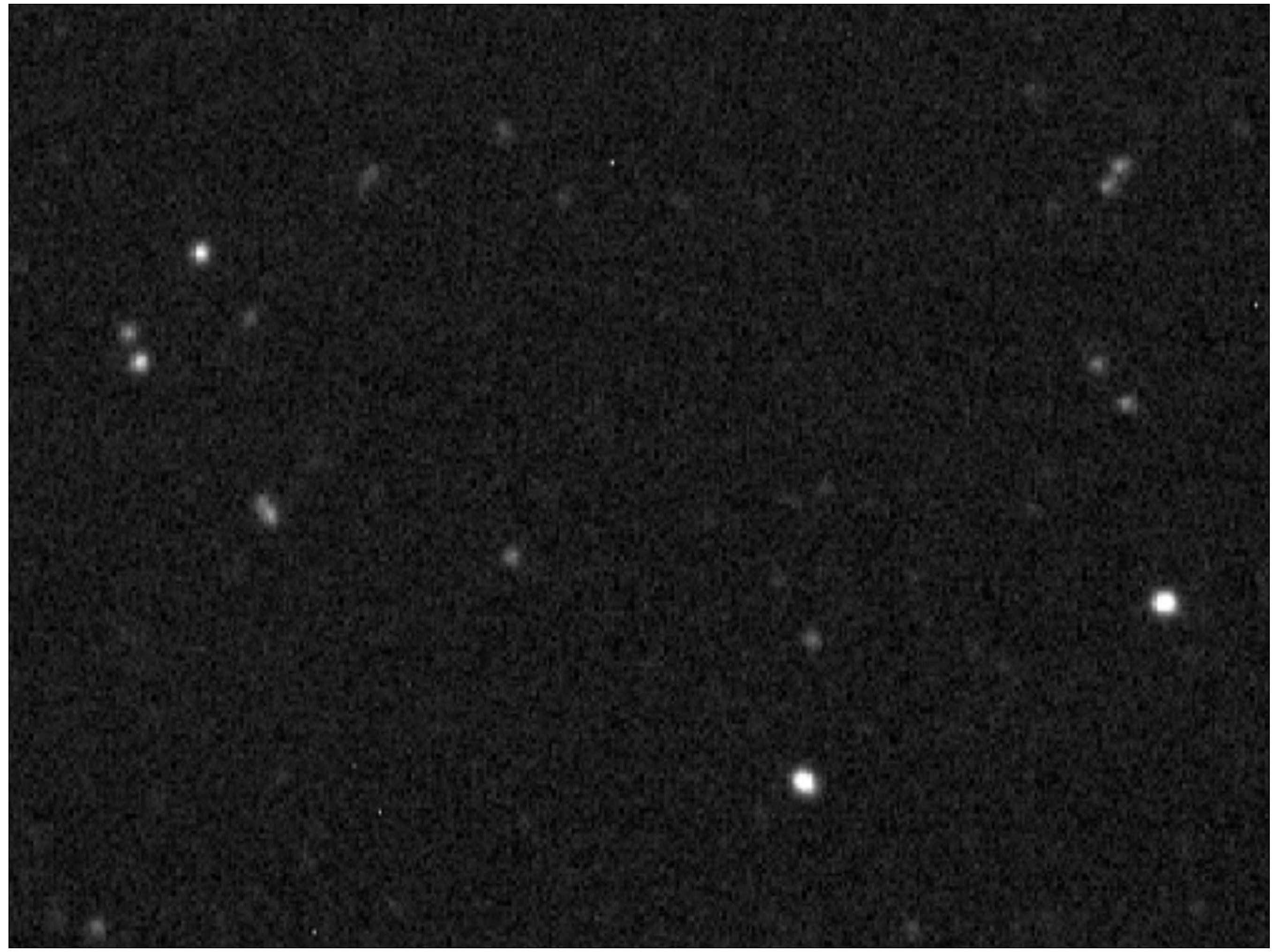


And this is the record of an occultation, observed on the night of the 24th July 2016.
The purple dot near the middle, marks the position of Lumen, the one hundred and forty first asteroid, discovered in our solar system back in 1875 by the Frenchman Paul Henry. Lumen is about 130km in diameter.



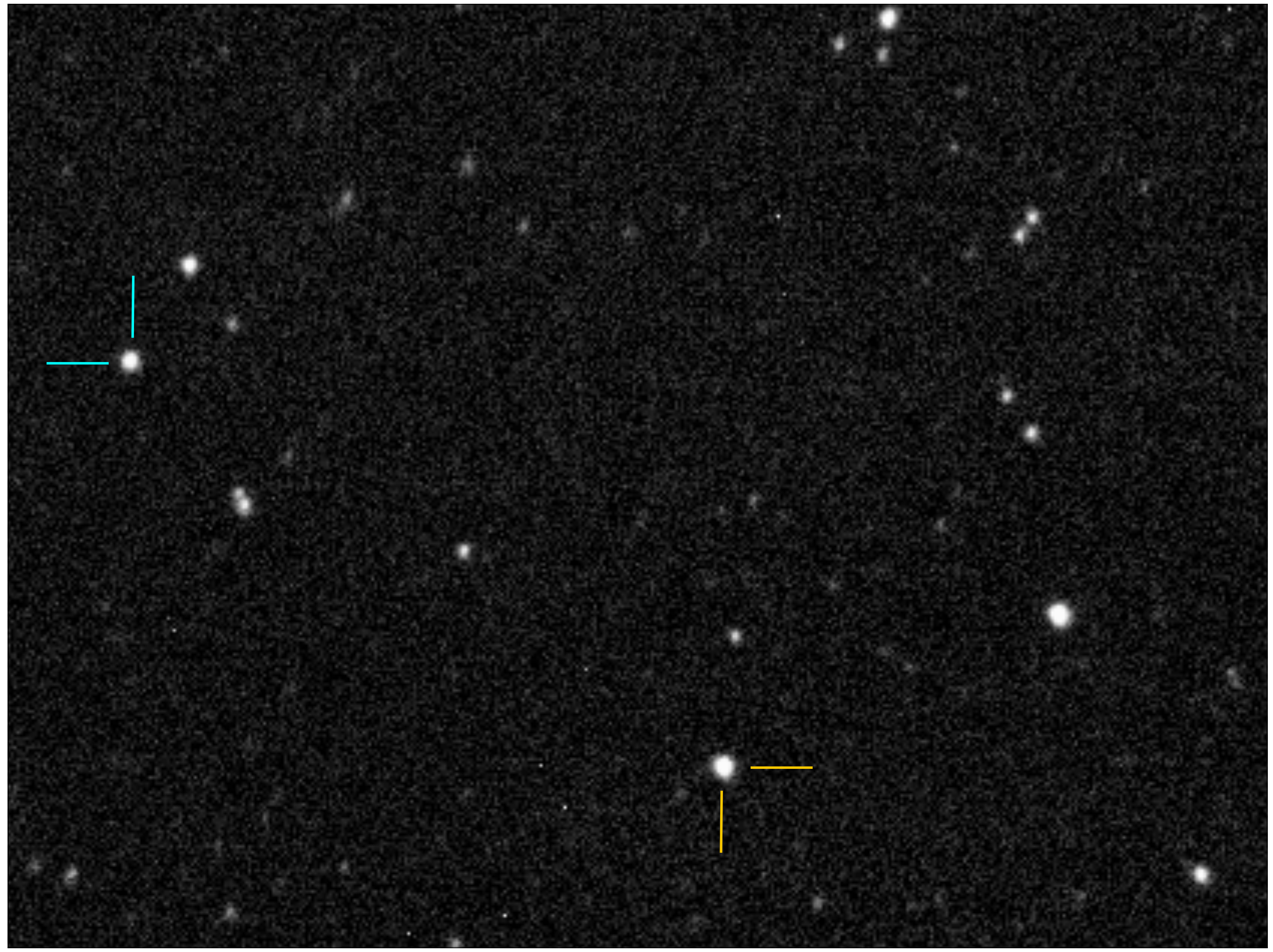
This is the path prediction of an occultation, by Lumen, of one of the many stars in Sagittarius.
The star that Lumen is occulting is not very bright ... it's way too dim to see by eye. For this eclipse you need a telescope.

And here's Lumen through the telescope. The asteroid is pointed to by the white lines, and the star is pointed to by red lines. This is in Sydney, about an hour before the occultation.

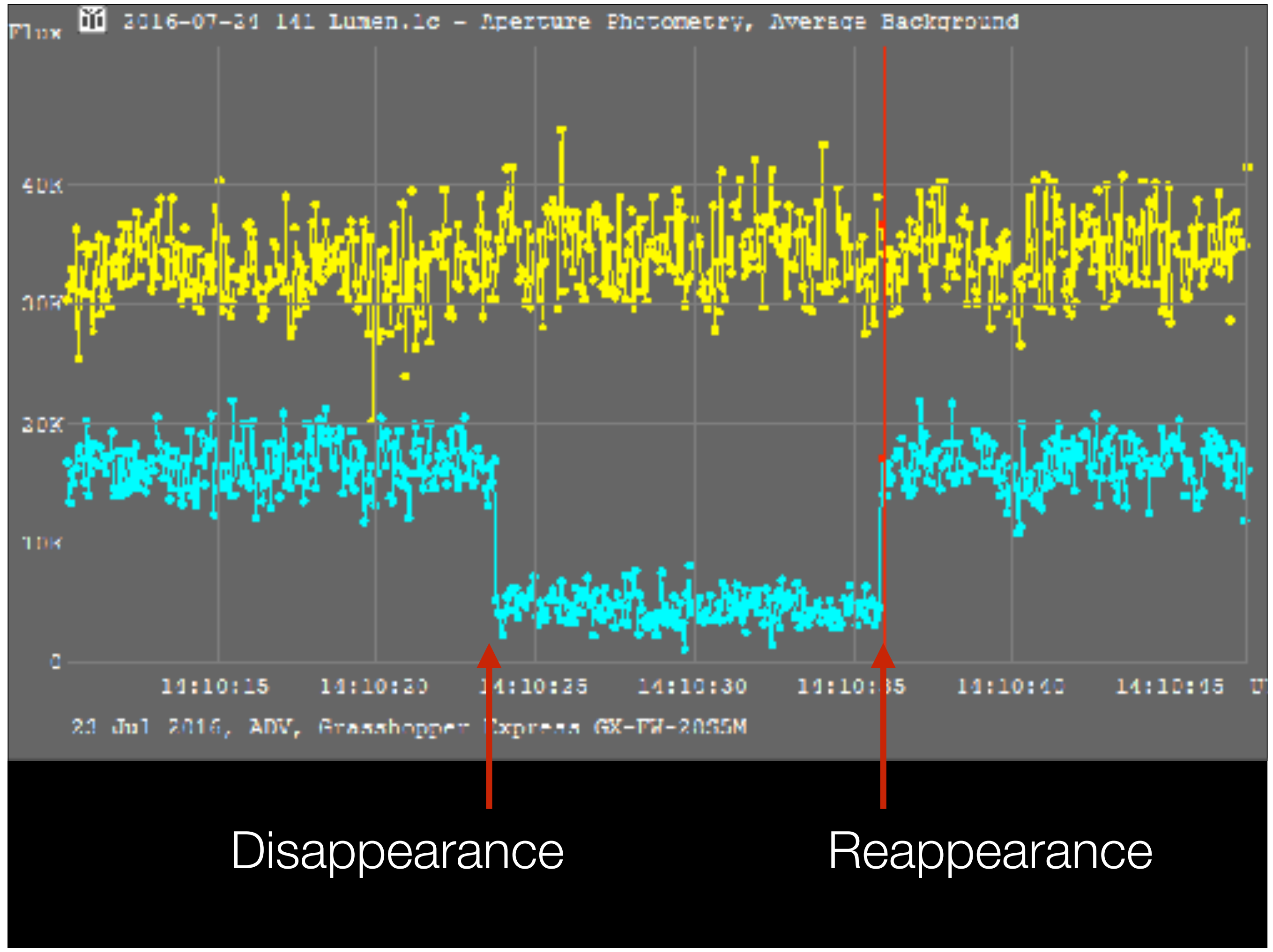


And we watch the approach, this is speeded up over a hundred times.
The asteroid appulses the star. The two discs of light get so close we can't see between them, and the combined brightness increases.

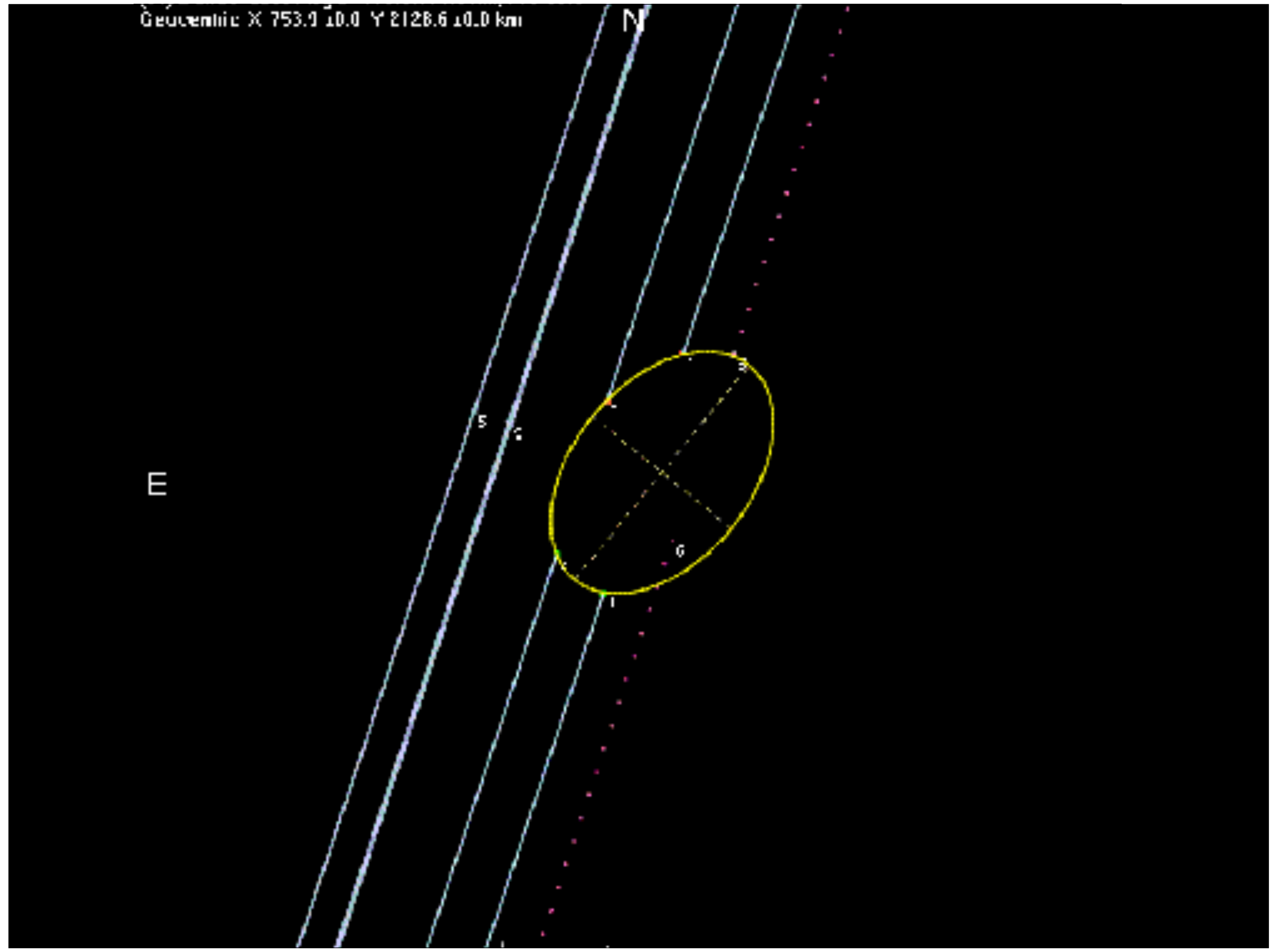
Now we are just a few seconds from the occultation, and we go high speed. So the image gets rather grainy. Watch the star.
We see the star gone ... and you can just see the asteroid flick in and out ... and back.
That's an occultation.



Now we analyse each frame of the video. We determine the intensity of light coming from the target (blue), and the intensity of light coming from a companion star (yellow).
Each frame of the movie is time stamped accurate to within a millisecond of true. This level of accuracy is very necessary. You'll see why a little later.

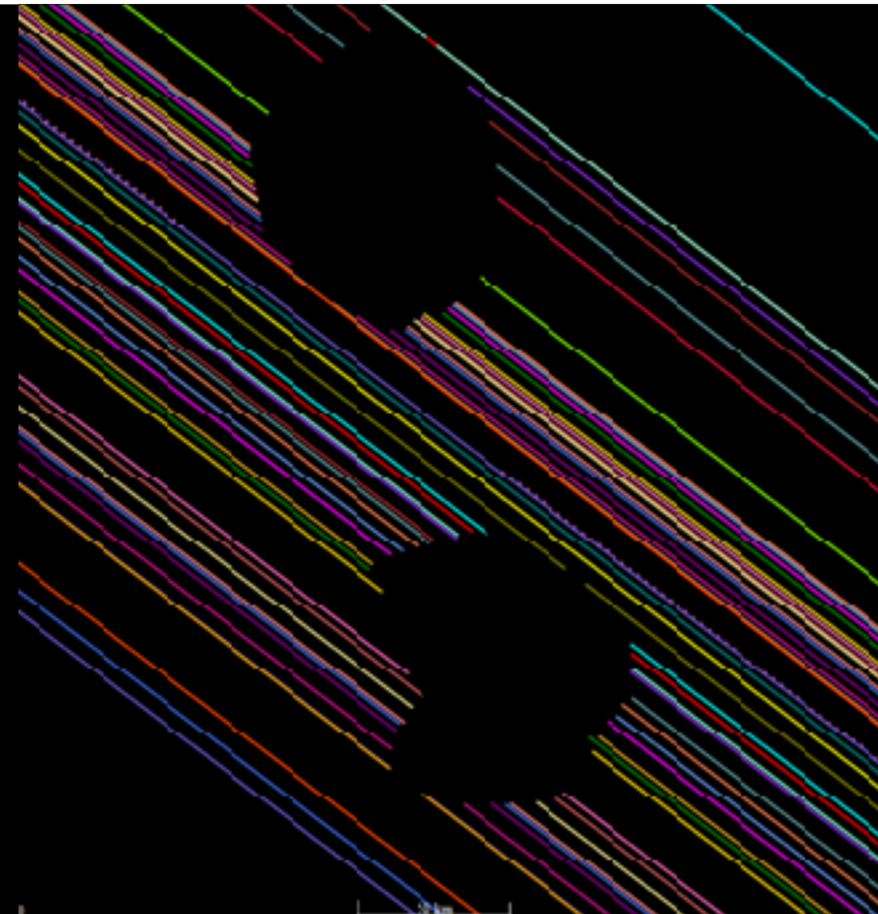


We graph the results, intensity of the star's light (up and down the way) against time (left to right). This is the light curve.
We now know the precise time that the star went behind the minor planet, and when it came out.
The velocity of the shadow transit is known from orbital element data, so we can determine the width of the asteroid when it crossed the telescope's observing point.



If we have two telescopes, in separate locations, we can do something even nicer. We can graph the light curve for each telescope. To align these two tracks, when they might be many kilometres apart, requires really exact time keeping, because the shadow of that asteroid is travelling at 10km a second, and the whole asteroid is only 130km wide at its widest.

With two light curves from two telescopes which are in separate locations, we can say pretty confidently where the minor planet is, and something about its shape.



http://www.asteroidoccultation.com/observations/Results/Data2011/20110719_AntiopeProfile2.gif

With fifty telescopes spread out over the shadow path, and fifty light curves, you can get awesome profiles of asteroids. This is the minor planet 90 Antiope at occultation in 2011. It's actually a binary asteroid, and this occultation probed its shape better than anything else has been able to do.

And this is why we do this stuff. Because you cannot get detail like this any other way, unless you actually send a spacecraft to the rock and get it to take pix for you.

Occultation reports for asteroids go to the Minor Planet Centre in Arizona. They are used to refine the orbits of the asteroids in the asteroid belt. Planetary scientists use these results to help investigate asteroids where space missions don't go.