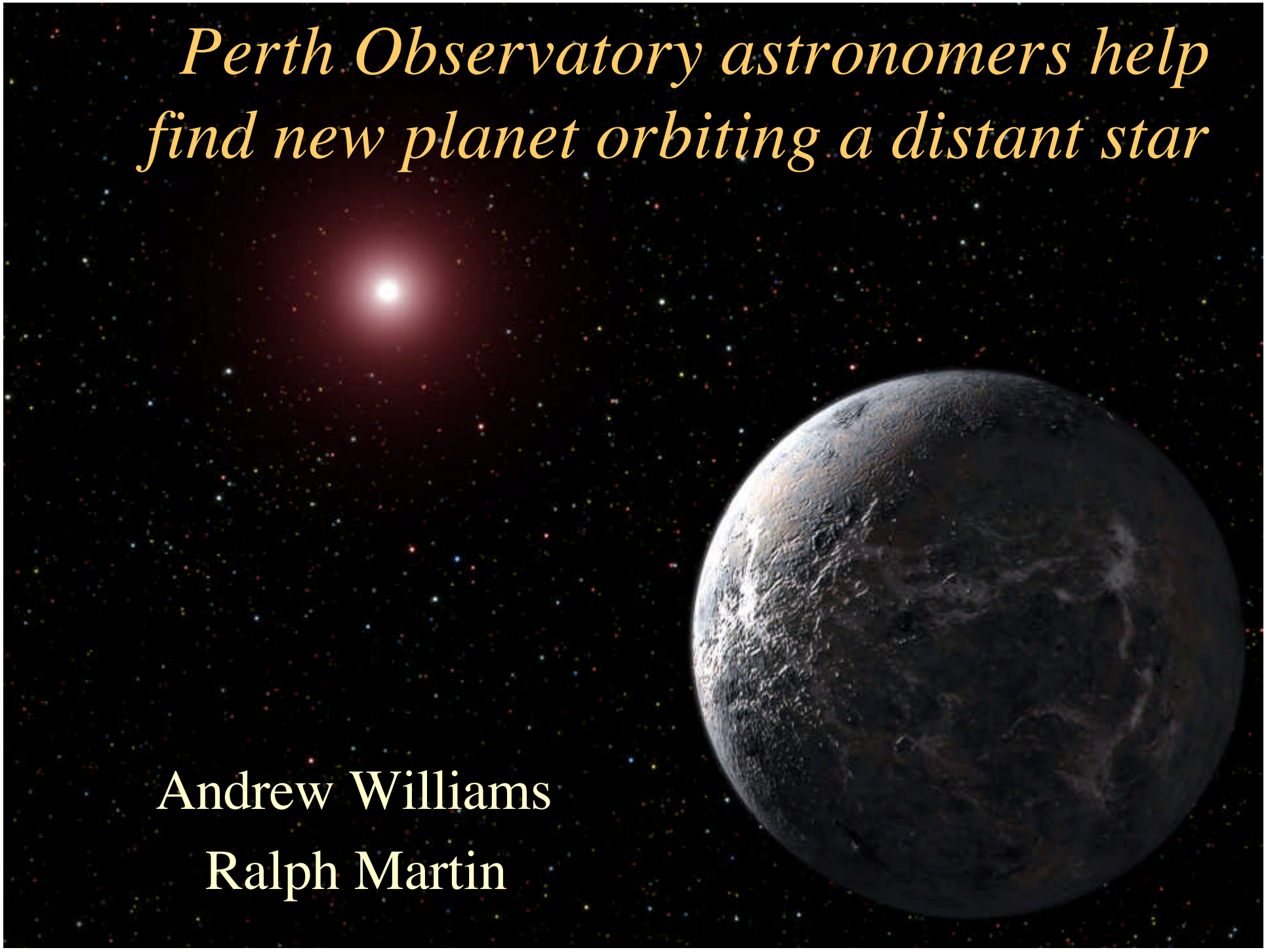
Perth Observatory astronomers help find new planet orbiting a distant star



Andrew Williams

Ralph Martin

How far away is it?

- The new planet is not part of our Solar System, orbiting our Sun – it's orbiting another star
- This star, its 'sun', is about 1/5th the mass of our Sun (within a factor of two), and cooler (red, not yellow)
- It's 20,000 light years away – more distant than any star you can see by eye
- Other than that, it's probably much like our Sun – a 'Main sequence' star, stable and long-lived

How big is the planet?

- The planet is about 5.5 times as heavy as the Earth - probably.
- We only know the *ratio* between the planet's mass and its star's – but we know that very accurately
- Because of the uncertainty in the star's mass, there's a small chance the planet could be up to twice as large (or half as large)
- In a decade or two, with better technology, we may be able to see the parent star separately, and determine a more precise mass for the planet

What's the planet like?

- The planet is about 2.9 times as far from its star as the Earth is away from the Sun
- It takes about 10 (Earth) years for each complete orbit around its star
- Given the distance to and brightness of its 'sun', the surface temperature must be about 220C below zero
- It's likely to be similar to a large version of Pluto – cold, and mostly made of water ice

Could it support life?

- The short answer is – no.
- The surface temperature must be very low – only around 50 above absolute zero, far too cold for any conceivable form of life
- Deep inside the planet, towards the core, it may be warm enough for liquid water, but the chances of life are remote

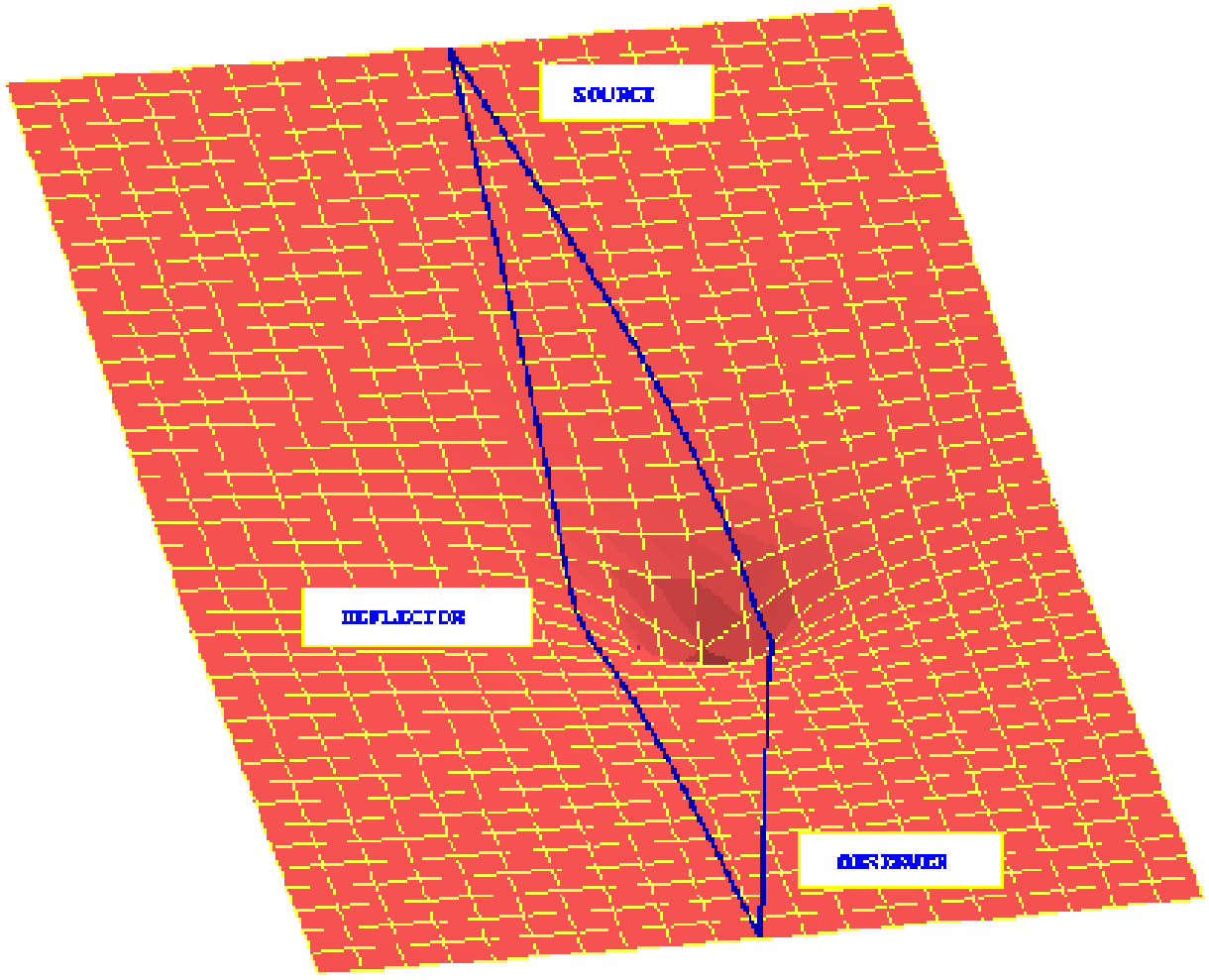
What's so special about this planet?

- Most planets found around other stars are very unlike the ones in our Solar System
- Most were found using a technique that is heavily biased towards large planets in very fast orbits – only a few days
- This planet is much more like the ones in our Solar System
- It was found using a new technique, Gravitational Microlensing

Gravitational Microlensing

- Uses the fact that the gravity from a star can amplify the light from another (background) star if they are lined up almost perfectly
- It actually forms multiple images of the background star by bending the light
- The images are only micro-arcseconds apart, so too small to see directly with any telescope (around the width of a hair held up 4000km away)

Gravitational lensing: curved spacetime

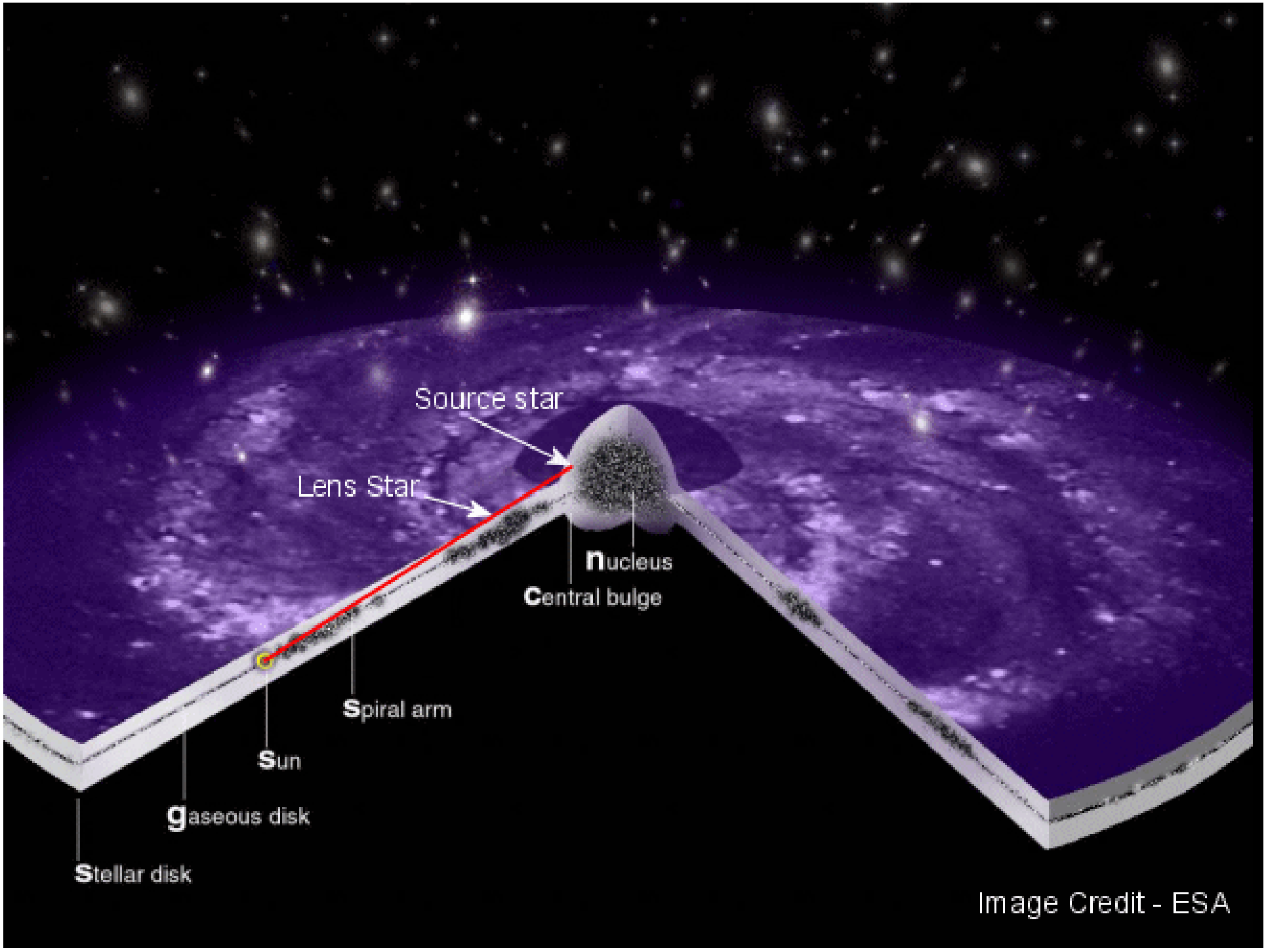


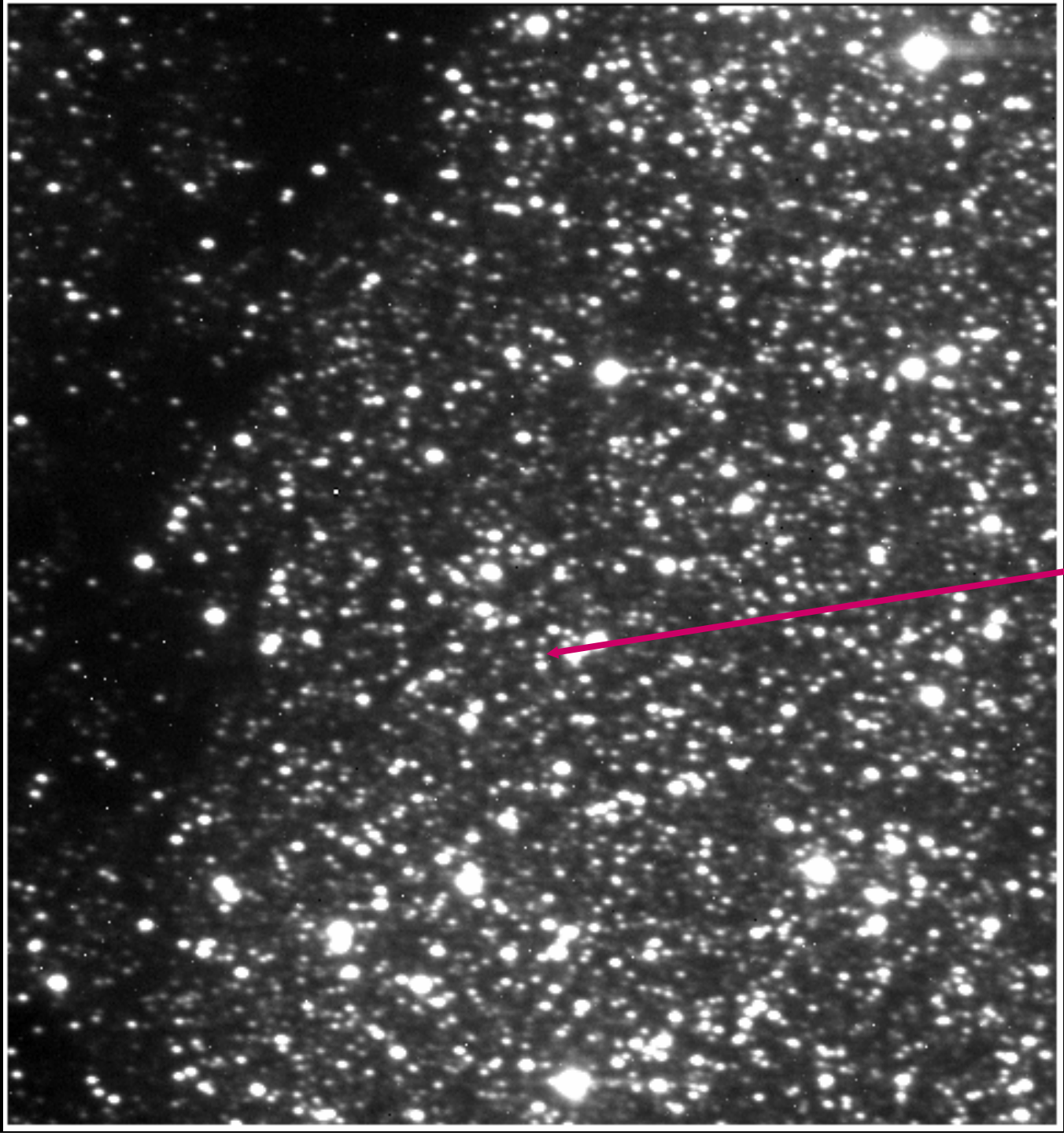
The observer can look in two (or more) different directions and see the same source

The angle between them depends on the mass of the lens, and the distances.

Spotting Microlensing

- The best way of spotting this microlensing effect is to look at areas of sky where there are lots of stars at a wide range of distances
- The bulge of the Milky Way has distant, bright giant and supergiant stars
- Between us and the bulge are dim, main-sequence stars (like our sun)
- At any given time, about one bulge star in a million is being ‘lensed’ by one of these faint, invisible main sequence stars
- Search teams measure the brightness of millions of stars, taking one image per night of dozens of crowded starfields


Source star
Lens Star
nucleus
Central bulge
Spiral arm
Sun
gaseous disk
Stellar disk
Image Credit - ESA



4207 giant stars in the galactic bulge, in a field 1/6th as wide as the full moon

About as many invisible main sequence stars (much too faint to appear in this image)

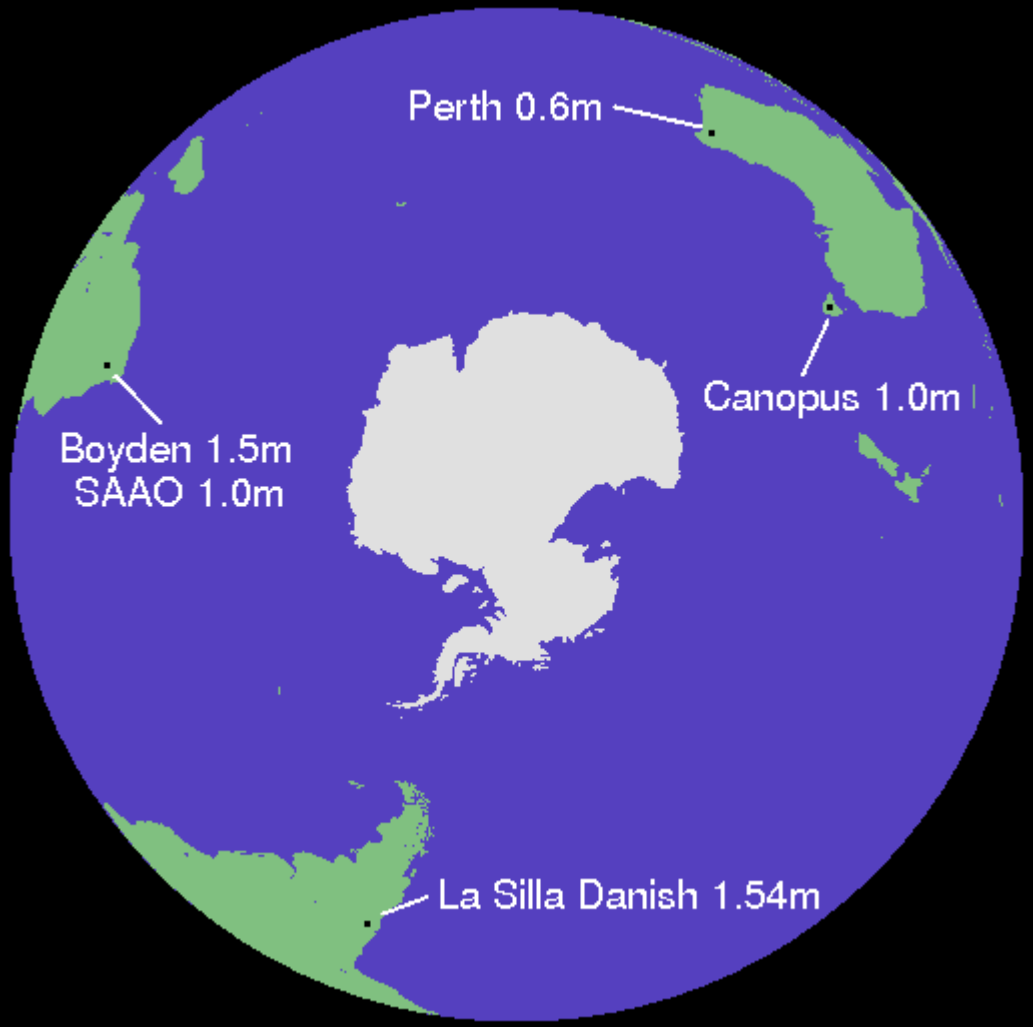
One of these stars (OB05390) is being lensed by a main sequence star, rising up to 3 times brighter

10 minute 512x512 pixel CCD image from Perth

Who are 'we'?

- Andrew Williams and Ralph Martin at Perth Observatory are founding members of PLANET (Probing Lensing Anomalies NETwork), formed in 1995
- PLANET, operating in conjunction with RoboNet (a network of automatic telescopes) made the discovery of a planet
- The microlensing event in which the planet was found was discovered a few weeks earlier by the OGLE team (Optical Gravitational Lensing Experiment) using a telescope in Chile
- The MOA group (Microlensing Observations in Astrophysics) confirmed the planet with a few images from New Zealand

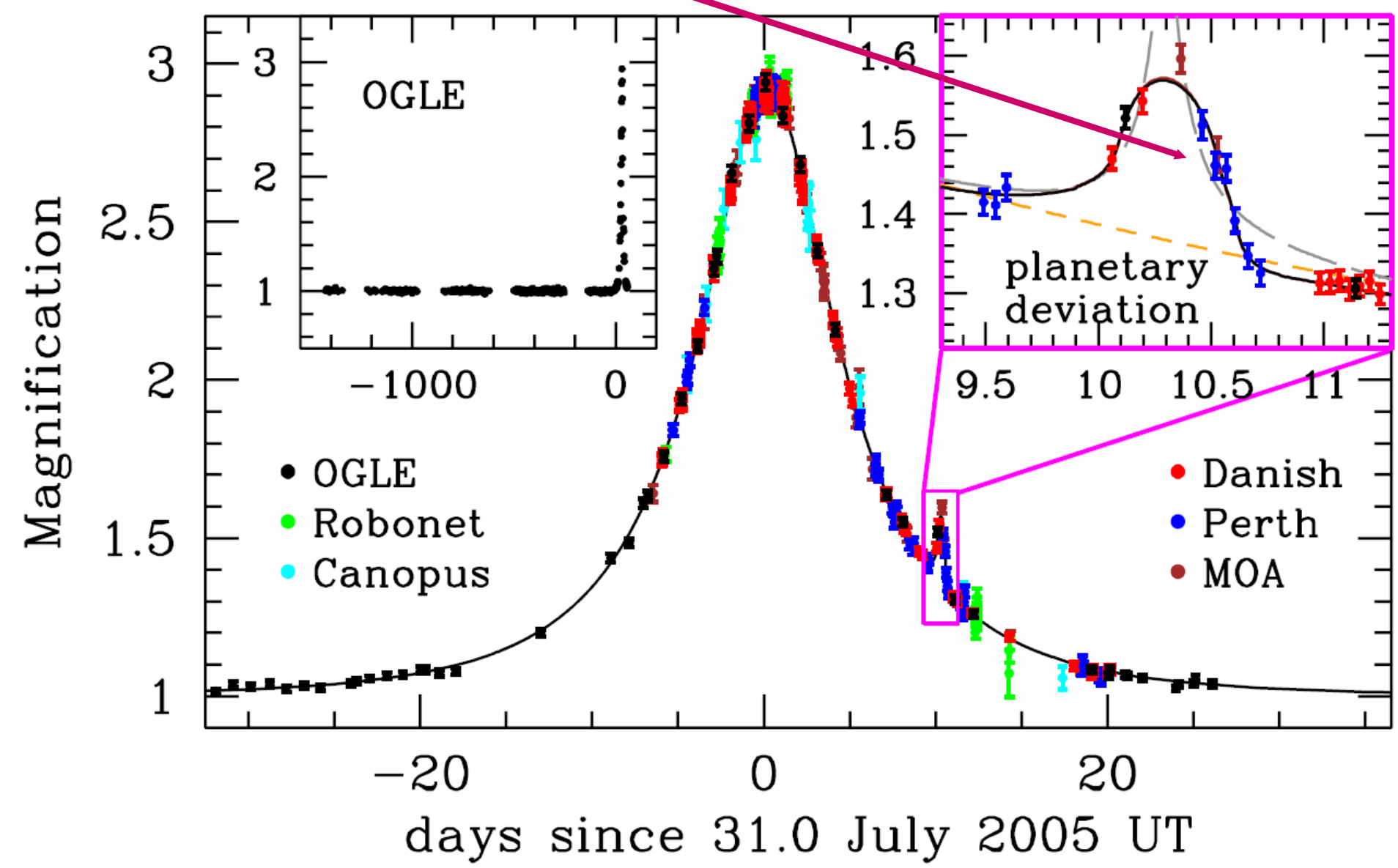
PLANET telescopes



What did we actually observe?

- The observations measure the brightness of a background star every few hours, as another (lens) star moves in front of it
- This lensing lasts for weeks or months, but for this event, there was a short (2-day) ‘glitch’ revealing the existence of a planet around the lens star
- Observing is a shared effort, with many telescopes following the same events, handing over from one to another at the end of the night at each location

Note the dark blue points from Perth that pin down the shape of the 'bump'



What would we see, with a 'perfect' telescope?

Whole event. Lens position in green, source position (where it would be without light bending due to the lens star) in red, images of background star in yellow. Covers 40 days in real time.

Zoomed-in view of the two-day period covering the 'bump' in the light curve caused by the planet. The planet itself is shown as a small blue dot.