Light from another world

In the last few years it has been known that planets orbit stars other than our Sun. Astronomers now have evidence for some 41 (and rising) such ‘extrasolar planets’, detected by the way they make their star ‘wobble’, pulling it slightly as they orbit round. However only large planets exert enough gravitational force to make this effect observable. And this method reveals no more about the planet itself than its mass, orbit period and radius.

To ‘see’ a planet, we need to gather the starlight reflected from it. And it is extremely difficult to see a distant planet, because its star radiates much more light than the planet reflects. It is for exactly the same reason we do not see stars during daylight hours –they are in the sky, but their light is overwhelmed by the light of our Sun.

It takes clever image processing to remove the effect of the central star. This method is described in a report in the weekly science magazine ‘Nature’ in mid-December 1999 (Vol. 402 No. 6763). With the planet’s reflected light 30 000 times more faint than that of its star, itself at a distance of 55 light-years from Earth, this is a staggering achievement. The scientists who made the breakthrough are Andrew Collier Cameron, Keith Horne and David James (all at the University of St Andrews) and Alan Penny (at the Rutherford-Appleton Lab near Oxford). They looked at the star Tau Boo for a total of 48 hours over 9 nights, in April 1998 and in April May and June 1999, using the 4.2 metre William Herschel Telescope at the La Palma observatory.

What you need

- Possibly also: a copy of the ‘Nature’ article, though it is full of technical detail and difficult to understand. The URL for the ‘Nature’ website is http://www.nature.com

- To obtain access to the search facilities on the Nature website, you will first need to register. This is free. Then a simple search using the keyword Bootis will list 5 items: two of these, both in Volume 402 Number 6763, are relevant.

Some questions for discussion

1. To subtract the effect of the star Tau Boo, the astronomers first had to establish exactly what its spectrum looks like in the range 385 nm to 611nm. How is the spectrum of a star obtained?

2. Unavoidable variations in the detector performance and atmospheric conditions while observing are regarded as noise. How can the effect of these be reduced?

3. The reflected starlight from Tau Boo has a blue-green colour. Why, once the signal of direct starlight has been removed, is there a spectrum for reflected light from the planet? In other words, why does the planet not show the same spectrum as the light incident on it?

4. The astronomers conclude that the orbiting planet is a gas giant 8 times more massive than Jupiter, 20 times closer to its star than the Earth is to the Sun. Among the planetary systems so far detected, it seems common for larger planets to spiral inwards towards the star, throwing any smaller inner planets out into space. So far, our planetary system seems to be a special case, with small rocky planets near the parent star. But do we have enough evidence to judge?

Things to think about

1. Could this discovery have been made without computing power and sophisticated techniques of data-processing?

2. Is the cost of developing new and increasingly-sensitive telescopes to learn more about the Universe justified?

Files provided
nil

Alternative approaches
For more about the search for planets around other stars, take a look at the Exoplanets website which has data on planets found and links to other sites.
http://etacha.as.arizona.edu/~eem/exo.html
One could make more of the ideas of signal-to-noise ratio, of statistical techniques for data-processing, or of the remote identification of molecules through their spectra.

Social and Human context
The big question is ‘are we alone?’ as intelligent life forms.