Star bright, how much do you weigh tonight?

Another set of weighing scales to estimate the stuff of stars has been proposed, says S.Ananthanarayanan.

The masses of stars, naturally, cannot be better than estimates. Not that we can directly take the weight of even a planet of the solar system. But here, we do have a body of observations that tell us the composition of the planet and we can tell the planet's dimensions quite accurately. We can thus estimate the density of the planet and guess its mass from its size.

When the planet has a moon, this becomes even more direct, as the period of revolution of the moon depends on the mass of the planet. With a reasonably good estimate of the distance of the moon from the planet, we can work out the planet's mass by knowing how long the moon takes to go around.

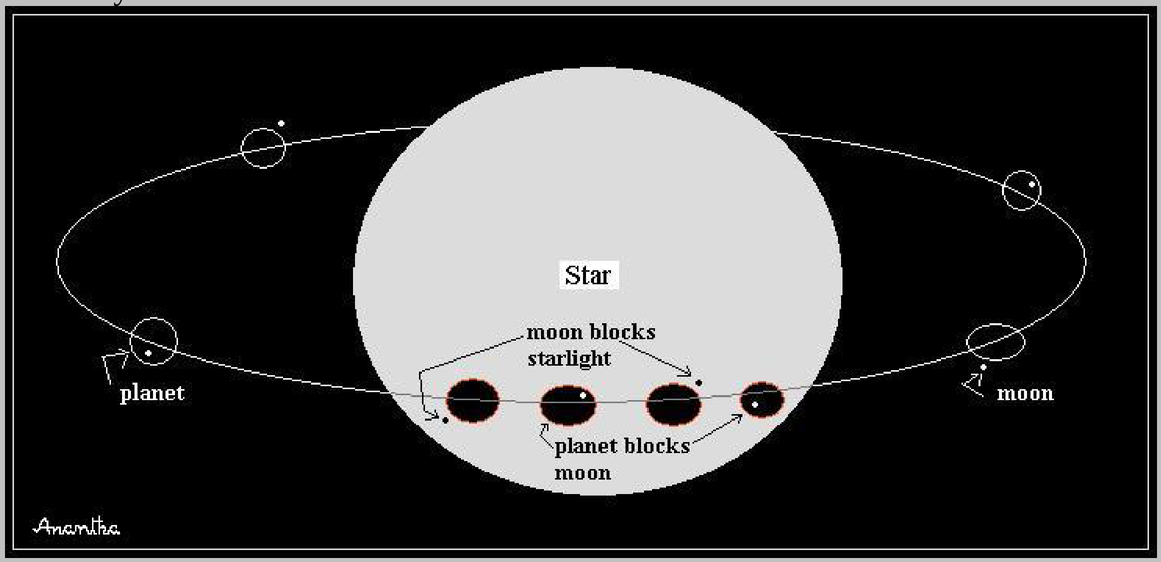
This kind of estimation becomes difficult in dealing with stars, because the data, first, is not extensive and then, all data is rather approximate. When the star has a planet, the period of revolution can be measured accurately, but it is difficult to tell the distance of the planet from the star. In such cases, when our real interest is in the planet, we can work out the distance from external estimates of the mass of the star.

The only reliable measurements of star mass has been through the study of binaries, or a pair of stars in orbit around each other. In these cases it is possible to actually measure the distances and time periods involved and with the help of the Kepler's Laws of planerary motion (which are the same for stars in orbit), we can work out the masses. ***David Kipping***, a predoctoral fellow at the Harvard-Smithsonian Center for Astrophysics, has proposed a new method for taking the weight of some of the stars that have a planet, which, in turn, has a moon.

Spotting planets

A major difficulty in spotting planets around stars is that the system being at such large distances, it is not possible to detect the reflected light of the planet in the glare of the star itself. This is the reason that the only way for a long time was through the ‘wobble’ that the movement of the planet creates in the motion of star. Because the planet going round makes the star bob forwards and backwards, the light emitted from the star shows changes that can reveal the period of revolution of the planet and also the extent of the ‘bob’ of the star. This has helped work out how large the planet is and also to guess how far from the star, with the help of information we already have about the star.

Another method that has been developed is to deduce the presence of the planet through the slight drop in the intensity of light from the star when the planet flies past the star. Although too small a shadow to see or photograph, we do have sensitive instruments that can accurately measure the light being received, and we can tell when a planet is transiting. This method, along with measuring the ‘wobble’ by the change in frequency of light, has enabled the bulk of the new ‘extrasolar’ planets that have been spotted in the last few years.



Add the moon

David Kipping of Harvard has suggested that in case the planet also has a moon, then the data could be sufficient to provide an accurate measure of the mass of the star. The way it would work is that there would be a difference in the light being received from the star with a planet in two conditions: when the moon of the planet is also blocking light and when the moon is behind or in front of the planet! This very slight up and down in the light intensity because of the planet’s moon would give away the period of revolution of the moon.

We thus end up with three measures about the three objects – the period of the moon, the period of the planet and also, with the help of the measure of the bobbing motion of the star, the relative masses of the star and planet. The transit of the planet across the star and of the moon across the planet also reveal the relative speeds of motion of the satellites, which provide measures of the size of the orbits. The data, taken together, is sufficient to work out the mass of the star. In the process, we also get accurately the mass and dimensions of the planet, which is usually of greater interest.

“basically, we measure the orbits of the planet around the star and the moon around the planet. Then, through Kepler’s Law of Motion, it is possible to calculate the mass of the star,” explains Kipping. “If there was no moon, this whole exercise would be impossible,” says Kipping. “No moon means we can’t work out the exact density of the planet, so the whole thing grinds to a halt.”

The method has not been actually used, so far, because we still do not have data about extrasolar planets that have moons. But things are likely to change once NASA’s latest ***Kepler mission***, which is a space observatory specially designed to detect extrasolar planets, launched in March 2009, starts discovering such systems.

“When they’re found, we’ll be ready to weigh them,” says Kipping.