On the Feasibility of Using Eclipsing Binary Timings as Probes for Extrasolar Planets

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Abstract By observing eclipsing binaries for a large number of cycles, extremely precise values of epoch and period may be determined. It is suggested that this precision may be used as a probe for the detection of light-time effects due to extrasolar planets around these stars. This work shows that while this technique may be theoretically possible, noise in the data for timings would normally be larger than the effect being sought. More accurate measurements of the times of minima would be needed for this technique to be feasible in detecting extrasolar planets.

1. Introduction

Over the last few years, there have been numerous reports of discoveries of extrasolar planets. Black (1996) gives a simple overview of the concept of using radial velocity measurements as a tool for detecting extrasolar planets. One shortfall of this technique is that the sensitivity of current instrumentation is limited to the detection of relatively large planets orbiting near the parent star.

2. Discussion

Long-term observations of eclipsing binary stars permit precise determinations of the orbital periods of these stars (Willson 1986). Careful analysis of times of minima can also permit the detection of epoch changes in the ephemeris equation. While a change in epoch is normally considered to be the result of changes in the binary pair itself, it could also be due to a physical shift of the center of mass of the binary pair as a result of the effect of an orbiting substellar companion. Some eclipsing binary stars are close enough to one another that perhaps stable planetary orbits could exist at distances of several astronomical units from the pair.

The aim of this study was to see whether or not such a shift would be large enough to be detectable. Investigations indicated that in fact a shift in epoch of several seconds (within detectability) would occur for planets equivalent to the size of the gas giants in our Solar System at distances from the binary stars equivalent to those found for gas giants around the Sun. Unfortunately, these planets would have orbital periods of decades. During the years needed to determine the shift of epoch due to the planet, mass exchange between the close binary stars may also occur, thus causing an epoch shift of its own. This effect would mask the effect of the planet.

3. Conclusion

While the technique of using eclipsing binaries as probes for extrasolar planets is theoretically possible, it is unlikely to be feasible due to changes in the binary system that may occur during the long time needed to detect the effect of a planet on the ephemeris equation. If a method could be found, however, for separating the different causes of changes in epoch for the eclipsing binary, then this technique holds promise for the detection of planets much farther from the stars than the current method of looking for Doppler shifts.

References

Black, D. C. 1996, *Sky & Telescope*, **92**, 20.

Willson, L. A. 1986, in *The Study of Variable Stars Using Small Telescopes*, ed. J. R. Percy, Cambridge Univ. Press, Cambridge, 219.