SF2A 2004
F. Combes, D. Barret, T. Contini, F. Meynadier and L. Pagani (eds)

HOW WOULD A RING AROUND AN EXTRASOLAR PLANET CHANGE THE UNRESOLVED PLANET PHOTOMETRY ?

Arnold, L.[1] and Schneider, J.[2]

Abstract. The next generation of high-contrast imaging instruments will provide the first unresolved image of an extrasolar planet. While the emitted infrared light from the planet in thermal equilibrium should show no phase effect, the reflected visible light will vary with the orbital phase angle. We study the photometric variation of the reflected light with orbital phase of a ringed extrasolar planet. We show that a ring around an extrasolar planet, both obviously unresolved, can be detected by its specific photometric signature.

1 Introduction

The discovery of extrasolar planets by radial velocity measurements has provided the first dynamical characteristics of planets (orbital elements and mass). The next step will be to investigate physical characteristics (albedo, temperature, radius etc.) and planet surroundings. Among the latter are planetary rings. Coming space or ground-based high-contrast imaging instruments will be able to provide the first image of an unresolved extrasolar planet, in the thermal infrared or in the visible light. The emitted thermal infrared light from the planet should show no phase effect assuming the planet is in thermal equilibrium. But the reflected visible light will vary with phase angle, as should be shown by a broad-band photometric follow-up of the planet during its orbital motion.

We thus argue (Arnold & Schneider 2004) that it is of interest to study how the presence of a ring around a planet would influence its magnitude as a function of its orbital position. This paper shows an example among others (discussed in Arnold & Schneider 2004) how the reflected light curve of a ringed planet is different from that of a ringless planet, thus revealing the presence of the ring.

[1] Observatoire de Haute-Provence, CNRS, 04870, Saint-Michel-l'Observatoire, France (arnold@obs-hp.fr)
[2] Observatoire de Paris-Meudon, CNRS, 92195, Meudon-Cedex, France

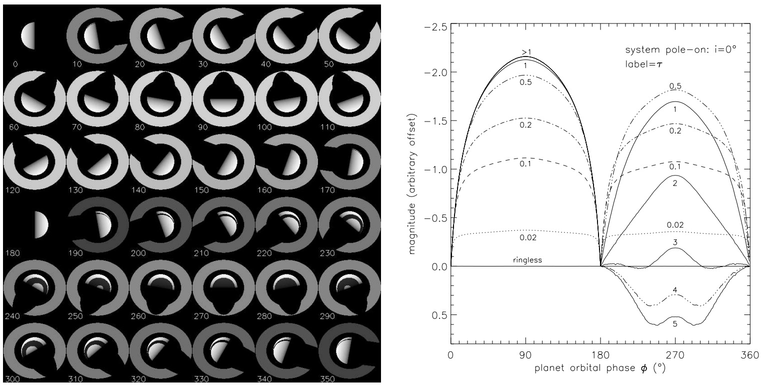

Fig. 1. Saturn-like planet photometry, with different optical thickness τ of the ring. Ring obliquity is 26.73°. The curve $\tau = 2$ is illustrated at left. All curves are normalized to the flux of a ringless planet seen at half phase.

2 An example of ring signature: A ringed planet observed pole-on

A ringless planet observed pole-on is always seen with the same phase angle (90°) and consequently has a constant magnitude. But if a non-zero obliquity ringed planet is observed pole-on, the ring alternately shows its illuminated and dark side. The light curves of Fig. 1 then show slope changes occurring at the equinoxes, due to the two observation regimes of the ring, seen either reflecting or transmitting the light. For Saturn, with typically an optical thickness of $\tau = 1$, the curve is almost symmetrical: the reflected and transmitted radiances are of the same order of magnitude. But for a thicker ring, the curves become highly non-symmetrical: The reflected radiance is much larger than the transmitted one. The ring shadow projected on the planet is responsible for brightness changes too, as shown especially for high values of τ. Moreover, with a low-obliquity ring, the transmitted light *a fortiori* remains low and the ring shadow on the planet becomes small, making the system brightness almost constant for the second half of the orbit.

3 Conclusion

The example shown here clearly demonstrates in a simple geometric case that a ring around a planet significantly influences the light curve of the system. A ring can thus be detected by a broad-band photometric follow-up of the planet. More geometric cases and ring signatures are discussed in Arnold & Schneider 2004.

References

Arnold L., Schneider J., 2004, A&A, 430, 1153