Mon. Not. R. astr. Soc. (1978) **184**, 523–525

The light curve at 10 μm of Algol near secondary minimum

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Received 1978 January 30; in original form 1977 November 24

Summary. The light curve of Algol near secondary minimum is presented. It shows a smooth decrease in amplitude of ~ 0.3 mag which is symmetric about the minimum and starts at an Algol phase of ~ 0.42.

Introduction

It has been suggested by Z. Kopal (private communication) that observations of the secondary minimum of Algol (β Persei) at 10 μm represent a method of learning the extent of gravity darkening in stars of advanced spectral type. The light curve of Algol has previously been measured in the infrared by Chen & Reuning (1966); Jameson, Longmore & Crawford (1973); Smyth, Dow & Napier (1975); Longmore & Jameson (1975) and Magro *et al.* (1977). The depth of the secondary minimum increases into the red, becoming as deep as 25 per cent at 5 μm (Magro *et al.* 1977). In this article we present new observations at 10 μm which concentrate on the behaviour of Algol around the time of its secondary minimum.

Observations

All the data are shown in Fig. 1. The observations were made at the $f/74$ Cassegrain focus of the 5-m telescope at Mt Palomar in 1977 February and the $f/60$ focus of the 1.5-m telescope on Mt Wilson in 1977 October. The detector in each case was a germanium bolometer filtered to measure flux from 8 to 13 μm. The phase ϕ of Algol was calculated from the relationship for the primary visible minima $\mathrm{JD}(\phi=0)=2440953.4657+2.8673075E$ given by Ashbrook (1976), corrected to the geocentric epoch; E is the number of cycles since the initial minimum.

The magnitudes of Algol on all nights were established relative to ρ Persei, an M4 star within 3° of Algol. The star ρ Per showed no evidence of having varied with respect to β Pegasi and β Andromedae between 1977 February and October but a variation as large as 5 per cent cannot be ruled out.

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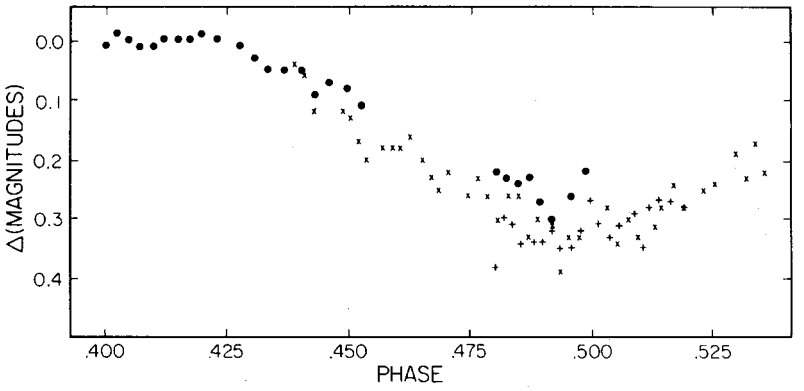

Figure 1. The light curve at 10 μm for Algol around secondary minimum is shown. The magnitude difference Δ is with respect to the nearby star ρ Per. Solid circles were obtained on UT 1977 February 8 on the Palomar 5-m telescope; the × and + were obtained on UT 1977 October 1 and 4 respectively on the Mt Wilson 1.5-m telescope. Phase is based on the visual minimum as determined by Ashbrook (1976).

For the purposes of studying the secondary minimum, a magnitude difference Δ defined to be 0.0 at $0.40 < \phi < 0.42$ is presented in Fig. 1. A Δ of 0.0 corresponds to a 10-μm magnitude of Algol [10 μm] = 1.7 ± 0.1; the 10-μm mag of β And is [10 μm] = −2.07. In addition to the data presented here, a measurement of Algol on 1977 October 2 at $\phi = 0.87$ gave $\Delta = 0.13 \pm 0.02$.

The measurements at Palomar were made on UT 1977 February 8. Approximately 4 min of observations of Algol were alternated with observations of ρ Per. The measurements of ρ Per followed a smooth curve expected from the atmospheric extinction with less than 1 per cent scatter. Clouds prevented observations from $0.45 < \phi < 0.48$. Data with ~ 3 per cent scatter in the flux of ρ Per were subsequently obtained for $0.48 < \phi < 0.50$. The statistical uncertainty in each point of the Algol data is less than 2 per cent.

The Mt Wilson data were obtained on UT 1977 October 1 and 4. Three observations of Algol, each of about 10-min duration, were alternated with a single observation of ρ Per. The measured fluxes of ρ Per followed a curve expected on the basis of the atmospheric extinction to within a scatter of 1 per cent. The statistical uncertainty in each point was $\leqslant$ 2 per cent on 1977 October 1 and $\leqslant$ 3 per cent on 1977 October 4.

Discussion

An interpretation of the present data will be given in a subsequent article by Z. Kopal. There is no evidence for a significant excess at 10 μm: outside of the eclipse [10 μm] = 1.7, while [4.8 μm] = 2.0 (Magro *et al.* 1977). The data show a smooth decline by 0.3 mag which starts at about $\phi \sim 0.42$. The limited data at phases greater than $\phi = 0.50$ are consistent with a symmetrical curve about $\phi = 0.50$.

Acknowledgments

We thank Z. Kopal for suggesting we make these measurements. We thank our night assistants J. Carrasco and J. Frazer. Observations were supported by National Science Foundation grant AST74-18555A2 and National Aeronautics and Space Administration grant NGL 05-002-207. D. Nadeau is a Fellow of the National Research Council of Canada.

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