White light photometry of the magnetic cataclysmic variable V405 Aurigae

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Abstract

We present the results of white light photometry of the 14th magnitude magnetic cataclysmic variable V405 Aurigae, carried out at the George Abell Observatory. These observations were carried out as a first photometric test of the equipment in the observatory. They reveal the expected double-peaked pulse profile of the system, with ~ 0.1 magnitude amplitude, which reflects the magnetic white dwarf spin period of 545sec.

1 Introduction

The observations reported here were carried out as a test of the photometric capabilities of the equipment at the George Abell Observatory. It is hoped that this becomes the first in an ongoing series of Reports from the Observatory, written by the users of it.

2 Background

V045 Aurigae is a 14th magnitude Intermediate Polar – a subclass of the magnetic cataclysmic variables. These are binary star systems in which a magnetic white dwarf accretes material via Roche lobe overflow from a main sequence dwarf companion. Material transferred from the inner Lagrangian point forms an accretion disc around the white dwarf, which is truncated at its inner edge by the white dwarf's magnetic field. Thereafter material follows the magnetic field lines down to the white dwarf surface, forming two 'accretion curtains' standing above the white dwarf's magnetic poles. The accreting material is decelerated in a shock and then settles onto the white dwarf surface, releasing X-rays via thermal bremsstrahlung and also optical cyclotron radiation. In V405 Aur, the white dwarf spins on its axis once every 545 sec, and the binary orbital period is 4.15 hr. Variability at both these periods is seen in the emission from the system (Haberl et al 1994; Allan et al 1996; Szkody, Armstrong & Fried 2000).

3 Observations

We observed V405 Aur between 20:36UT and 22:56UT on the night of Saturday 19th November 2005 using the Alan Cooper Telescope. This is the 40cm Meade LX200 Schmidt Cassegrain Telescope, with a 4m focal length, at the Open University's George Abell Observatory. The telescope was equipped with an SBIG STL1001E CCD camera, giving a spatial resolution of 1.24 arcsec per pixel and an image size of 21 arcmin. Despite high humidity, low level mist, and

a nearly full moon, seeing was relatively good with a Full Width Half Maximum point spread function of 2.0 pixels, or 2.5 arcsec. 400 images were obtained in white light (i.e. no filter) with an exposure time of 15 sec. There was a deadtime of around 5 sec between each exposure during which the full-frame data were read out. Standard calibration frames, including bias frames, dark frames and dome flats, were obtained after the target observations.

4 Data Reduction

All images were bias and dark subtracted and flat-fielded using MaximDL v4 software. Relative photometry was performed with respect to a reference star of known, constant magnitude (see finder, Fig 1), whose stability was confirmed by comparison with three further check stars.

5 Results

The resulting light curve of V405 Aur (Fig 2) was analysed using a Fourier Transform, which clearly shows a signal at a frequency corresponding to *half* the expected 545 sec period (Fig 3). This is not surprising, as the pulse profile is known to be double peaked, and the period was originally thought to be 272 sec becuase of this. Folding the lightcurve at the period of 545 sec shows the double-peaked pulse profile (Fig 4) noted by previous observers. The amplitude of the modulation is around 1/10 magnitude in these white light observations.

6 Conclusions

These observations clearly demonstrate the capabilities of the George Abell Observatory to carry out time series photometric observations of reasonably faint targets, under poor atmospheric conditions. The next test planned is to observe a similar target to carry out multi-colour photometry (i.e. interleaved observations in multiple BVRI filters).

References

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Haberl, F., Thorstensen, J.R., Motch, C., Schwarzenberg-Czerny, A., Pakull, M., Shambrook, A., Pietsch, W., 1994, A&A, 291, 171 Discovery of the new intermediate polar RXJ0558.0+5353

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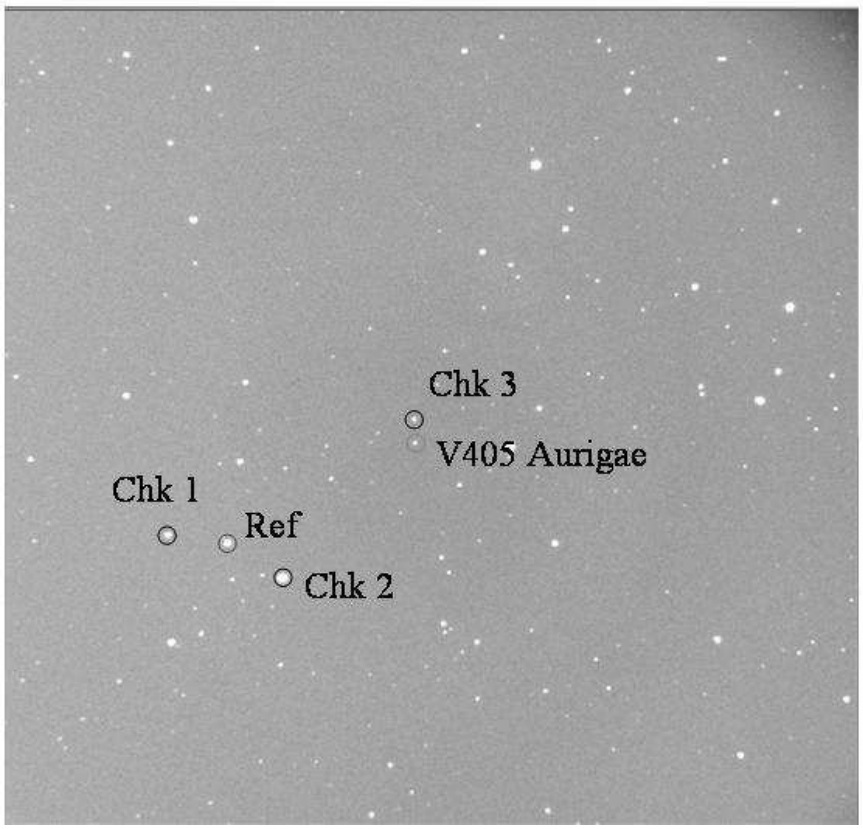

Figure 1: A median stack of the 400 bias and dark subtracted, flat-fielded white light images of the V405 Aur field. The reference star (with V=11.104) and three check stars are indicated. North is up and East is to the left, the image is 20 arcmin across.

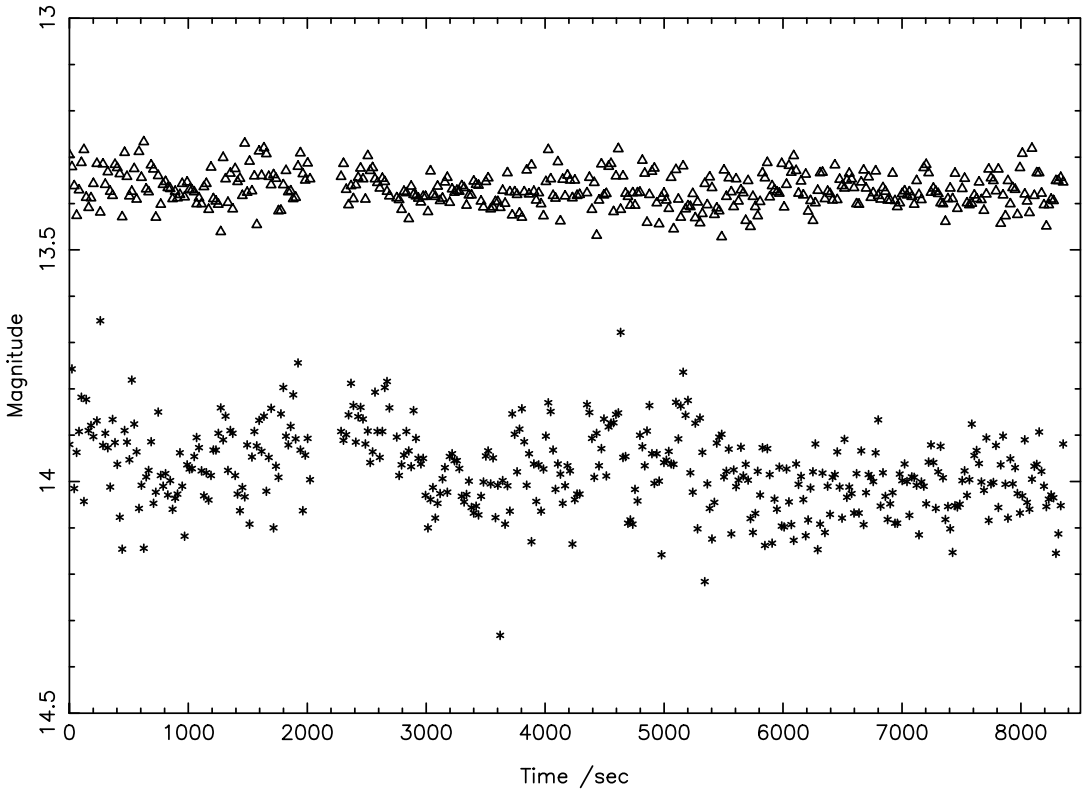

Figure 2: The lightcurve of V405 Aur obtained in white light. Also shown for comparison (upper curve) is the lightcurve of check star number 3, which is of similar magnitude and shows constant brightness.

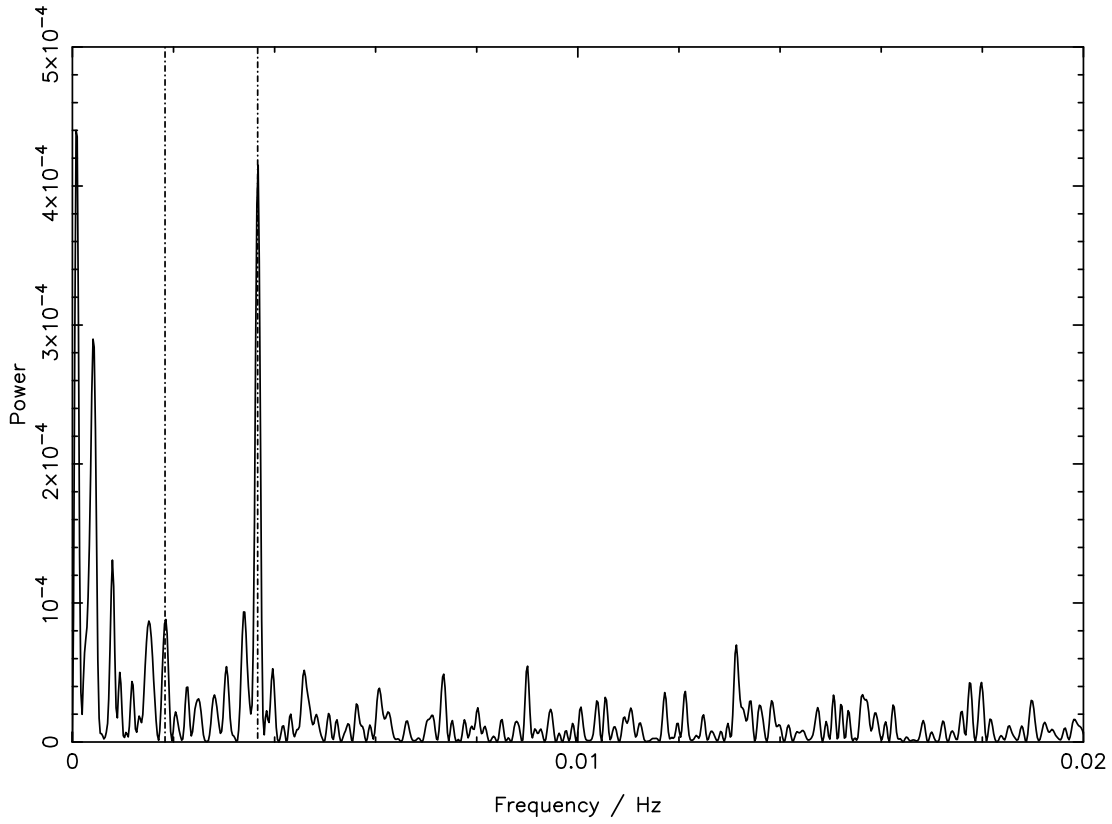

Figure 3: A power spectrum of the V405 Aur lightcurve. Significant power at a frequency of 3.667×10^{-3} Hz, corresponding to a period of 272.72 sec, is clearly seen. This is half the white dwarf pulse period of 545.45 seconds.

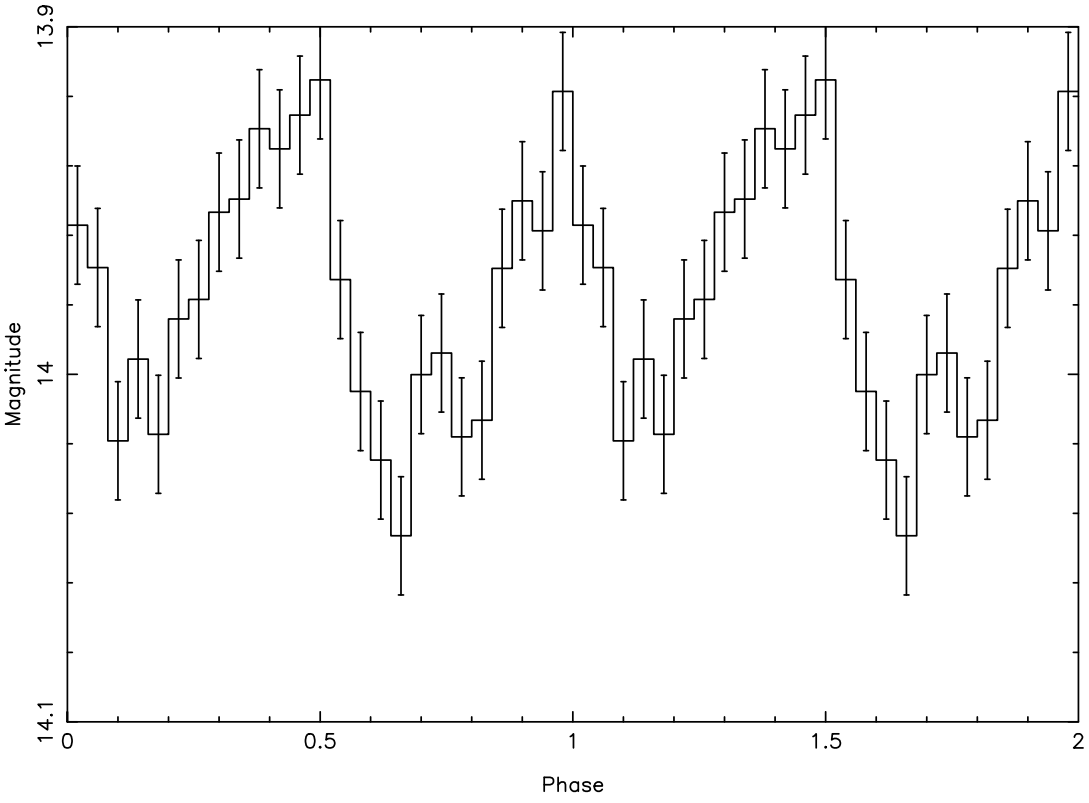

Figure 4: The lightcurve of V405 Aur folded at the white dwarf spin period of 545 sec, and shown repeated over two cycles for clarity. Error bars are the r.m.s. variation within each phase bin.