Accretion Phenomena and Related Outflows, IAU Colloquium 163
ASP Conference Series, Vol. 121, 1997
D.T. Wickramasinghe, L. Ferrario, and G.V. Bicknell, eds.

Optical Photometry of the Eclipsing LMC Supersoft Source CAL 87

K.A. Southwell, P.A. Charles

Department of Astrophysics, Keble Road, Oxford, OX1 3RH, UK

D. O'Donoghue

Department of Astronomy, University of Cape Town, South Africa

C. Alcock, R.A. Allsman, D. Alves, T.S. Axelrod, D.P. Bennett, K.H. Cook, K.C. Freeman, K. Griest, J. Guern, M.J. Lehner, S.L. Marshall, B.A. Peterson, M.R. Pratt, P.J. Quinn, A.W. Rodgers, C.W. Stubbs, W. Sutherland, D.L. Welch

The MACHO Collaboration

Abstract. We present optical photometry of the eclipsing supersoft source, CAL 87. We find the eclipse structure to be stable over ~ 4 y, derive an improved ephemeris of $T_o = \mathrm{HJD}\ 2450111.5144(3)+0.442674(7)E$, and see new structure in the light curve morphology.

1. MACHO Project Photometry

We show in Fig. 1 optical photometry of the eclipsing supersoft source, CAL 87, obtained via the MACHO project from 1992 Aug – 1996 May (see Alcock et al. 1996). The broad primary eclipse is $\sim$ 0.2 mag deeper in the blue, and

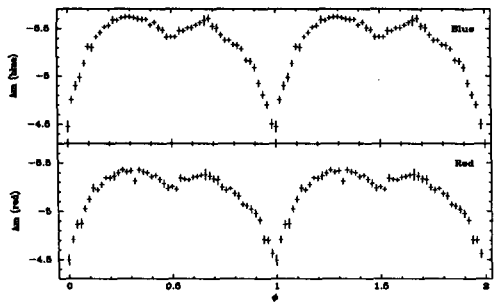

Figure 1. The blue and red MACHO light curves of CAL 87. The data are folded and averaged into 50 phase bins.

a shallower secondary dip is seen in both passbands at $\phi \sim 0.5$. The latter probably results from obscuration of the irradiated face of the donor star (van den Heuvel et al. 1992). The $B - R$ colour (not plotted) shows pronounced

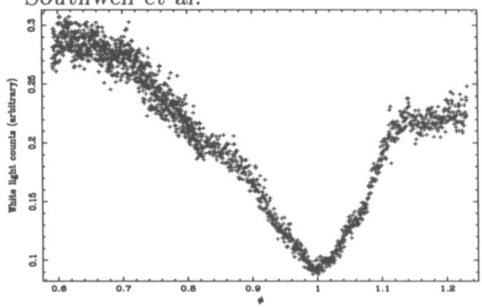

Figure 2. SAAO high speed white light curve of CAL 87. Note the obvious structure at $\phi \sim 0.82 - 0.87$ and $\phi > 1.1$.

reddening through the primary eclipse, and also marginal evidence for a slight reddening centred on $\phi \sim 0.55$. Examination of the yearly data-sets from 1992-1996 failed to reveal any significant changes in the orbital period or overall morphology, although the step in the egress at $\phi \sim 1.1$ (see also Fig. 2) sometimes seemed more pronounced. We derive $P = 0.442676 \pm 0.000007$ d from the complete dataset in each filter, consistent with previous measurements (e. g. Schmidtke et al. 1993).

2. High speed photometry

Fig. 2 displays a white light curve of a single eclipse, consisting of continuous $10 - 20$ s integrations, obtained with the UCT CCD and SAAO 1.9 m telescope. We derive an ephemeris of T_o = HJD 2450111.5144(3) for the time of minimum light. The extended ingress and kink at $\phi \sim 0.82 - 0.87$ may be explained by variable obscuration by the thickened accretion disc rim (Callanan et al. 1989; Armitage & Livio 1996; Alcock et al. 1996). A turn-over is observed in the egress for $\phi > 1.1$. This is similar to the variability seen in Z Cha (Cook & Warner 1984), caused by the presence of a hot spot on the disc. In CAL 87, an analogous component may be the strongly irradiated inner-surface of the accretion disc bulge.

References

Alcock, C. et al. 1996, MNRAS, submitted

Armitage, P. J. & Livio, M. 1996, ApJ, in press

Callanan, P. J., Machin, G., Naylor, T. & Charles, P. A. 1989, MNRAS, 241, 37P

Cook, M. C. & Warner, B. 1984, MNRAS, 207, 705

Schmidtke, P. C., McGrath, T. K., Cowley, A. P. & Frattare, L. M. 1993, PASP, 105, 863

van den Heuvel, E. P. J., Bhattacharya, D., Nomoto, K. & Rappaport, S. A. 1992, A&A, 262, 97