OPEN EUROPEAN JOURNAL ON VARIABLE STARS
July 2007 http://var.astro.cz/oejv ISSN 1801–5964

CCD PHOTOMETRY OF CF TUC AND A NOTE ON THE ORBITAL PERIOD

Innis, J.L.[1]; Coates, D.W.[2]; Kaye, T.G.[3]

1) Brightwater Observatory, Australia, brightwater@iraf.net
2) Monash University, Australia, denis.coates@sci.monash.edu.au
3) Spectrashift, USA, tomkaye@tomkaye.com

Abstract: CF Tuc is a far–southern example of an RS CVn–type eclipsing binary. The orbital period of just under 2.8 d is known to be variable, although the reasons for this variation are not clear. A small number of CCD observations of CF Tuc were obtained at the Brightwater Observatory in 2006 September–November. While phase cover was incomplete, a primary minimum was well observed. This time of minimum indicates that the period has been constant since 1995, and hence that the period change predicted to occur sometime after 1999 has not taken place. We derive an updated ephemeris of HJD 2453994.140 ($\pm$ 0.005) + 2.797481 ($\pm$ 0.000008) $\times$ E, where E is the cycle number.

CF Tuc (HD 5303) is a bright eclipsing RS CVn–type binary with a period ∼2.797 d. The light curve shows changes over time, due to the presence of starspots. Basic system parameters and/or spot modelling have been determined by various authors, for example **Coates et al. (1983); Budding and McLaughlin (1987); Budding and Zeilik (1995); Cutispoto and Leto (1997); Anders et al. (1999)**. The components are close to G0 V/IV + K4 V/IV (op cit.).

The orbital period was first noted to be variable by **Thompson et al. (1991)**. This work was later extended by **Anders et al. (1999)** who applied the magnetohydrodynamic theory of **Applegate (1992)** to CF Tuc. Applegate's theory postulates a coupling between deep convection on the active (cooler) star and angular momentum which, by changing the oblateness of the star, produces changes in the orbital period while keeping total angular momentum conserved. A relationship between out–of–eclipse brightness (due to changing spot cover over an activity cycle) and orbital period is therefore inferred. On the basis of the data then to hand, **Anders et al. (1999)** predicted a period change was likely soon after 1999–2001. As reported in **Innis et al. (2003)**, the period of CF Tuc remained unchanged from 1995 to mid 2002, hence the predicted change did not occur.

Because of the interest in following the behaviour of this system, we included it in the observing programme at the Brightwater Observatory. A description of the equipment and methods we used can be found in **Innis et al. (2007)**, but, in brief, we used a 70–mm diameter, 480–mm focal length refractor and SBIG ST–7 CCD, giving a field of view of ∼0.80×0.55 degrees. CF Tuc and the comparison star (HD 5210) and several check stars can be observed simultaneously on the same frame. While **Innis et al. (1984)** suggested HD 5210 may be variable, other studies **(Budding and McLaughlin, 1987; Cutispoto and Leto, 1997)** have found no evidence to support this suggestion. We see no evidence for variation of HD 5210 in our new data: The rms for the V differences HD 4644−HD 5210 is 0.008 mag. We use V=8.69 for HD 5210 to determine the V magnitudes of CF Tuc.

We commenced observations in 2006 September. During observations on 2006 September 15 it was realised that a primary eclipse was in progress. The V data from this night are shown in Figure 1. From these data we derive a time of minimum of HJD 2453994.140

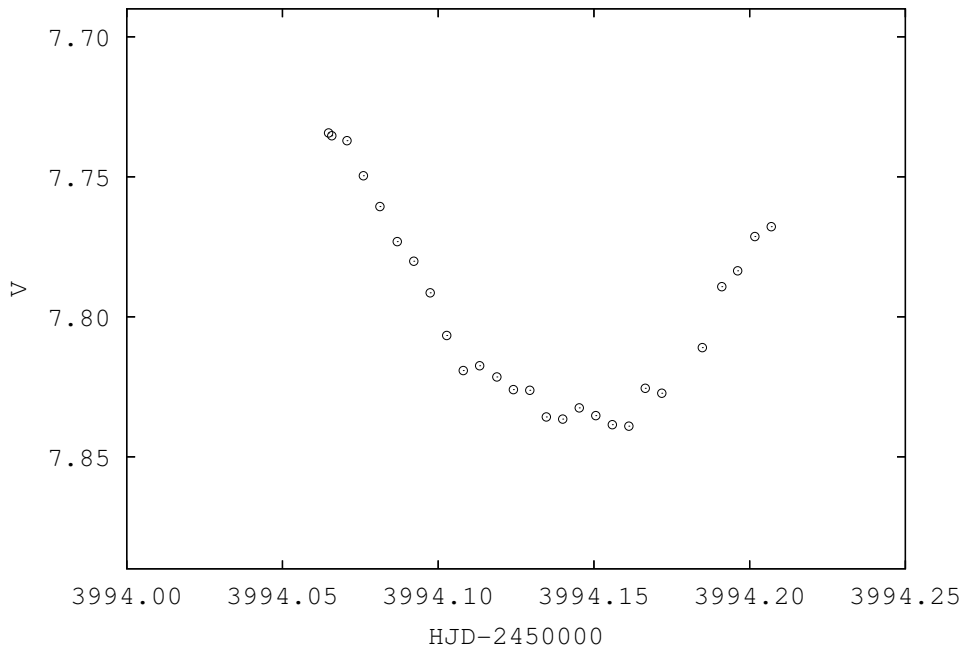

Figure 1: Detail of primary eclipse of CF Tuc, 2006 September 15. We used V=8.69 for the comparison star HD 5210 in deriving the V magnitudes. From these data we derive a time of minimum of HJD 2453994.140 ± 0.005 by a chord bisector method.

± 0.005 by a chord bisector method. Using the ephemeris of **Anders et al. (1999)** of HJD 2444219.270 + 2.797715 × E, where E is the cycle number, we obtain an $O-C$ value of −0.346±0.005 d. The complete $O-C$ data for CF Tuc, as far as we know to exist, including our new measurement, are shown in Figure 2. It is clear there has been little or no change in the period since mid 1995.

Innis et al. (2003) derived an ephemeris for CF Tuc, current for mid 2002, of HJD 2450351.825 + 2.797492 × E. Our new datum suggests a current period of 2.797481 d is a slightly more appropriate value, assuming that the period has been constant since ∼HJD 2450351. Hence we suggest a current ephemeris of

$$HJD\ 2453994.140(\pm 0.005)\ +\ 2.797481(\pm 0.000008)\ \times\ E \qquad (1)$$

for CF Tuc, which may assist other southern observers in planning observing programmes for the coming season.

Our 2006 V data are plotted with the new ephemeris in Figure 3. As noted earlier, phase cover is very limited. We intend to continue our observations of CF Tuc.

Acknowledgements This work has made use of the SIMBAD database of the Stellar Data Centre (CDS) Strasbourg, the NASA ADS abstract database, the data–reduction packages IRAF (NOAA, USA) and MUNIWIN (by David Motl), and the numerical analysis program OCTAVE (J. Eaton and colleagues). D. Coates thanks the Faculty of Science, Monash University, for the provision of an Honorary Research Fellowship.

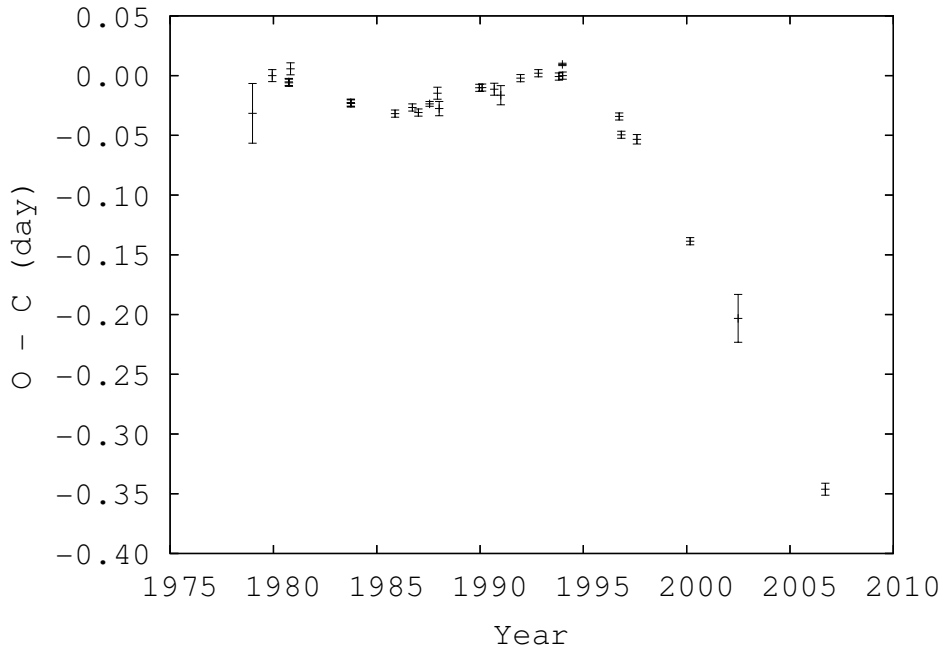

Figure 2: $O - C$ diagram for CF Tuc.

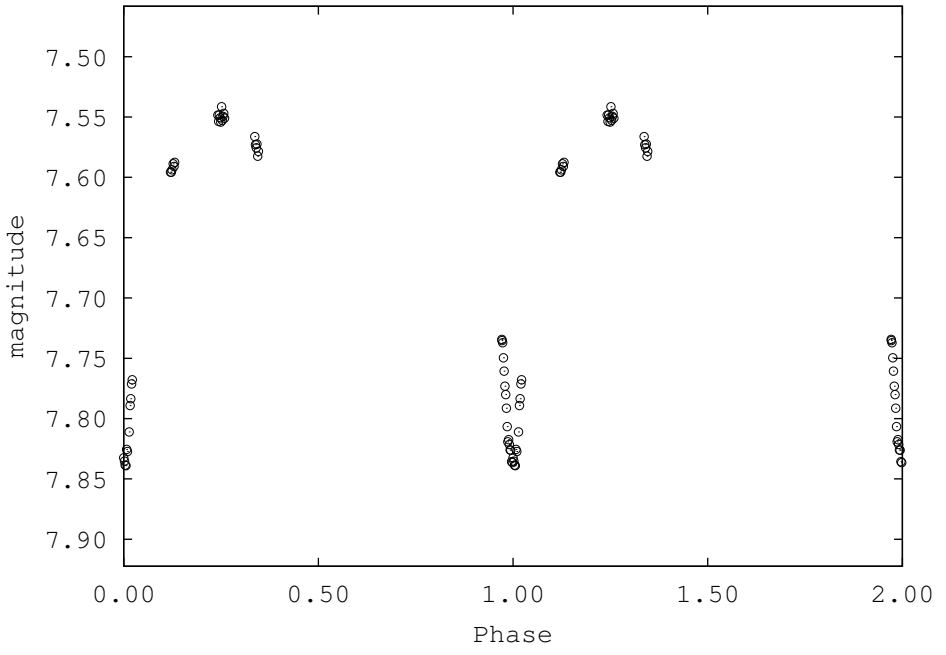

Figure 3: Brightwater Observatory V data for CF Tuc, from 2006 September–November. We used the ephemeris HJD 2450351.825 + 2.797481 × E, with the slightly revised period derived from the new time of primary minimum reported here.

References

- Anders, G.J, Coates, D.W., Thompson, K., Innis, J.L., 1999, *MNRAS*, **310**, 377, 1999MNRAS.310..377A
- Applegate, J.H., 1992, *ApJ*, **385**, 621, 1992ApJ...385..621A
- Budding, E., Mclaughlin, E., 1987, *Ap&SS*, **133**, 45, 1987Ap&SS.133...45B
- Budding, E., Zeilik, M., 1995, *Ap&SS*, **232**, 355, 1995Ap&SS.232..355B
- Coates, D.W., Halprin, L., Sartori, P.A., Thompson, K., 1983, *MNRAS*, **202**, 427, 1983MNRAS.202..427C
- Cutispsoto, G., Leto, G., 1997, *A&AS*, **121**, 369, 1997A&AS..121..369C
- Innis, J.L., Coates, D.W., Thompson, K., 1984, *IBVS*, **No. 2544**, 1984IBVS.2544....1I
- Innis, J.L., Coates, D.W., Thompson, K., Thomson, R., 2003, *IBVS*, **No. 5444**, 2003IBVS.5444....1I
- Innis, J.L., Coates, D.W., Kaye, T.G., 2007, *PZ*, **27**, 1, http://www.astronet.ru/db/varstars/msg/1221359
- Thompson, K., Coates, D.W., Anders, G., 1991, *PASAu*, **9**, 283, 1991PASAu...9..283T