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FT LUPI: STUDY OF THE PERIOD AND LIGHT CURVE

FT Lupi (S 5001 = CoD $-42^{o}9876$ (9.6) = CPD $-42^{o}6864$ (9.3) = HD 132316 (F5) = BV 851 = CSV 2228) is a close eclipsing binary of the southern hemisphere. It was discovered photographically and classified as an Algol system by Hoffmeister (Erg.A.N.,12,1,1949). Subsequently Hoffmeister (Veröff. Sonn. 6,3,132,1965) published a photographic light curve and 27 times of minima, eleven of which are visual determinations; he determined a period P = $0^{d}.4700903$ days and reclassified FT Lupi as a β Lyr system with amplitudes A1 = 0.8 and A2 = 0.3 mag and suggested that irregularities in the light curve were present. Strohmeier (Mitt. Veränd. Sterne 3,1,1965) published an ephemeris with P = 0.4700895 days and indicated that no irregularities are superposed in the light curves. Further, Strohmeier (IBVS No.184, 1967) obtained an ephemeris (P = $0^{d}.470089$) from 34 photographic minima. Bauernfeind (Veröff. Bamberg, Band VIII,81,1968) gave 120 times of photographic minima; from these data he obtained a systematic trend of the residuals (O-C) in relation to the light elements given by Strohmeier in 1967. Strohmeier and Knigge (MNASSA 28,75,1969) catalogued S5001 (in Centaurus) as EA and quoted the ephemeris given in IBVS No.184. It was reported in Bull.A.A.S. 3,72,1971 that Gleim gathered 3-colour photoelectric observations at Cerro Tololo. Mauder and Kappelmann (A.G.Mitt. 55,72,1982) discussed FT Lupi among other interesting contact double stars. They showed a V light curve and commented a preliminary photometric solution and absolute elements. They gave a photoelectric period P = $0^{d}.470073 \pm 0.000002$, as well as a period variation leading to a mass transfer of about 0.3×10^{-6} $M_{\odot}$/year from the primary to the secondary component. Mauder and Kappelmann reproduced the O-C diagram of the minima given by Bauernfeind; they also plotted the minima obtained by Strohmeier (IBVS No.184,1967) and a minimum time found by themselves.

The present study is based on 675 UBV photoelectric observations obtained by one of us (S.L.L.) along four years since 1980 with the 154 cm reflecting telescope at Bosque Alegre Station of Cordoba Observatory; 16 times of minimum light covering about 1700 cycles were derived for each colour, individual

Table I

Min.	J.D. hel. (2400000 +)	Cycles	(O-C)	(O-C)'
II	44769.68020	-621.5	0.0021	0.0025
II	45002.83985	-125.5	0.0008	0.0010
II	45034.80671	-57.5	0.0023	0.0024
II	45060.65903	-2.5	0.0001	0.0002
II	45061.60021	-0.5	0.0011	0.0012
I	45061.83160	0.0	-0.0024	-0.0023
I	45063.71250	4.0	-0.0018	-0.0018
II	45064.88837	6.5	-0.0012	-0.0011
I	45090.50706	61.0	-0.0020	-0.0020
II	45090.74444	61.5	0.0003	0.0003
I	45116.83333	117.0	-0.0003	-0.0004
II	45117.53947	118.5	0.0006	0.0006
I	45117.77240	119.0	-0.0014	-0.0015
I	45531.44618	999.0	0.0001	-0.0008
II	45532.62285	1001.5	0.0017	0.0005
II	45533.56125	1003.5	-0.0001	-0.0009

minima from the three light curves never differed by more than 0.0003 days; their averages are listed in Table I. A least squares linear ephemeris from these data gives:

$$\text{Min. I} = \text{J.D.Hel. } 2445061.8340 + 0^{d}.4700820 \cdot E \qquad (1)$$
$$\pm 0.0003 \pm 0.0000007$$

The residuals (O-C) are listed in Table I. From these elements we computed the phases for the V-light and (B-V) colour curves shown in Figure 1. They are given differentially in relation to the comparison star HD 132201 (F0), in the sense variable minus comparison star. The light curve is precisely defined; no large scattering is observed (especially at minima) as found by Mauder and Kappelmann. The depth of primary minimum is 0.9 mag while for secondary is 0.28 mag. The maximum light following primary minimum is about 0.03

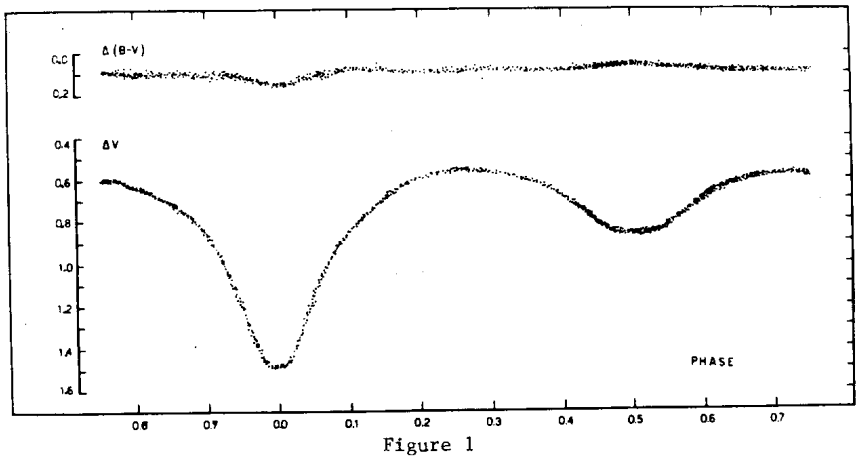

Figure 1

mag higher than that following secondary one. Our observations show the secondary minimum to be flat, thus being an occultation; the duration of this total eclipse is at least 45 min. The (B-V) colour curve is almost constant, except at primary eclipse which is redder by 0.05 mag and bluer at secondary one by about 0.02 mag.

Since there is a considerable number of minima published for FT Lupi during the last 80 years we included all of them in a period study. In the course of the analysis we found some trouble in identifying Bauernfeind's (1968) minima; a study of the data for different epochs and authors allowed a precise identification of all observations starting from the photoelectric data. Determination of the period for different epochs has clearly shown that it is becoming shorter; then all observations were included both in a linear and parabolic least squares ephemerides. The results are:

$$\text{Min. I} = \text{J.D.Hel. } 2445061.880 + 0^d.470089 \cdot E \qquad (2)$$
$$\pm 0.038 \pm 0.000006$$

$$\text{Min. I} = \text{J.D.Hel. } 2445061.834 + 0^d.470083 \cdot E - 0.114 \cdot 10^{-9} E^2 \qquad (3)$$
$$\pm 0.025 \pm 0.000002 \quad \pm 0.029 \cdot 10^{-9}$$

therefore the period is changing at a rate $\dot{P} = 0.0076$ sec/year. The (O-C)' values of the photoelectric observations from the parabolic elements are listed in Table I. The residuals for all observations are given in Figure 2 for the ephemerides (2) and (3). It should be noted that the parabolic elements are well defined, even for photographic and visual observations. A fit to these values exactly predicts, within the errors, the period and slope of the photoelectric elements found for 1981 - 1983.

In conclusion, we presented precise photoelectric V-light and (B-V) colour curves obtained during four years of observations. It was found that FT Lupi shows complete eclipses and that no seasonal changes of light were pre-

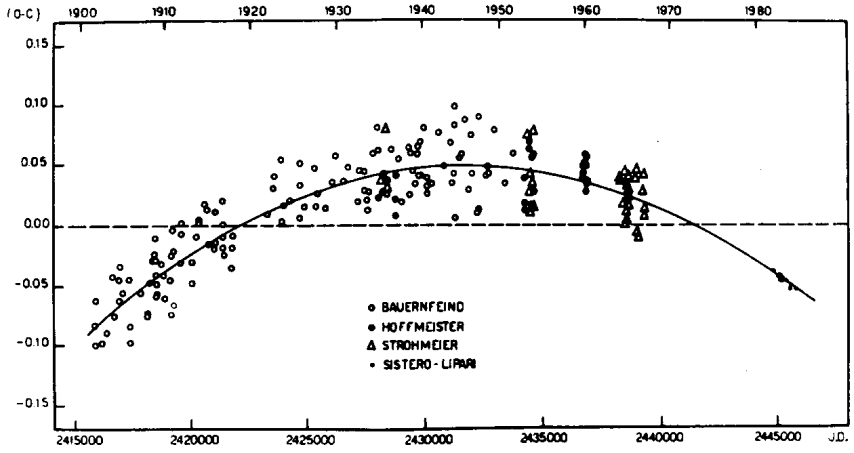

Figure 2

sent. A first detailed study of the period was made and its variation has been well established, though it is smaller by a factor of about 2 than that suggested by Mauder and Kappelmann (1982). The parabolic elements given by formula (3) should be used to predict future circumstances. Finally, we note that a periodic (O-C) light-time effect cannot be ruled out; this would be possible only for an orbital period larger than 160 years.

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