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ON THE PERIOD OF 44 i BOOTIS

The period of the W UMa system 44 i Bootis has been studied extensively. Recently Oprescu et al. (1989, 1991) reported that sudden period changes occurred in 1977-1978 and in 1986-1987. Burke, et al. (1992) re-analyzed the data set of Oprescu, et al. (1991) as well as some new observations, and reported a new quadratic ephemeris representing a continuously changing period.

I observed 44 i Bootis on six nights from May 1990 through May 1992, obtaining 14 new photoelectric records of 8 eclipse minima (5 primary, 3 secondary) as shown in Table 1. The observations were made from Running Springs, CA, USA (elevation = 1870m) using a 35cm Schmidt-Cassegrain telescope and an Optec SSP-3 photometer. Johnson B and V filters were used for all nights except JD 2448058 which was in V only. A PC-based data acquisition system (Jones, 1991) recorded all integrations along with the mean time of each integration accurate to ± 1 second. Data reduction was by conventional methods to extinction-corrected differential instrumental magnitudes vs. the comparison star 47 k Bootis. No check star was used. Epochs of minimum were determined graphically by the method of bisection of chords. The error estimates in Table 1 are the standard deviations of the midpoints of the chords. The data are available from the IAU Archives as file number 250E.

Table 1. Observations

UT	HJD (+2400000)	FLTR	TYPE
06 May 90	48017.8247 ± 0.0008	B	II
	48017.8252 ± 0.0007	V	II
	48017.9584 ± 0.0003	B	I
	48017.9588 ± 0.0004	V	I
16 June 90	48058.8007 ± 0.0005	V	II
	48058.9354 ± 0.0012	V	I
02 July 90	48074.7360 ± 0.0002	V	I
	48074.7362 ± 0.0009	B	I
15 May 91	48391.8320 ± 0.0002	V	I
	48391.8327 ± 0.0009	B	I
19 April 92	48731.8291 ± 0.0011	V	II
	48731.8297 ± 0.0004	B	II
02 May 92	48744.8179 ± 0.0003	V	I
	48744.8182 ± 0.0003	B	I

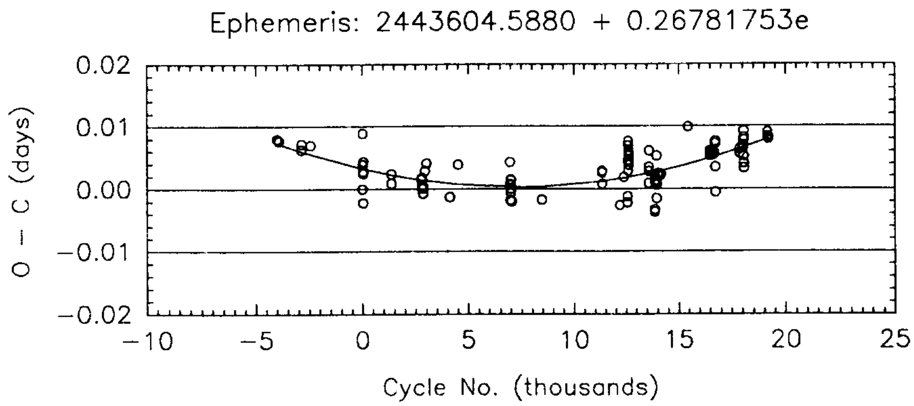

Fig. 1. O-C plot for 44 Bootis, resulting from the "pre-1987" linear ephemeris of Oprescu et al. (1989). The solid line represents a parabolic fit described by eq. 1 which was used to derive the new quadratic ephemeris of eq. 3.

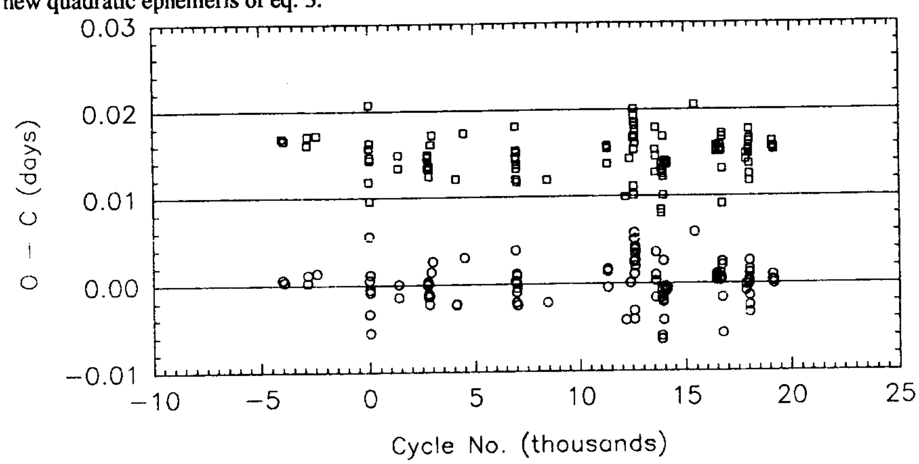

Fig. 2. O-C plot for 44 Bootis. Circles represent points calculated using eq. 3, squares represent points calculated using the quadratic ephemeris of Burke, et al. (1992).

When I attempted to check the new times of minimum in Table 1 against the ephemeris of Burke, et al. it appeared that the initial epoch of that ephemeris was in error. I therefore repeated the analysis by Burke, et al. but with slightly different initial assumptions. They disregarded minima in the data set of Oprescu, et al. (1991) prior to JD 2443604 whereas those points were included in this analysis. I have also included the new observations listed in Table 1. The most important difference is that Burke, et al. assumed that the initial epoch used by Oprescu, et al. was "grossly in error". I believe instead that the discrepancy resulted from the incorrect assumption by Oprescu, et al. that the same initial epoch can be valid both before and after a sudden period change. If one accepts that the "post-1987" line in fig. 2 of Oprescu, et al. (1991) represents an instantaneous period (that is, a line tangent to the curve which accurately describes the period change), then both the initial epoch and the period can be valid. Otherwise, as noted by Burke, et al., one must reject the ephemeris on the grounds that the graph is inconsistent with the reported initial epoch.

Figure 1 was plotted using the "pre-1987" ephemeris of Oprescu, et al. All of the values are plotted individually, that is, minima of the same epoch in different filters are not collapsed to means. The solid line in Fig. 1 represents the result of a parabolic least-squares fit which yields the function:

$$f(e) = \underset{\pm 6.58\times10^{-12}}{5.45\times10^{-11}}\,(e^2) - \underset{\pm 1.2\times10^{-7}}{8.0\times10^{-7}}\,(e) + \underset{\pm 4.87\times10^{-4}}{3.272\times10^{-3}}. \tag{1}$$

Adding the assumed linear ephemeris

$$\text{Pr. min.} = 2443604.5880 + 0^d.26781753\,(e) \tag{2}$$

to equation 1 yields the corrected nonlinear ephemeris:

$$\text{Pr. min.} = \underset{\pm .0005}{2443604.5913} + \underset{\pm .00000012}{0^d.26781673}\,(e) + \underset{\pm 6.58\times10^{-12}}{5^d.45\times10^{-11}}\,(e^2). \tag{3}$$

The errors are standard errors from the least-squares fit.

Fig. 2 is the data set of Fig. 1, where open circles represent points calculated using eq. 3, and open squares are points calculated using the quadratic ephemeris of Burke, et al. The latter are clearly shifted systematically by an error in initial epoch, although the coefficients of the e and e^2 terms in their quadratic ephemeris are consistent with mine, within the respective standard errors. Eq. 3 provides a good fit to the data, with only a small shift in the initial epoch of Oprescu et al. imposed by the least-squares process, leading to the conclusion that the initial epoch of Oprescu et al. was in fact, essentially correct (O-C = -0.0033).

As noted by Burke, et al., evaluating the derivative of the quadratic ephemeris at some epoch yields a value for the instantaneous period at that epoch. To use Burke, et al.'s example, at E = 18054, eq. 3 yields a value of $P = 0^d.26781870$, close to the value reported by Oprescu, et al. For the "pre-1987" period, solving the derivative of eq. 3 at the initial epoch predicts a slightly shorter period than that reported by Oprescu, et al. (1989).

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