COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 1798

Konkoly Observatory
Budapest
1980 June 3

93 LEONIS: A NEW VARIABLE STAR

The bright ($V = 4^{m}.5$) star 93 Leonis is a long-period RS CVn binary with a spectral type of A + G5 IV-III according to Batten et al. (1978) and an orbital period of $71^{d}.70$ according to Cannon (1910). Young and Koniges (1977) quote a spectral type of F8 IV but note that a secondary component in the spectrum, probably the cooler star, is responsible for the moderately strong Ca II H & K emission.

To look for the photometric distortion wave characteristic of so many other RS CVn binaries, we observed 93 Leo photoelectrically in 1976 and in 1979. The 1976 observations, by Landis, revealed no variation larger than $\pm 0^{m}.01$, as reported by Heiser (1978), but the 1979 observations did show 93 Leo to be variable, with an amplitude around $0^{m}.03$.

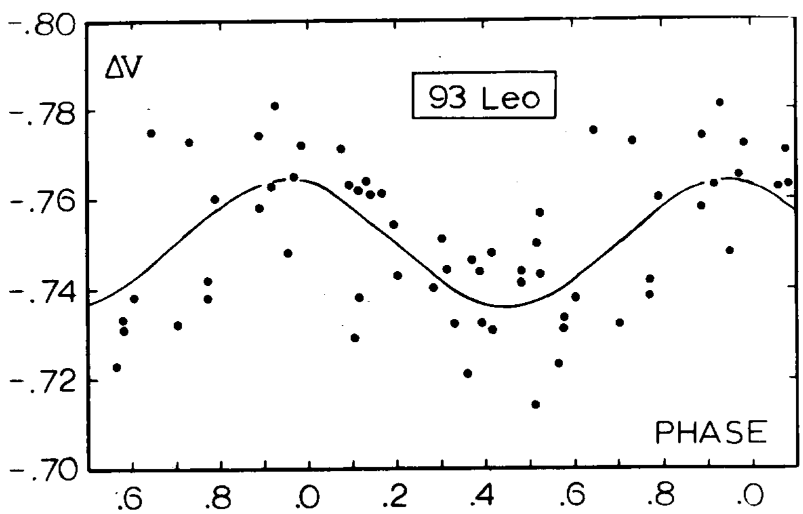
We observed 93 Leo differentially with respect to the comparison star 92 Leo mostly in one color. Landis had observed on 14 nights in 1976 between JD 2,442,871.6 and 2,442,937.6. Louth, Montle, Skillman, and Vaucher observed on 44 nights in 1979 between JD 2,443,906.9 and 2,444,043.6, almost two cycles of the $71^{d}.7$ orbital period. Details of the observations at Dyer are given by Vaucher (1979). The individual differential observations, generally three on each night, were corrected for differential atmospheric extinction with nightly extinction coefficients at Dyer but mean coefficients at the other observatories. Then they were transformed to V of the UBV system with known transformation coefficients and a mean color difference of $\Delta(B-V) = -0^{m}.41$, where Δ is in the sense 93 minus 92 Leo. At Dyer observations were obtained also in B of the UBV system, but they are not presented here.

On 8 nights in 1979 at Dyer the comparison star 92 Leo was observed 17 times differentially with respect to the check star HR 4505. There was no indication of significant variability of one respect to the other, the standard deviation of a single observation from the mean being ± $0\overset{m}{.}005$ in V and ± $0\overset{m}{.}009$ in B.

Nightly means of the 1979 ΔV magnitudes are plotted in the Figure versus phase computed with the ephemeris

$$\mathrm{JD(hel.)} = 2{,}418{,}017.865 + 71\overset{d}{.}70 \cdot n \ ,$$

where the epoch is a time of conjunction (the A-type star behind) derived from the time of periastron given by Cannon (1910) and the period is that used by



Cannon in his determination of the spectroscopic orbit. We used Fourier analysis to express the light as

$$\ell = A_0 + A_1\cos\theta + A_2\cos 2\theta + B_1\sin\theta \ ,$$

where unit light corresponds to $\Delta V = -\ 0\overset{m}{.}750$. The Fourier fit appears as the curve in the Figure. The resulting coefficients are given in the Table below.

	1976	1979
A_0	0.9739 ± 0.0022	1.0000 ± 0.0019
A_1	+0.0055 ± 0.0033	+0.0122 ± 0.0025
A_2	+0.0012 ± 0.0032	+0.0015 ± 0.0028
B_1	+0.0011 ± 0.0031	−0.0038 ± 0.0028

The variation we see in 1979 is probably a distortion wave, with a full amplitude of $\Delta V = 0^m.028 \pm 0^m.005$ and a minimum at $0^P.452 \pm 0^P.034$. Seeing this variability prompted us to look again at the 1976 photometry. Fourier analysis of those observations resulted in the coefficients shown also in the Table. The distortion wave was probably there in 1976 also because, although its amplitude of $\Delta V = 0^m.013 \pm 0^m.007$ was smaller and significant at only the 2σ level, its minimum at $0^P.532 \pm 0^P.087$ was at the same phase, within the uncertainties. A final curiosity is the smaller value of A_0 in 1976, indicating a mean light level almost $0^m.03$ fainter than in 1979. Any uncertainty in the transformation of Landis' data should have produced a systematic error of only $\pm 0^m.005$.

We can probably say with confidence that the differential reflection effect cannot be producing this variation. For one reason, measurable reflection would be unlikely in such a long-period binary. For a second reason, its amplitude may be variable. And for a third reason, maximum light occurs around phase $0^P.0$, when the A-type (presumably the hotter) star is behind. In making this last statement we are assuming the uncertainty in Cannon's $71^d.70$ period is around $\pm 0^d.01$, in which case phases in our Figure would be uncertain by only $\pm 0^P.05$. If the uncertainty is much larger, then we have lost our fix on the phasing, because the vanishingly small A_2 coefficients can provide no help.

D.S.H. is happy to acknowledge that part of this work was supported by N.A.S.A. research grant NSG-7543.

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