COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 1508

Konkoly Observatory
Budapest
1978 November 27

16 LACERTAE: A β CEPHEI VARIABLE IN AN ECLIPSING SYSTEM

Over one-quarter of a century ago Walker (1951) discovered that the single-line spectroscopic binary 16 Lacertae (Struve and Bobrovnikoff 1925) is also a β Cephei variable. Since then several extensive series of observations of the star, both photometric and spectrographic, were obtained by Walker (1952, 1954), Struve et al. (1952), and McNamara (1957). A detailed analysis of these data was performed by Fitch (1969). He found that the β Cephei-type light and radial velocity variations of 16 Lacertae consist of at least three sine-wave components. The frequencies, in order of decreasing amplitude of the corresponding components, amounted to 5.91134, 5.85286, and 5.49990 cycles per day. Moreover, from the night-to-night radial velocity variation Fitch (1969) determined the period of the orbital motion as equal to $12^{d}.097 \pm 0^{d}.001$ (i.e., the orbital frequency = 0.0826 ± 0.00001c/d), and somewhat improved the orbital elements, previously given by Struve et al. (1952). Unfortunately, the question whether there are any light variations correlated with the orbital motion could not be answered, because all photometric observations of 16 Lac available at the time have been obtained with the same comparison star, 14 Lacertae, which is variable on a time scale of the order of a few days (Walker, 1953).

16 Lacertae was observed by Jerzykiewicz on 31 nights in August, September, and October, 1965. The observations were taken at the Cassegrain focus of the Lowell Observatory's 21-inch reflecting telescope with a conventional UBV photometer and standard D.C. equipment. 2 Andromedae was used as a comparison star. The results of a preliminary periodogram analysis of the

B magnitude observations (Jerzykiewicz,1976) can be summarized as follows. The existence of the three sine-wave components in the light variation of the star is confirmed. The primary frequency turns out to be essentially the same as that determined previously by Fitch (1969), while the frequencies of the two fainter components both differ by about one cycle per year from the values obtained previously. Moreover, the mean brightness of the star appears to be very nearly constant on all nights, except on JD 2439054. This night is also the only one in 1965 during which the observations deviate significantly from the synthetic light-curve, computed as a sum of the three above-mentioned sine-wave components.

A comparison of the B observations of 16 Lacertae on JD 2439054 with the synthetic light-curve is shown in Fig. 1. At the beginning of the night, around JD 2439054.59 the star appears to be about $0^{m}.040$ fainter than expected. Then the deviations gradually decrease, becoming insignificantly small at about JD 2439054.75.

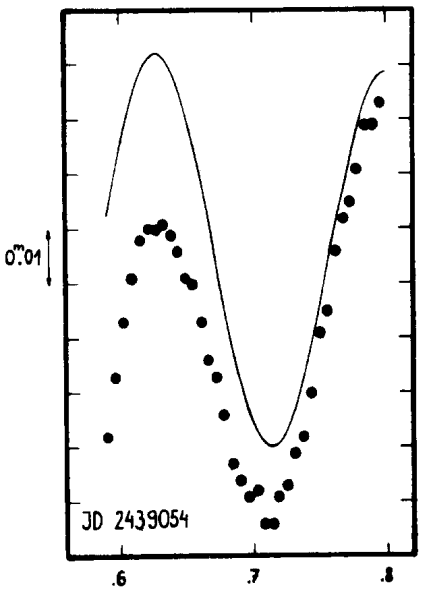

Fig.1. A comparison of the B magnitude observations of 16 Lacertae on JD 2439054 (points) with the 1965 synthetic light-curve (solid line). The observations were obtained at the Lowell Observatory.

In the autumn of 1977, between about the middle of September and the end of October, we secured nearly 470 photoelectric observations of 16 Lacertae on 18 nights. The observations were carried out at three different locations, two in Europe, viz., Białków station of the Wrocław University Observatory and the Mt. Chiran station of the Haute Provence Observatory, and one in Mexico, at San Pedro Mártir, Baja California (National University of Mexico Observatory). The observers were Jerzykiewicz and Musielok in Białków, Jerzykiewicz and Le Contel at the Mt.Chiran station (the night assistant was José Daguillon), and Jarzębowski in San Pedro Mártir. All observations were taken in blue light. 2 Andromedae was used as a comparison star.

A periodogram analysis of the 1977 photometry of 16 Lacertae has already been completed. The three sine-wave components were again found to be present in the light variation, but with the amplitudes considerably smaller than in 1965. The synthetic light-curve determined from all observations fits the data to within the observational errors on most nights. For the sake of illustration observations on two such nights are displayed in Fig.2 (top). However, on the night JD 2443433, shown in the bottom of Fig.2, the observations deviate from the synthetic light-curve in a similar way as they have done on JD 2439054 in 1965. The deviations are greatest for two points around JD 2443433.63,i.e. the first observations obtained on this night from San Pedro Mártir.

Now, the difference between the moments of the greatest deviations in 1977 and 1965, JD 2443433.63 minus JD 2439054.59, divided by the spectroscopic orbital period of $12^{d}.097$, turns out to be equal to 361.99, i.e., very nearly a whole number.Moreover, a comparison with the orbital-velocity variation, as determined by Fitch (1969), shows that the orbital phase corresponding to JD 2439054.59 falls on the descending branch of the velocity curve, at the point where it crosses the γ-axis. We conclude, therefore, that the deviations of the observed brightness of 16 Lacertae from the synthetic light-curves, seen on JD 2439054 and JD 2443433, are caused by an eclipse of the star by the companion, taking part in the $12^{d}.097$ orbital motion.

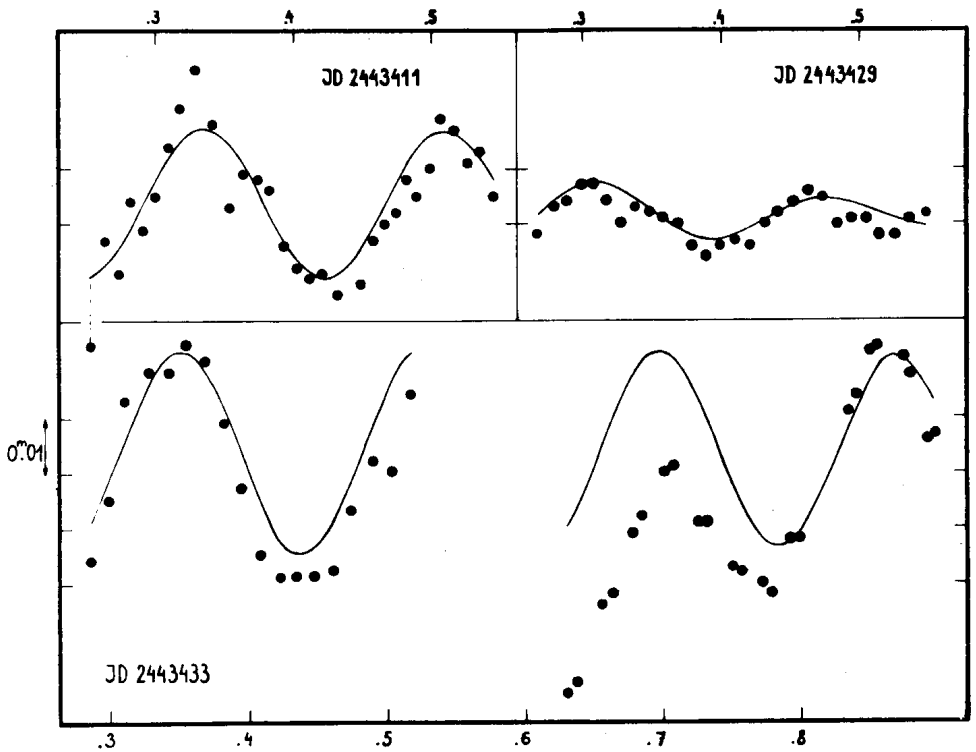

Fig.2. A comparison of the blue-light observations of 16 Lacertae on three nights in 1977 (points) with the 1977 synthetic light-curve (solid lines).The observations on JD 2443433 (bottom) were obtained at the Mt. Chiran station of the Haute Provence Observatory, France (left) and at San Pedro Mártir, National University of Mexico Observatory, Mexico (right).

The depth of the eclipse amounts to about $0^m.040$, and the duration of the eclipse can be estimated as equal to $0^d.4$.

As far as we are aware, 16 Lacertae is the first β Cephei variable found to be a component in an eclipsing system.

M. JERZYKIEWICZ
T. JARZĘBOWSKI
B. MUSIELOK
Wrocław University Observatory
ul. Kopernika 11
51-622 Wrocław
Poland

J.M. LE CONTEL
Observatoire de Nice
B.P. 252
06007 Nice Cedex
France

References:

Fitch, W.S. 1969, Ap.J. 158, 269
Jerzykiewicz, M. 1976 in Multiple Periodic Variable Stars, W.S.Fitch ed. (Budapest, Academic Press), 2, 39
McNamara, D.H. 1957, Ap.J. 125, 684
Struve, O., and Bobrovnikoff, N.T. 1925, Ap.J. 62, 139
Struve, O., McNamara, D.H., Kraft, R.P., Kung, S.M., and Williams, A.D. 1952, Ap.J. 116, 81
Walker, M.F. 1951, P.A.S.P. 63, 35
Walker, M.F. 1952, Ap.J. 116, 106
Walker, M.F. 1953, Ap.J. 118, 481
Walker, M.F. 1954, Ap.J. 120, 58