RESULTS OF GEOS OBSERVING PROGRAMS

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Abstract

The Groupe Européen d'Observations Stellaires (GEOS) program is described briefly, and ephemerides and light curves are given for the RRab star NSV 4285 Cnc and the eclipsing star BG Lyn (RRVI-51 Lyn).

1. Introduction

The Groupe Européen d'Observations Stellaires (GEOS) is an international European group of amateur and professional astronomers devoted to the observation and study of variable stars. One of its exciting aspects is the visual monitoring of suspected variable stars and named ones lacking reliable published elements. Some of us have concentrated on periodic stars of supposed short period, especially those classified E?, RR?, S?, and IS?.

2. Observations

2.1. Method

We mainly use the Argeländer or the fractional method, or a mixture of these, to estimate the brightness of the star. Along with the date and time (UT), the estimates are recorded in the form A (x) V (y) B , where "x" and "y" are the steps (defined by whatever method used) between stars A, V, and B, and "V" is the variable.

The comparison stars, A and B, are to be chosen by the observer, but a definitive sequence is set after discussion with other observers. The magnitudes of the comparison stars are often unknown. A value is determined by comparison with other reference stars of another variable star in the surroundings, or by using a scale expressed in tenths of a magnitude, or even an arbitrary scale. One must not forget that the main purposes are the confirmation of the variation and type, and the search for a possible period. Several observers could present their own observations with different scales; the most important features are the extremes, which should allow the computation of a period.

As the stars observed are supposed to vary quite rapidly, several hours of monitoring are needed each night to confirm (or not) the rapid variations, find the amplitude, and to collect enough data to search for the star's period, if it has one. With stars of large amplitude (at least 1 magnitude), we prefer to use a simple least-squares method. On the other hand, we use more sophisticated programs for more complicated cases, especially when a pulsation period exceeds several days.

We observe stars with amplitudes greater than 0.4 magnitude, but in fact the detection of small-amplitude variations (less than 1 magnitude) is not very difficult, if you can use suitable comparison stars with one almost matching the mean brightness of the suspected variable star. For more information about the visual detection of small amplitude variables, see Cerada *et al.* (1988).

In general we are lonely observers, but sometimes we gather at a place for several nights of observation, where we observe the same stars with a severe rule: no comments on the behavior of the stars during the observing session. When some of the stars studied need some confirmation or more precise data, we try to participate or to organize a photoelectric mission to a professional observatory in Europe. Below are two examples of stars observed and studied by GEOS.

2.2. NSV 4285 Cnc

Discovered by Weber (1962), the star was listed in the *New Catalogue of Suspected Variable Stars* (Kukarkin 1982) as a star with rapid variation. Its coordinates are: $8^h 40^m 56^s$, $+24^\circ 00'$ (1950.0). See Figure 1 for a finder chart.

The visual observations began in 1983. During the first night, it became obvious that the star was indeed varying rapidly. Only a few nights were necessary to define the RRab type. By 1989, nineteen GEOS observers had performed 2,200 estimates and recorded 66 maxima. Figure 2 presents the composite light-curve made by the author using more than 800 visual estimates, compared with the photoelectric V curve, described below. From that figure, one can notice the very good agreement in phase between the two curves. More worrisome is the scattering of the visual curve, especially around the minimum light. It could be an astrophysical, a psychological, or an atmospheric effect. As is true of most RRab stars, the light curve of NSV 4285 shows the Blazkho effect, which distorts the light curve in phase and in brightness. A more important effect is the way the observer expresses the brightness of the variable when it matches a comparison star. In Figure 2, it is obvious that the observer sometimes notes the brightness of the variable as equal to the comparison (arrows), but never notes correctly the variable to be just a little more or less bright than the comparison star. That fact was noticed long ago, and affects many observers. It is clearly seen on composite light curves constructed from many estimates, where it appears as two empty spaces just above and below the brightness of each comparison star. Also if visual observations, made during several hours in a single night, are not corrected for differential absorption, it could affect especially the bluer stars, if the comparison stars are not of the same color. These all may account for the scattering of this light curve. Figure 3 presents the 100 mean points from the same visual light curve.

During two photoelectric missions at the end of 1987 and 1988, seventy-nine measures in B and V were recorded by GEOS members using a cooled photometer equipped with filters of the Geneva photometric system, attached to the Jungfraujoch Observatory's 76-cm telescope. Transformation of the B-V values from Geneva system into Johnson and Morgan's system was done using Meylan and Hauck formulae (1981). The V amplitude reached 1.0 magnitude (see Figure 2).

All the data now allow us to publish a preliminary ephemeris for NSV 4285:

$$\mathrm{Max}(\mathrm{JD}_{\mathrm{hel.}}) = \underset{\pm 0.003}{2447153.696} + \underset{\pm 0.000002}{0.545785}\,E \qquad (1)$$

The error limits were calculated for a 95% level of confidence.

From time to time, other observations will be needed to check the ephemeris, and it would be interesting to do the same with many other RR Lyrae or eclipsing stars.

2.3. BG Lyn (RRVI-51 Lyn)

Discovered by Kinman *et al.* (1982) during a search for RR Lyrae stars towards the galactic anticenter, BG Lyn was classified as an EA? eclipsing, based on 63 photographic plates. These photographic observations range from magnitude 10.70 to 12.60 with a mean at 11.20. However, the star was too bright for the 20-inch Lick astrograph, so the measures are somewhat imprecise. Its coordinates are: $7^h 53^m 03^s$, +40° 50.9 (1950.0). See the finder chart in Figure 4. From 1983 to 1987, eleven GEOS observers made about 1,000 visual estimates.

After several nights, it became clear that the star was indeed an eclipsing binary with a period of 1.2 days, but not of the EA type. The brightness variations were found to be continuous with minima of unequal amplitude (like EB systems) and a maximum amplitude a little less than 1.0 magnitude. Using 17 primary minima, determined by the tracing paper method, a preliminary ephemeris was calculated.

To check the validity of this preliminary ephemeris, we have made a composite light curve with the photographic observations (see Figure 5). A primary minimum, clearly visible, is shifted around phase 0.97, but there is no evidence for a secondary one. For more information, see Dequinze (1990). A mean visual light curve of 40 mean points was computed using the final ephemeris and 455 estimates from the author. The nearly sinusoidal shape of the curve reinforces the EB type for the star (see Figure 6).

Three photoelectric missions at the end of 1987, 1988, and 1989, organized by GEOS at Jungfraujoch Observatory in Switzerland, have recorded 227 measures in B and in V, using a cooled photomultiplier photometer equipped with filters of the Geneva photometric system, attached to the 76-cm telescope. Transformation of the B-V values from the Geneva system into Johnson and Morgan's system was done using the Meylan and Hauck formulae (1981). The shape of the V light curve confirms the visual observations; the amplitude reached 0.89 magnitude for the primary minimum and 0.33 mag. for the secondary one (see Figure 7). The B-V index light curve (see Figure 8) shows clearly that the system is composed of two early type-A stars. The bluer and hotter component is occulted by the secondary during the primary minimum; the total amplitude of the color index is small (0.13 magnitude). When unocculted, the system seems a little redder and fainter before primary minimum than after.

New photoelectric data now allow us to improve the preliminary ephemeris for BG Lyn published by Dequinze (1990). The error limits were calculated for a 95% level of confidence.

$$\text{Min (JD}_{\text{hel.}}) = \begin{array}{ccc} 2442776.961 & + & 1.199839\,E \\ \pm 0.007 & & \pm 0.000005 \end{array} \qquad (2)$$

References

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Kholopov, P. N. *et al.*, 1982, *New Catalogue of Suspected Variable Stars,* Moscow.

Meylan, G., Hauck, B. 1981, *Astron. Astrophys. Suppl. Ser.*, **46**, 281.

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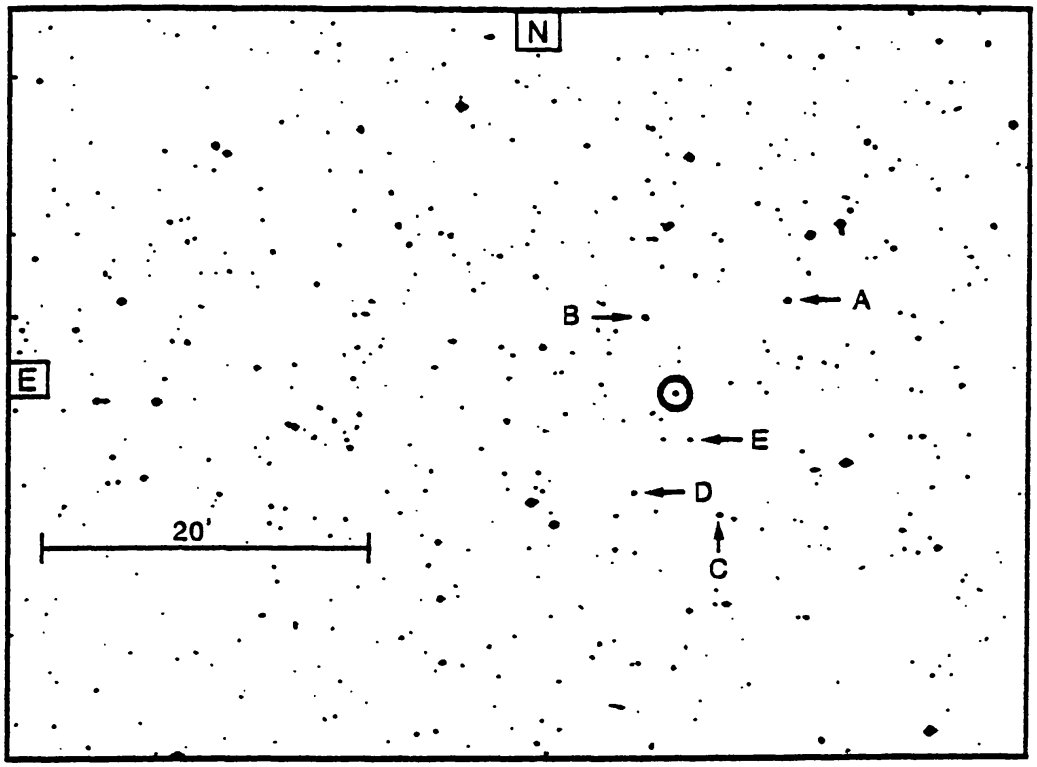

Figure 1. NSV 4285 and its comparison stars. Adapted from *Atlas Stellarum*, H. Vehrenberg.

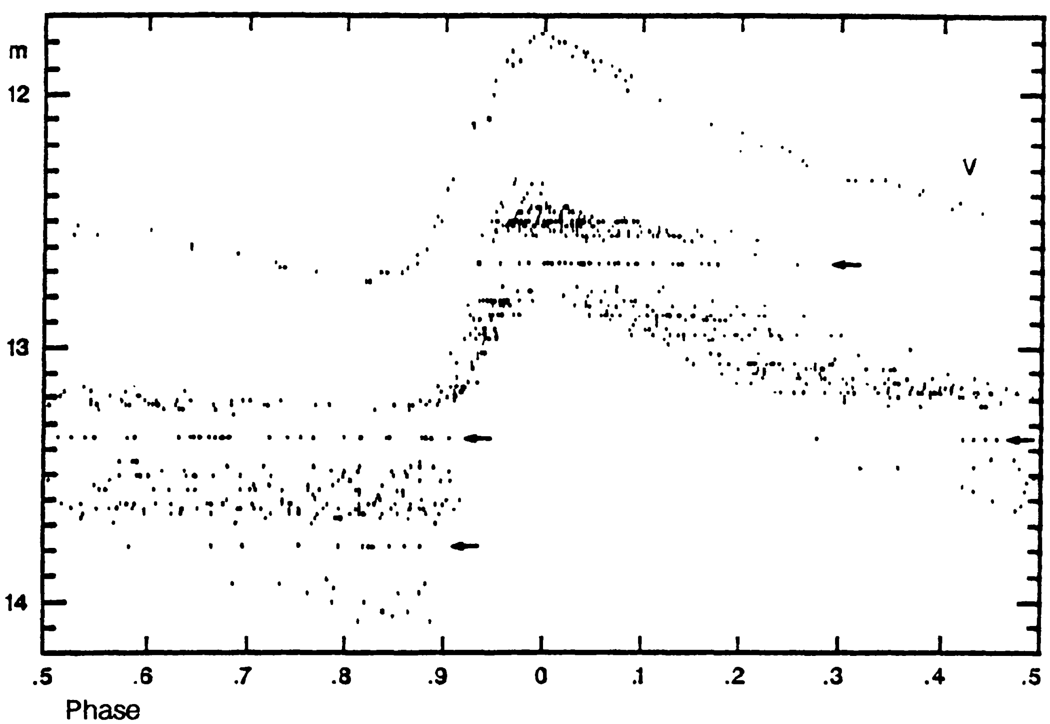

Figure 2. Composite light curves of NSV 4285, from 800 visual estimates made by the author, compared with the V curve made at Jungfraujoch Observatory (Switzerland).

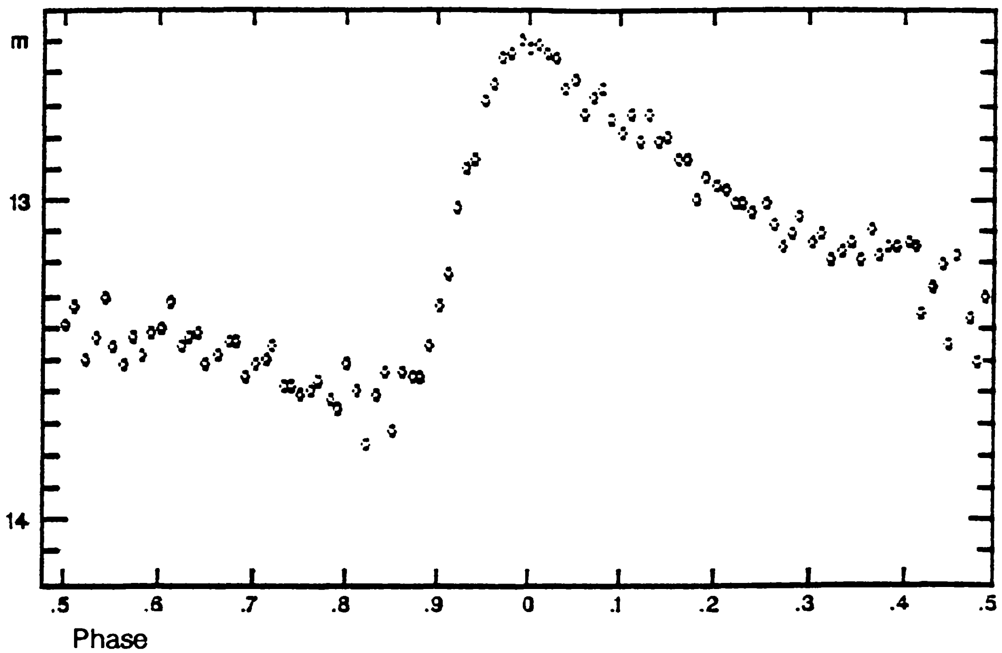

Figure 3. NSV 4285, mean visual light curve made from 800 estimates made by the author.

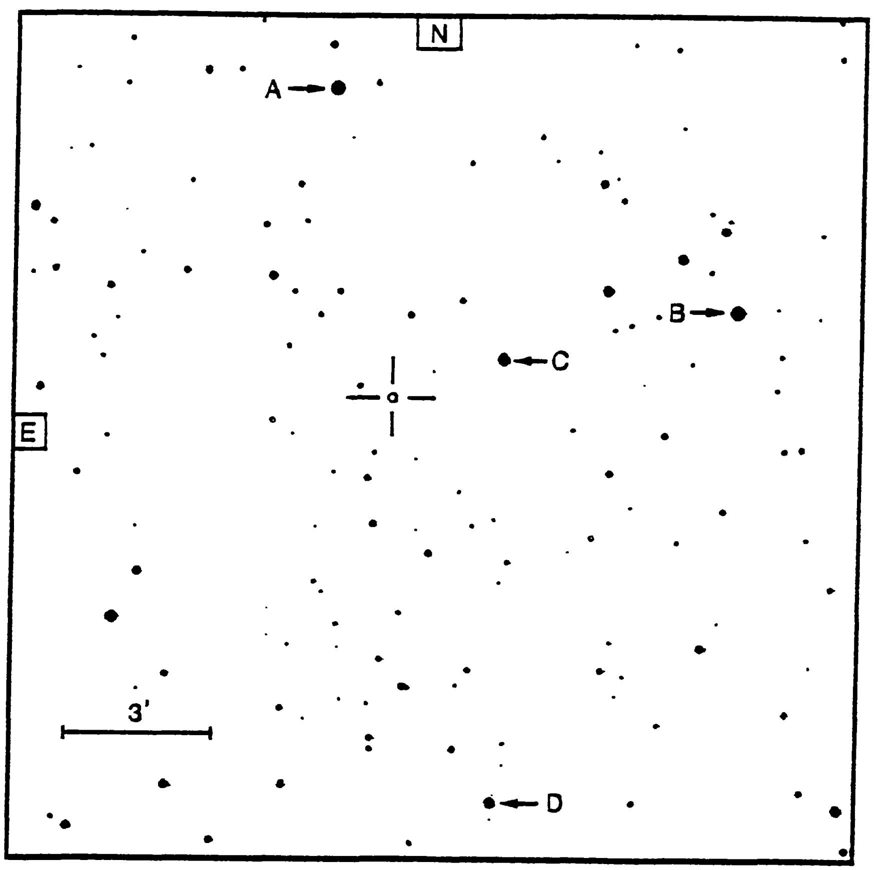

Figure 4. BG Lyn (RRVI-51 Lyn) and its comparison stars. Adapted from Kinman *et al.* 1982.

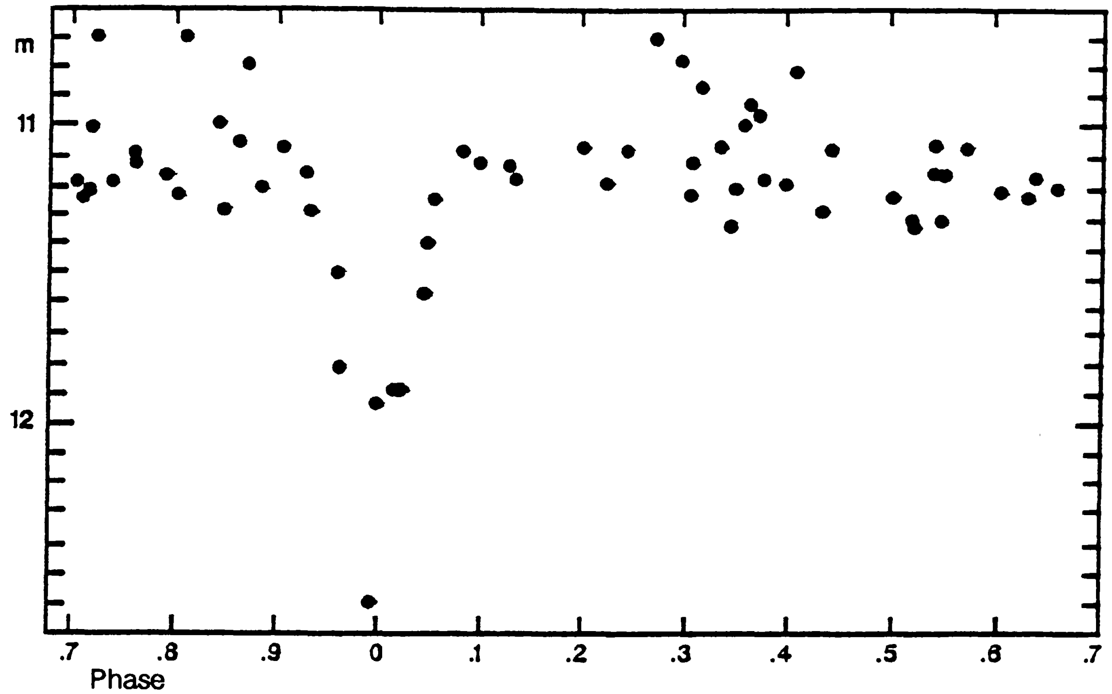

Figure 5. Photographic curve of BG Lyn (RRVI-51 Lyn) compiled from 63 plates (Kinman *et al.* 1982), using equation (1). No secondary minimum is visible.

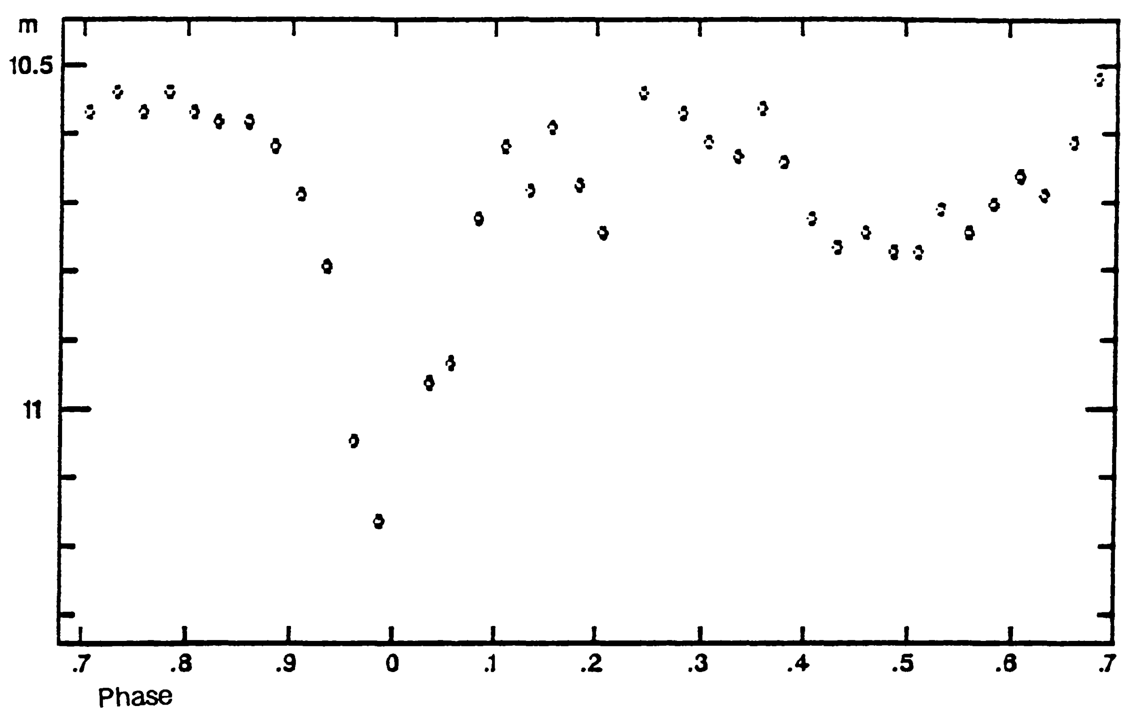

Figure 6. Mean composite light curve of BG Lyn (RRVI-51 Lyn) made from 455 visual estimates made by the author.

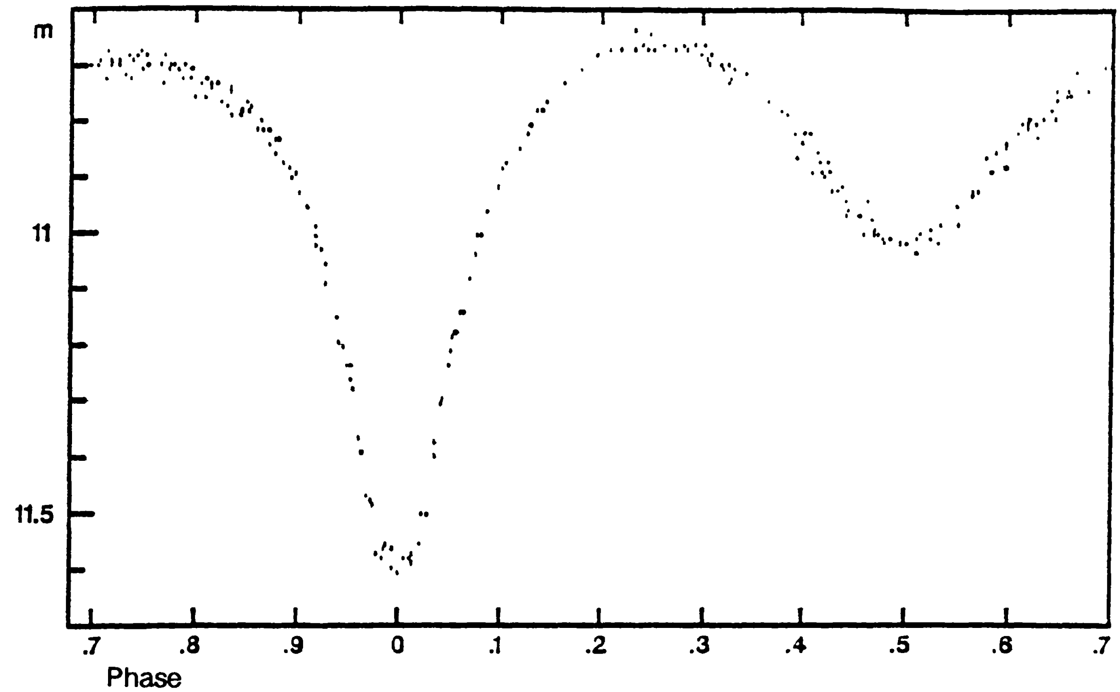

Figure 7. Photoelectric V curve of BG Lyn (RRVI-51 Lyn) made at Jungfraujoch Observatory.

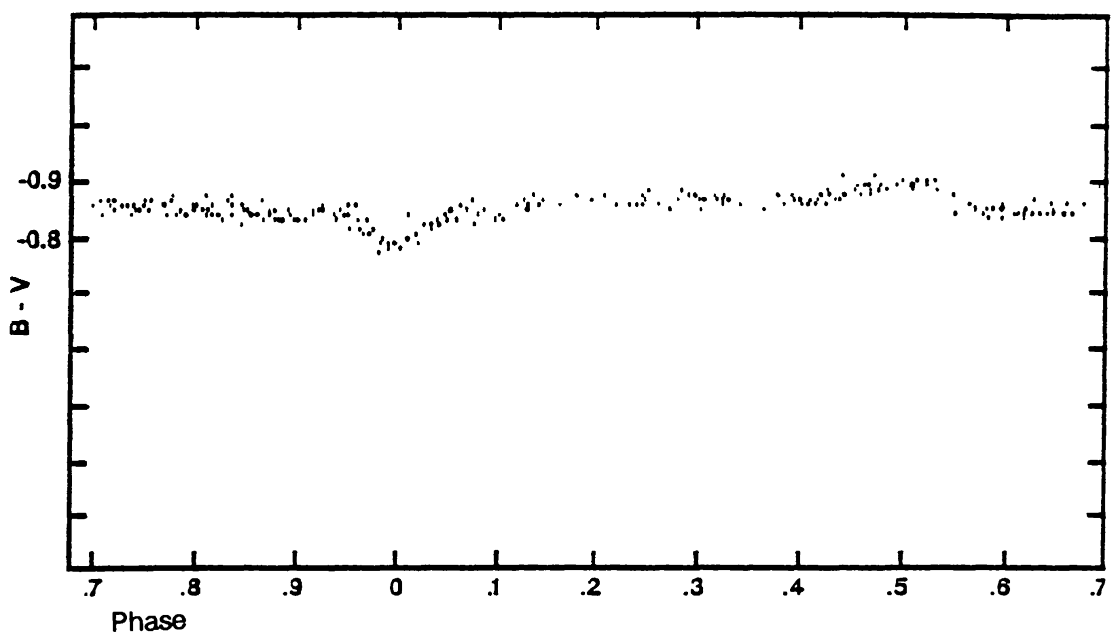

Figure 8. B-V index curve of BG Lyn (RRVI-51 Lyn).