HD 101947—the First Very-Long-Period Classical Cepheid in Our Galaxy?

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The ESO observatory on La Silla is not just a place where you go to observe—it is also an important meeting place for European astronomers. Many papers with co-authors from different institutes have resulted from encounters over a cup of tea and a "completo". This was also the beginning of the long collaboration between Drs. Walter Eichendorf from the Astronomical Institute in Bochum, FRG, and Bo Reipurth from the Copenhagen Observatory, Denmark. Over a period of several months, they continued to observe a star that later turned out to be unique among the Cepheids in our galaxy.

The Danish, German and Swiss telescopes on La Silla are often used by "national" observers spending several months on the mountain—in contrast to most other ESO observers. This means that a huge observational material can be secured for a programme, and also that such an observer at times can be recognized on the black circles around his eyes at the end of an observing run. But it also means that different types of programmes can be initiated, for example the study of very long-periodic phenomenae.

Meeting on La Silla and recognizing this fact, we incorporated each night, in our respective photometric and spectroscopic programmes, observations of the bright, 5^m yellow supergiant HD 101947, which Fernie (*IBVS* No. 1305) from observations on a few nights suspected to be a Cepheid with the long period of one month. Our observations have shown this to be a conservative estimate: We now believe HD 101947 is an extremely long-period low-amplitude classical Cepheid with a period of 125 days, thus making it by far the longest-period Cepheid hitherto known in our galaxy. In addition, this star may be especially important for Cepheid research, because of its membership in the small young open cluster Stock 14, which has been observed by two Bochum observers, A. F. J. Moffat and N. Vogt, in their study of southern open star clusters.

All classical Cepheids known today in our galaxy have periods ranging from 2 to 40 days, most of them falling in the period range between 4 and 8 days. In the Magellanic Clouds, however, Cepheids have been found with periods up to hundreds of days. A few searches for such Cepheids have been carried out in our galaxy—with no success so far. Of course, heavy selection effects work against the discovery of these stars in our galaxy, in particular, if their amplitudes are small. Recently several investigations based on Cepheids have been published on possible systematic differences between galaxies. Such differences, which might be due to chemical differences, could even influence the calibration of the extragalactic distance scale.

Observations on La Silla

Between February and July 1978, HD 101947 was observed with the Danish 50 cm and the Bochum 61 cm telescopes on La Silla, photometrically and spectroscopically with the Strömgren photometer and the Bochum spectrum scanner. Part of the observations were kindly performed by our successors after we left La Silla. As one result, we present

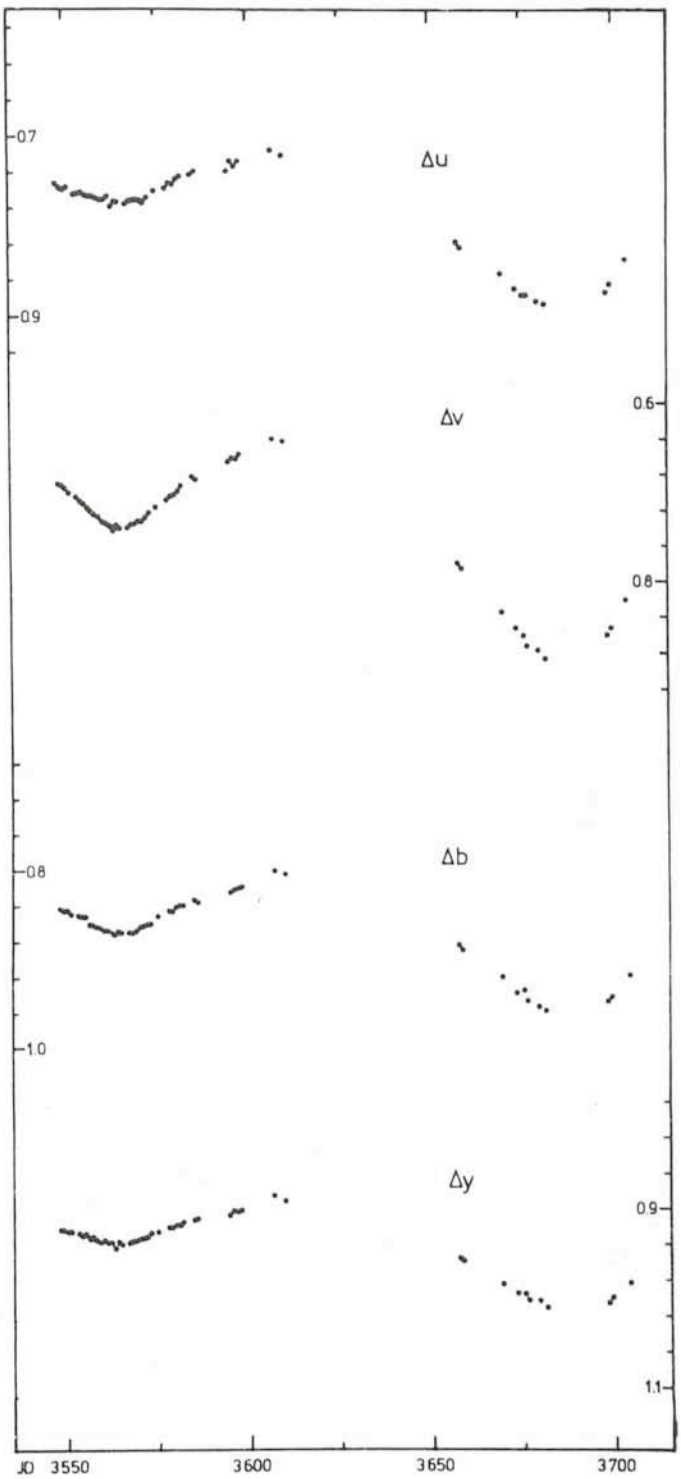

Fig. 1: *The uvby lightcurve of HD 101947, which after the work described here has been named V 810 Centauri. The diagram covers half a year from January to July 1978.*

here the differential uvby lightcurves (HD 101947 – HD 102350 in the instrumental system). Figure 1 covers half a year. The internal accuracy of all measurements is better than 0.005.

We have observed two minima, and because of the very smooth behaviour of the light variations we can fairly safely exclude that another minimum happened during the gap in the observations. Therefore the period of the light variations of HD 101947 appears to be about 125 days, with maximum amplitudes ranging from 0.13 in y to 0.24 in v.

During the first descending branch and minimum of the lightcurve we obtained blue and red scanner spectra as well as H α line profiles. On all spectra a clear H α emission in the absorption core is seen, shifted redwards about 1.5 Å. A careful check did not reveal any variations in the spectra.

The Nature of HD 101947

It will obviously take some time to find out whether the lightcurve is really periodic, and we shall here assume that it repeats, a suggestion that may find some support in the very smooth light changes. Without going into details here, we found it very improbable that HD 101947 is a binary with ellipsoidal variations, a SRd star or a RV Tauri star. The spectral type, the luminosity class, an increasing blueness with increasing brightness and the H α emission at least at certain phases are all characteristics of long-period Cepheids. Also the low galactic latitude of $b = -0°38'$ is typical for these stars. A period of 125 days gives an absolute magnitude of -8.3 in Sandage and Tammann's period-luminosity relation, in good agreement with the value of -7.9 we get from the distance of Stock 14.

Using a theoretical HR diagram from Cox and Hodson (IAU Symposium No. 80) we find HD 101947 situated on the blue edge of the Cepheid instability strip with nearly perfect agreement between the theoretically expected and the observed period.

Two features of the lightcurve cannot be readily explained: the small amplitudes, and the changing amplitudes. Concerning the first point we have already noted that perhaps different chemical compositions would give Magellanic Cloud long-period Cepheids large amplitudes, and galactic ones small amplitudes. Or, being situated on the blue edge of the instability strip, HD 101947 may be a first overtone pulsator, for which smaller amplitudes are theoretically expected, and it may even be switching to the fundamental mode. Also, it has recently been found that resonance phenomena may be effective for long-period Cepheids. For example, the small amplitudes might result from a coupling of a damped first overtone pulsation with an excited fundamental mode. The problem of changing amplitudes could perhaps also be understood as double-mode pulsations, which are known from short-period Cepheids.

The discovery of more stars in our galaxy behaving like HD 101947 may help to solve this question. For other galaxies, finding stars with amplitudes of only 0.2 over months may be rather difficult at the moment.

Stock 14 and IC 2944

The young, loose, open cluster Stock 14 is situated at a distance of approximately 2.5 kpc on the inner side of the Carina spiral feature. Only 1 degree away is the cluster and large H II region IC 2944. At the IV. European IAU meeting in Uppsala A. Ardeberg and E. Maurice reported that IC 2944 actually consists of at least seven aggregates

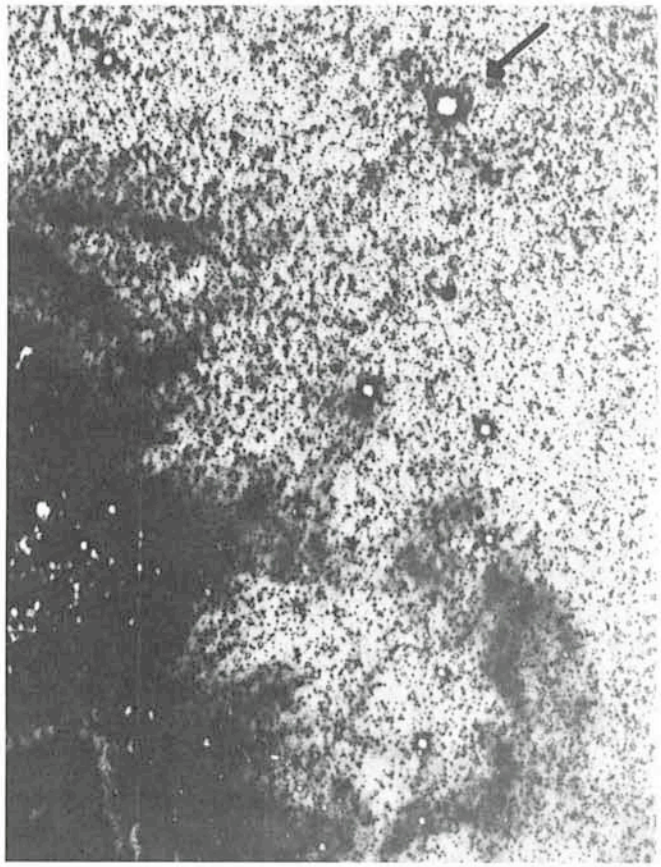

Fig. 2: *An equidensity-picture of the region around IC 2944 and Stock 14 in red light. North is on top. In the lower left the large H II region IC 2944 is seen; the bright star indicated by an arrow is HD 101947. It is evident that IC 2944 extends at least to a very small angular separation from Stock 14.*

This picture is an overlay of two equidensity-pictures (one of first and one of second order) of a red plate taken by G. Lyngå (Lund). In this way the H II region is very dark, but the fine extensions towards Stock 14 are easier to see than in a usual photograph. For the picture we are grateful to the staff photographer in Bochum, Mr. W. Hünecke.

stretching out along the line of sight. The one closest in angular distance to Stock 14 also seems to be at comparable distance, suggesting that they may be physically connected. We have made a preliminary search for faint bridges of matter between Stock 14 and the aggregates in IC 2944 using the technique of equidensitometry on deep red plates, taken by G. Lyngå. Figure 2 shows an example of the pictures obtained that way, and it is seen that part of the H II region in IC 2944 is stretching out at least to small angular distances from Stock 14. A more detailed study with a microdensitometer on more plate material is in preparation. Also radial-velocity studies in the region will be important to solve this question.

To confirm the Cepheid nature of HD 101947, more observations over long-time intervals will be necessary, both photometrical and spectroscopical. For a precise understanding of the pulsations, observations over more than a decade may perhaps be needed. We shall certainly try to continue observing HD 101947, but we here want to take the opportunity to urge observers in the southern hemisphere to include this exciting star in their photometric and spectroscopic observing programmes.

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