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THE PERIODICITY OF THE PHOTOMETRIC VARIATIONS OF HR 7671 (HD 190390)

HR 7671 (HD 190390) has been classified as a F-type giant by Cowley (1976), but evidence is accumulating now that the colors and the spectrum of this star are those of a supergiant (e.g. Olsen, 1983; Sasselov, 1985; Eggen, 1985). Since its galactic latitude is rather high ($b^{II} = -21.5°$), HD 190390 is then a rather uncommon object. Additionally, it has recently been found that the star is a photometric variable. Olsen (1983) observed a steady decrease of the brightness of HD 190390 in data covering five nights and later on observed similar variations but with another range.

Our interest in HD 190390 arose from the large scatter of its data in the Geneva photometric system (Rufener, 1981). We have been collecting new observations of this object in the Geneva system since late 1982, using the Swiss photometric telescope at the European Southern Observatory. In the present paper, we report on the discovery of a stable periodicity in our data, that cover 1040 days, from September 1982 till July 1985.

The visual brightness variations during September-October 1982 and May-July 1985 are shown in Figure 1. The time is expressed in Julian Days - 2440000. A time scale of the order of a month can clearly be recognized in the variations. A similar time scale is present in the 45 measurements made in 1983 and in the 22 measurements made in 1984. Fourier analysis of the whole set of 123 data points reveals a most significant period of 28.49 days. A least-square cosine fit with this period has an amplitude of 0.11 mag and accounts for 80% of the total variance. The number of cycles covered is 36. The phase diagrams for the color indices [U-B] and [B-V] and for the visual brightness m_V are given in Figure 2.

It is apparent from Figure 1 that the amplitude and the shape of the light curve vary from cycle to cycle. Indeed, the residual scatter around the mean light curve in Figure 2, σ_{res} = 0.038 mag, is much larger than the estimated observational error, which is 0.004 mag. However, no reduction with any other period can remove a significant fraction of the remaining variance. The scatter thus reflects irregular cycle-to-cycle variations.

The [U-B] and [B-V] variations are respectively in antiphase and in phase with the light variations. Such color variations are reminiscent of the behavior of variables in the Cepheid instability strip. The spectral type of HD 190390 and the length of the period are two other arguments which naturally lead us to discuss the properties of this variable in terms of what is known about the Cepheids.

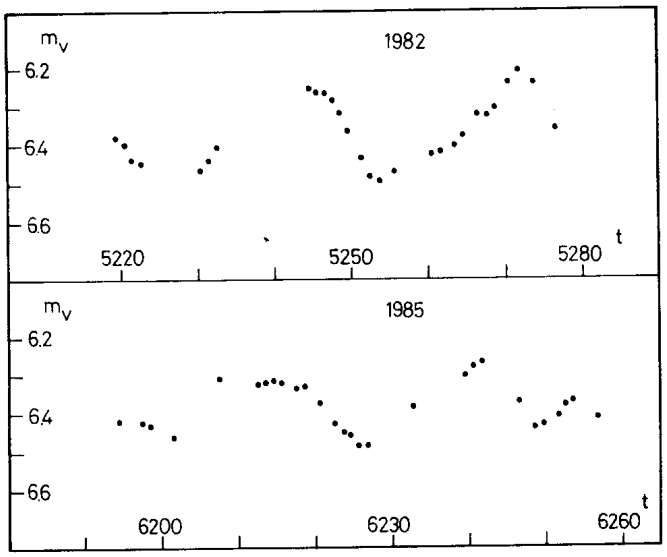

Figure 1: Light variations of HD 190390 during 1982 and 1985.

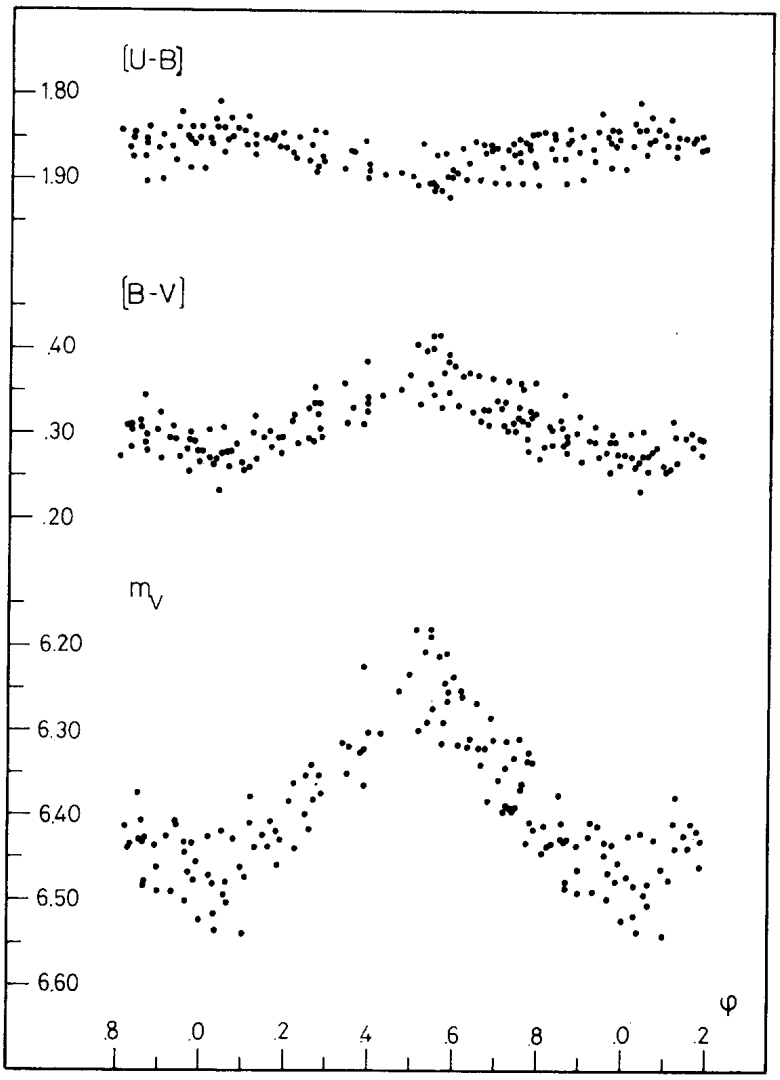

Figure 2: Phase diagrams for the color and light variations of HD 190390 during the period 1982-1985.

It is highly unlikely that HD 190390 is a bona fide population I Cepheid. The light variations show irregularities and the colors are much bluer than those of the known long period Cepheids. Third, the galactic latitude of the star and the absolute magnitude it would have if the period-luminosity relation were valid for it would imply a distance of more than 1 kpc from the galactic plane, clearly uncompatible with the known scaleheight of the population I Cepheids.

A high vertical distance is not uncompatible with HD 190390 being a population II Cepheid. Also, there are indications that it is a metal-weak star (Sasselov, 1985). On the other hand, the kinematics of the star do not indicate a pronounced population II character (Eggen, 1985). Moreover, the irregularity and the shape of the light curve are atypical even for long-period population II Cepheids.

A third possibility is that HD 190390 is similar to HD 161796 and to HD 163506 (Burki et al., 1980), stars that belong to a group of variable supergiants at high latitude, labeled "UU Her stars" by Sasselov (1984). The exact evolutionary stage of these stars is unknown, but it might be that they are in rapid evolutionary phase. HD 190390 would be the first strictly periodic member of the group. The study of the secular variations of its period is of high interest for the constraints it imposes on the evolutionary stage of the star and, incidentally, on that of the whole group.

We therefore plan to continue monitoring this star. A program of simultaneous radial velocity observations with CORAVEL has now been started. The results of this program will be published together with a quantitative discussion of all photometric data.

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