HR 211 FROM MAPLE OBSERVATORY AND HIPPARCOS

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Abstract

Starting in October 1993, HR 211 was observed photoelectrically in V on 76 nights over 5 years. The complete light curve and the power spectrum reveal a period close to a month with a possible long-term variability present. This is compared with the Hipparcos wide-band photometry, which runs from December, 1989, to February, 1993, and consists of 68 observations. For these, a period search suggests variability on a time-scale of about a month, with no long period apparent. An attempt is made to explain this and other dissimilarities.

1. Introduction

HR 211 (57 Piscium, HD 4408) was assigned to the author as an "adopted" star in Project SARV (Percy *et al.* 1994). This photometric survey of the known and suspected variables in the *Bright Star Catalogue* (Hoffleit and Jaschek 1982) has the purpose of clarifying their variability status, and learning more about their pulsation properties, processes, and evolution.

When the five-year light curve showed a long-term pattern in the star's variability, Dr. Percy suggested comparing the Maple Observatory results with those of the Hipparcos satellite (ESA 1997), which, in addition to parallax measurements, performed photometry on a large number of suspected variable stars.

2. Photometry and period search

For the Maple photometry, two telescopes were used, a 25-cm Schmidt-Cassegrain from spring to fall and an 11-cm polar-axis refractor during the winter. A separate V transformation coefficient was determined for each. The Optec SSP-3 photoelectric photometer was coupled to a 286 computer running Robert Jones' data acquisition program ACQ (Jones 1991). The computer handled the recording of real time, the length of the integration periods, and the averaging of the three integrations. The resulting data file was converted to AAVSO format and fed to the reduction program written at AAVSO Headquarters by Charles M. Jones.

Period searching was done with the Date-Compensated Discrete Fourier Transform program of the Maria Mitchell Observatory (MMO) (Ferraz-Mello 1981). In addition to producing a range of probable periods, this gives a statistical estimate of significance and a plotting file of powers and frequencies for all trials. The latter was used to print the power spectra by means of a standard spreadsheet.

3. Results (Maple photometry)

Though somewhat compressed in the complete light curve (Figure 1), the short-term variations during each season's observations are apparent. They average around thirty days and are typical of a semiregular pulsating star. Also visible is a change in mean magnitude and in amplitude from one season to another. In fact, both the light curve and the power spectrum suggest a long term variability in addition to the basic pulsation period, a feature found in many stars of this kind.

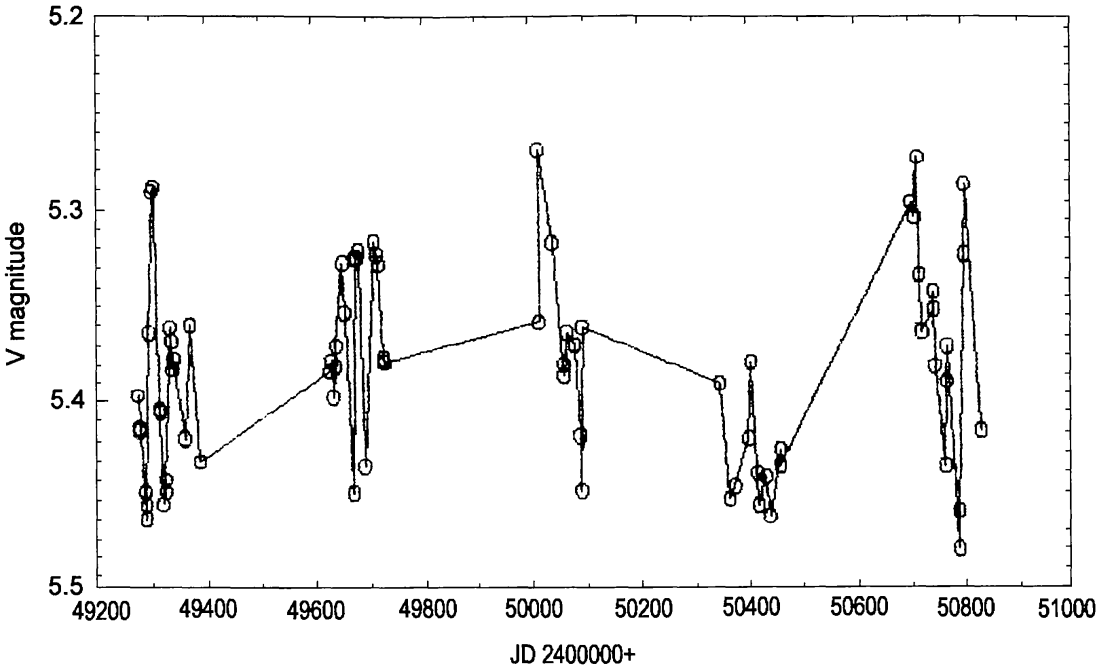

Figure 1. Maple Observatory light curve of HR 211, October 1993 to January 1998. Seasonal changes in mean magnitude and amplitude are noticeable, and the short-term fluctuations indicate a period of about a month.

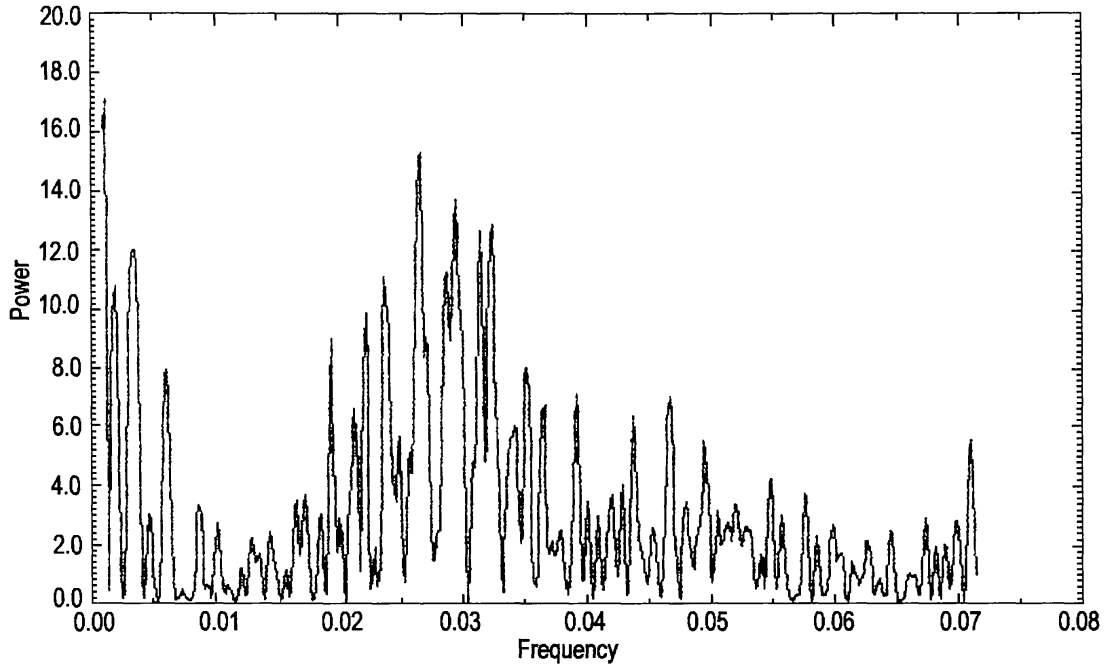

Figure 2. Power spectrum based on all Maple Observatory data. The two clusters of peaks indicate a period near a month and another possible long-term variation in the low-frequency region.

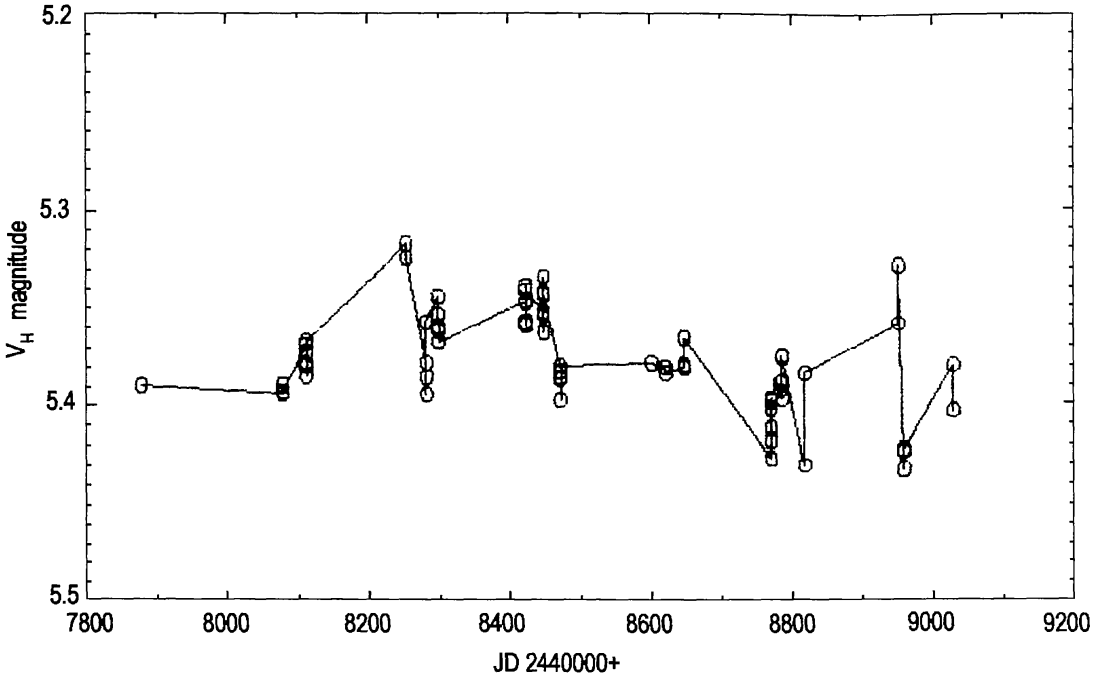

Figure 3. Light curve of the Hipparcos data from December 1989 to February 1993. The smaller overall amplitude is very noticeable. The vertical clusters indicate same-day observations. The spacing of these may have some regularity which results in the alias structure apparent in Figure 4 below.

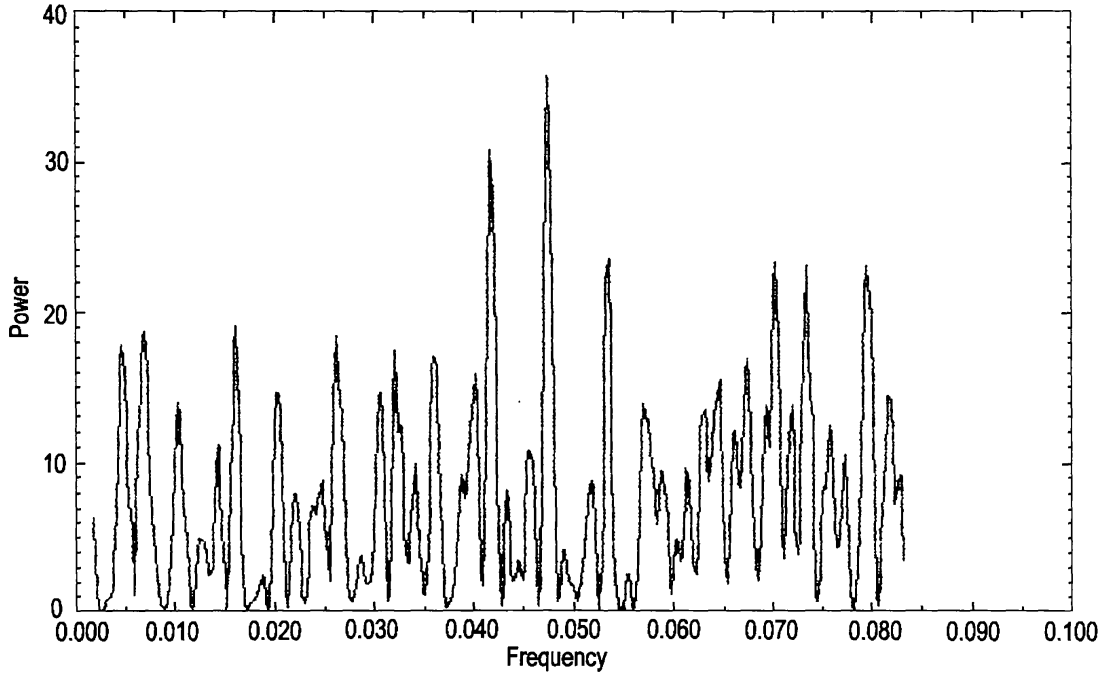

Figure 4. Power spectrum based on the Hipparcos data. The alias structure is extensive, but the primary peaks indicate a period close to one month. There is no indication of long-term variability.

4. The Hipparcos photometry

The 68 Hipparcos observations are very unevenly spaced. Actually, while the observations cover just over 3 years, data from only 18 days are included. These are made up of anywhere from two to six observations taken at different times on the same day. In addition, there are, in the data, long-term and short-term gaps; the 5 long ones average 141 days and the 8 short ones 23 days. For the light curve (Figure 3) and the power spectrum (Figure 4), all of the data were used. The light curve has a very "clumpy" appearance, and the short-term changes are not too clearly visible. Most noticeable, on the other hand, is the smaller amplitude present throughout. The power spectrum obtained from the MMO period search program (Ferraz-Mello 1981) seems to provide some evidence for variability on a time scale of about a month. There is no indication of long-term variability. The original Hipparcos listing, from which the data were obtained, describes the star as definitely variable, but with the period uncertain.

As an experiment, means were taken of each day's repetitions and the resulting 18 data points were processed separately. A period search produced exactly the same results: possible variation in the range of one month, but no trace of a longer period.

5. Conclusions

When information was sought on the exact configuration of the Hipparcos photometric system, Dr. Percy, in a personal communication, pointed out that the Hipparcos photometric band was very wide, spanning B and V and even a bit of R (Percy 1998). The bandpass of the V filter in the SSP-3 photometer ranges from 500 to 580 and peaks at 540 nm, wholly in the yellow-green region of the spectrum. This happens to coincide with the TiO absorption bands in M stars, which are very sensitive to temperature. As a result the V amplitude of pulsating red giants tends to be comparatively large. With a much broader bandpass, the amplitude in the Hipparcos photometry would be diluted. Furthermore, the wide-band photometry might well pick up variability from other sources. This could explain the different appearance of the two light curves.

As a result, one is forced to conclude that the differences in appearance of the light curves and power spectra are more likely to originate from differences in the two photometric systems than from possible changes in the behavior of HR 211. A further cause could lie in the much more irregular spacing of the Hipparcos data. Excluding the unavoidable seasonal gaps, the average separation between the Maple data points is 7.96, while that for Hipparcos is 23.37 days.

6. Acknowledgements

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