THE LIGHT VARIATIONS OF THE RED SUPERGIANT MU CEPHEI

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The causes of light variations in red supergiants are still discussed. In particular it is not clear if these variations result from deterministic or narrow-band stochastic (pseudo-periodic) processes or from a mixture of both types.

Mu Cephei is among these objects that with the greatest deal of observations as it has been under surveillance since 1848. Its visual observations from 1881 to 1935 has been discussed in several papers. These data are quite reliable because they are due to the largest part to only one observer. The most recent analysis of them (Mantegazza,1982; hereafter cited as paper I) showed that they can be interpreted as the result of the superimposition of two waves with periods of 4700 and 873 days and of their non-linear couplings. However this fact, even if it tends to suggest the presence of deterministic processes (e.g. multimode pulsations), is not sufficient to rule out the possibility of pseudo-periodic ones. In fact the observations cover only a few cycles of the longer wave and besides the visual data cannot be very accurate. These random processes could be connected for example to the star's convective motions or to the stellar rotation.

In order to verify the previous results and to improve the knowledge of the phenomena regarding mu Cephei I decided to collect all the observations of this star following 1938. Not all of these data are reliable, therefore after an accurate selection I adopted the photoelectric measurements published by: Larsson-Leander(1962), Coyne and Kruszewski (1968), Polyakova (1975) and references therein, Polyakova (1978), and Abramyam (1982). These data span over 7800 days, thus they permit a resolution in frequency that is about 3 times inferior to that of the visual data analysed in paper I. Because of the limited resolution it was not possible to fit on these data the model of paper I (in fact the least-squares solution is unstable). On the other hand the gap of 17 years between the two data sets prevented from extrapolating that model. Therefore it was necessary to analyse the photoelectric data separately. Fig. 1 shows the autocorrelation function estimated from these data. It clearly shows two peaks centred at about 900 and 4700 days, values which correspond to the periods derived in paper I. Successively the data were analysed with the least-squares power spectrum tecnique adopted in paper

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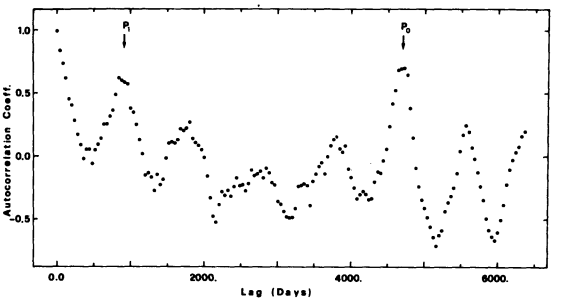

Fig. 1 - Autocorrelation function

I. Due to the limited resolution it was not possible to identify all the terms found in paper I. However by calculating successive spectra in which the previously identified terms were introduced as known-constituents (see paper I) it was possible to single out 7 terms: $f_0 (=1/P_0)$, $2f_0$, $3f_0$, $4f_0$, $f_1 (=1/P_1)$, $2f_1$, f_0+f_1. Finally the values of f_0 and f_1 were iteratively refined in such a way that the 7 term model as a whole gave the best least-squares fit. The values found were 4650 and 920 days for P_0 and P_1 respectively. These values are coincident within their uncertainties with those found in paper I. It is possible to see that the terms of the model of paper I that are not present in this solution are too close to the terms above listed in order to be resolved. The synthesized light curve computed with this model is shown in fig.2. In this figure the dots represent forty days averages of the photoelectric data.

In conclusion the analysis of the photoelectric data furnish an independent confirmation that in the light curve of mu Cephei are present two cyclic phenomena and their non-linear couplings, and that there is a substantial agreement with the model derived from the analysis of the visual data. However a much longer set of observations is needed in order to verfy if these terms are due to purely deterministic processes and in order to identify the physical processes that generate them.

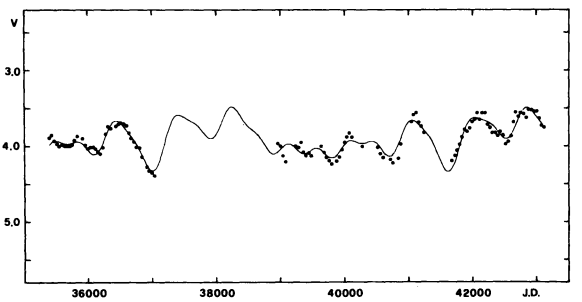

Fig. 2 - Dots: 40-day means of the photoelectric data
solid line: synthesized light curve

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