FURTHER PHOTOMETRY AND ANALYSIS OF 1 MONOCEROTIS

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INTRODUCTION

Light variability of the sixth magnitude star 1 Mon (HR 2107, HD 40535) was first discovered by Cousins (1963). Subsequent observations by Jones and Lagerweij (1966), Danziger and Dickens (1967) and Valtier (1971) revealed that the period of light variation is near $0^d.137$ and that the amplitude of the light curve is variable. Millis (1973) observed this star in 1971 and 1972 in U,B and V filters on seventeen (17) nights. Shobbrook and Stobie (1974) have observed this star on nine (9) nights in 1972 and 1973 in U,B and V.

Desikachary (1974) made a periodogram-analysis of Millis' data and also obtained amplitudes in the various frequencies present by Fourier analysis. However, Millis' conclusion from his own anaylsis that the causes of long period variations may be intrinsic and Desikachary's conclusion that it can be extrinsic (tidal distortions produced by a faint companion) are not compatible with each other.

For a proper understanding of the long-range variations in the amplitudes, it is necessary to have a series of observations spread over many years. With this point in mind, we decided to observe this star. We propose to continue the observations over the next few seasons. Here we are presenting the first of the series of observations.

EQUIPMENT AND OBSERVATIONS

The 15" photovisual refractor of the Nizamiah Observatory, Hyderabad, was used with an unrefrigerated IP 21 Photomultiplier in combination with a DC amplifier (GEC) and a Honeywell-Brown Recorder (10 mV range). A stabilished high-voltage power supply fed a constant voltage (800 volts) to the photomultiplier.

Observations were made with standard (Johnson) B and V filters. The comparison star used was 2 Mon (HR 2108), which is a nearby 5th magnitude star of similar spectral class and colour (B-V) as 1 Mon. No check star was used since the constancy of 2 Mon was well-established by previous investigators (Millis 1973). Relevant data is given in Table 1.

TABLE 1

Star	HR Number	HD Number	Co-ordinates α (1900)			δ (1900)	Spectral type	Mag. V	Colour (B-V)
			h	m	s				
Var (1 Mon)	2107	40535	05	54	1.6	—9° 23′	F2 II	6.28	+0. 3
Comp (2 Mon)	2108	40536	05	54	19	—9° 34′	Am	5.02	+0.18

The star was observed on twelve (12) nights during January through March, 1976. The extinction corrections were applied for each night using the observations of the comparison star. On two nights, the observations were scanty. We find that the probable error of a single observation is $\pm\ 0^m.008$ in B and $\pm\ 0^m.007$ in V, and the overall observational error $\leqslant \pm\ 0^m.020$ in B and V. (Probable errors are taken from the investigation of the light variation of 66 Eri, which was observed during the same period as 1 Mon with the same equipment).

The $\triangle$m (variable—comparison)in V and B filter on instrumental system are plotted against HJD for all the nights in figure 1 and 2 respectively. Solid curves represent the computed values after a least-square fitting (see next section).

ANALYSIS

There are two types of δ Scuti stars as far as the frequency and amplitude variations are concerned. In one type, frequencies and amplitudes vary over a time scale as short as one day, e.g., θ Tuc or one week, e.g., ρ Phe (Stobie and Shobbrook 1976). In the other type, the frequencies remain stable over long periods of time. 1 Mon belongs to the latter type (Stobie and Shobbrook 1976). Hence we have performed a Fourier analysis of our data using the fundamental (ν_0), first overtone ($2\nu_0$) and beat (ν_L) frequencies obtained by Desikachary (1974). The equation fitted was

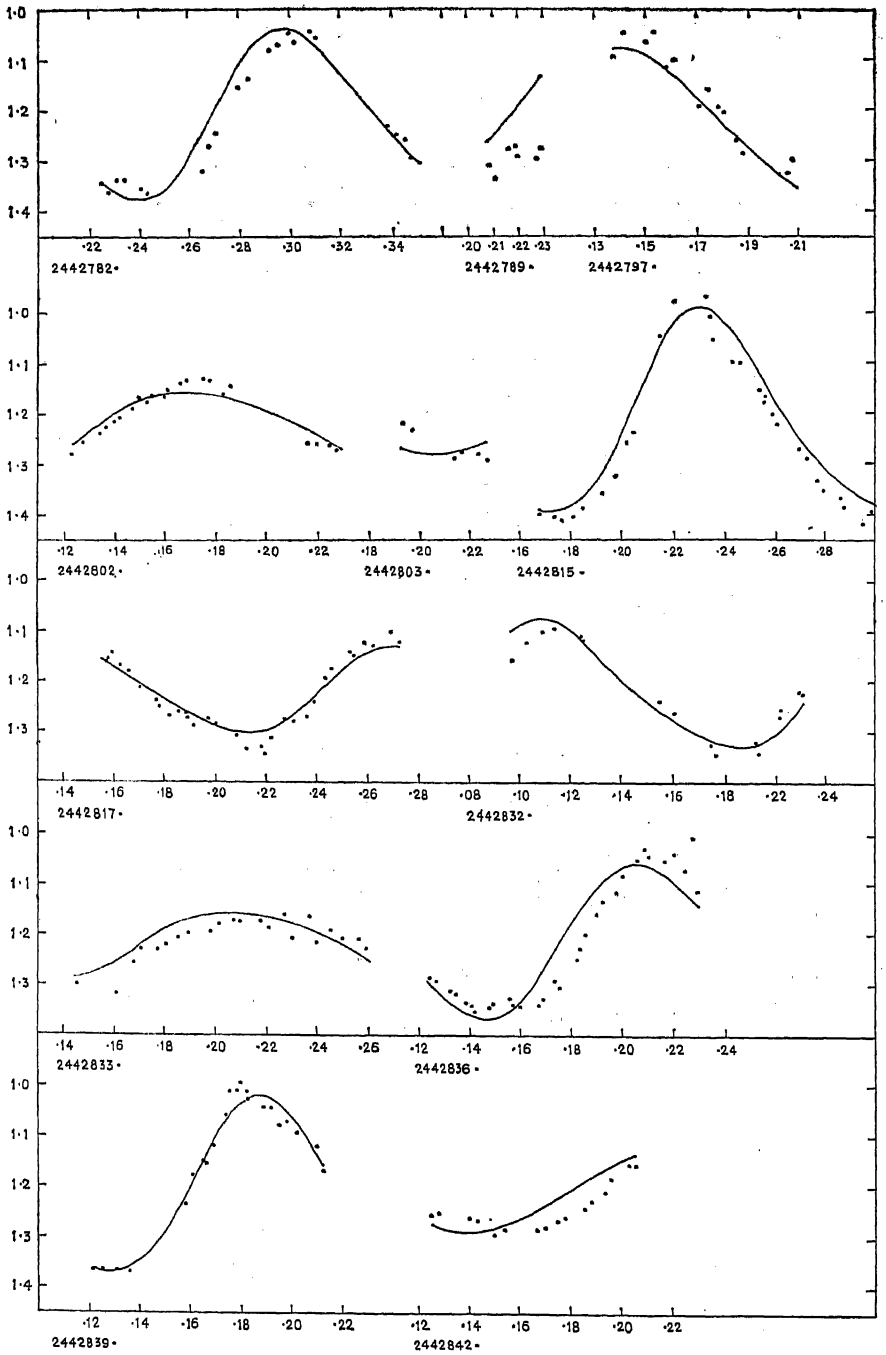

Fig. 1 : The magnitude difference is plotted as a function of Heliocentric Julian day for the V filter

$$\Delta m\,(t_k) = \langle \Delta m \rangle + \sum_{i=0}^{1} \sum_{j=-1}^{+1} \left[a_{i,j} \operatorname{Sin} 2\pi\,(\nu_i + j\nu_L)\,\Delta t_k + b_{i,j} \operatorname{Cos} 2\pi\,(\nu_i + j\nu_L)\,\Delta t_k \right],$$

where $\langle \Delta m \rangle$ = average value of Δm, $t_k = t_k - T_o$,

T_o = JD 2442782.0 and $a_{i,j}$, $b_{i,j}$ are constants.

A least square solution gave us $\langle \Delta m \rangle$ and the twelve constants which were combined to get the amplitudes in various frequencies as given in Table II. Probable errors in the amplitudes were $\leqslant \pm$ 0.0014 in V and $\leqslant \pm$ 0.0032 in B filter. Our epoch T_o was JD 2442782.0 as compared to JD 2440990.0 for Millis' data. Our constants for yellow light fit our data to the same degree of accuracy as Desikachary's constants fit Millis' data. Some systematic departures from the fit are present in both the fittings. We further wish to remark that the fitting in B filter is not as good as in V filter, the reason for which is not understood as the accuracy of our observations is nearly the same in both the colours.

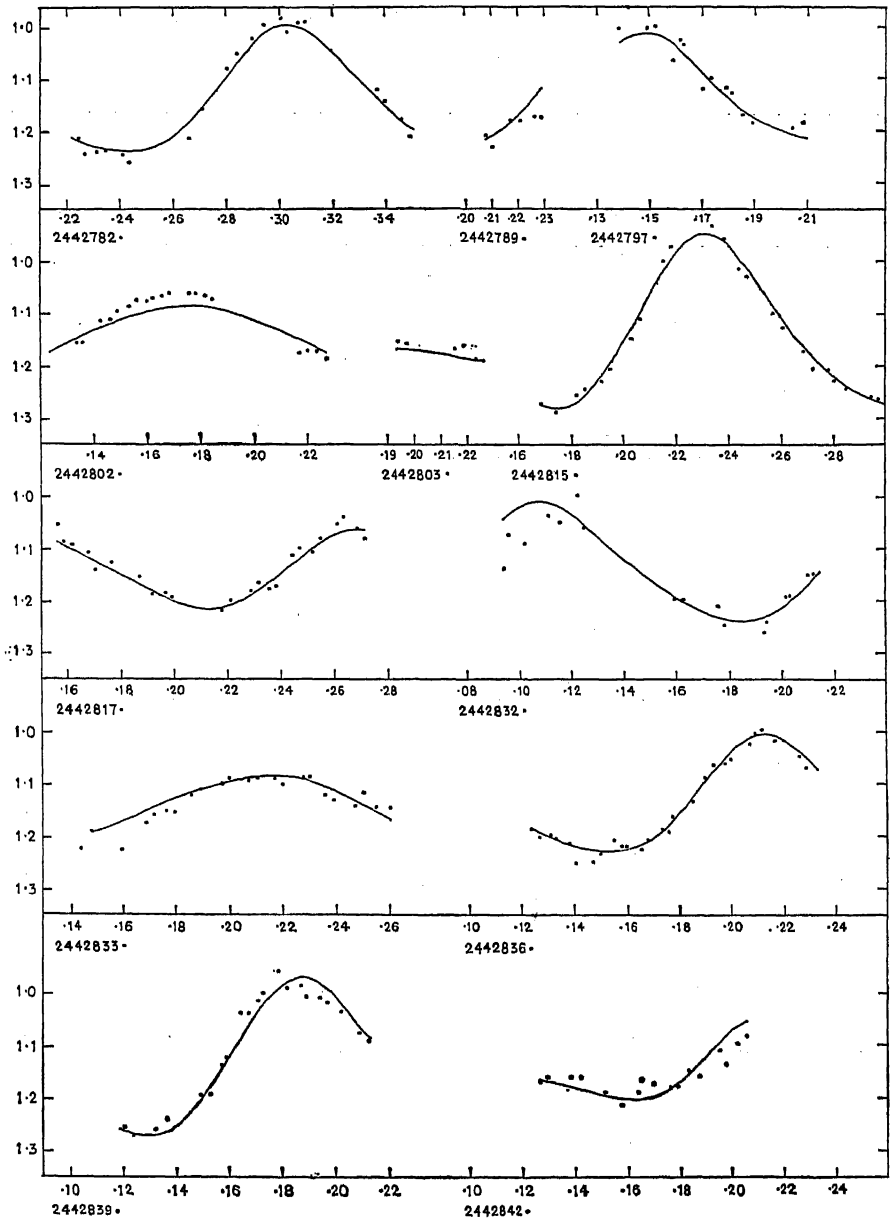

Fig. 2: The magnitude difference is plotted as a function of Heliocentric Julian day for the B filter

CONCLUSIONS

Table 2 also gives the values of amplitudes in various frequencies obtained by Desikachary (1974), by Shobbrook and Stobie (1974) and by us. The probable errors in the amplitudes are also indicated in the table. Intercomparison ot these data indicates that, whereas the amplitudes in all the other frequencies have remained more or less constant, that in the first harmonic ($2\nu_0$) has become nearly half of its value during 1971-73.

At the moment, we are unable to say anything regarding the agent causing such a change in amplitude in the first overtone. It seems desirable to investigate the long-range variations in the amplitudes of the various frequencies. We propose to continue the observations of this star over the next few seasons, for noting any possible changes in amplitudes. This might give a clear understanding of the agent causing long period changes in δ Scuti variables.

TABLE 2

Amplitudes for 1 Monocerotis

Frequency (cycles/day)	Desikachary (1974) Data: 1971-72 (Yellow)	Shobbrook & Stobie (1974) Data: 1972-73 (Yellow)	Present Investigation Data: 1976 (Yellow)	(Blue)
	m	m	m	m
ν_0 = 7.34618	0.0897	0.0839±.0008	0.0944±.0013	0.1242±.0031
$\nu_0-\nu_L$ = 7.21711	0.0216	0.0215±.0008	0.0253±.0013	0.0218±.0032
$\nu_0+\nu_L$ = 7.47525	0.0646	0.0600±.0008	0.0599±.0014	0.0662±.0032
$\nu_1=2\nu_0$ =14.69236	0.0134	0.0153±.0008	0.0067±.0013	0.0150±.0030
$\nu_1-\nu_L$ =14.56326	0.0047	0.0048±.0008	0.0068±.0014	0.0070±.0032
$\nu_1+\nu_L$ =14.82143	0.0185	0.0193±.0008	0.0177±.0014	0.0129±.0032

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