PERIODIC MODULATIONS IN THE OPTICAL LIGHT CURVES OF EX HYDRAE

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ABSTRACT. We present here new results on the periodic modulations in
the optical light curves of EX Hydrae observed during 1982-84. The
period analysis has been done using synchronous summation and
discrete Fourier transform methods. We report new periodicities at
34.7 min and 26.7 min apart from confirming the detection of 46.3
min modulation recently reported. We also include our data to derive
the rate of decrease of the 67 min period.

1.0. INTRODUCTION

EX Hydrae has long been known as an eclipsing binary (Mumford, 1964)
having short eclipses recurring with 98.3 min periodicity.
Classified recently as an intermediate polar (Warner, 1982), it is a
binary system consisting of a white dwarf accreting matter from a
red dwarf.
    Other periodicities discovered in the system are at 67 minute
confirmed to be the rotational period of the white dwarf (Kruszewski
et al., 1981, Cordova et al., 1985), and at 46.3 minute (Cordova et
al., 1985) at present speculated to be a beat of 1/2 Porb (= 49 min)
and a longer as yet undiscovered 0.58 day precessional period of the
disc.

2.0. OBSERVATIONS

We conducted photometric observations using the 1 metre reflector at
the Vainu Bappu Observatory at Kavalur. A dry ice/thermoelectrically
cooled RCA 4832/EMI 9804 QB tube was used at the Cassegrain focus of
this reflector.

Observations were conducted in March 1982, Jan-Feb 1983 and
April 1984. Most of the long runs were taken without filter. Typical
integration times used were 1s or 2s.

3.0. RESULTS AND DISCUSSIONS

3.1. Periodicities in the System

The longest stretch (about 5 hr) of almost continuous data was
obtained on 23 Feb, 1983 and this data train was used for the time
series analysis. The data was subjected to an epoch folding
algorithm (Warner, 1972) and a discrete Fourier transform (Deeming,
1975). The discrete Fourier transform output shown in Figure 1
indicates periods at 67 min, 46.3 min, 34.7 min, and 26.7 min. These
periodicities are also confirmed by the epoch folding algorithm.
The 67 min period with a 21% modulation is the well known rotational
period of the white dwarf.
The 46.3 min period which has a 5% differential amplitude has been
reported earlier only by Cordova et al., 1985. Their observations
conducted in March 1983 also exhibit a similar modulation and
therefore this periodicity has remained coherent for at least a
month.

We report new periods at 34.7 and 26.7 min, with modulations of
about 5% and 4% respectively. The 34.7 min period could be a beat,
in prograde sense, of the second harmonic of the 67 min period and a
0.58 day precessional period of the disc. The 26.7 min period could
be the beat of the 46.3 min and 67 min periods.

Confirmation of the 0.58 day precessional period of the disc
and exposition of models for the system would require additional
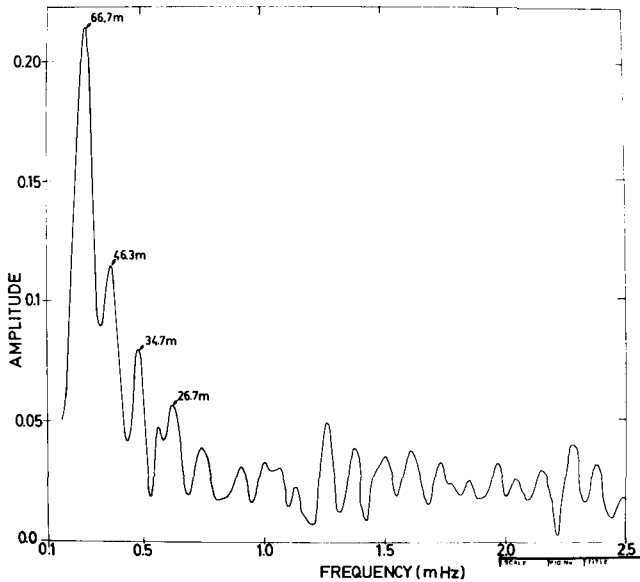long term/global monitoring of this system in X-ray and optical
bands.

Figure 1. Output of discrete fourier transform.

3.2. (O-C) calculations

The decreasing trend of the 67 minute variation has been noticed and
reported since 1980 (see Vogt et al., 1980, Kruszewski et al., 1981,
Gilliland 1982, Sterken et al., 1983). We added the times of maxima
(in HJD) of our observations to earlier data set. Using Vogt's
linear ephemeris we calculated the O-C and E for the complete data
and these values were fitted with a quadratic to yield the following
ephemeris:

$$T_{max}(HJD)=2437699.8899 + 0.046546534 \ E - 0.98 \ 10^{-12}E^2 \quad (1)$$
$$\pm 6 \qquad\qquad \pm 18 \quad \pm 0.011$$

Figure 2 shows the plot of O-C versus E for the complete data with
the quadratic fit. The rate of decrease of the 67 minute period as
derived from the ephemeris given in Equation (1) is

$(4.2 \pm 0.47) \ 10^{-11}s \ s^{-1}$. This gives $P/\dot{P} = 3 \times 10^6$ years.

Figure 2. (O-C) versus cycle number.
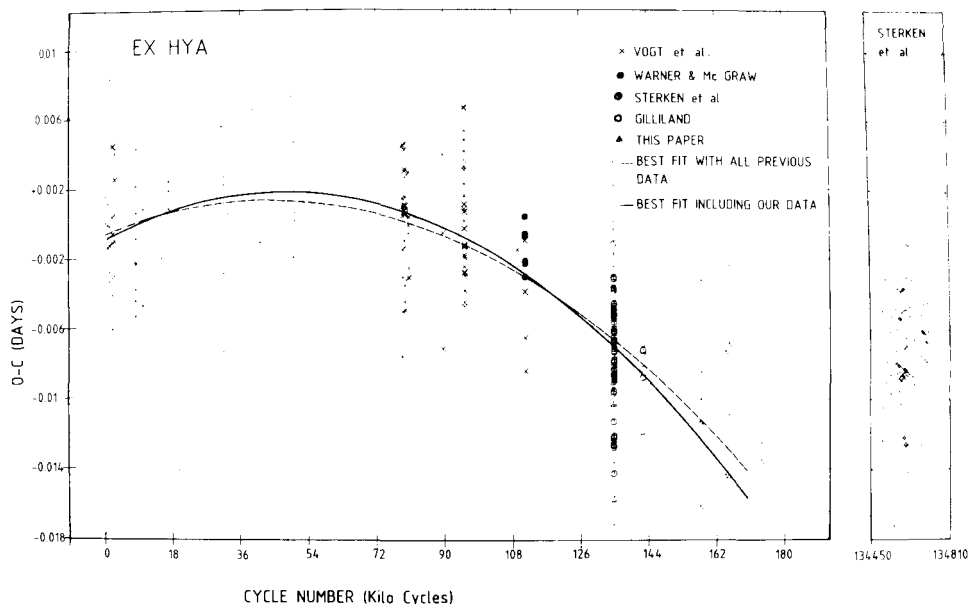

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REFERENCES

Cordova, F.A. et al., MNRAS, 1985, 212, 447.
Deeming, T.J., Astrophys Space Science., 1975, 36, 137.
Gilliland, R.L., Ap.J., 1982, 258, 576.
Kruszewski, A. et al., Sp.Sci.Rev., 1981, 30, 221.
Mumford, G.S., PASP, 1964, 76, 57.
Sterken, C. et al., Astron and astrophys., 1983, 118, 325.
Vogt, N. et al., Astron and astrophys., 1980, 85, 106.
Warner, B. and Robinson, E.L., MNRAS, 1972, 159, 101.
Warner, B. and Mc Graw, J.T., MNRAS, 1981, 196, 59.
Warner, B., 'Cataclysmic Variables and Related Objects', edited by
        Mario Livio and Giora Shaviv, P155, D. Reidel Publ. Co.
        1982.