A $\sim 14$ DAYS STAR WITH TWO PHASE-LOCKED MODES OF PULSATION IN THE EROS DATABASE

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Abstract

Using CCD photometry obtained by the EROS collaboration in 1991-1993, we have discovered an LMC variable star with a light curve that is oscillating with a mean period of $\sim 14$ days and an amplitude of $\sim 0.3$ mag. The oscillations appear with irregular amplitude variations. The Fourier spectrum shows that the pulsation of this star is phase locked between two modes of frequencies $f_0$ and $1.5 \times f_0$. Moreover, this object has strong $H\alpha$ and $H\beta$ emission lines and neutral lines of Helium that suggest a spectral type between late O and early B. In a preliminary analysis, we derive a luminosity of $L = 3.4 - 3.8 L_\odot$ and an effective temperature in the range $\log(T_{\text{eff}}) = 3.85 - 4.2$.

1 Observations

CCD photometry was obtained in a field of 0.5 square degree in the bar of the LMC between 1991-1993 for EROS. About 2500 images spanning $\sim 130$ days were taken in two broad bandpass filters $B_E$ and $R_E$ centered respectively on 490 and 670 nm in the 9192 campaign, and 5500 images were taken of the same field with a pair of very similar filters ($B_{E2}$, $R_{E2}$) for the 1992-1993 campaign. We have systematically searched the EROS database
Figure 1: \( B_E \) light curve from 1991-1992, and the beginning of 1992-1993 campaign.

for variable stars using the modified periodogram technique and the AoV method.

Among the hundredth detected variable stars, we have discovered a bright LMC variable star (\( \alpha = 5h18m10.5, \delta = -69^\circ35m59, \) equinox 2000.0) with a 'period' of \( \sim 14 \) days and a particular behavior, a clear alternance between cycles with larger and smaller amplitudes (Fig 1). A Fourier fit with 8 independent frequencies leads to a spectrum with two dominant frequencies at \( f_0=825.69 \) pHz and at 1.5003\( \times f_0 \) (Fig.2). This suggests that the pulsation of this star is phase locked between two modes of frequencies \( f_0 \) and 1.5\( \times f_0 \).

From the photometry, assuming different values of reddening (\( E(B-V) = 0.10-0.30 \)) and applying the temperature scale from Kurucz’s atmospheric models, we estimate the effective temperature of the star to be in the range...
Figure 2: Fourier spectrum of the 1991-1993 light curve, of the prewhitened light curve in which the two frequencies $f_0$ and $f_1$ have been removed, and the spectral window. Notice the power around 0.07 (fundamental frequency), and the secondary peak around 0.11.
log($T_{\text{eff}}$) = 3.85 − 4.2.

The apparent magnitude of the star is $V_J = 13.60$. Assuming a distance modulus to the LMC of $\mu_{\text{LMC}} = 18.5$ mag, and a bolometric correction in the range $-0.3$ to $-2$, we derive a luminosity in the range $L = 3.4 - 3.8L_\odot$.

Low resolution spectroscopy in the wavelength range 3700 − 7000 Å has been obtained at ESO la Silla in December 1995 with the ESO 1.5m equipped with a Boller and Chivens spectrograph. The resolution was 7 Å, and we get a signal to noise ratio of 50 at 6000 Å. This star belongs to the LMC. Its spectrum shows strong Hα and Hβ emission lines, and neutral lines of Helium indicating a spectral type between late O and early B (Fig 3).

Further observational information are:

1. This star is located in the same area in the bar of the LMC, where 7 pre main sequence star candidates (PMSC) have been found.
2. It presents strong Balmer emission lines (equivalent width of 91 Å for Hα).
3. Its colour and spectrum suggest a spectral type between late O and early B.
4. We have no evidence for the presence of an extended HII region around...
this object.
(5) It is brighter than the PMSC which we discovered in the LMC.
(6) It presents an irregular photometric variability with a time scale of $\approx 14$ days. However, the photometric variability seems to be due to a two mode phase-locked pulsation. The observed large amplitude leads to favour a radial pulsation rather a non-radial one.

Based on these arguments, we suggest that this star can be a pre main sequence object or a post-AGB star. A companion poster examine the possible nature of this object by means of a linear stability analysis of hydrostatic envelopes, and computations ofodynamical models.

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References
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Frame : tt0001
Identifier : LMC
ITT-table : log.itt
Coordinates : -23589.8, -10122.4 : -19367, -4795.6
Pixels : 1, 1 : 580, 580
Cut values : 50, 200
User : beaulieu