Draft version October 8, 2021
Typeset using LaTeX **RNAAS** style in AASTeX62

# The rapid far ultraviolet variability of ET And and its rotational period

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*Keywords:* stars: chemically peculiar, stars: individual (ET And, HR 8869, HD 219749)

## ABSTRACT

Evidence is presented that the far ultraviolet flux of ET And (A0Vp SiSr) recorded by the International Ultraviolet Explorer (IUE) was variable over a time scale of about one hour on 07 August 1979. In contrast, the spectra taken over 9 hours on 03 August do not show any flux variability. This behaviour is discussed using the light curve of ET And recently acquired with TESS. We also derive a refined rotational period, $P_{rot} = 1.618845 \pm 0.000006$ days, from the detrended TESS light curve.

ET And is an early-type chemically peculiar star (HR 8891, HD 219749, A0Vp SiSr, V=6.5 mag). 142 references can be found for ET And in SIMBAD [1]. Ouhrabka & Grygar (1979) have shown that ET And is the primary component of an excentric single-lined binary system. Ouhrabka (1981) determined a high excentricity (e = 0.46). Hildebrandt & Hempelmann (1981) also found a period of about 1.6 days which they interpreted as due to rotational modulation. Lehmann et al. (1999) reported rapid variability in the Hipparcos photometry of ET And with a period of 0.103966 days which agrees quite well with the period of 140 minutes previously found by Hildebrandt et al. (1985).
The purpose of this note is to report on the the far ultraviolet (UV) variability of ET And using all spectra acquired with IUE and to derive a new rotational period for ET And from the recently acquired TESS light curve.

ET And was observed 26 times with the IUE in the frame of program APBKR (Spectroscopy of three CP stars at UV wavelengths, PI: Dr Rakos). Twelve high-resolution SWP (Short Wavelength Prime camera observing from 1200 up to 2000 Å) spectra were obtained through the large aperture on 03 and 07 August 1979. Observations through the large aperture allowed to measure absolute fluxes. The spectra were retrieved from the Mikulski Archive for Space Telescopes [2]. No attempt has been made to compare all these spectra in order to look for flux variations prior to this work. Barylak & Rakos (1983) used these spectra to determine the apparent rotational velocity of ET And.

The high-resolution spectra were smoothed using a boxcar of 100 points to increase the signal-to-noise ratio and highlight flux variations. The spectra taken on 03 August over a 9 hours time interval do not show any significant flux variation larger than the 5% flux reproducibility of IUE. In contrast, two spectra taken on 07 August 1979, SWP06094 and SWP06095, separated by only 1 hour, do significantly differ as can be seen on Figure 1 (left panel). The optical brightness of ET And over a wide spectral band around 5400 Å was recorded with the FES (Fine Error Sensor) on board the IUE before each exposure and slightly decreased: 9126 counts before SWP06094 and 9075 before SWP06095, which is consistent with the decrease of the far UV flux.

It is interesting to compare the behaviour of ET And in UV light with the recent TESS light curve to shed light on its peculiar variability in the far UV. The TESS light curve of ET And shows a periodic signal with an estimated period close to 1.62 days. In order to derive an accurate value of this period, we used the PDCSAP flux data sets from sectors 16 and 17. We constructed the TESS data set by normalizing each data set individually, and obtained

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[1] http://simbad.u-strasbg.fr/simbad/
[2] https://archive.stsci.edu/

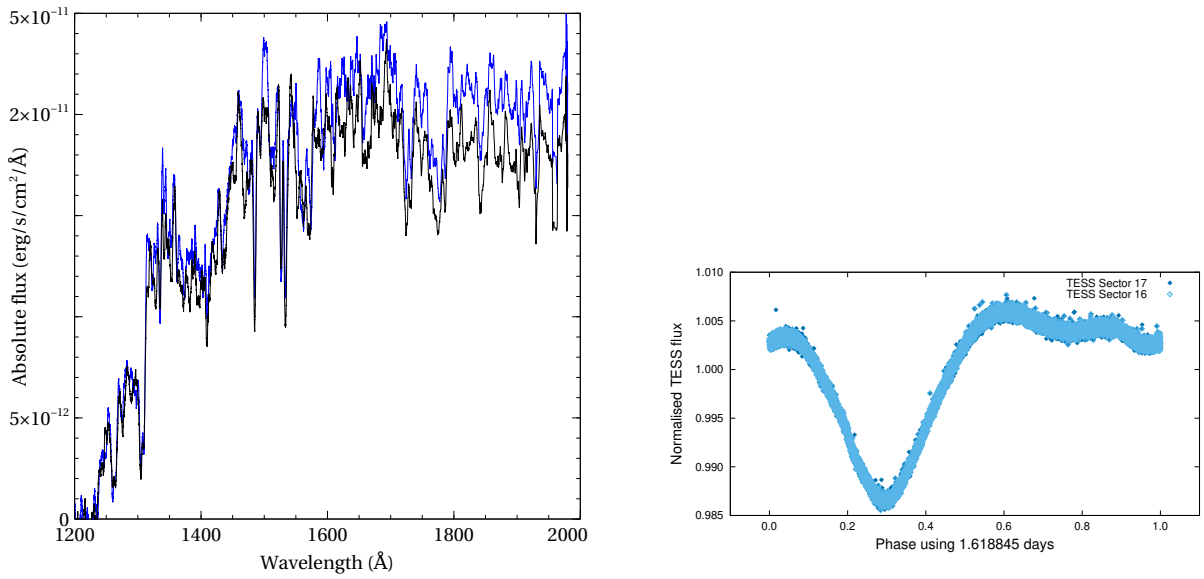


**Figure 1.** Left: Rapid flux variations in consecutive FUV spectra SWP06094 and SWP06095 obtained one hour apart. Right: Normalized TESS light curve of ET And phased against the rotation period of 1.618845 days.

a detrended, normalized and combined light curve with 27345 data points. We applied the code Period04 (Lenz & Breger 2004) to perform the Fourier analysis in the frequency range 0 - 25 $d^{-1}$ in successive steps by prewhitening for the most dominant frequency after each run. The computation gives a frequency of 0.618192 $d^{-1}$ in the first run, followed by a series of dominant harmonic frequencies in the next stages. Up to 10 harmonic terms were thus detected from the Fourier analysis. An additional low frequency was found at 0.022 $d^{-1}$, but this probably has an instrumental origin. The corresponding residual periodogram also shows a series of low-amplitude harmonic terms, among which 17f, 18f and 19f are most evident. Using a multi-dimensional least-squares fit and including up to 10 harmonic terms (i.e. 2f, 3f, ..., 7f and 11f, 12f, ..., 14f), we identified the frequency f = 0.6177245 ± 0.0000024 $d^{-1}$, corresponding to the rotational period $P_{rot}$ = 1.618845 ± 0.000006 days. After prewhitening for the dominant frequency and its harmonic terms, the low frequency near 0.022 $d^{-1}$ was found back. No evidence for short-period variability was detected in the periodogram of the residual data over the frequency range from 25 - 80 $d^{-1}$.

The mean light curve of ET And is not symmetric as in most CP stars. Over each period, two secondary minima and maxima are observed just after maximum light. Following this maximum, the flux slowly decreases by $\sim$ 0.3%, then drops rapidly by $\sim$ 20% to the primary minimum and rises back to the following maximum (Figure 1, right panel).

The TESS light curve helps understand the peculiar variability pattern of ET And in the far UV. It is likely that the IUE observations on 07 August shown in Figure 1, were taken during the rapid flux decrease from the second secondary to the primary minimum, whereas the spectra taken on 03 August were acquired just after a primary maximum.

## ACKNOWLEDGEMENTS

We thank the TESS Asteroseismic Science Operations Center (TASOC) for providing asteroseismological data from the NASA TESS mission to the members of the TESS Asteroseismic Science Consortium (TASC).

*Facility:* TESS

## ADDITIONAL MATERIAL

The appendix displays the Fourier spectrum of the normalized TESS data of ET And showing the rotation period of 1.618845 days and multiple harmonics (red lines).

REFERENCES

Barylak, M., Rakos, K. D., 1984, A&A, 127, 366

Scholz G., Gerth E., and Panov K.P., 1985, Astron. Nachr., 306, 329-337

Lenz, P., Breger, M., 2004, in IAU Symposium, Vol. 224, The A-star Puzzle, eds. J Zverko, J. Ziznovsky, S.J. Adelman, & W.W. Weiss, 786-790

Ouhrabka, M., Grygar, J., 1979, Inf. Bull. Var. Stars, 1600, 1

Ouhrabka, M., 1981, Publ. Special. Astrophys. Obs, 32, 45

Hildebrandt, G., Hempelmann A., 1981, Astron. Nachr., 302, 155

Lehmann H., Scholz G., Hildebrandt G., and Panov K., A&A, 351, 267