NONRADIAL OSCILLATIONS IN ZETA OPHIUCHI IN 1991

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The line-profile variations have been found in many early-type stars surrounding the classical β Cephei variables in the H-R diagram. The feature of the variations has not been known enough mainly because of their periods of about one day. To specify the cause of the variations, however, it is necessary to make clear their features such as the multi-periodicity, the relation between the photometric variations and the spectroscopic ones, and the cause of existence or non-existence of mode (or period) switching (Balona 1991, Smith 1991). In Be stars, the correlation of the amplitude of the variations with their emission cycle is also important (Ando 1986).

TABLE I
Estimated (Period, m, k) in temporal domain

Candidates of periods (hr)	m	k	Amplitude ($\times 10^{-3}$)
2.14(2.43)±0.04	6∼7	0.1±0.1	∼4.8
2.49(3.33)±0.08	5∼6	0.1±0.1	∼4.5

We have been extensively monitoring the line-profile variations in a Be star, ζ Oph, a prototype of the line-profile variables to investigate their features (Vogt and Penrod 1983, Harmanec 1989). We have already shown that the variations could be reproduced well by two NRPs throughout our observations between 1987 and 1990. The correlation of the amplitudes of NRPs with its Be emission cycle is also found in the star. In this paper, we discuss the NRPs in May 1991, about one year after its latest emission episode.

The short-term variations in the He I λ6678 absorption line were monitored using the coude spectrograph of the 1.88-m telescope at the Okayama Astrophysical Observatory (Kambe 1991). The spectra thus obtained are shown in figure 1 as the 3-D contour map.

We use the mode identification method which was first developed by Gies and Kullavanijaya (1988) and later extended by Kambe et al. (1990) to analyze the observed line-profile variations. Our results are listed in table

Astrophysics and Space Science **210**: 219–221, 1993.

I. In this season, a mode with a period of 2.15 *hr* and a mode with a period of 2.49 *hr* are detected; taking into account aliasing due to the sparse of the data, these mode could correspond to modes with periods of 2.43 *hr* and 3.33 *hr* which have been detected in all of our previous observations. The m-value for a mode with a period of 2.49 (3.33) *hr* is slightly larger than that of previous observations, but it might be superficial. Multi-site simultaneous observations could be preferable way to increase the quality of the data.

The amplitudes of the two modes seem to be smaller compared to those in the midst of its last emission episode (1990 May), but slightly larger than previous ones (figure 2).

Though the results have much ambiguity due to the shortage of the data, we could confirm the previous results of the correlation between the amplitudes of the variations with its Be cycle; that is, the amplitudes of NRPs increase toward the emission episode, reach their maximum at the episode and decrease after that. However, the role of NRPs in the mass loss activity from Be stars are still uncertain.

Numerical calculations were performed with Image Processing Facility (VAX 4000 computer) at the National Defense Academy.

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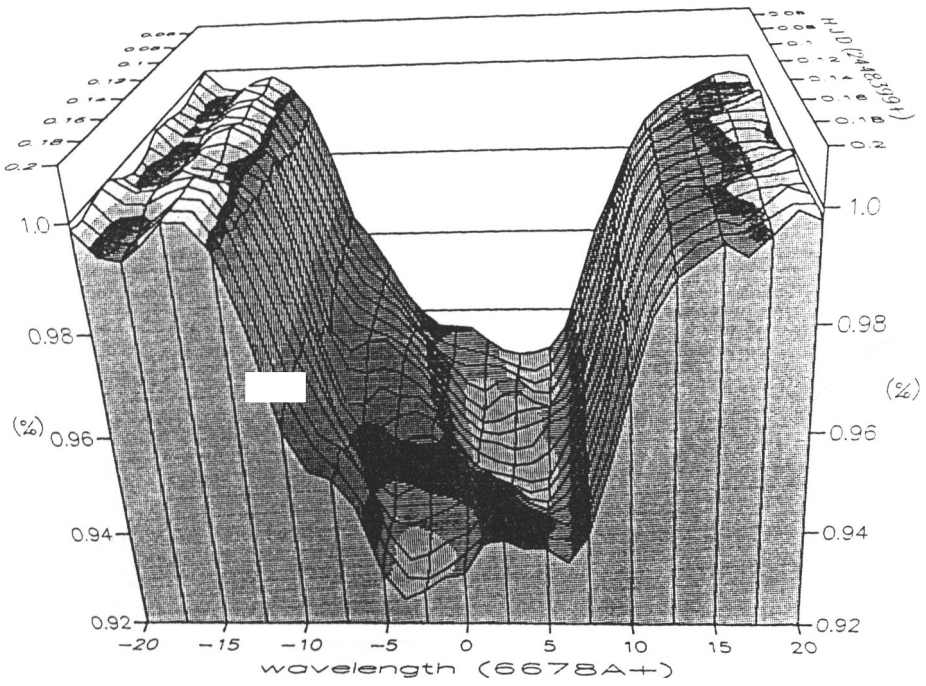

Fig. 1. 3-Dimensional view of observed profiles (He I λ6678) of May 22, 1991.

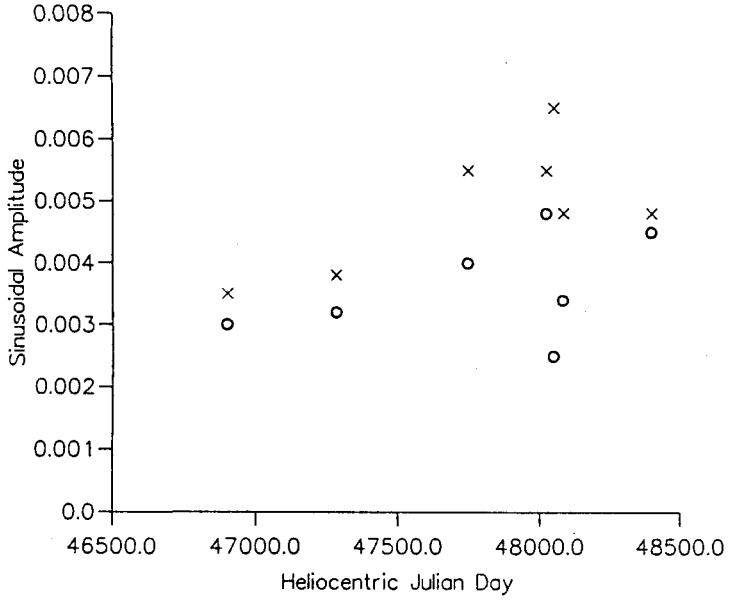

Fig. 2. The amplitudes of two main sinusoidal waves detected during our observations of 1987-1991 (o; a $l == m = 4$ mode with a period of 3.33 hr, ×; a $l = -m = 7$ mode with a period of 2.43 hr). The abscissa is the Heliocentric Julian Day with an offset of 2400000.

https://doi.org/10.1017/S0252921100014238 Published online by Cambridge University Press