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THREE DELTA SCUTI STARS IN THE OLD OPEN CLUSTER NGC 2506

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During our observational survey to search for low-amplitude pulsating stars (e.g., δ Scuti stars and γ Dor stars) in open clusters, we discovered three new δ Scuti type variable stars in a field of the old open cluster NGC 2506. Kaluzny & Shara (1988) also monitored stars in a wider area of the cluster than our observation but found no variable stars, probably due to their limited data sets (only nine exposures for three nights).

Time-series V CCD photometry was performed for ten nights from December 11th, 1996 to March 5th, 1997. The observations were done with a SITe 1024 CCD camera attached to the 1.8-m telescope at Bohyunsan Optical Astronomy Observatory (BOAO). Field of view of a CCD image is $5'8 \times 5'8$ at $f/8$ Cassegrain focus of the telescope. Typical photometric seeing was less than $2''0$. We also carried out UBVI photometry to study physical properties of variable stars in the cluster (Kim *et al.* 2000 for detailed results).

Data analyses such as CCD image process, PSF (Point Spread Function) photometry and the ensemble normalization, have been carried out by the methods described by Kim *et al.* (1999). We examined light variations of 590 stars in the observed field using 304 CCD frames and found three new pulsating stars. Finding chart of these new pulsating stars is shown in Figure 1.

Power spectra and light curves are displayed in Figures 2 and 3, respectively. Each pulsating star has a dominant frequency. Three pulsating stars are located within the δ Scuti instability strip in the color-magnitude diagram (Figure 4). It should be noted that V1, a probable cluster member deduced from the membership probability (Mermilliod 1992), is located at a bluer and brighter region than the main-sequence turn-off point of the cluster; i.e., it might be identified as a pulsating blue straggler star.

Observational parameters of the three new δ Scuti stars are summarized in Table 1. Two B and V deep-exposed data were used to estimate the color index. Photometric errors are less than 0^m01 .

Table 1: Observational parameters of the new δ Scuti type variable stars

	ID ¹	RA ₂₀₀₀ ¹	DEC ₂₀₀₀ ¹	\overline{V}^2	$\overline{B - V}^2$	Period	Epoch ³	ΔV	P_μ^1
V1	5462	7 ^h 59 ^m 58 ^s .1	-10°45'55''	13 ^m 69	0 ^m 21	0 ^d .0678	431.242	$\sim 0^m03$	0.71
V2	5467	7 ^h 59 ^m 53 ^s .6	-10°45'49''	14 ^m 50	0 ^m 29	0 ^d .0921	430.209	$\sim 0^m17$	0.91
V3	5589	7 ^h 59 ^m 57 ^s .8	-10°47'21''	14 ^m 75	0 ^m 35	0 ^d .0815	513.082	$\sim 0^m11$	0.00

¹ Identification, coordinates and membership probability (Mermilliod 1992)

² Photometric data from Kim *et al.* (2000)

³ Epoch at maximum brightness (H.J.D. - 2450000.0)

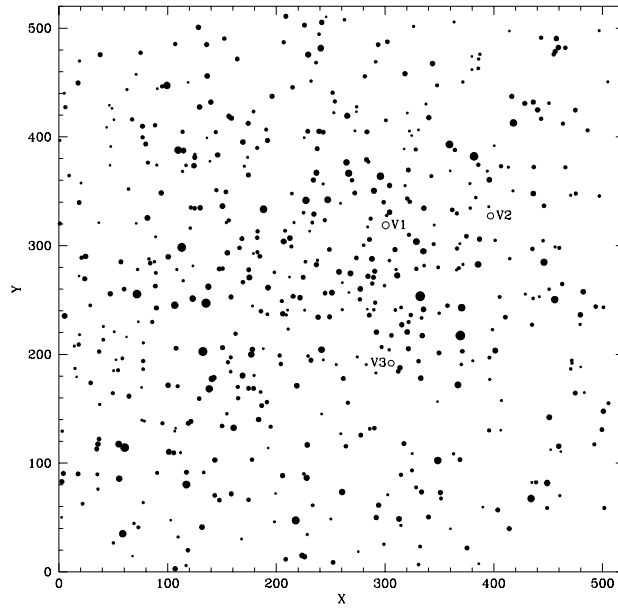


Figure 1. Observed CCD field ($5'8 \times 5'8$) of the open cluster NGC 2506. Three variable stars discovered in this study are represented by open circles. North is up and east is to the left

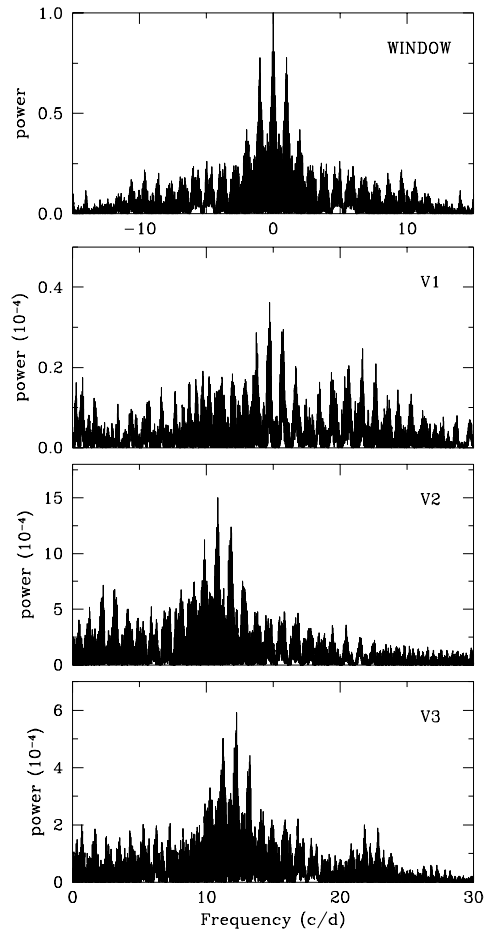


Figure 2. Power spectra of the three variable stars. The spectral window is shown in the top panel. The dominant frequency is 14.742 c/d for V1, 10.854 c/d for V2 and 12.264 c/d for V3

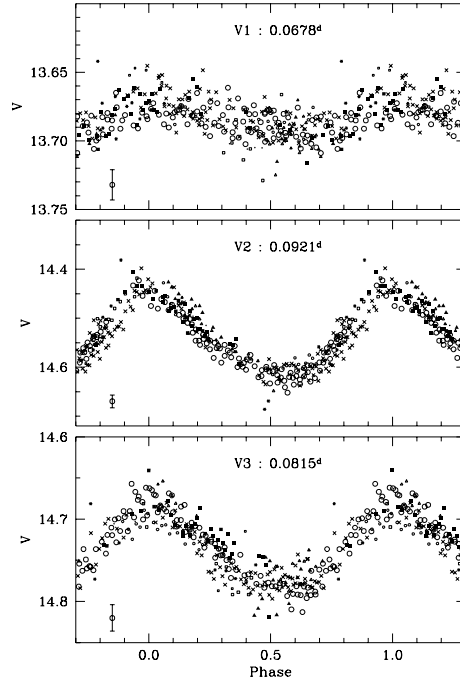


Figure 3. Light curves of the three pulsating stars. Data points are differently marked for each observing night. Typical observation errors are represented by error bars

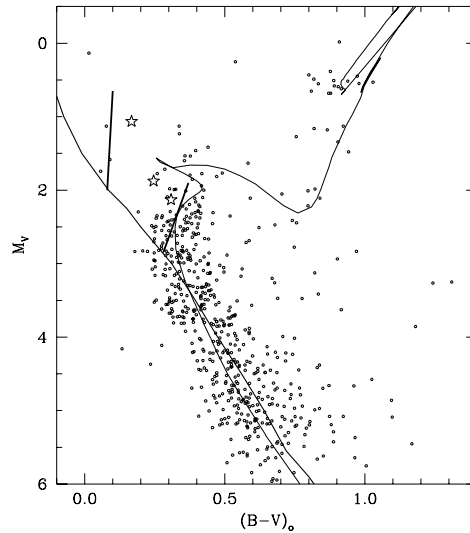


Figure 4. Positions of pulsating stars in the color–magnitude diagram of NGC 2506, using photometric data by Kim *et al.* (2000). Thick and thin lines denote an empirical ZAMS (Sung & Bessell 1999) and a theoretical isochrone (Girardi *et al.* 2000), respectively. Thick solid bars, nearly perpendicular to the ZAMS, represent δ Scuti instability strip (Breger 1979). The pulsating stars are marked by star symbols. We adopted the reddening of $E(B - V) = 0.04$, distance modulus of $(V - M_V)_0 = 12.5$ and age of $\log t = 9.25$ (Kim *et al.* 2000)

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