

## A Variable Star Survey of the Open Cluster NGC 2126

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**Abstract.** We present the first CCD photometric observations of the northern open cluster NGC 2126. Data were taken on eight nights in 2002 February and December with a total time span of  $\sim 57$  hours. We have discovered six new variable stars and have estimated the main characteristics of the cluster.

### 1. Introduction

NGC 2126 is a moderately rich open cluster in the constellation Auriga which has never been studied with the CCD technique (the only paper dealing with the cluster was published by Cuffey 1943). Besides multicolour photometric observations, we have obtained time series data to search for variable stars in the field. This paper presents the results of this project.

### 2. Observations

Johnson-Cousin  $V(RI)_C$  data, spanning  $\sim 57$  hours, were taken on eight nights in 2002 February and December at the Piszkestető Station of the Konkoly Observatory using the 60/90/180-cm Schmidt telescope, equipped with a Photometric AT-200 CCD camera. The image reduction was done with standard tasks in IRAF, while time series data were reduced with the DAOPHOT package. Differential light curves for about 800 stars in the field were calculated with the ensemble normalization technique (Gilliland & Brown 1988).

### 3. Results

#### 3.1. Parameters of the cluster

We have fitted isochrones taken from Bertelli et al. (1994) to the colour-magnitude diagrams (CMD). In order to separate the cluster's stars from other stars in the field, an astrometric study was performed by cross-correlating our data with the USNO B1.0 catalog (Monet et al. 2003). This led to a clearer CMD after removing the foreground stars with non-zero proper motions (they did not show any concentration around the cluster).

In order to decrease background contamination, we selected the inner  $8'$  of the cluster for the isochrone fitting. This region contains 103 stars between  $V = 11^m3 - 18^m5$ , whose CMD can be seen in the bottom panels of Fig. 1.

We have determined important physical parameters of the cluster:  $m - M = 11^m0 \pm 0^m5$ ,  $E(V - I) = 0^m4 \pm 0^m1$ ,  $E(V - R) = 0^m08 \pm 0^m06$ . The reddenings were converted to  $E(B - V)$  using the coefficients listed in Rieke & Lebofsky (1985), the result is  $E(B - V) = 0^m2 \pm 0^m15$ , consequently the distance to the NGC 2126 is  $1.3 \pm 0.6$  kpc.

#### 3.2. New variable stars

We have discovered six variable stars in a field of  $29' \times 18'$  centred on the cluster, which is about  $8'$  in diameter. The light curve shapes suggest the following classifications:

Two (V1, V2) of the new variables showed clear variability, but our dataset is too short to determine reliable periods. For V1, both Phase Dispersion Minimization and Fourier analysis suggested  $P = 1.6447$  d or half that value, 0.82235 d. For V2, the data can be equally well folded with periods around 0.5 d and 1 d.

Another two stars (V3, V5) showed rapid oscillations with full amplitudes of a few tens of mmag. Two frequencies could be identified in both light curves with S/N ratios larger than 4; the periods are for V3: 0.096 d and 0.078 d, and for V5: 0.087 d and 0.082 d. The frequency ratios (V3:  $f_1/f_2 = 0.81$ , V5:  $f_1/f_2 = 0.94$ ) suggest non-radial modes of pulsation for both stars. In summary, V3 and V5 are probably multiply periodic pulsating  $\delta$  Sct variables.

V4 is an Algol-type eclipsing binary. We could observe only one minimum which does not allow the determination of the period.

The most interesting variable star is V6. We observed well-defined minima and steady oscillations outside eclipses with amplitude and cycle length characteristic of  $\delta$  Sct pulsation. With these properties, V6 seems to be an eclipsing binary with at least one pulsating component. The period analysis resulted in  $P_{orb} = 1.17320 \pm 0.00003$  d. We also performed a separate period analysis of data from which eclipse minima were excluded. This showed the oscillations to be surprisingly stable. They have a period  $P_{pul} = 0.12369$  d and the phase diagram shows remarkably small scatter. Another interesting result is that  $f_{pul}/f_{orb} = 9.07$ , suggesting that there might be a 1:9 resonance between the orbital motion and pulsation.

We also observed V6 with the 1-m telescope at the Tel-Aviv University Wise Observatory. The spectral lines and the continuum shape suggest an F-type star, so that the oscillations may be attributed to  $\delta$  Sct pulsations.

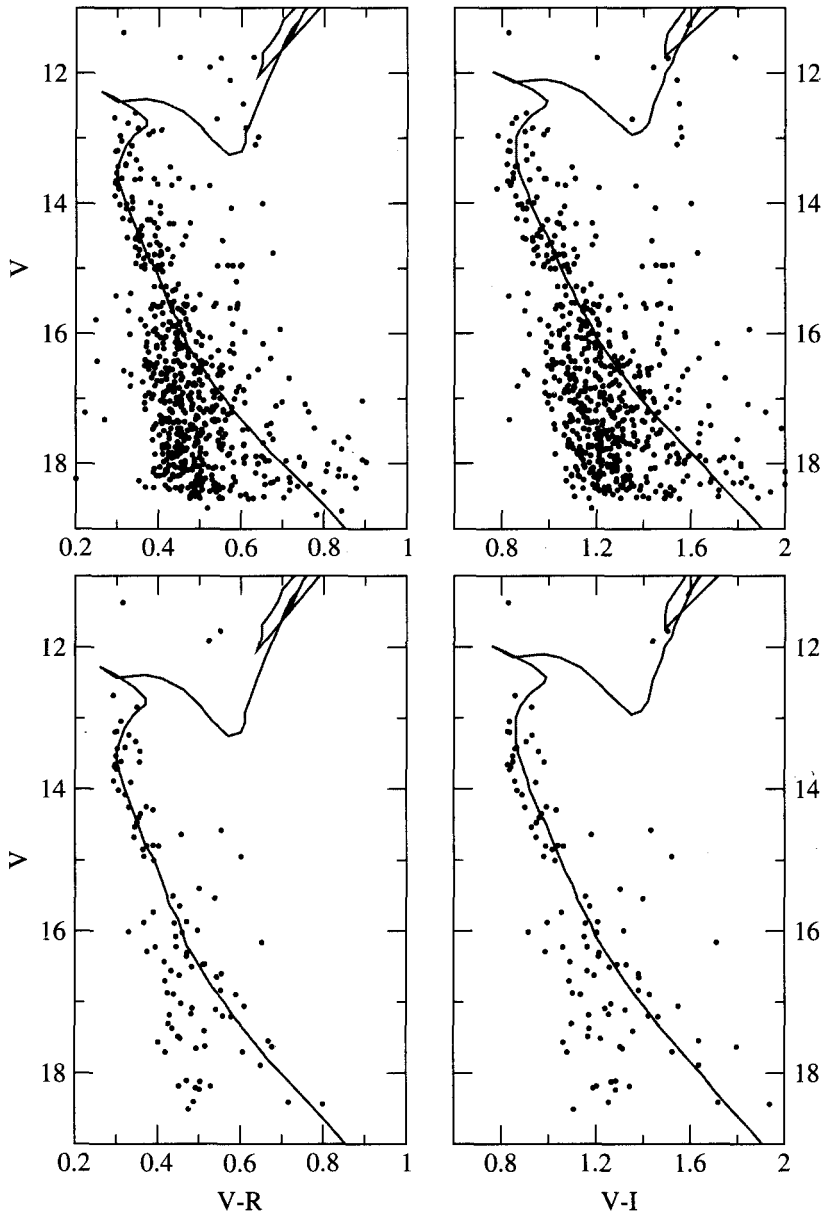


Figure 1. The colour-magnitude diagrams of NGC 2126. Top row: full field of view; bottom row: the central field of 8' diameter. The solid lines show the  $\log t = 9.1$  isochrone.

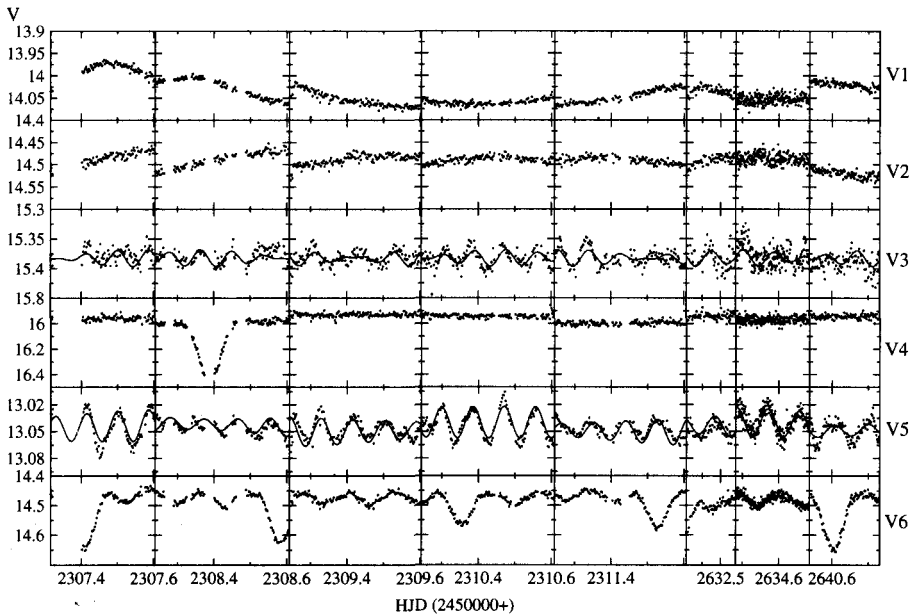


Figure 2. Individual light curves of the six new variable stars. The solid lines denote Fourier fits for V3 and V5.

From the six variables, only V6 has non-zero proper motion, thus its cluster membership can be excluded, it is a foreground object. The locations of the variables on the CMD suggest membership for V1, V4 and V5; V2 and V3 are most likely non-member stars.

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## References

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