

CCD *UBV* photometry and kinematics of the open cluster NGC 225Selçuk Bilir^{a,*}, Z. Funda Bostancı^a, Talar Yontan^b, Tolga Güver^a, Volkan Bakış^c,
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Abstract

We present the results of CCD *UBV* photometric and spectroscopic observations of the open cluster NGC 225. In order to determine the structural parameters of NGC 225, we calculated the stellar density profile in the cluster's field. We estimated the probabilities of the stars being physical members of the cluster using the existing astrometric data. The most likely members of the cluster were used in the determination of the astrophysical parameters of the cluster. We calculated the mean radial velocity of the cluster as $V_r = -8.3 \pm 5.0 \text{ km s}^{-1}$ from the optical spectra of eight stars in the cluster's field. Using the *mml* : *mrow* > $U - B$ vs $B - V$ two-colour diagram and UV excesses of the F-G type main-sequence stars, the reddening and metallicity of NGC 225 were inferred as $E(B - V) = 0.151 \pm 0.047 \text{ mag}$ and $[\text{Fe}/\text{H}] = -0.11 \pm 0.01 \text{ dex}$, respectively. We fitted the colour-magnitude diagrams of NGC 225 with the PARSEC isochrones and derived the distance modulus, distance and age of the cluster as $\mu_V = 9.3 \pm 0.07 \text{ mag}$, $d = 585 \pm 20 \text{ pc}$ and $t = 900 \pm 100 \text{ Myr}$, respectively. We also estimated the galactic orbital parameters and space velocity components of the cluster and found that the cluster has a slightly eccentric orbit of $e = 0.07 \pm 0.01$ and an orbital period of $P_{\text{orb}} = 255 \pm 5 \text{ Myr}$.

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1. Introduction

NGC 225 ($\alpha_{2000.0} = 00^{\text{h}}43^{\text{m}}39^{\text{s}}$, $\delta_{2000.0} = +61^{\circ}46'30''$; $l = 122^{\circ}.01$, $b = -1^{\circ}.08$; WEBDA database¹) is a sparsely populated and not a well-studied open cluster. Its age determined by Lattanzi et al. (1991) from photographic measurements and a recently revised study by Subramaniam et al. (2006) do not agree with each other. The limited number of observations, which are from older photographic measurements and some 2MASS data,

motivated us to observe and study NGC 225 by contemporary CCD technology at optical wavelengths.

Proper motions and approximate photographic visual magnitudes of the stars in the field of NGC 225 were first given by Lee (1926). First precise *UBV* photographic and photoelectric measurements of the cluster were performed by Hoag et al. (1961), who also constructed V vs $B - V$ colour-magnitude (CMD) and $U - B$ vs $B - V$ two-colour diagrams (TCD). Johnson et al. (1961) measured the reddening for the cluster as $E(B - V) = 0.29 \text{ mag}$ using the data presented by Hoag et al. (1961). Svolopoulos (1962) determined the spectral classes for a number of stars in the field of the cluster, for which the photoelectric magnitudes were already given by Hoag et al. (1961), and measured the reddening, the distance modulus and the

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distance of the cluster as $E(B - V) = 0.29$ mag, $(m - M) = 9.0$ mag and $d = 630$ pc, respectively. Hoag and Applequist (1965) measured H_γ equivalent widths of the brighter stars in the field of the cluster photoelectrically and determined their spectral classes. The distance modulus of the cluster were estimated as $(m - M) = 9.1$ mag. But, later when Becker and Fenkart (1971) catalogued open clusters its distance was re-established again, where the reddening, uncorrected the distance modulus, the distance and the apparent diameter of the cluster were given as $E(B - V) = 0.29$ mag, $(m - M) = 9.87$ mag, $d = 630$ pc and $D = 14$ arcmin, respectively. Lattanzi et al. (1991) investigated NGC 225 in detail and determined 28 probable member stars of the cluster according to the proper motions measured in their study. They had used

the photographic plates taken in B and V bands for estimating its age, reddening and distance as $t = 120$ Myr, $E(B - V) = 0.25 \pm 0.08$ mag and $d = 525 \pm 73$ pc, respectively. Almost one and a half decades later, the cluster was studied by Subramaniam et al. (2006), who re-estimated the cluster parameters using photographic UBV and Two Micron All Sky Survey's JHK_s photometry (2MASS, Skrutskie, 2006). Subramaniam et al. (2006) estimated the age of the cluster differently as $t = 0.5\text{--}10$ Myr and argued that its age is not 120 Myr as already suggested by Lattanzi et al. (1991). Strengthening this conclusion they proposed that two Herbig Be stars with H_α emission, dust lanes and nebulosity exist in the vicinity of the cluster implying possible results of recent star formation.

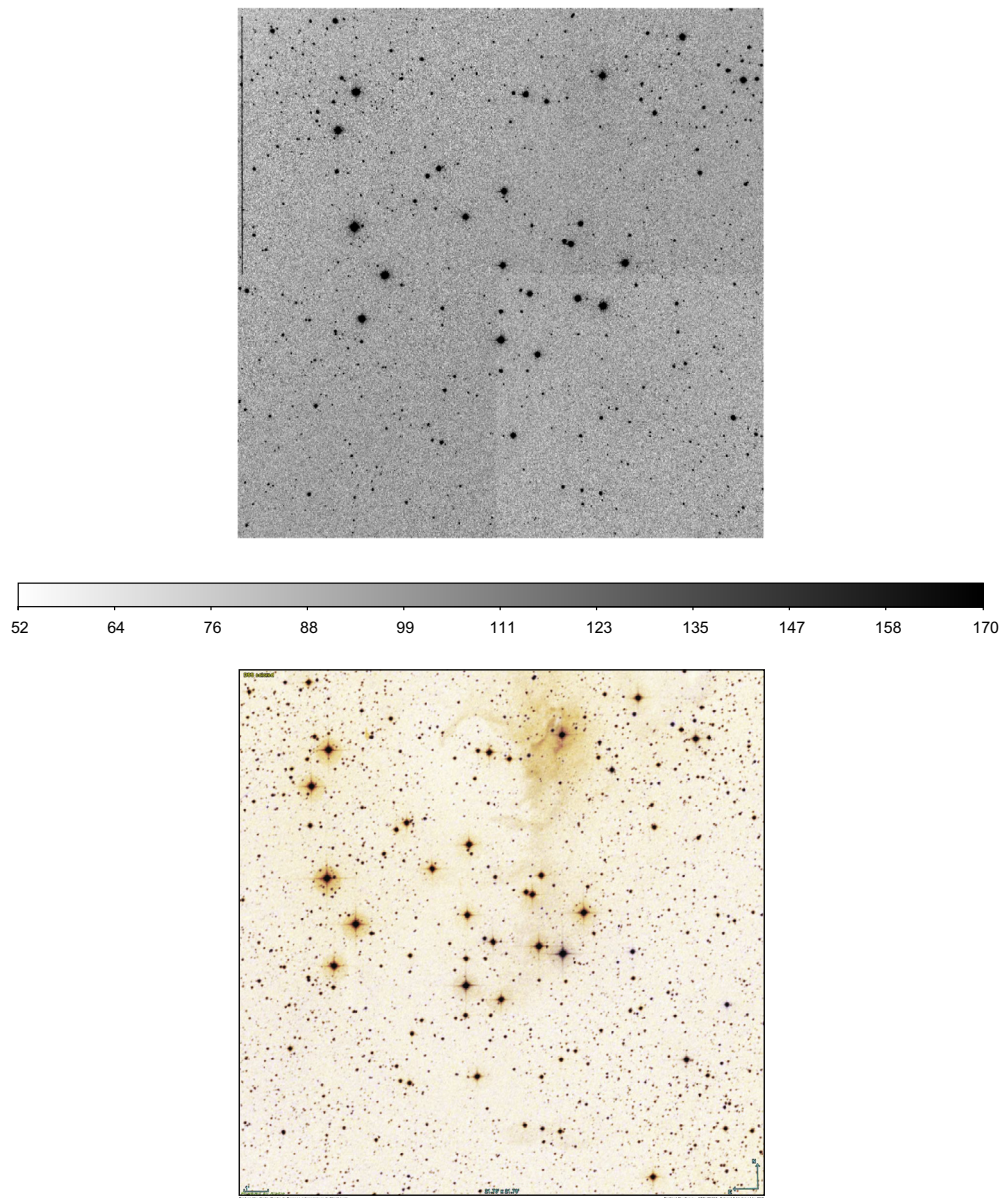


Fig. 1. An inverse coloured composite V -band image of NGC 225 (*upper*) obtained with T100 telescope of the TÜBİTAK National Observatory. The integral exposure time and the field of view are 30 s and about 21×21 arcmin, respectively (North top and East left). A 2MASS composite image with the same size is also presented (*lower*).

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