Strömgren-Hβ photometry of the young open cluster NGC 6913

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Abstract. We present new CCD $uvby\beta$ photometry of about 50 stars located in the central region of the open cluster NGC 6913. The individual stellar distances and color excesses of established cluster's members are analyzed and new estimate of the cluster's distance is provided.

Keywords. Stellar clusters and associations, $uvby\beta$ photometry, NGC 6913.

1. Introduction

The young open cluster NGC 6913 (M 29) is located in a low-extinction area toward the Great Cygnus Rift. Despite several extensive studies, the distance estimates to the cluster are still controversial, differing by as much as a factor of two. Tifft (1958) suggested two groups at 1.6 and 2.1 kpc. Photoelectric $uvby\beta$ photometry yielded 1.1 kpc, not in agreement with spectroscopically-based estimates (Crawford *et al.* 1977). More recently, utilizing Vilnius, BV and JHK photometry and spectra, Straizys *et al.* (2014) obtained 1.54 kpc. In order to re-evaluate the main cluster parameters, we provide new analysis of the existing $uvby\beta$ data and supplement them with new CCD $uvby\beta$ photometry of the central 15 × 15 arcmin region of NGC 6913. The $uvby\beta$ photometric system (Strömgren 1966, Crawford & Mander 1966) should in general be able to provide independent estimates of reddening, distance, metallicity and age, thus helping to constrain the existing disagreements.

2. Observations

The data were obtained during three consecutive nights in May/June, 2008, on the 0.9 m WIYN (Wisconsin Indiana Yale National Optical Astronomy Observatory) telescope at Kitt Peak National Observatory (KPNO). The telescope was equipped with the S2KB CCD camera, which employs a 2048 × 2048, 21 μ-pixel detector for a field of view of 20.5 arcmin, and a set of KPNO $uvby\beta$ filters.The reduction of the images followed standard procedures for bias subtraction, flat fielding, illumination and scattered light corrections

using the IRAF software package. About 20 cluster's stars with $uvby\beta$ photoelectric photometry (Crawford *et al.* 1977) were used as standards. The reduction was carried out in $V, b - y, c_1, m_1$ and β, as outlined by Crawford & Barnes (1970). In order to account for an apparent second-order variations in the point spread function across the field, we investigated various approaches to perform the photometry, including aperture photometry and 2-dimensional fitting with Gauss and Moffat functions. The 2-dimensional Gauss fit was found to provide the least error in the photometric transformations.

3. Results and Discussion

Our analysis of the photoelectric $uvby\beta$ data of Crawford & Barnes (1970) indicates that the bright stars that make the cluster recognizable are located at a distance of $895(+47, -44)$ pc. The fainter stars in the field seem to be more distant by 500 pc.

The new CCD $uvby\beta$ observations support this conclusion. Up to a limiting magnitude of about 14, we found no B-type stars located closer than 1 kpc. The impression is that the young compact group of bright OB stars is projected onto a background of fainter B-type stars. The obtained distance of 895 ± 45 pc is significantly smaller than the spectroscopically based 1540 ± 150 pc (Straizys *et al.* 2014). All these stars are located closer than a distance modulus of 11 mag, which corresponds to 1.6 ± 0.35 kpc (assuming an error of ± 0.5 mag in the distance modulus determination). This disagreement arises most likely from a possible overestimation of the spectroscopic distances(details on such comparisons can be found in Kaltcheva & Golev 2011). The inspection of the photometric diagrams do not imply a peculiar behavior that can significantly affect the $uvby\beta$ photometry-derived distances for the brightest cluster's members.

NGC 6913 is positioned within the boundaries of the Cyg OB1 association, one of the several OB associations within the giant H II region Sh 2-109. This nebulosity is possibly a complex of smaller H II regions overlapping along our line of sight since in this direction we are looking straight down the Orion spur (Sharpless 1959). Recent X-ray emission findings (Uyaniker *et al.* 2001) also suggest that Sh 2-109 consists of overlapping, not physically related, features. A distance less than 1 kpc, as suggested here, would place NGC 6913 closer than other young clusters located within the formal boundaries on the Cyg OB1/OB3 associations, like NGC 6871 and IC 4996, implying overlapping star-forming regions in this direction.

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