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Proper motions of stars in the globular clusters using WFI@2.2 m telescope

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Abstract. We present results of our studies for a sample of Galactic globular star clusters with the aim of deriving relative proper motions. We used CCD archival data observed with Wide Field Imager (WFI) mounted on ESO 2.2 m telescope at La Silla, Chile. Astrometric software designed by Anderson *et al.* is used to derive relative proper motions. The vector point diagrams show clear separation of field stars from the cluster stars. We used proper motions to determine membership probabilities and to produce color-magnitude diagrams with most probable cluster member stars. Our membership catalogue can be used to study the membership status of the peculiar stars including various variables reported in the literature.

Keywords. (Galaxy:) globular clusters: general, stars: kinematics

1. Introduction

Proper motions in Galactic globular clusters are of great interest due to their application to interpret the kinematics and dynamics of the Milky Way. Proper motions can be used to decide whether a particular star belongs to the cluster or it is more likely a field star. Ground based data holds importance in proper motion work by virtue of covering wider region of the clusters and complements the HST which can resolve the central regions of globular clusters. CCDs have revolutionized the proper motion work as the required epoch gap has reduced and one can go to much fainter magnitudes. Wide field imaging CCDs made with mosaicing techniques cover a wide region of globular clusters.

2. Data and reduction procedures

The images used for proper motion studies of globular clusters were obtained with the Wide Field Imager (WFI) camera mounted on 2.2 m ESO/MPI telescope located at La Silla, Chile. The epoch gaps for the studied globular clusters are in the range of ∼3-14 yrs. WFI is a mosaic of 8 CCDs, 2k×4k pixels each. Mosaic CCDs of the WFI enable a wide field of view observation (34×33 arcmin^2) of the globular clusters. Typical seeing during the observations was ∼1-1.5 arcsec.

To reduce the WFI images, the procedure discussed by Anderson *et al.* (2006, A06) was used. The first main aspect of this procedure is to make multiple PSFs per CCD chip to capture the variation of the PSF across the mosaic system. Usually 3×5 PSFs are made for each CCD, thus 120 total PSFs for an image. The second main thing is to solve for the geometric distortion effect using the solution provided by A06. Finally, the local transformation approach is used to remove any uncorrected geometric distortion effect.

Reference stars to calculate proper motions were selected using the position of stars in the color-magnitude diagrams (CMD) and then, the program was iterated to include good proper motion. The detailed procedures to obtain the proper motion has been discussed by A06; Bellini *et al.* (2009); Yadav *et al.* (2008, 2013); Sariya *et al.* (2012, 2015, 2017). A centroid around the cluster proper motion center in the vector point diagrams gives the cluster members. Then, the method given by Balaguer-Núñez *et al.* (1998) was used to determine membership probabilities of the stars.

3. Results and Discussion

Our research group derived proper motions and membership probabilities for the stars in the area of globular clusters NGC 6809, NGC 6366 and NGC 3201 (Sariya *et al.* 2012, 2015, 2017). Number of the studied stars is ∼12600, 2530 and 8322 for NGC 6809, NGC 6366 and NGC 3201 consecutively. The electronic catalogues contain equatorial coordinates, proper motions, photometric magnitudes and membership probabilities. Using most probable cluster members, we produced CMDs showing clean sequences having only a little field stars contamination. The membership catalogues were also used to discuss membership status of known variable stars, blue stragglers and X-ray sources reported in literature. Our studies exhibit the superiority of CCDs over photographic plates with proper motion determinations possible using data having only a few years epoch gap.

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