STUDY OF INTERMEDIATE AGE (~10-30 Myr) OPEN CLUSTERS

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OVERVIEW

We present the study of a sample of intermediate age open clusters (age ~ 10 -30 Myr) using optical (UBVRI) and infrared photometric data. Optical photometry was obtained as part of the San Pedro Martir Open Clusters Project (SPM-OCP, Schuster et al. 2007; Michel et al. 2013). Infrared photometry was retrieved from 2MASS, WISE and GLIMPSE databases. Open clusters included in the SPM-OCP were selected from catalogues presented by Dias et al. (2002) and Froebrich, Scholz & Raftery (2007). One of the main goals of the SPM-OCP is to compile a self-consistent and homogeneous set of cluster fundamental parameters such as reddening, distance, age, and metallicity whenever possible. In this work, we have analyzed a set of 35 clusters from the SPM-OCP with estimated ages between ~ 10 and 30 Myr. Derived fundamental parameters for each cluster in the sample as well as an example of typical color-color and color-magnitude diagrams are presented. Kinematic membership was established by using proper motion data taken from the literature. Based on infrared photometry, we have searched for candidate stars to posses a circumstellar disk within each clusters. For those selected candidates a follow-up spectroscopic study is being carried on.

OBSERVATIONS AND DATA REDUCTION

All observations were carried out at the 0.84m telescope of the Observatorio Astronómico Nacional at San Pedro Mártir, B.C., Mexico. The same instrumental setup (telescope, CCD and filters) was used through all runs. Also the same observing procedures, reduction method and system of standard stars (Landolt 1983, 1992) were used through all the runs. A set of UBVRI Johnson-Cousins filters, mounted on the filter-wheel "Mexman" was used. The SITE1 (SI 003) CCD camera, with 1024 x 1024 pixels array (24 μm pixel size), was used as detector. The pixel size projected on the sky was 0.393´´ and the total field of view was 6.73 x 6.73 arcmin^2.

Data reduction was performed following standard procedures within IRAF. DAOPHOT task was used to obtain PSF fitting photometry. Typical error in V band is smaller than 0.1 mag for V < 17 mag.

Cluster	RA	Dec	E(B-V)	$(m-M)_o$	log(Age)	
					mean	error
King 16	00 43 45	+64 11 08	0.88	12.8	7.50	0.20
Berkeley 4	00 45 01	+64 23 05	0.80	12.6	6.80	0.05
NGC 281	00 52 59	+56 37 19	0.32	12.2	7.25	0.05
NGC 366	01 06 26	+62 13 48	1.10	12.3	7.40	0.05
NGC 457	01 19 35	+58 17 12	0.45	12.3	7.50	0.05
NGC 637	01 43 04	+64 02 24	0.55	12.2	7.35	0.15
Riddle 4	02 07 23	+60 15 25	1.10	12.1	7.25	0.05
NGC 884	02 22 23	+57 07 33	0.49	11.6	7.43	0.23
Tombough 4	02 28 54	+61 47 00	1.20	12.1	7.05	0.05
Czernik 8	02 33 00	+58 44 00	1.12	12.3	7.40	0.05
NGC 957	02 33 21	+57 33 36	0.68	11.9	7.35	0.05
Berkeley 65	02 39 00	+60 25 00	1.02	11.7	7.05	0.05
NGC 1444	03 49 25	+52 39 30	0.70	10.1	7.25	0.25
NGC 1502	04 07 50	+62 19 54	0.70	10.2	7.05	0.05
Berkeley 11	04 20 36	+44 55 00	0.93	12.4	7.33	0.13
Kronberger 1	05 28 21	+34 46 30	0.52	11.3	7.50	0.05
NGC 2129	06 01 07	+23 19 20	0.70	11.7	7.05	0.05
NGC 2169	06 08 24	+13 57 54	0.15	9.9	7.10	0.10
NGC 2175	06 09 39	+20 29 12	0.66	11.6	7.45	0.05
NGC 2414	07 33 12	-15 27 12	0.55	13.5	7.10	0.10
NGC 6604	18 18 03	-12 14 30	0.97	11.5	6.65	0.05
Biurakan 2	20 09 12	+35 29 00	0.33	10.5	7.25	0.05
Collinder 419	20 18 07	+40 43 55	1.22	11.0	6.65	0.05
Berkeley 87	20 21 42	+37 22 00	1.37	10.5	7.05	0.05
NGC 7261	22 20 11	+58 07 18	1.00	12.7	7.15	0.05
Berkeley 94	22 22 42	+55 51 00	0.60	13.1	7.05	0.05
Teutsch 53	22 24 32	+60 24 53	1.00	12.5	7.15	0.05
Berkeley 95	22 28 18	+59 08 00	1.40	13.1	7.30	0.20
Berkeley 96	22 29 24	+55 24 00	0.58	13.2	7.05	0.05
King 10	22 54 54	+59 10 00	1.15	13.1	7.50	0.05
NGC 7510	23 11 03	+60 34 12	0.97	12.4	7.15	0.05
King 21	23 49 54	+62 43 00	0.82	12.3	7.05	0.05
NGC 7772	23 51 46	+16 14 48	0.30	9.8	7.25	0.05
King 12	23 53 00	+61 58 00	0.54	12.4	7.05	0.05
NGC 7788	23 56 45	+61 23 54	0.53	11.5	7.35	0.15

Table of results

Basic parameters derived for our cluster sample.

PRELIMINARY RESULTS

Fully calibrated photometry in five bands were obtained from our data (UBVRI). Infrared photometry (J, H , Ks) from 2MASS catalogue was appended to our database. When available GLIMPSE and WISE data were also included. Data from other photometric systems available in the literature and information on proper motions were also included in our final database. In this way analysis of spectral energy distribution in a wider range in wavelength and kinematic properties of clusters is possible.

Fundamental cluster parameters were derived using the optical color-color diagram, (U-B) vs (B-V), and five different color-magnitude diagrams together with theoretical zero age main sequence (ZAMS) and isochrones. The ZAMS by Schmidt-Kaler (1982) and Padova isochrones (Girardi et al. 2000, Bertelli et al. 2008, Marigo et al. 2008) were used. Derived parameters and other relevant information for each cluster are presented in the Table of results.

A typical set of diagrams used to derive cluster parameters are shown in Figures 1 to 5, for the particular case of NGC 6604. Since for this cluster GLIMPSE data were available, a preliminar analysis of disk population was done. From Fig. 4 we can see that ten stars are clearly identified as thick disk objects. A spectroscopic follow-up study is being carried out to obtain spectral types of these stars as a second stage of the project.

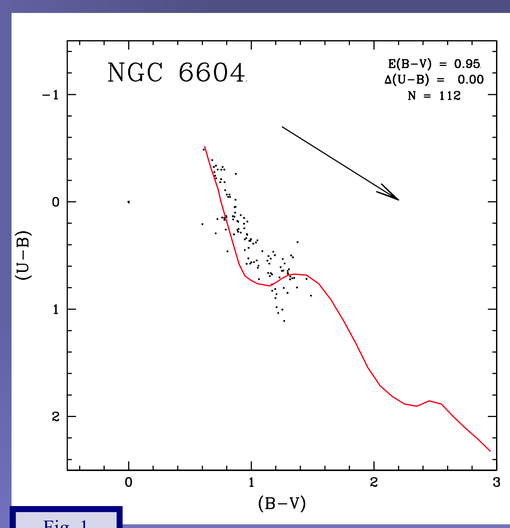

Fig. 1

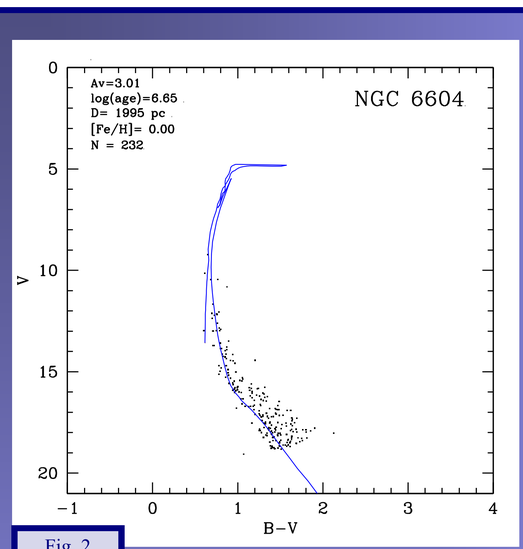

Fig. 2

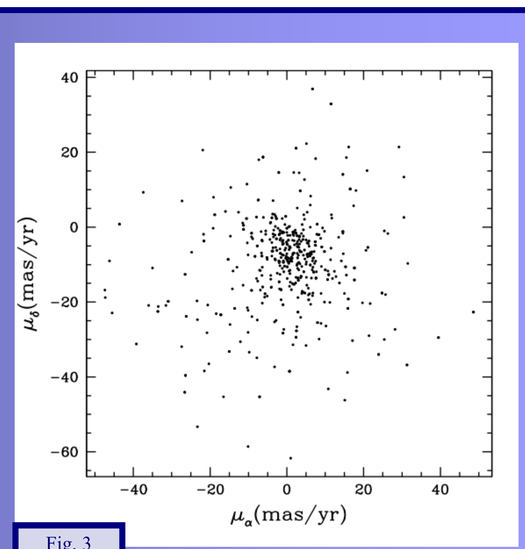

Fig. 3

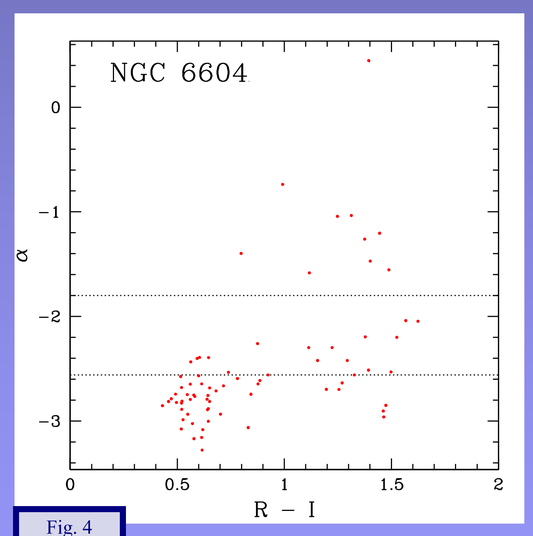

Fig. 4

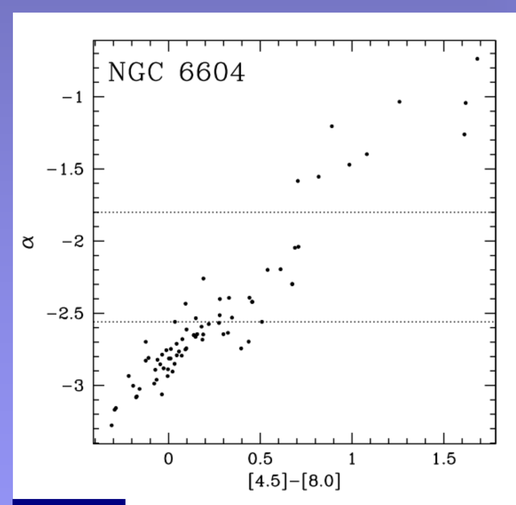

Fig. 5

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ACKNOWLEDGMENTS

This project was supported by UNAM-PAPIIT grant In 109311. The Observatorio Astronómico Nacional at San Pedro Mártir, is a facility operated by Instituto de Astronomía of the Universidad Nacional Autónoma de Mexico. We acknowledge the staff of the San Pedro Mártir Observatory for their support.