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Near IR study of the young cluster NGC 2453

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Abstract. In an attempt to understand early phases of stellar evolution and star formation, we have taken up the study of extremely young star clusters in the near infrared wavebands. These clusters are deeply embedded inside the molecular gas and dust but radiate substantially in the infrared. We have observed one such cluster NGC 2453 from Mt Abu Infrared Observatory (MIRO) operated by the Physical Research Laboratory, using the NICMOS-3 infrared array mounted on the 1.2 m Cassegrain focus telescope. The observations were made in the J, H and K′ wavebands in February 2000. The data reduction and the photometry has been performed using IRAF. Preliminary results are presented.

Key words : NICMOS camera, open clusters, near-infrared, cluster distance.

1. Introduction

NGC 2453 (+ C 0745–271 = OCL 670) located at α 2000 = 7h 47m 45s, δ2000 =–27° 14′ 30″ is an open cluster of Trumpler class I3m (Lynga 1987) in Puppis. This cluster is a bit old to explore the spiral arm and resides between the two galactic arms. It is a moderately young cluster with an estimated age of 40 Myrs. It has been studied by several authors. Following tells the confusion regarding its age : Seggewiss (1971), using few stars photometry, gave a distance of 1490 pc while Moffat & Fitzerald (1974) estimated a distance of 2.9 ± 0.2 kpc by fitting MS stars and used V vs B–V and V vs U–B. Later Gatheir (1984) arrived at a distance of 5.0 ± 0.6 kpc for this cluster ! In 1995, Mallik et al used BVI photometry from Kavalur using 1.2m and 2.34m telescopes and calculated a distance of 5.9 ± 0.2 kpc. They used deep ccd imaging in BVI. Raw instrumental magnitudes were converted to standard photometry system. They took account of extinction, E(B–V) from earlier work. Radial distribution of stars in concentric circles show that brighter stars are closer to the center of cluster. Since kinematic information was not sufficient, a firm membership could not be ascertained. The inference was drawn by looking at the distance of stars from the cluster center. This cluster lies in a direction of low interstellar extinction. The stars in this have significant amount of dust and gas and radiate in infrared. Near infrared photometry, therefore, will provide detailed information on these sources as there is large extinction at shorter wavelengths. We report such a study on this cluster.

2. Observations and data analysis

Observations were made on 5th, 6th and 7th February 2000 at the Mt. Abu Infrared Observatory (MIRO) operated by the Physical Research Laboratory, using the NICMOS-3 infrared array mounted on the 1.2 m Cassegrain focus telescope. NICMOS-3 is a 256 x 256 pixel, HgCdTe array detector (Joshi et al. 1999). The observations were made in the J, H and K′ wavebands using 2′ by 2′ FOV with 30s, 20s and 3 seconds exposure times, respectively. Due to large background, larger integrations are made possible by taking a large number of shorter exposures at each location, particularly in the H and K′ bands, to improve the signal to noise ratio. A number of standard stars (Hunt et al 1998) were also observed during each night for calibration. Dark frames were taken corresponding to each exposure time during each observing run.

The data reduction was done using IRAF with additional locally developed tasks as necessary. All the images at one location were averaged to produce a single frame per location. A sky frame was constructed by median combining all observations. The resulting sky frame was subtracted from the observed frame. From all the dark frames a master dark frame is constructed by median combining. Using the sky and dark images, master flat field image was constructed. This master flat field frame was applied to all the sky corrected images. All the 25 images of the cluster were mosaiced to obtain the cluster field.

3. Results and discussion

We have performed photometry of over 350 stars observed in the cluster field in each waveband using IRAF and DAOPHOT (Stetson 1992). Out of these, about 70 have been cross identified with the observations of Mallik et al (1995) for preliminary analysis. In Table 1 we report the photometric results of this analysis. Here (X-Y)o values are after the correction applied to respective (X-Y) values. A colour magnitude diagram is shown in Figure 1.

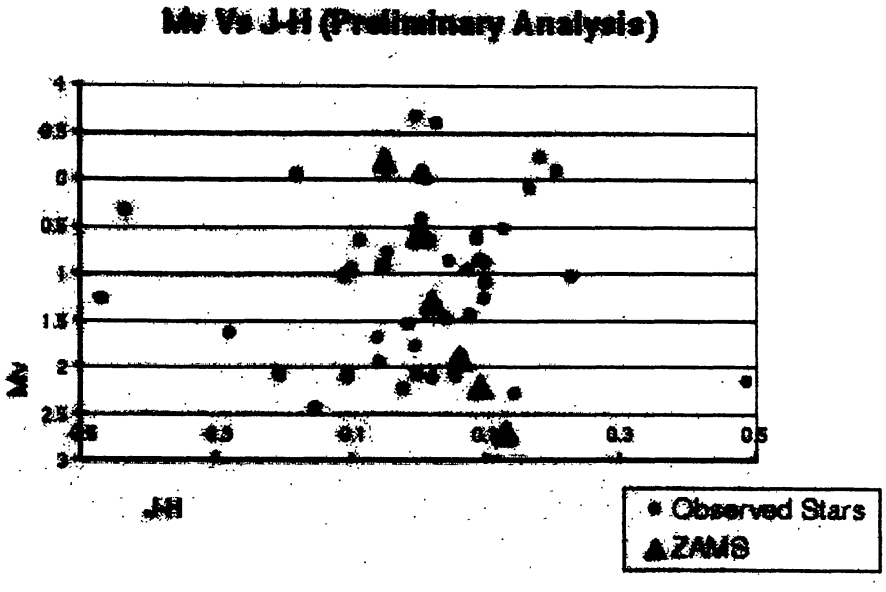

Figure 1. Colour magnitude diagram for some stars in NGC 2453. Mv is absolute magnitude.

Here V is the apparent magnitude and Mv the absolute magnitude (Mallik et al. 1995). A comparison is shown of the visual intrinsic magnitudes with (J-H) values of the main sequence stars. The peculiar magnitudes of some stars may be due to the high background noise and the poor quality of images due to low signal to noise ratio in the K′ band. Many of the fainter stars have not been identified in the K′ band. A large integration time is required for the K′ band taking larger number of short exposure frames per location.

Table 1. Magnitudes in J, H, K′ and absolute magnitude in V for some of the stars in NGC 2453. The star numbers, MF, are based on the work of Moffat & Fitzerald (1974).

MF	J	H	K′	J-H	H-K′	(J-H)o	(H-K′)o	Mv
1	13.593	13.318		0.275		0.1011		0.9
2	11.457	11.263	10.595	0.194	0.8278	0.0201	0.7385	0.67
3	14.646	14.37	14.173	0.276	0.3568	0.1021	0.3675	2.27
4	12.457	12.297	11.786	0.16	0.6708	-0.0139	0.5815	1.55
5	13.229	13.164		0.065		-0.1089		1.05
6	12.911	12.692		0.219		0.0451		0.89
7	12.454	12.097		0.357		0.1831		-0.22
8	12.431	12.049	12.048	0.382	0.1608	0.2081	0.0715	-0.09
9	13.048	12.647		0.401		0.2271		1.04
10	13.053	12.925		0.128		-0.0459		0.78
12	12.974	12.711		0.263		0.0891		0.64
13	14.471	14.241		0.23		0.0561		2.12
14	14.146	13.975		0.171		-0.0029		1.78
15	13.264	12.998		0.266		0.0921		0.87
20		14.217						2.29
24	15.279	14.978	12.144	0.301	2.9938	0.1271	2.90	
27	12.267	11.926	12.364	0.341	-0.2782	0.1671	-0.3675	0.1
28	11.874	11.67	11.541	0.204	0.2888	0.0301	0.1995	-0.59
29	12.83	12.59	14.441	0.24	-1.6912	0.0661	-1.7805	1.88
30	13.556	13.283	14.326	0.273	-0.8832	0.0991		
31	13.776	13.524		0.252		0.0781		1.45
32	14.396	14.201		0.195		0.0211		2.13
34	13.163	12.887		0.276		0.1021		1.11
35	14.189	13.871		0.318		0.1441		2.29
36	14.087	13.973		0.114		-0.0599		1.69
37	14.162	14.141		0.021		-0.1529		2.44
38	12.512	12.519		-0.007		-0.1809		-0.05
41	14.683	14.021		0.662		0.4881		2.16
42	14.128	14.013		0.115		-0.0589		1.94
47	13.74	13.525		0.215		0.0411		1.49

Table 1. Continued

MF	J	H	K′	J-H	H-K′	(J-H)o	(H-K′)o	Mv
48	13.977	13.909		0.068		-0.1059		2.11
49	13.805	13.911		-0.106		-0.2799		1.64
51	13.329	13.156		0.173		-0.0009		2.1
52	13.395	13.32		0.075		-0.0989		0.96
53	13.992	14.024		-0.032		-0.2059		2.1
56		15.455	10.084		5.5308		5.4415	1.33
57		13.15	12.755		0.5548		0.4655	0.83
58	12.266						-0.41	
59	13.328	13.207		0.121		-0.0529		0.94
60	13.172	13.085		0.087		-0.0869		0.67
61	12.496	12.32	12.076	0.176	0.4038	0.0021	0.3145	-0.02
63	11.914	11.741		0.173		-0.0009		-0.66
64		13.111					0.96	
65		14.657					2.38	
75	12.487	12.304		0.183		0.0091		-0.07
77	13.211	12.963		0.248		0.0741		0.97
78	13.05	12.898	12.375	0.152	0.6828	-0.0219	0.5935	2.24
79	10.254	10.12	10.19	0.134	0.0898	-0.0399	0.0005b	0
81	11.652	11.947	11.05	-0.295	1.0558	-0.4689	0.9665	1.28
82	14.775	15.036		-0.261		-0.4349		0.33
85	14.309	11.914	11.348	2.395	0.7258	2.2211	0.6365	1.23
16a	12.197	12.009	12.022	0.188	0.1468	0.0141	0.0575	0.02
16b	12.405	12.223	12.022	0.182	0.3608	0.0081	0.2715	0.44

The plot of Mv vs J-H shows the sample of stars observed by Moffat and Fitzgerald with the ZAMS. Thus the data obtained is reasonably good and complete analysis of all the data will be published later.

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References

Gathier R., 1984, Ph.D. thesis, Univ Groningen
Hunt L.K., et al 1998, AJ 115, 2594
Joshi U.C., Ganesh S. Baliyan K.S. et al, 1999, EAMA conf. proceedings, p57
Lynga G., 1987, Open Cluster Data Catalog, CDS Strasbourg

Mallik D.C.V., Sagar R., Pati A.K., 1995, A&AS, 114, 537

Moffat A.F.J, Fitzgerald M.P., 1974, A&AS, 18, 19

Seggewiss W., 1971, Veroffentl. Astron. Inst. Bonn, Nr. 83, 21

Stetson P.B., 1992, in Astro. Data Analysis Soft. Systems, eds. DM Worrall C., Biemsesderfer & J Barns, ASP Conf-25, p 297