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Mass function study of six open clusters Be 10, Be 67, To 5, Be 15, Be 71 and King 1

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Abstract. In the present study, we have used the CCD data to determine the luminosity and mass function of six open clusters. Members of clusters are identified using photometric and statistical criteria. From these members, we have derived luminosity functions and determined the mass function slopes for the clusters under study. The mass function slopes for clusters Be 10, Be 67, To 5, Be 15, Be 71 and King 1 are 1.39±0.73, 3.41±0.98, 1.32±0.47, 1.35±0.46, 3.02±0.81 and 1.46±0.71 respectively. These slopes agree with the Salpeter value (x=1.35) within errors except for clusters Be 67 and Be 71 which have steeper slopes. The clusters Be 10, Be 67, To 5 and Be 15 show mass segregation while King 1 gives weak evidence of mass segregation and Be 71 does not show the effects of mass segregation. All the clusters under study are dynamically relaxed.

Keywords : Stars: luminosity function, mass function - open clusters and associations: general.

1. Introduction

The mass function of open star clusters provide information about the star formation processes and the evolutionary history of the galaxies. Considerable work has been done on mass functions of clusters during the last two decades (Scalo, 1986, 1998; Sagar and Griffiths, 1998; Phelps and Janes, 1993; Pandey et al., 2001; Prisinzano et al., 2001; Piatti et al., 2002; Yadav and Sagar, 2002, 2004a; Piskunov et al., 2004; Sung and Bessel, 2004;

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Table 1. Basic parameters of the open clusters. $E(V-I)$ is the value of cluster reddening and t is the cluster age

Cluster	R. A. $(^{hh:mm:ss})$	Decl. $(^{\circ}:':'')$	radius (arcmin)	distance (kpc)	log t (t in years)	E(V-I) (mag)	Reference
Be 10	03 39 27	66 32 00	6.0	2.29	8.80	1.15	Lata et al. 2004a
Be 67	04 38 08	50 44 58	3.5	2.45	9.00	0.99	Lata et al. 2004a
To 5	03 47 48	59 03 13	8.5	1.75	8.30	1.03	Lata et al. 2004a
Be 15	05 02 05	44 30 00	4.5	3.00	8.50	1.24	Lata et al. 2004b
Be 71	05 40 56	32 16 42	3.0	3.90	8.80	1.16	Lata et al. 2004b
King 1	00 22 00	64 23 00	4.0	1.90	9.20	1.17	Lata et al. 2004b

Baume et al., 2003, 2004a and references therein). However, we are still not in a position to say whether the initial mass function (IMF) is universal or changes with time due to different star forming conditions (Larson 1999; Elmegreen 2000). Scalo (1986, 1998) and Kroupa (2002) have deduced a uniform IMF using different populations. Prisinzano et al., (2001) found that IMF cannot be represented by a unique power law and also noticed that all the clusters with ages ≤ 0.5 Gyr have very similar MF slopes, while Piskunov et al., (2004) found that in spite of non-monotonic behaviour of observed luminosity functions, cluster IMFs can be described as power law functions with a slope similar to the Salpeter's value.

Massey et al., (1995) have neglected the influence of metallicity on the IMF slope. In contrast, Kroupa (2001) states that the most obvious parameter which varies with time and could lead to IMF variations is the metallicity. Jeffries et al., (2003) also found the IMF slope to be metallicity dependent.

In the present study we have estimated luminosity function and mass function slopes of six open clusters namely Be 10, Be 67, To 5, Be 15, Be 71 and King 1. The basic parameters of these clusters are listed in Table 1. Details of the photometric observations and information are given in Lata et al., (2004a) and Lata et al., (2004b) (hereafter referred to as paper I and II respectively). The radius for the present cluster sample ranges from 8.5 to 3.0 arcmin. The stars present inside the cluster radius have been used to estimate cluster parameters. These parameters are derived using the UBVRI CCD data published in Paper I and II. The distances for these clusters have been obtained using their colour-magnitude diagrams (CMDs). The age of a cluster has been determined by fitting theoretical isochrones given by Girardi et al. (2002) to the observed CMDs. All the clusters under study are of intermediate age. The effect of data incompleteness and field star contamination have been taken into account during estimation of mass function slopes of the clusters.

2. Data

The broad band UBV Johnson and RI Cousins photometric observations for the clusters were carried out using the CCD system at f/13 Cassegrain focus of the 104-cm Sampur-

Table 2. Pixel coordinates of the cluster centres with their radius estimate. The area of cluster region is AR times the area of the field region.

Cluster	X_c (pixel)	Y_c (pixel)	AR	area of cluster region (arcmin^2)	area of filed region (arcmin^2)
Be 10	397	408	0.67	113.0	169.0
Be 67	529	415	0.31	38.47	126.0
To 5	402	497	0.81	226.87	280.1
Be 15	389	531	0.38	63.58	169.0
Be 71	525	375	0.20	28.74	140.74
King 1	585	525	0.30	50.24	169.0

nanand reflector of the Aryabhatta Research Institute of observational sciencES (ARIES), Nainital, during 1999 – 2002. The CCD detector is a square of 2048 pixel size and each square pixel of 24 μ size corresponds to 0.38 arcsec square on the sky. The entire chip covers a field of about 13 × 13 arcmin^2 on the sky. In order to improve signal to noise ratio for fainter stars, observations were taken in binned mode of 2×2 pixel^2. Several bias and twilight flat field frames in all the filters have also been taken to clean the images. Multiple long and short exposures have been obtained for the cluster regions. For calibrating the cluster observations, Landolt (1992) standard stars in SA98, SA 92, PG0231 and PG0918 were also observed. The nearby field regions for clusters Be 10, Be 15 and King 1 were observed to estimate the contamination due to the field stars in the cluster region. As the cluster diameter for To 5 is 17 arcmin, we observed the cluster by dividing it into four sub-regions namely North-West, South-East, South-West and North-East regions. Further details of the observations and results obtained for the clusters under study are described in the papers I and II.

3. Luminosity function

The distribution of stars according to their brightness is called the luminosity function. For deriving luminosity function we preferred the (V, V-I) diagram over the (V, B-V) diagram as it is generally deeper at least by a magnitude. To derive the luminosity function of any cluster, it is necessary to have knowledge about the cluster membership. For this purpose, we separate out the field stars and also apply data completeness factor according to the following procedures.

3.1 Cluster members and field stars

For the separation of cluster members from the field stars, the combination of photometric and spectroscopic information with kinematical data allows us to identify the foreground/background objects properly. Since we have no information about spectroscopic and kinematical data of the stars observed by us, the method of statistical field star subtraction has been used assuming that the field stars within the cluster and surround-

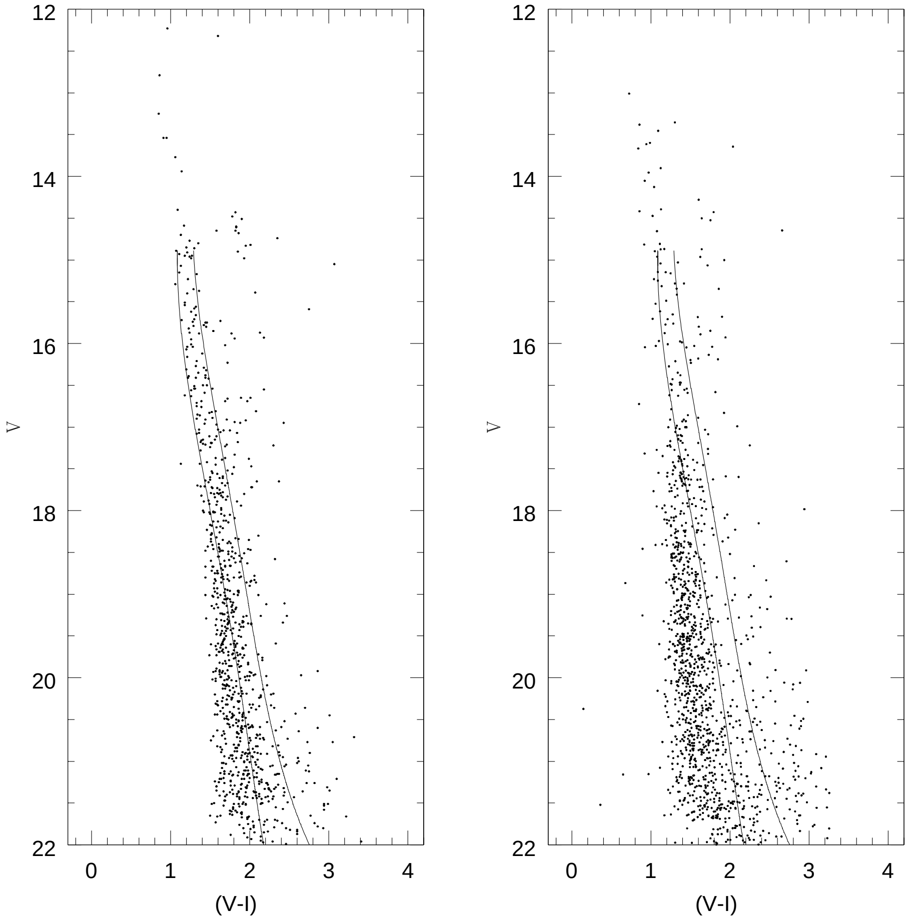

Figure 1. V, (V-I) diagrams for stars of the Be 10 cluster and field regions. The solid lines envelope the main-sequence stars and thus separate them from the others.

ing nearby areas are distributed in a similar way. A number of other studies (Wilner and Lada 1991, Phelps and Janes 1993, Sagar and Griffiths 1998) have also used the statistical approach to determine the luminosity functions. A brief description of the procedure applied in case of cluster Be 10 is given below. The apparent (V, V-I) diagrams for cluster Be 10 and for its field region are shown in Fig 1. The CMDs show a well defined main-sequence contaminated by field stars. The cluster sequence towards the fainter end has more scatter. This may be due to photometric errors as well as field star contamination. It is not possible to separate field stars from the cluster members only on the basis of their closeness to the main populated area of the CMDs, because field stars at the cluster distance and reddening also occupy this area.

3.2 Field star contamination

The entire CCD covers a field of $\approx 13' \times 13'$ on the sky. For estimating field star contamination we have observed the field regions for clusters Be 10, Be 15 and King 1 located at a distance of about 7 arcmin from the cluster centres. For the remaining clusters, regions observed along with the clusters To 5, Be 67 and Be 71 located at a distance of 8.5, 3.7 and 3.0 arcmin away from the cluster centre have been used to estimate the field star contamination. In terms of the cluster radius, the separation between the cluster and field regions is $\sim$1 for Be 10, To 5, Be 67 and Be 71 while it is 1.55 and 1.75 for Be 15 and King 1 respectively. The area observed for cluster and field regions along with the pixel coordinates of the cluster centre are provided in Table 2. The region inside the cluster radius has been considered as the cluster area. In (V, V-I) colour-magnitude diagram we draw a strip to define the main sequence of the cluster and the same is drawn in the colour-magnitude diagram of the corresponding field region. The stars inside this strip can be considered as members and the stars outside this strip can be assumed as field stars. The width of the strip is about 1.0 mag, because all the clusters have a well-defined and broad main-sequence. The broadening of main sequence is due to the photometric errors, binaries as well as presence of field stars. In this way, for further analysis, we take only those stars which lie within the cluster radius as well as stars which fall inside the strip defined in Fig. 1.

3.3 Completeness of the CCD data

We may not detect all the stars present in the CCD frame due to the stellar crowding and inefficiency of the data reduction programmes. In order to avoid an appreciable increase in the stellar crowding of the original data frame, we have randomly added only 10 to 15% of actually detected stars as artificial stars of known magnitudes and positions into the original frames. This is done using the DAOPHOT software package (Stetson 1987). The frames were re-reduced in the same manner as was done for the original frames. We estimated the completeness factor (CF) as the ratio between the number of artificial stars recovered and the number of stars added per magnitude bin. The values of CF thus obtained, as a function of brightness are listed in Table 3. The procedure to use CF values for the correction of data incompleteness has been discussed in detail by several authors (Mateo 1988; Sagar and Richtler 1991; Banks et al., 1995). We have used the approach given by Sagar and Richtler (1991) where they adopt minimum value of the completeness factors of the pair (in two wavelength bands) for correcting star counts.

3.4 Luminosity function

The main sequence luminosity functions of all the clusters under discussion have been obtained using their (V, V-I) diagrams. The main-sequence stars have been isolated from

Table 3. Completeness factor (CF) as a function of brightness. CFC and CFF are the CF for cluster and field regions.

V range (mag)	Be 67		Be 71		V range (mag)	Be 10		Be 15		To 5		King 1	
	CFC	CFF	CFF	CFF		CFC	CFF	CFC	CFF	CFC	CFF	CFC	CFF
15.5-16.5	1.00	1.00	0.95	0.95	12-13					1.00	1.00		
16.5-17.5	0.99	0.99	0.90	0.90	13-14					1.00	1.00		
17.5-18.5	0.94	0.94	0.85	0.85	14-15	1.00	1.00	1.00	1.00	1.00	1.00		
18.5-19.5	0.94	0.94	0.74	0.74	15-16	1.00	1.00	1.00	1.00	0.99	0.99	1.00	1.00
19.5-20.5	0.67	0.67	0.48	0.48	16-17	0.99	1.00	1.00	0.98	0.99	0.99	1.00	0.95
20.5-21.5			0.22	0.22	17-18	0.98	0.99	0.98	0.98	0.97	0.97	0.98	1.00
					18-19	0.98	0.96	0.98	0.98	0.91	0.91	0.98	0.96
					19-20	0.91	0.75	0.96	0.97	0.71	0.71	0.97	0.96
					20-21	0.46	0.41	0.93	0.80				

others by making a strip in (V, V-I) diagram as mentioned above. The star counts have been made in 1.0-mag bins in V of the stars lying inside the strip as shown in Fig. 1 for Be 10. The brighter magnitude limit of the luminosity function has been decided from the stellar evolutionary effects, while the fainter one has been decided from the data completeness limit. The width of the magnitude bins has been chosen in such a way that statistically significant numbers of stars are present in all LF bins of both cluster and field regions. To determine probable cluster stars, N , we have used the following relation:

$$\mathrm{N} = \frac{N_{MC}}{CFC} - \mathrm{AR} \times \frac{N_{MF}}{CFF}$$

where N_{MC} and N_{MF} are the MS star counts for cluster and field regions while the CF values for the corresponding regions are denoted by CFC and CFF respectively. In this way we have constructed luminosity functions for all clusters after subtracting field stars and applying data incompleteness which are listed in Table 4 and plotted in Fig 2. This figure shows that luminosity function for all the clusters increases towards the fainter side barring the cluster King 1. The nature of the luminosity function will be discussed individually. The luminosity function of Be 10 and Be 67 rises steadily while the luminosity function of To 5 rises almost like a ladder upto 17.0 mag after this a dip is found and again it rises rapidly upto V=19.0 mag. In case of Be 15 and Be 71 we have found a dip at V=17 and 19 mag respectively and after this the luminosity function increases steadily. For cluster King 1 the luminosity function first increases upto 17 mag and it decreases like the globular cluster luminosity function. Hence the cluster King 1 shows deficiency of lower main-sequence stars. Actually, this is not the first cluster which shows deficiency of lower main-sequence stars. There are many open clusters that show the deficiency of lower main-sequence stars for example NGC 3680 and NGC 7762 (Patat and Carraro, 1995) and NGC 2301 (Mohan and Sagar, 1988).

4. Mass function

From the luminosity function of a cluster, we have obtained mass function (MF) using theoretical evolutionary tracks and the cluster parameters like age, metallicity and reddening. For this, we have fitted isochrones given by Girardi et al., (2002) to the CMD

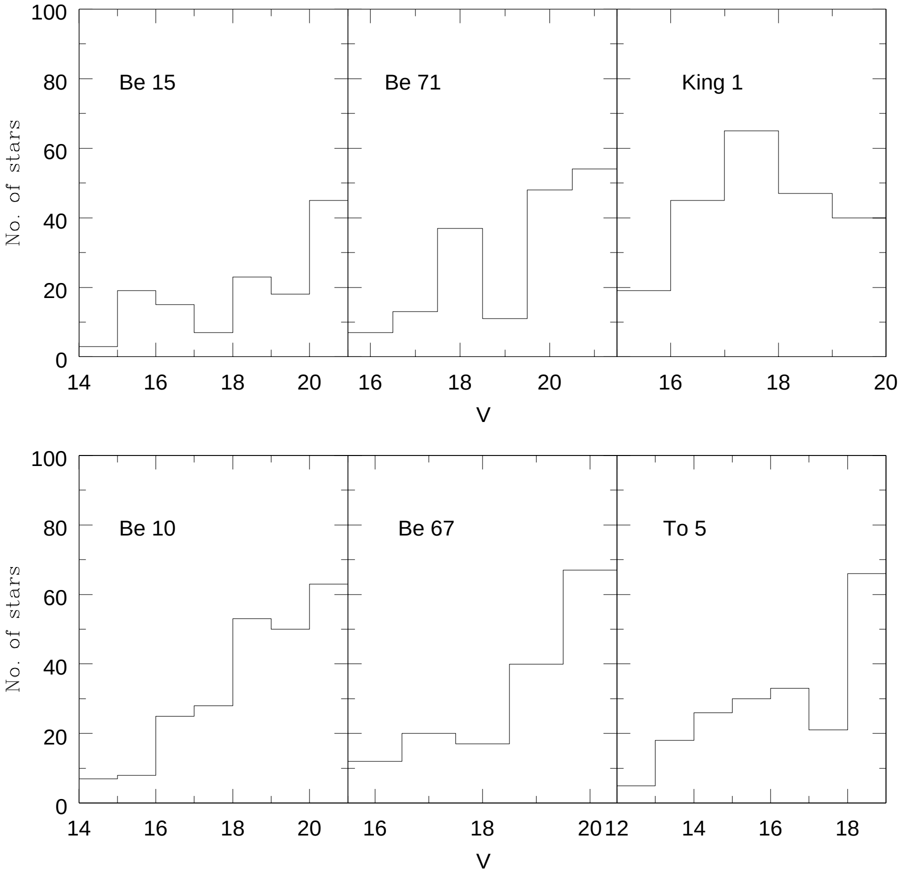

Figure 2. The luminosity function for clusters under discussion.

with the known parameters like distance modulus, reddening and age that are necessary to convert the magnitude into mass. The mass functions, for the clusters under discussion, derived in this way are plotted in Fig 3. The figure indicates that the stellar mass functions follow a power law. The mass function slope has been derived from the mass distribution (M). If dN denotes the number of stars in a mass bin dM with central mass M, then the value of the slope is determined from the linear relation

$$\log \frac{dN}{dM} = -(1+x) \times \log(\mathrm{M}) + \mathrm{constant}$$

using the least square regression relation. The Salpeter (1955) value for the slope of MF is $x = 1.35$. The values of mass function slopes for clusters Be 10, Be 67, To 5, Be 15, Be 71 and King 1 are 1.39±0.73, 3.41±0.98, 1.32±0.46, 1.35±0.46, 3.02±0.39 and 1.46±0.71 respectively. These slopes agree with the Salpeter value within the errors except for

Table 4. Luminosity function for clusters used in the present study. N_{MC} and N_{MF} denote MS star counts for the cluster and field regions in various magnitude bins. N is the number of probable cluster members after applying field star and data incompleteness corrections.

Range in	N_{MC}	N_{MF}	N	N_{MC}	M_{MF}	N
V mag	Be 10			Be 15		
14-15	10	4	7	6	7	3
15-16	19	17	8	22	9	19
16-17	39	22	25	21	15	15
17-18	53	39	28	33	68	7
18-19	64	17	53	84	162	23
19-20	61	17	51	105	234	18
20-21	47	24	63	152	250	45
	Be 67			Be 71		
15.5-16.5	14	6	12	10	15	3
16.5-17.5	22	8	20	19	28	7
17.5-18.5	18	7	17	41	48	10
18.5-19.5	43	17	40	34	130	26
19.5-20.5	55	33	67	55	159	32
20.5-21.5				53	207	41
	To 5			King 1		
12-13	7	2	5			
13-14	20	2	18			
14-15	35	11	26			
15-16	54	30	30	26	24	19
16-17	74	51	33	56	36	45
17-18	93	90	21	91	93	65
18-19	192	163	66	94	158	47
19-20				117	258	40

clusters Be 67 and Be 71. The corresponding mass ranges are 2.40 – 0.90, 2.10 – 0.95, 4.00 – 1.10, 3.5 – 0.95, 2.70 – 0.95 and 1.76 – 0.90 $M_\odot$ respectively.

4.1 Comparison with similar open cluster studies

For our sample of clusters, no mass function study is available. The MF slopes estimated in the present study vary from 1.32 to 3.41. For cluster To 5 it is the flattest, while for Be 67 it is the steepest. The MF slopes for all clusters are in agreement with the Salpeter value within errors except for clusters Be 67 and Be 71. The values of MF slopes for Be 67 and Be 71 are significantly different from the Salpeter value. Both these clusters have steeper MF slopes. The average MF slope of clusters Be 15, Be 10, To 5 and King 1 comes out to be 1.38±0.06. Similarly there are many other studies in which mean value of MF slope has been estimated (see Sagar et al., 2001). These values range from 1.3 to 1.8. Recently Le Duigou and Knödlseder (2002) also found mean value of x=1.30. The flattest value of average mass function slope obtained so far is (x=1.0±0.14) (Porras et al., 2003).

To see the dependence of MF slope on cluster age and galactocentric distance (R_G), we combined our data with previous ones (Sagar 2000, 2001) and also included latest data which are available in the literature (Prisinzano et al., 2005, 2003; Vázquez et al., 2005; Bragg, 2004; Baume et al., 2004a, b and 2003; Jeffries et al., 2003; Giorgi et al.,

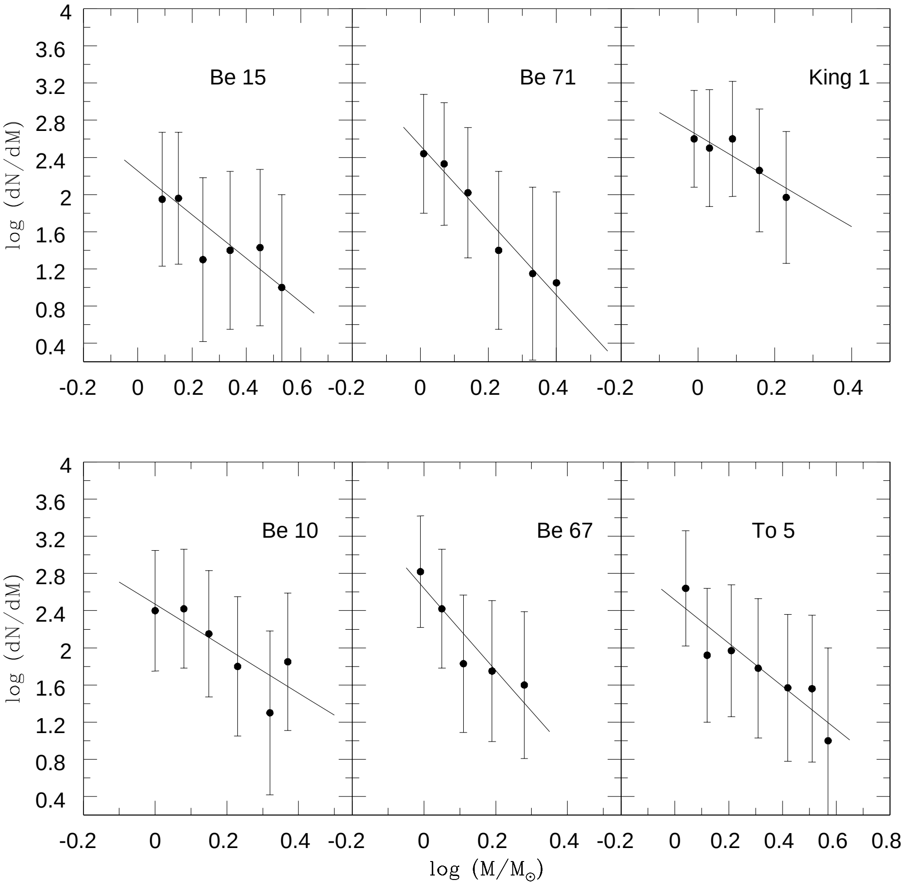

Figure 3. The mass function for clusters under discussion. The error bars represent errors which have been estimated using Poission statistics.

2002; Yadav & Sagar 2002, 2004a, b; Bica et al., 2004; Durgapal & Pandey 2001; Burke et al., 2004,). In Figs 4a and 4b, we have plotted MF slope vs age and MF slope vs R$_G$. Fig 4b shows that the MF slope has no apparent dependence on R$_G$. Fig. 4a shows that MF slope increases with age. By fitting a least square linear regression we get the following relation between age and MF slope:

$$\log (t) = (0.48 \pm 0.12)x + (-2.11 \pm 0.91)$$

This variation may be due to the dynamical evolution or intrinsic differences in the IMF of these clusters. However, to draw any conclusion about variations in MF slopes of open clusters it is necessary to determine physical parameters of clusters and know the uncertainties present during estimation of MF slope more carefully.

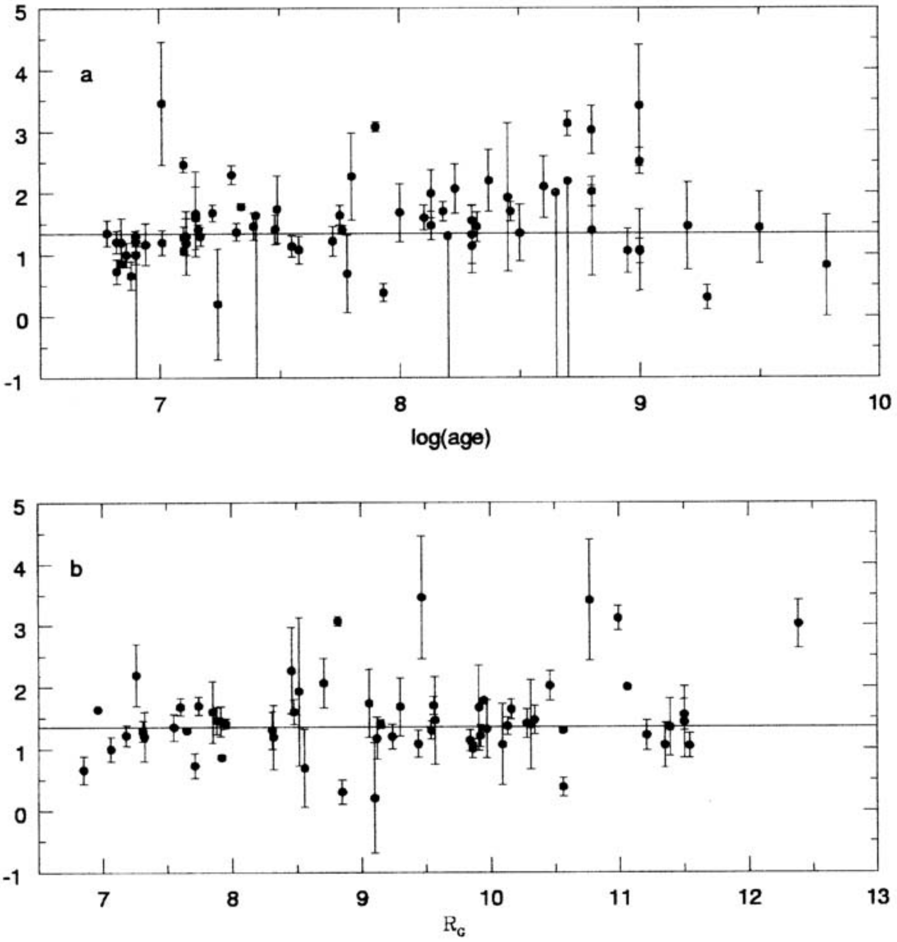

Figure 4. The dependence of MF slope on the galactocentric distance, R_G and age of the cluster.

5. Uncertainties in determination of MF slope

Open clusters have many advantages in determining the mass function slope, but there are many problems during the determination of the actual mass function slope. Scalo (1998) and Sagar (2001) have discussed these problems which produce uncertainty during estimation of mass function slopes of open clusters. Some of them are field star contamination and data incompleteness, radial mass segregation and binary content.

The problems of field star contamination and data incompleteness have been discussed in the section 3. Improper corrections for field star contamination and data incompleteness can yield quite different values for the MF slopes. Though both the corrections increase with decreasing brightness, yet they affect MF slopes in exactly the opposite way. The mass function slope becomes flatter if data incompleteness is not applied, while it becomes steeper if correction for field star contamination is ignored.

The radial mass segregation was observed by Pandey et al., (1990) and Raboud and Mermilliod (1998a,b) in a number of open clusters. Due to the presence of low mass stars in the outer parts of the open clusters, these regions have to be taken into account. To remove this uncertainty, the entire area of the cluster field has to be observed. If we do not take this into account, the MF slope would be flatter. Various studies explain the effect of mass segregation on mass function. According to de la Fuente Macros (1999), the dynamical evolution of small clusters is very dependent on the IMF but its importance decreases when considering richer clusters. He also mentioned that IMF have differential behaviour with cluster life time. Small clusters dissolve earlier than the heavy ones (Baumgardt, 1998). The importance of mass segregation as a result of energy equipartition increases with the age of the cluster and it is expected that it will be the dominant source of error for old clusters. This is called age bias in the determination of IMF. Kang and Ann (2002) state that the global luminosity function is not affected by mass segregation unless member stars have escaped from the cluster. Without loss of member stars due to evaporation process, the global luminosity function should increase towards the faint magnitudes if the IMFs of open clusters are assumed to be Salpeter type. Bonatto and Bica (2003) also draw a similar conclusion and state that the advance stages of mass segregation would affect more significantly the analysis of very old and dynamically evolved clusters. Later on, Bonatto et al., (2004) conclude that in addition to advance stages of mass segregation, galactic tidal stripping would affect the luminosity functions of open star clusters. Sung and Bessel (2004) find that the slope of the mass function also shows radial variation. It is flat within the core and gradually steepening with distance from the cluster centre.

Sagar and Richtler (1991) investigated the probable effects caused by unresolved binaries and found that the MF slope might be affected by a value of Δx=0.2, depending on the fraction of binary stars among cluster members. If we consider the presence of unresolved binaries, the observed MF slope would be flatter.

The overall effect of these uncertainties, especially radial mass segregation and unresolved binaries, would yield a steeper MF slope relative to the observed MF slope (Scalo, 1998). To determine reliable MF slopes the above mentioned points have to be taken into account.

Thus we can conclude that the present MF slope for the clusters under discussion may not be very different from the actual one. However, more observations are needed to confirm our results.

6. Dynamical relaxation time

At the time of the birth of cluster stars, if mass is supposed to be distributed uniformly in the whole volume of the cluster, no spatial variation of mass is seen at that time. But, due to dynamical relaxation, spatial variation can be seen in almost all the intermediate and old open clusters.

Because of dynamical relaxation, high mass stars give up energy to the lower mass stars and try to fall into the centre of the system (Giersz and Heggie, 1996). This rapid sinking of the most massive stars towards the centre leads to cluster expansion (Kroupa 2000). It means that low mass stars having higher velocities and try to occupy larger volume. Thus, mass segregation develops in the time scale required to exchange energy between stars of different mass by scattering. The dynamical relaxation, T_E, is the time in which the individual stars exchange energies and their velocity distribution approaches a Maxwellian equilibrium. T_E for the present sample is estimated using the following relation

$$T_E = \frac{8.9 \times 10^5 \sqrt{N} R_h^{3/2}}{\sqrt{\bar{m}} \log(0.4N)}$$

where N is the number of cluster members, R_h is the radius which contains half the cluster mass and $\bar{m}$ is the average mass of the cluster stars (Spitzer and Hart 1971). Since we cannot estimate the value of R_h from the present data, we assume that R_h is equal to half the cluster radius listed in Table 1. The mass has been obtained by multiplying the number of stars in each bin by the mean mass of the bin which comes out to be 186, 162, 296, 206, 143 and 260 $M_\odot$ for clusters Be 10, Be 67, To 5, Be 15, Be 71 and King 1 respectively.

The relaxation times for clusters Be 10, Be 67, To 5, Be 10, Be 71 and King 1 are $\log T_E = 7.2, 6.9, 7.2, 7.1, 6.9$ and 7.0 respectively, where T_E is in years. A comparison of cluster age with its dynamical relaxation time indicates that the former is greater than the latter. One may conclude that all the clusters are dynamically relaxed.

7. Mass segregation

Mass segregation in an open cluster means that massive stars are more concentrated towards the cluster centre when compared to low mass stars due to equipartition of energy between stars with different masses. The question is whether the observed mass segregation is a result of the process of star formation itself or due to dynamical relaxation. The mass segregation in the intermediate age open clusters might be a combination of both (Sagar et al. 1988). The mass segregation affects the structure of the cluster (Kang and Ann, 2002) and that is why, the corona is developed in a cluster. Bonatto and Bica (2003) suggest that the halo is enriched in low mass stars, transferred there from the inner parts as a consequence of the internal dynamical evolution. However, tidal losses

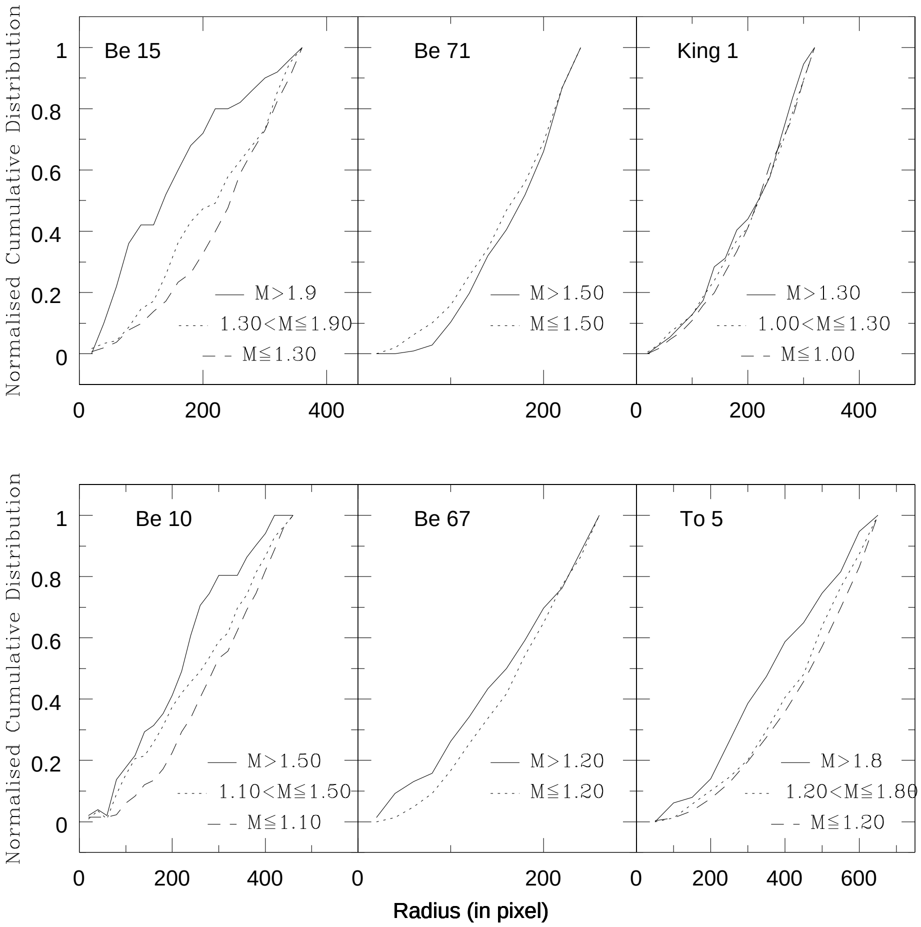

Figure 5. Cumulative radial distribution of stars in different mass ranges. M is in solar unit.

to the galactic field are also important. Baume et al., (2004b) have also found core-corona structure in the cluster NGC 2588 produced by dynamical effect. According to Nilakshi et al., (2001) the corona is an integral part of a cluster existing from the time of its formation, as if the appearance of corona is only due to dynamical evolution in the cluster, it should appear only for intermediate/old clusters. But, they found nine clusters of all ages in which the corona is absent. It supports that it is not necessary that mass segregation be present in all clusters. In the present study, mass segregation has not been found in the cluster Be 71.

To study the mass segregation in the clusters under study we constructed cumulative radial distribution for two or three mass groups. The cumulative radial distribution is shown in Fig. 5 for the clusters under discussion. Fig. 5 indicates that the effects of mass segregation are present in all clusters except Be 71. The above statement can be confirmed by Kolmogorov-Smirnov (KS) test. The confidence levels estimated using KS test are listed in Table 5. This test indicates strong evidence for mass segregation in Be 10, Be 67, To 5 and Be 15 but weak evidence for King 1. The cluster Be 71 does not show the effect of mass segregation. It means that low mass stars are more centrally concentrated as compared to massive stars. Durgapal and Pandey (2001) also found no mass segregation in two clusters Be 64 and Be 69. They concluded that if it is real, it indicated that either equipartition of energy has not completely taken place as expected due to dynamical evolution of the clusters or the stellar distribution is severely affected by the galactic tidal field. While according to hypothesis given by Raboud (1999) the clusters which initially contained an important population of massive stars should not present any mass segregation.

Table 5. Results of statistical test. M is mass in solar unit.

Cluster	Confidence level in % by K-S test			Mass group I	Mass group II	Mass group III
Be 10	99	98	100	$M>1.5$ and $1.1<M\leq1.5$	$1.1<M\leq1.5$ and $M\leq1.1$	$M>1.5$ and $M\leq1.1$
Be 67	85	-	-	$M>1.2$ and $M\leq1.2$	-	-
To 5	100	90	100	$M>1.8$ and $1.2<M\leq1.8$	$1.2<M\leq1.8$ and $M\leq1.2$	$M>1.8$ and $M\leq1.2$
Be 15	99	98	100	$M>1.9$ and $1.3<M\leq1.9$	$1.3<M\leq1.9$ and $M\leq1.3$	$M>1.9$ and $M\leq1.3$
King 1	50	50	80	$M>1.3$ and $1.0<M\leq1.3$	$1.0<M\leq1.3$ and $M\leq1.0$	$M>1.3$ and $M\leq1.0$

8. Conclusions

Using CCD photometric data, we have estimated the luminosity and mass functions for six open clusters. All the clusters under study are of intermediate age. For estimation of field star contamination we have used the statistical method. The completeness of the data has been determined empirically as a function of MS brightness for both the clusters and the field regions. The observed cluster LF has been corrected for both data incompleteness and field star contamination. We have used theoretical models for obtaining true LFs into MFs. The main conclusions of this study are:

1. The luminosity function of King 1 shows deficiency of stars towards the fainter end.
2. The mass of cluster stars ranges from 0.90 to 4 $M_{\odot}$. The mass function slopes are in agreement with Salpeter value within errors except for Be 67 and Be 71.
3. We have found variation of MF slope with age but not with R_G.
4. The clusters under study show the effects of mass segregation except for Be 71.
5. All the clusters are dynamically relaxed because dynamical relaxation time is less than the cluster age.

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