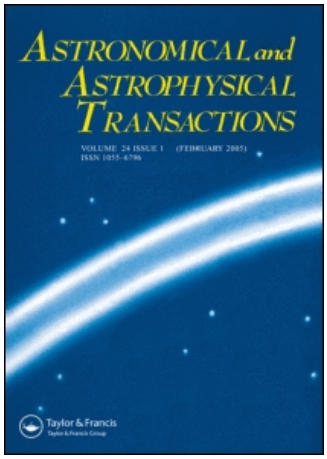


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# MASS FUNCTIONS OF OPEN STAR CLUSTERS FROM THE USNO-A1 CATALOGUE DATA

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Mass functions of 36 open clusters are constructed with the use of photometric data taken from USNO-A1 catalogue. The slopes of cluster mass functions are estimated, the shape of frequency distribution of these values is discussed.

KEY WORDS Open clusters

## 1 INTRODUCTION

The USNO-A1 catalogue contains a large amount of low precision but deep photometric data for stars of the whole sky which can be used for the investigation of statistical properties of open star clusters. In our current work these data were used for the construction of luminosity functions of 80 open clusters; the discussion of these results will be published later. Cluster distances and ages were taken from the new version of the 'Homogeneous catalogue of open cluster parameters' (Loktin *et al.*, 1997). The use of one source of photometric data and one method of their treatment would provide us with a homogeneous set of luminosity functions which can be compared to each other and give the opportunity of construction of composite mass functions for various cluster subgroups.

For the calculation of the mass function from luminosity function we have to use the mass-luminosity relation. For the determination of star mass one must use not only absolute stellar magnitude, but take into account the age of a star, because during evolutionary movement from ZAMS on the color-magnitude diagram star changes its luminosity without a noticeable change of mass. To account for this effect we decided to use evolutionary masses taken from theoretical isochrones from Bertelli *et al.* (1994).

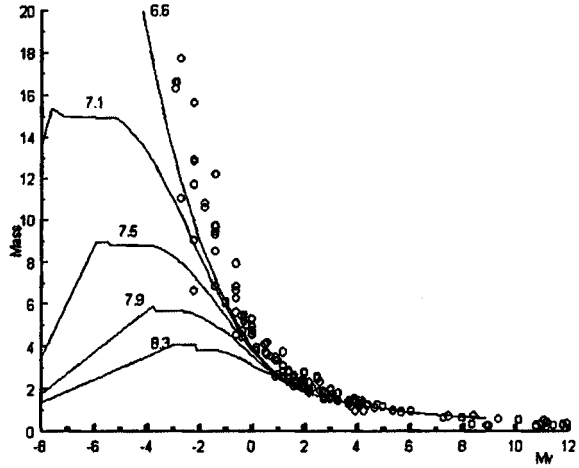


**Figure 1** Comparison between evolutionary and dynamical star masses.

To check the accordance between evolutionary star masses and the values determined from double stars analysis, we used mass determinations from close binary systems collected by Svetchnikhov and Gorda (1999). This comparison is shown in Figure 1. Another goal of this comparison is to clarify the determination of masses of low mass stars because isochrones provide us with masses only $> 0.8$ solar masses.

One can see on Figure 1 that there is a marked discrepancy between these two mass scales for massive stars. This discrepancy can partly be assigned to the difference in the values of bolometric corrections used by the two groups of investigators. For stars with masses $< 1$ solar we can use the mass-luminosity relation from eclipsing binary data because of the good coincidence of evolutionary and observed masses in this interval.

## 2 INDIVIDUAL CLUSTER MASS FUNCTIONS

For every cluster of the sample we transformed the luminosity function into a mass function using the usual procedure of transformation of frequency distributions. To investigate the slopes of cluster mass functions we selected from our sample only clusters that have certain linear parts in their mass functions. Finally we chose 39 clusters, and for these objects we calculated the estimates of slope coefficients $\alpha$. The frequency distribution of these estimates is shown in Figure 2.

The mean value of $\alpha$ is equal to 1.73 with an rms error 0.12. The shape of this distribution leads to the conclusion that the width of the distribution is a result not only of random errors, but caused by real differences between the slopes of mass functions of various clusters. It is evident, that the convolution of the narrow real

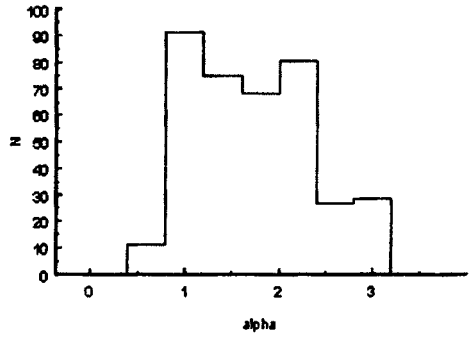


**Figure 2** Frequency distribution of the slopes of mass functions of 39 open clusters.

distribution, which is the case for the unique value of the slope for all clusters, with a gaussian distribution of errors must lead to a symmetrical bell-shaped distribution. The mean of the formal rms errors of individual estimates of the slope coefficients is equal to 0.12, which is much less than the width of the distribution in Figure 2. We can conclude that there is no unique value of $\alpha$ for all open clusters.

## 3 COMPOSITE MASS FUNCTIONS

In our work (Zakharova and Loktin, 2000) composite luminosity functions for clusters of the sample divided into 6 age intervals were determined. These functions can be used for the calculation of the mean slopes of cluster mass functions for various age groups. Five such composite mass functions are shown in Figure 3, and the results of the estimation of slopes for four younger curves are given in the table.

Columns of the table contain the mean age of the group, estimates of alpha and their errors, lower and upper limits of mass intervals and the number of clusters in the group.

The mean value of $\alpha$ is equal to $1.50 \pm 0.05$, which is smaller than the mean $\alpha$ from individual mass functions. This shift can be explained by the asymmetry of distribution in Figure 2 and by the fact that for construction of composite mass functions we used more clusters. But this mean value is also greater than Salpeter's value, and the small rms error leads to the conclusion that the difference between our value and that of Salpeter is statistically significant.

To check the existence of an age dependence of the mass function slope we calculated by least squares method the expression

$$\alpha = 1.92 - 0.05 \log(t) \qquad (1)$$

with the error of the coefficient before $\log t = \pm 0.02$. This value of the error shows that the slight age dependence is nearly significant, but the appearance of this dependence may be caused by a steeper run of mass function for massive stars.

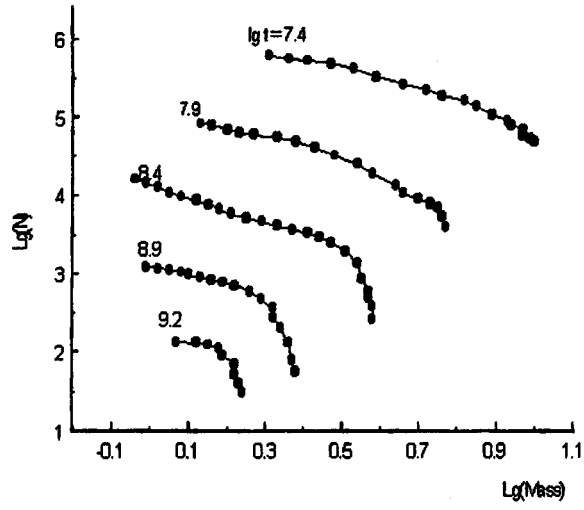


**Figure 3** Mass functions calculated from combined cluster luminosity functions for 5 age intervals.

**Table.** Mass function slope estimates for open clusters in four age intervals.

| $\langle\log(t)\rangle$ | $\alpha$ | $\sigma_\alpha$ | $\log(M)_{\max}$ | $\log(M)_{\min}$ | $N$ |
|---|---|---|---|---|---|
| 7.4 | 1.50 | 0.07 | 0.970 | 0.410 | 12 |
| 7.9 | 1.45 | 0.10 | 0.636 | 0.126 | 16 |
| 8.5 | 1.54 | 0.03 | 0.510 | −0.042 | 17 |
| 8.9 | 1.32 | 0.10 | 0.288 | −0.010 | 11 |

## 4 CONCLUSIONS

We can use the data of the USNO-A1 catalogue for the determination of cluster luminosity and mass functions. These data provide us a homogeneous set of such distributions for a considerable number of clusters.

The mean slope of cluster mass functions slightly exceeds the value proposed by Salpeter. There is no appreciable change of the slope of cluster mass functions during the last billion years.

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