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Variation of the Cluster Luminosity Function Across the Disk of M51

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Abstract. We study the luminosity function (LF) of the star clusters in M51. Comparing the observed LF with the LF resulting from artificial cluster populations suggests that there exists an upper mass limit for clusters and that this limit and/or the cluster disruption varies with galactocentric distance.

1. Introduction

In cluster populations with a power law cluster initial mass function (CIMF) the highest mass cluster in a sample is determined by the number of clusters (besides statistical fluctuations). This is no longer true if there exists a physical upper mass limit for clusters.

Information about the CIMF can be derived from the present day luminosity function (LF). Although there is not a one-to-one relation between the CIMF and the LF, modeling the LF with an artificial cluster population with varying CIMF parameters can aid the interpretation of the LF. According to the models of Gieles et al. (2006a), a bend in the LF (i.e. a double power law distribution function) may be the signature of a CIMF, truncated at the high mass end. The (filter dependent) location of the bend is intimately connected to the value of the upper mass limit (brighter bends correspond to higher possible cluster masses).

Bends in the LF are observed in NGC 6946, M51 (Gieles et al. 2006a,b) and Antennae galaxies, NGC 4038/4039 (Whitmore et al. 1999). Here we examine the cluster population of M51, dividing it in subsamples at different galactocentric radii. By comparing to the artificial populations we draw conclusions on the CIMF and cluster disruption parameters across the disk.

2. The Cluster Population of M51

We use the Hubble Heritage ACS mosaic of M51 in the passbands *F435W*, *F555W* and *F814W*, covering the complete system of M51 and its companion (Mutchler et al. 2005). Point sources are extracted and qualified as a cluster if (1) the source is detected in all three broadband filters, (2) the radius of the source was fit better with an extended cluster profile than with a delta function (using the *ISHAPE* algorithm; Larsen 1999) (3) the cluster has a radius of at least 0.5 pc (the resolution of the *ISHAPE* routine), and (4) the nearest neighbouring source is at least 5 pixels away.

After performing aperture photometry on all sources, the LF can be constructed for the population brighter than the 95% completeness limit (-6.3 abs mag *F435W* and *F555W* and -6.0 abs mag for *F814W*) and for three galactocentric distance intervals. Results can be seen in Table 1.

Table 1. Fit results of the complete sample in all three pass bands. (1) is the passband, (2) the number of clusters within the fit range. (3), (4) and (5) contain both slopes ($N(L)\mathrm{d}L \propto L^{-\alpha}\mathrm{d}L$, α_1 for the faint end side, α_2 for the bright end side) and the location of the bend of the double power law fit respectively. The second part contains for the B band the galactocentric distance dependence. Similar results are obtained in the other filters.

Passband	N	α_1	α_2	M_{bend}
F435W	3891	1.96 ± 0.04	2.52 ± 0.08	-8.33 ± 0.15
F555W	4750	1.99 ± 0.04	2.56 ± 0.07	-8.38 ± 0.13
F814W	8041	2.08 ± 0.02	2.54 ± 0.08	-8.90 ± 0.16
F435W:	N	α_1	α_2	M_{bend}
$0 < d < 3$ kpc	1267	1.67 ± 0.06	2.60 ± 0.17	-8.76 ± 0.17
$3 < d < 5.5$ kpc	1415	2.08 ± 0.05	2.71 ± 0.22	-8.42 ± 0.22
$5.5 < d < 8.5$ kpc	1209	2.17 ± 0.03	2.55 ± 0.31	-7.99 ± 0.31

3. Conclusions on Upper Mass Limits and Disruption Parameters

Although more detailed modeling is necessary for quantitative results, the conclusions following the models of Gieles et al. (2006a) for the galactocentric dependence of the upper mass limit and disruption parameters are:

1. Subsets closer to the center have their bends at brighter magnitudes, suggesting higher possible cluster masses.

2. Subsets closer to the center have shallower faint-end slopes, indicating faster disruption.

The two effects are not to be seen separately though. Faster disruption alters the location of the bend in the same direction as a higher upper mass limit. In a follow up study the statistical significance of the results will be further investigated and a more quantitative analysis will be given Haas et al. (2006).

References

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