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Thousands of Star Clusters in M51 with *HST/ACS*

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Abstract. We study the entire star cluster population in the disk of M51 by using radius measurements, and we see evidence for a universal preferred radius for both young and old cluster populations and for an increased cluster formation rate at a galactocentric distance of ∼6 kpc, which is similar to the corotation radius.

1. M51 – a Star Cluster Laboratory

M51 is a nearby (8.4 Mpc) face-on spiral galaxy with a very rich cluster population. It is an excellent candidate for studies of the formation and evolution of young clusters (YCs) in spiral disks. Earlier studies have used *WFPC2* data (Bastian et al. 2005, Lee, Chandar & Whitmore 2005), which did not cover the entire spiral disk, and the limited resolution made it difficult to select a large cluster sample based on radii. We exploit the superb resolution (∼2 pc per pixel) of the new *HST/ACS* Hubble Heritage image of M51, which covers 17.5×24.8 kpc of the spiral disk, to select a large sample of YCs based on their radii. We study the radius distribution and the surface density distribution of the YCs throughout the disk.

We measure the half-light radii ($R_{\rm eff}$) of > 75.000 sources in our data with the *Ishape* routine (Larsen 1999), which convolves the PSF of the telescope with analytical models of the light profile of a cluster for different radii, and then minimizes the χ^2. For the analytical models Moffat 15 functions were used, since these are the best-fitting models for YCs in the LMC (Elson, Fall & Freeman 1987). If the source is extended ($R_{\rm eff} > 0.5$ pc, the lower limit of *Ishape* at the distance of M51) we assume it is a YC. We find ∼5000 YCs brighter than the 90% completeness limit in *F435W*, *F555W* and *F814W*.

2. Surface Density Distribution

In Fig. 1 (left) we show the surface density distribution of the ∼5000 resolved YCs throughout the spiral disk. The distribution shows an overdensity at a galactocentric distance of ∼6 kpc. This location is remarkably similar to the corotation radius of ∼ 5.8 kpc (using the pattern speed from Zimmer, Rand & McGraw 2004), which is the distance where the spiral arms have the same rotational velocity as the stellar and gaseous material (indicated by the arrow in Fig. 1). The overdensity suggests that the corotation radius is a preferred site for cluster formation.

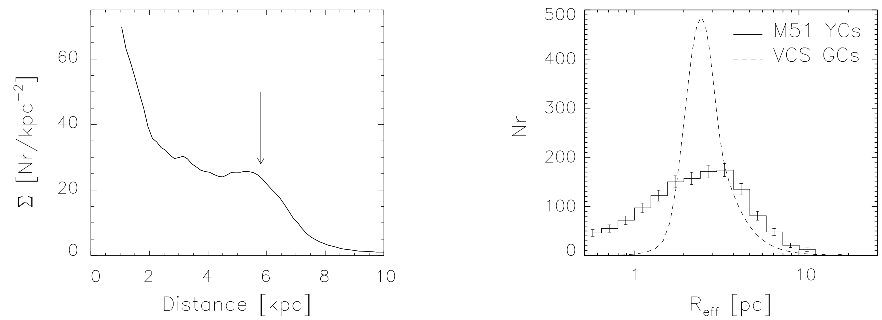

Figure 1. *Left:* The surface density distribution of ∼5000 resolved YCs in M51. The arrow indicates the location of the corotation radius. *Right:* The radius distribution of ∼1300 YCs in the low background region of M51 (histogram) and of the GCs of the *ACS Virgo Cluster Survey* (dashed line).

3. Size Distribution

The radius measurements are easily influenced by blending effects in crowded regions or by a highly variable background. The YCs in low background regions are less biased by these effects. Therefore, we selected a smaller sample of ∼1300 clusters in low background regions. Fig. 1 (right) shows the radius distribution of this smaller sample with accurate radii. Also plotted is the radius distribution of the globular clusters (GCs) of the *ACS Virgo Cluster Survey* (VCS) of Jordán et al. (2005). Both distributions concern completely different populations and although the general shape of the distributions is different, both distributions peak at a similar half-light radius of ∼3 pc. We note that the radius distribution of Milky Way GCs also peaks at 3 pc. This suggests that the preferred radius of star clusters is determined during the formation or during the very early evolution of the clusters and that it is not susceptible to change.

In a forthcoming paper (Scheepmaker et al. 2006) we will include the high background regions as well as ages and masses of the star clusters in M51. Combined with their radii we then have the tools to study the formation and evolution of a galaxy's entire cluster population.

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