The Virtual Observatory as a Tool to Study Star Cluster Populations in Starburst Galaxies

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1 The Cluster Luminosity Function

The cluster luminosity function (CLF) is one of the most important diagnostics in the study of old globular and young compact star cluster populations. While the CLFs, and therefore also the *initial* mass functions, of young star cluster systems are closely approximated by power laws, for old globular cluster systems the CLF shape is well-established to be roughly Gaussian, with an apparently universal turnover luminosity (mass). This follows naturally from standard models of globular cluster formation and evolution, e.g., [2] [4].

The processes responsible for the depletion of low-luminosity, low-mass star clusters over the time-scales required to transform the young power-law CLFs into lognormal distributions are tidal interactions with the background gravitational field of the parent galaxy and evaporation of stars through two-body relaxation within clusters. From the models of [2] and [4] it follows that *any* initial mass (or luminosity) distribution will shortly be transformed into peaked distributions (but see [5] [6]).

One should be cautious, however, to generalize these models, since they only apply to quiescent, non-interacting galaxies. In the time-varying gravitational potentials of interacting and merging galaxies we expect significantly different mass spectra and time-scales for the dynamical evolution of star clusters due to, e.g., external pressure and shocks.

2 Scientific Questions and the Virtual Observatory

Using the wealth of archival data from the *Hubble Space Telescope* and large ground-based facilities, we are currently using the ST-ECF ASTROVIRTEL tools[1] to obtain CLFs and colour distributions in several optical and/or near-infrared passbands, in order to address these issues statistically.

We caution strongly that it is obviously very important to obtain accurate ages for the individual clusters and to correct the observational CLF to a common age before interpreting the "intrinsic" CLF, see Fig. 1 [1] [3].

[1] E.g., *querator* (http://archive.eso.org/querator) for imaging observations and *listator* (http://archive.eso.org/listator) for spectroscopic observations.

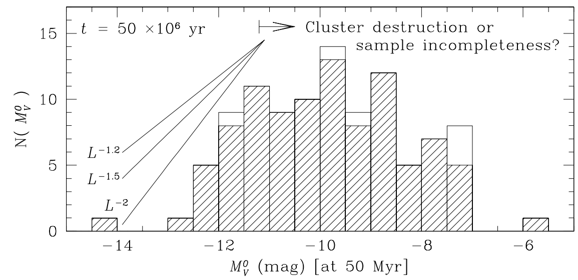

Fig. 1. CLF for the M82 B cluster sample corrected individually to a fiducial age of 50 Myr. The CLF may be broadened due to dynamical destruction of lower mass clusters, although the degree to which our cluster sample is incomplete for these brightnesses is uncertain (this was beyond the scope of our paper [1]).

The ASTROVIRTEL initiative allows us, for the first time, to address questions such as:

1. Is the *intrinsic* CLF (or, alternatively, the cluster initial mass function) a power law in all cases?
2. What are the time-scales for the evolution from the power-law young compact CLFs into old globular CLFs?
3. Is there a clear difference between OB associations/open clusters and compact globular clusters at formation or do they all form a continuum mass spectrum?
4. Can we "observe" dynamical cluster destruction by comparison of young star cluster systems in ongoing mergers and merger remnants of various ages?
5. Is there an environmental dependence on the efficiency and therefore on the time-scale of low-mass star cluster depletion?
6. Is the (old) globular CLF *universal*?
7. Do stronger starbursts favour the formation of more massive clusters?
8. Does the ratio between field star formation and star formation in clusters depend on the galaxy or interaction properties?
9. Can we determine the violent star and cluster formation of galaxies based on star cluster colour distributions and deep luminosity functions?

References

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