Tracing galaxy evolution by their present-day luminosity function

Elmo Tempel

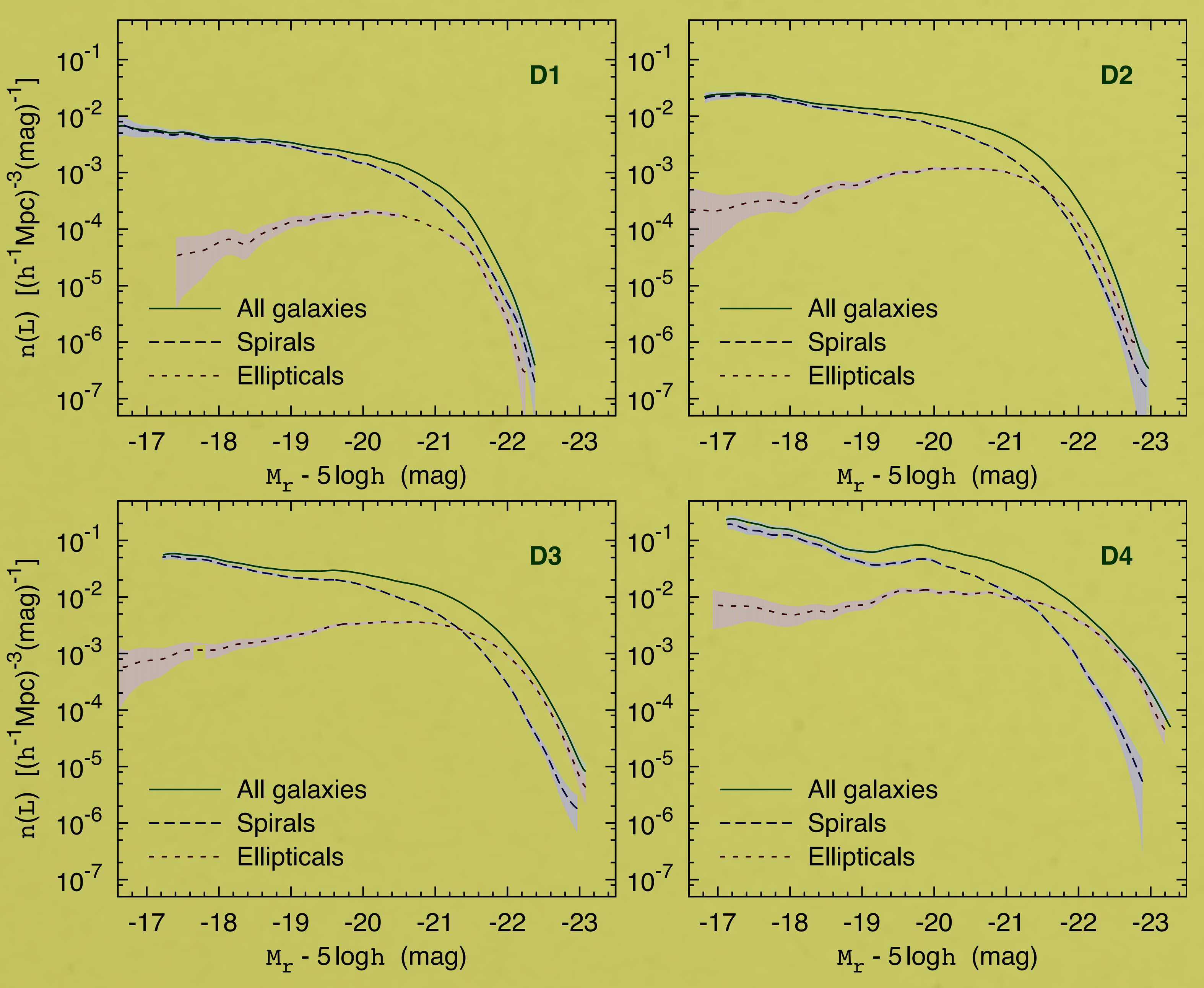
Tartu Observatory, Estonia, elmo@aai.ee

Abstract

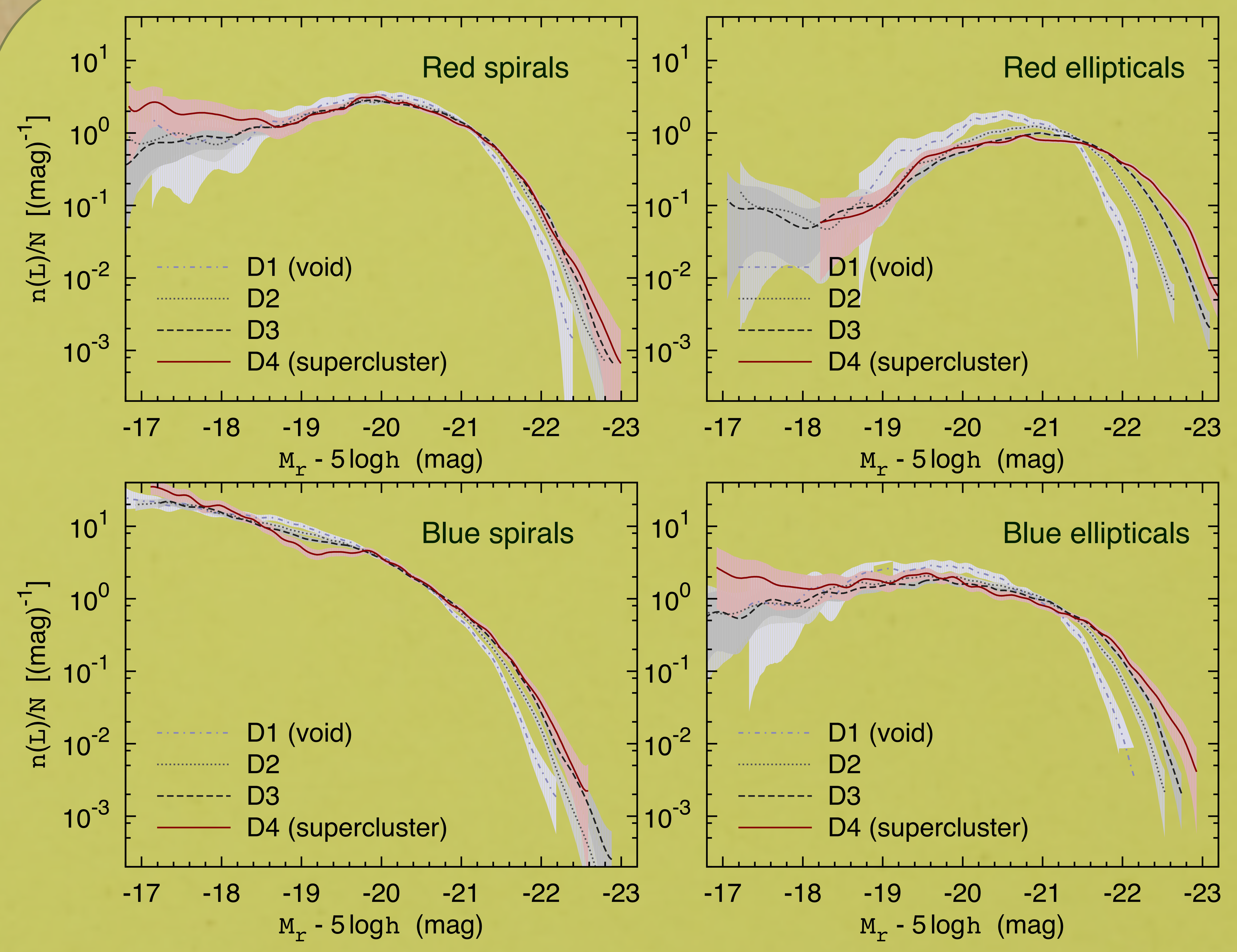
In the present study we concentrates on the large-scale structure: how galaxy evolution is related with the surrounding large-scale environment of superclusters and voids. Galaxy luminosity functions are derived for different morphological types (spiral, elliptical) and various colours (red, blue) of galaxies, to trace the evolutionary effects of galaxies, which a priori should be different for void and supercluster galaxies.

One of the principal results of the present study was the conclusion that the evolution of spiral galaxies is almost independent of the global environment, especially for blue and red spirals separately, showing that the formation of spiral galaxies has to be similar in all environments. Meanwhile, the luminosity function of elliptical galaxies depends strongly on the environment. This shows that the global environmental density is an important factor (via merging history) in the formation of elliptical galaxies.

The results of the present study show clearly, that besides the local/group environment, the global (supercluster-void) environment plays also an important role in the formation and evolution of galaxies. Accounting for the role of global environment can help to solve several problems in the present picture of galaxy formation and evolution.



Attenuation-corrected LFs for different types of galaxies in different environments: the upper-left panel shows the LFs for least dense environment (D1) and the bottom-right panel shows the LFs for most dense environment (D4). Green solid lines show the LFs for all galaxies; blue dashed lines show the LFs for spiral galaxies; red dotted lines show the LFs for elliptical galaxies.



Attenuation-corrected LFs for red (upper panels) and blue (lower panels) populations; for spirals (left panels) and ellipticals (right panels), in different global environments. Note that the evolution of spiral galaxies is almost environmental independent.

Summary

In the present study the 2dFGRS and the SDSS were used to study the LF of galaxies for different samples in various global environments. The global luminosity density field was used to define the large-scale environments with different global densities from voids to superclusters. We used the 2dFGRS sample to derive the LF of group galaxies. We also studied the nature of isolated galaxies, and demonstrated that isolated galaxies are not truly isolated at all. We used the SDSS data to construct the LFs separately for galaxies of different morphology (spiral and elliptical) and of different colours. For the SDSS sample, we took special care to correct the galaxy luminosities for the intrinsic attenuation, since for spiral galaxies the attenuation can affect significantly the galaxy luminosity.

References and further reading:

Tempel, E. 2011, PhD thesis, University of Tartu

Tempel, E., Saar, E., Liivamägi, L. J., Tamm, A., Einasto, J., Einasto, M., & Müller, V. 2011, A&A, 529, A53

Tempel, E., Einasto, J., Einasto, M., Saar, E., & Tago, E. 2009, A&A, 495, 37

Conclusions

- The LF of elliptical galaxies depends strongly on the environment, and the environment is more important for red elliptical galaxies than for blue elliptical galaxies. This suggests that global environmental density is an important driving force (via merging history) of elliptical galaxy formation.
- The evolution of spiral galaxies (the LF of spiral galaxies) is almost independent of the global environment, especially for blue and red spirals separately, showing that spiral galaxy formation has to be similar regardless of the surrounding global density.
- The highest global density regions (superclusters) are significantly different from other regions. Here the fraction of elliptical galaxies is greater than in other environments and there are relatively less faint spiral galaxies than in the low-density counterparts.
- The brightest galaxies are absent from the void regions. After correcting for the intrinsic absorption, spiral galaxies dominate the LF of void regions at every luminosity. In higher-density environments, the faint end of the LF is determined by spiral galaxies and the bright end by elliptical galaxies. For all environments, the faint end includes mostly blue galaxies and the bright end mostly red galaxies.