

— APPLICATIONS —

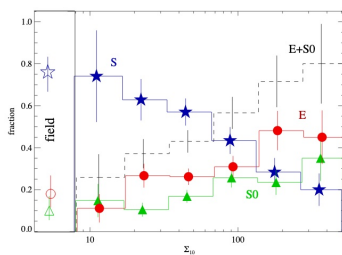
by E.SLEZAK

Different applications can be chosen by the attendees.

Application 1

Galaxies have different morphologies, colours, luminosities, and masses. It appears that the mix of the different morphological types do depend on the local environment conditions, with spheroidal-like objects like elliptical galaxies mostly found in high-density regions while disk objects like spiral galaxies dominate the population in the field regions. This result, which can be quantified in different ways, is thought to be a consequence of different physical processes acting onto galaxies and shows that the evolution of these galaxies is at least partly due to interactions with neighbours, the intergalactic medium or both.

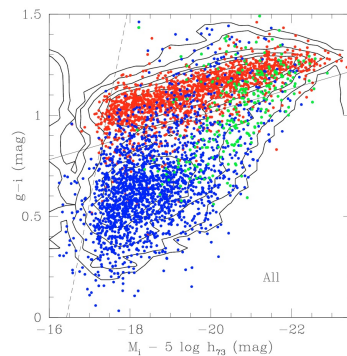
In this applicative part, one will have to reproduce and study this result. To do so, one will first be provided with : i) more details on the physical processes at play in high density regions like mergers and ram-pressure stripping ; ii) a description of model fitting techniques and useful algorithms/software if necessary. Then, by making use of on-line databases, one will have to download data for different fields, either primary images or catalogues of galaxies depending on the skills of the attendee, and extract/obtain/compute the information required for the project accordingly, that is a proxy for the morphological type of each galaxy within the various fields and an estimate of the local number density of galaxies at each location. Finally, the dependence of the chosen proxy with the density of galaxies will be computed, discussed and compared to recent similar studies.


(Ma & Ebeling 2011)
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Application 2 :

Galaxies with different morphological types have different colours and masses due to different merger histories and past/current star formation rates. This diversity is clearly exhibited in a colour-magnitude diagram which enables one to identify the so-called red sequence of passive elliptical galaxies, the blue cloud of spiral galaxies actively forming new stars, and the green valley of quenched spirals in between. Since elliptical galaxies are a tracer of overdense regions of galaxies, namely clusters of galaxies, such a red sequence is used to detect dynamically relaxed clusters of galaxies, characterize them and identify their galaxy members.

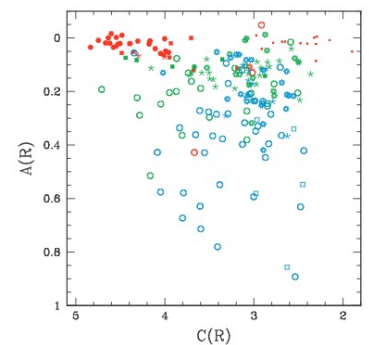
In this applicative part, one will study the demographics of the galaxies for different fields with or without known (super)clusters of galaxies, at low and high redshifts. To do so, one will first be provided with more theoretical information about quenching mechanisms and AGN feedback processes. Then, colour-magnitude diagrams will be built for the different fields under study by downloading the relevant data using on-line databases. The transition between starforming galaxies and quiescent ones will be mapped and the red sequence(s) used to identify existing clusters with their galaxy members in the various fields. (Automatic) detection issues of this red sequence will be addressed at this step. Finally, a modeling of these red sequences will be performed and the variation of the slope parameter with the redshift discussed in terms of mass assembly and star formation efficiency.


(Gavazzi+2010)

Application 3 :

Galaxy structural analyses provide unique information about the formation processes that change galaxy structures over time. Parametric fitting using bulge/disk decomposition and a Sersic function to measure galaxy sizes and surface brightness profiles is extensively used for local galaxies. Non parametric methods, based for instance on the concentration, asymmetry and clumpiness (CAS) system, appear well-suited for analyzing the major features of more distant objects lacking spatial resolution and therefore for deriving galaxy evolution over cosmic time. Such an approach is currently tested to get reliable morphologies for the forthcoming Euclid mission.

In this applicative part, one will classify realistic galaxies simulated for Euclid using a generative model and test the ability of the CAS system to discriminate among morphologies. To do so, one will first get a deeper insight into the assumptions, limitations and biases of the different methods used nowadays to quantify galaxy structural components and learn about generative adversarial (neural) networks. Questions related to noise issues, PSF blurring, reproducibility and parameter degeneracies will be addressed as well the benefit of using priors when modeling embedded physical components (eg. bulge, disk, bar, spiral arms). Then, one will implement the CAS measurements and perform the classification of a list of galaxies sampling the whole morphological range including peculiar (disturbed) cases. Finally, efficiency and completeness of this approach will be computed thanks to the truth table, and results discussed in terms of single/multiple components, bright/faint features, regular/irregular shapes.


(Conselice+2015)

— MAIN PROGRESSION STEPS —

- **Tier 1:** i) theoretical courses : main properties and demographics of the galaxy population in the local Universe, key physical processes at play in galaxy evolution within the Λ CDM hierarchical model of structure formation (+ exercices) ; ii) start of the homework bibliographical study and of the practical projet.
- **Tier 2:** i) theoretical courses : structural parameters and evolution in time of sizes, evolution of the Hubble sequence, mergers, luminosity functions (+ exercices / presentation of a review paper) ; ii) homework is on-going, first results from the practical projet.
- **Tier 3:** i) theoretical courses : evolution of the cosmic star formation rate density, the Lyman- α universe and the reionisation epoch ; ii) bibliographical study (report due), final results and report for the practical project.
- **Last week:** preparation of the final oral defense.

— EVALUATION —

- **Theory grade [30%]**
 - exercices (40%): math. demonstrations, underlying physics, consequences
 - Presentation of a review paper (60%): context, questions, methods, results, etc.

- **Practice grade [30%]**
 - bibliographical study (50%): completeness of the survey, diversity of ressources, relationships with the theoretical/observational notions described in the meteor, etc.
 - Project (50%): initiative, progress, analysis
- **Defense grade [40%]**
 - Oral and slides quality
 - Context
 - Project / Personal work
 - Answers to questions

— CONTACT —

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