

Lab 12. Galaxy Classification & Evolution

Equipment

- Good photocopies (Hardcopies of the Hubble Tuning Fork and of the examples)
- Access to the Web and/or already downloaded galaxy images and cluster images. The cluster images need to be viewed in magnification.
- Optional: Hubble Atlas, Carnegie Atlas, Arp Atlas

Mini Lecture prior to Lab

- Students can do this lab on their own.
- Having covered the basics of Galaxies and Classifications in the lectures would be useful, but it turns out that students can do this lab reasonably well without having heard much about galaxies. However, for Part II, they will need to know the basics about stars, their luminosities and colors, and about blue, pink, and dark nebulae.

General Procedure & Lab Setup

- Let the students get on classifying the galaxies, but please watch out that they look at the enlarged images on the computer. If they do not, please pick a galaxy they misclassified and then discuss it while looking at the larger image. (Note that classification from the thumbnails is possible, but only after they have trained themselves a little to know how to recognize what.)
- Initially some students may confuse dust lanes with Spiral arms
- S0's may need additional explanation – they are not ellipticals, they are disk galaxies (with a bulge) but do not show any spiral arms in the disk.
- In part II the students are challenged to think. Please encourage them to do so.
- Check the first tables in parts III and IV. If the numbers are too far off, the interpretation will become rather difficult and confusing. (There should be an increase of ellipticals and decrease of spirals as you go to denser and denser environments; and more Irregulars in the HDF.)

Notes & Suggestions

- If the students have problems classifying galaxies please mention that this is a real problem, particularly at high redshifts.
- When working in groups, please watch out that students do not copy each other's answers, but that every group member does their fair share. Please encourage the students to write the comments during the lab session, i.e., not at home.
- In parts III & IV they are asked to interpret their own results as best as they can. Please do encourage them to interpret their data – the point of this exercise is for them to get the experience of actually doing the research. It is pretty surprising how close the students come to some of the more conventional ideas on galaxy evolution.

General Concepts & What students might get out of this Lab

- A sense of how real research is done
- To what degree they should believe results stated in popular astronomy articles
- That nothing is an error – not even Hubble's "evolutionary interpretation" which we still use, but only for classification purposes.

Scientific Methodologies

- How classification (even if it is not the best scheme) can lead to results
- How to use "subjective" number counts to make quantitative statements
- How statistical uncertainties can affect the interpretations of the results and validity of the arguments