The relation between stars and gas in distant galaxies

Jacky Cao
Level 4 Project, MPhys Physics
Supervisor: Dr. Mark Swinbank
Department of Physics, Durham University
Submitted: November 9, 2018

Observing any galaxy in the universe will yield the fact that it contains stars and also gas. The dynamics of both can be explored by observing galaxies and collecting spectroscopic data.

Abstract abstract

Contents

1. INTRODUCTION

Amongst the different types of cosmic structure within our universe, galaxies can be seen as the island powerhouses of industry and activity. Containing countless stars, gas, dust, and dark matter [1], it would be difficult not to express the statement that the motions of these objects must be linked in some galactic relationship.

By utilising the most powerful tool in astronomy, observation, galaxies, their structure and the motions of the objects within them can be studied to a great depth. As an example, if we took optical measurements of the stellar population, we could use that information to estimate the potential age of the galaxy. We know that redder stars are older and bluer stars represent a more young set of objects [1]. Or if we wanted to know about the material composition or even the distance to a certain galaxy, we could split the collected light in a spectrograph to produce a spectrum. Values of redshift and the content of a galaxy can be obtained by looking at the absorption and emission lines within a galactic spectrum [1].

Gathering and processing this optical and spectroscopic information allows us to build a broad picture of the internal workings of a galaxy. Then with further analysis we can begin to comprehend the intricate re-

lationships contained within these individual islands.

To begin with we must consider a general picture of galaxies, after which we will be able to appreciate and explore more complex ideas.

a. Galactic classification

As we stated previously, a galaxy can be quite broadly defined as a collection of gas, dust, stars and dark matter. But if we were to observe a large enough sample then we would begin to see that the galaxies can be grouped and classified together.

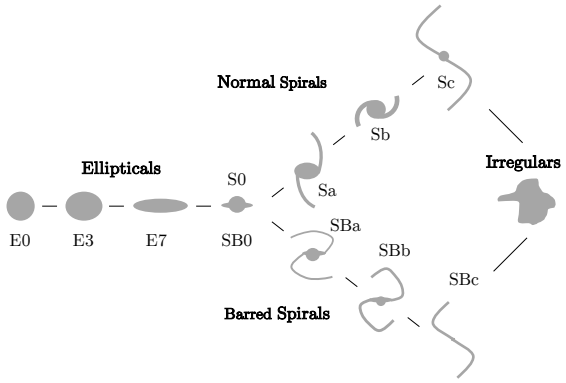


FIG. 1: The Hubble Sequence containing three general groupings: ellipticals, spirals, and irregulars. The diagram does not show the evolution of galaxies but their classification. (*This diagram has been adapted from An Introduction to Modern Astrophysics* [1].)

asdasd

2. ANALYSIS

sfsadf
sdfsadf

b. pPXF

-

3. DISCUSSION

-

This categorisation is called the *Hubble Sequence* or the *Hubble Tuning Fork* [1]. From Figure [add ref to figure] we can see that galaxies can be divided into ellipticals, spirals and irregulars. With ellipticals along the horizontal handle, and the two prongs representing normal and barred spirals, the sequence itself does not show the evolution of the galaxies, rather it provides a way to view the different morphologies of galaxies on one graph.

We introduced the concept that through optical measurements of the stars

What do I want to say with this? I want to introduce galaxies, the different types of galaxies, how they form, how they can be confused with other types of structure.

b. Data

askjdnaksld

1. *HUDF and MUSE*

To obtain spectroscopic information on the Hubble UDF objects, the Multi-Unit Spectroscopic Explorer or MUSE was employed. This instrument is

what is MUSE, where it is on the VLT, problems, limitations of MUSE - why it is useful...etc

a. Cube extraction

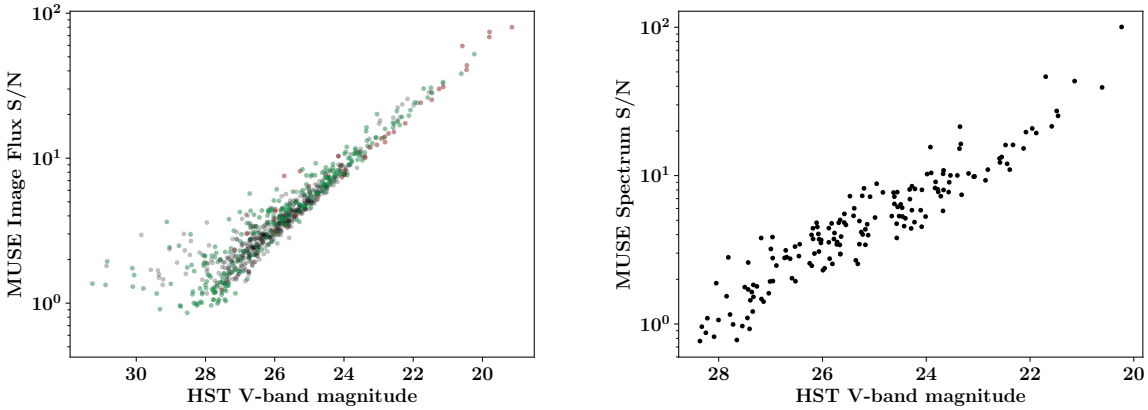
asdasd

4. CONCLUSIONS

In conclusion, through extensive data and statistical analysis it can be said that the dynamics of stars and gas in galaxies are ... (?)

(a) MUSE HUDF **(b)** HST HUDF

FIG. 2: (a) A colour image created from the MUSE spectroscopic data of the HUDF. The wavelength range was split into three equal regions and then collapsed to create three bands (R, G, B). A final colour image was produced by combining these separate frames together. (b) The optical HUDF as captured by the Advanced Camera for Surveys instrument on the Hubble Space Telescope [2].



(a) Image S/N vs. V-band **(b)** Spectroscopic S/N vs. V-band

FIG. 3: —

Acknowledgments

The author would like to thank Dr. M. Swinbank and Dr. A. Tiley for their continual help and support throughout the project period, without which, the project would have been experimentally grounded.

References

[1] Bradley W. Carroll and Dale A. Ostlie. An Introduction to Modern Astrophysics. Pearson, 2nd edition, 2007.

[2] NASA, ESA, S. Beckwith, and HUDF Team. Hubble Ultra Deep Field. `https://svs.gsfc.nasa.gov/30946`, May 2018. [Online; accessed 5th November 2018].