Finding the First Quiescent Galaxies with JWST

THE UNIVERSITY of EDINBURGH

Evan Jones

Supervisor: Dr Adam Carnall

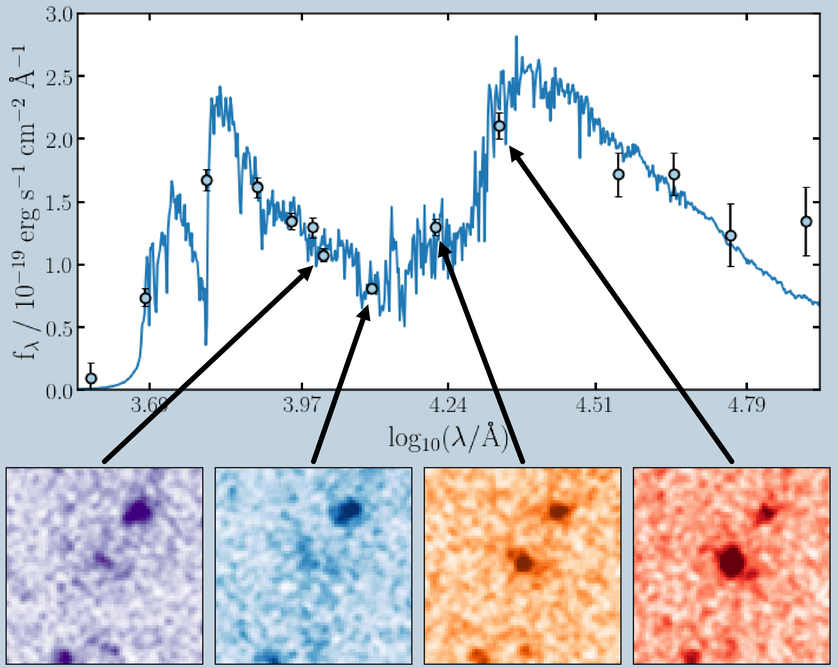
Introduction

The majority of nearby galaxies have stopped forming stars, or *quenched*. Studying these *quiescent* galaxies is therefore important in understanding how individual galaxies evolve, and how the population of galaxies evolves with time. An important aspect of this is understanding when galaxies first quenched. To study the oldest galaxies, we must look back in time, to higher redshifts.

When galaxies stop forming stars they become much dimmer and redder, so are harder to view. To detect these dim, red galaxies, we need large, infrared telescopes, like the James Webb Space Telescope (**JWST**).

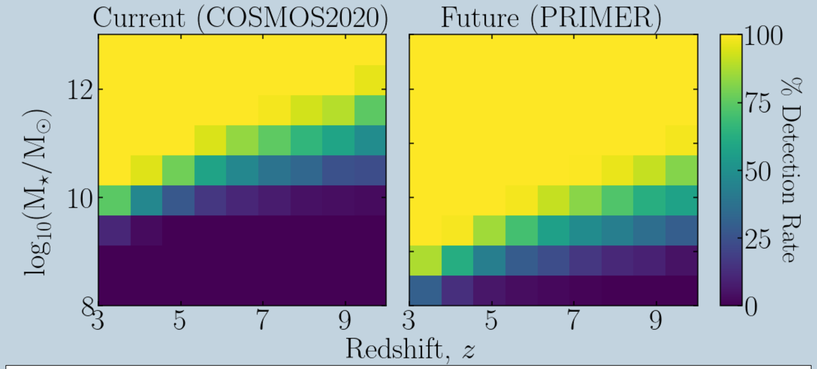
Methods and Results

Most of what we know about galaxies comes from studying *spectra*, how the intensity of light changes with its wavelength. You can build up a low-resolution spectrum, called a *Spectral Energy Distribution,* or **SED**, by measuring brightness through different filters, instead of splitting light up.



This is useful because you can measure several galaxies in an image at once, whereas with spectra you cannot. Measuring the brightness of an object through different filters generates the SED (shown by circles) above. By fitting a spectrum (the line) with a code like BAGPIPES[1] you learn the properties of the galaxy above. It has a redshift of $z=4.14^{+0.05}_{-0.06}$, a stellar mass $\sim 2 \times 10^{11}$ Solar Masses, and is no longer forming stars.

Mock photometry is generated by working out the brightness of simulated galaxies in different filters, based on their physical properties. By comparing these to the detection limits of telescopes, we can see what percentage of quiescent galaxies can be detected now, and compare this to what will be detected with JWST. The figure below is a comparison of the COSMOS2020 survey[2] to the upcoming PRIMER survey, with JWST. Currently, 52% of galaxies are detected. This rises to 76% using JWST.



Conclusions

The physical properties of galaxies can be constrained using SEDs to identify high redshift quiescent galaxies in large samples, and JWST will detect many new galaxies of interest.

[1]A. C. Carnall et al., MNRAS **480**, 4379 (2018). [2]J. R. Weaver et al. ApJS **258**, 11, 11 (2022).