Data analysis Exercises — 5

The role of environment for quenching star formation in observed low-redshift galaxies: Analysis of SDSS data (DR8)

1. Plot a histogram for sSFR at different stellar mass bins (e.g., 9.5-10, 10-10.5, 10.5-11, 11-12). What do you find? Interpret your result.

2. Distinguish star-forming from quiescent galaxies by using sSFR as a discriminant. Looking at the plot of Fig. 1, what could be a good choice for the critical sSFR?

3. Plot the fraction of quiescent galaxies vs galaxy stellar mass, what do you observe and why?

Data analysis Exercises — 5

The role of environment for quenching star formation in observed low-redshift galaxies: Analysis of SDSS data (DR8)

4. Split your galaxy sample into different stellar mass bins, and plot the quiescent galaxy fractions versus different density estimates (Neighbour number count within a cylinder of 0.5, 1 and 2 Mpc). Interpret your results.

5. What are potential caveats of the analysis above? If you want to better isolate environmental effects on SF quenching, what would be needed?

6. The analysis has been done for low redshift ($z<0.1$) galaxies. How would you expect the quiescent galaxy fractions at a given galaxy mass and density to evolve towards higher redshifts and why? [DeLucia, Hirschmann & Fontanot 2019 may provide some helpful insights].

Information for Exercises — 5

The role of environment for quenching star formation in observed low-redshift galaxies: Analysis of SDSS data (DR8)

The SDSS catalogues has the following format:

ssfr, errlow_ssfr, errup_ssfr, mass, errlow_mass, errup_mass, density_05Mpc, density_1Mpc, dens_2Mpc, dens_3_o,annu_1_o, annu_2_o, annu_3_o, annu_5_o, dummy1, dummy2, dummy3, r_a, Dec, redshift, Mag_r, max, distmax, dens_01_o, dens_02_o

SSFR: specific SFR = SFR/Mstellar; units: log(1/yr)

MASS: stellar mass; units: log(Msun)

density_05Mpc, density_1Mpc, dens_2Mpc: number counts of neighbour galaxies within a projected cylinder of 0.5, 1, and 2 Mpc (not in log!)

Note that detailes on projected density are given in Wilman+10 (see also Hirschmann+14)

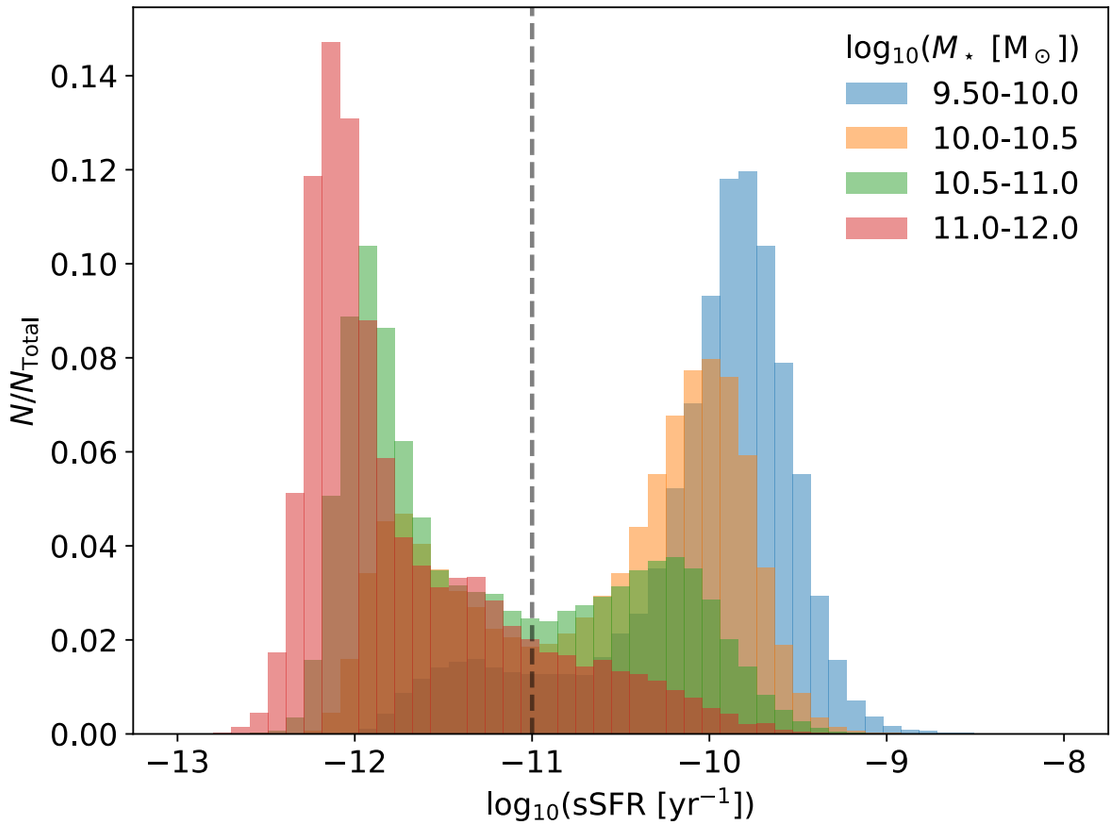
Mag_r: absolute r-band magnitude

For the following analysis, select only galaxies brighter than Mr = -18 (to be complete in the considered redshift space).

Solutions — 5

1. Plot a histogram for sSFR at different stellar mass bins (e.g., 9.5-10, 10-10.5, 10.5-11, 11-12). What do you find? Interpret your result.

We find a bimodality where low-mass galaxies have a higher sSFR than high-mass galaxies, or i.e. low-mass galaxies form more stars per stellar mass than high-mass galaxies

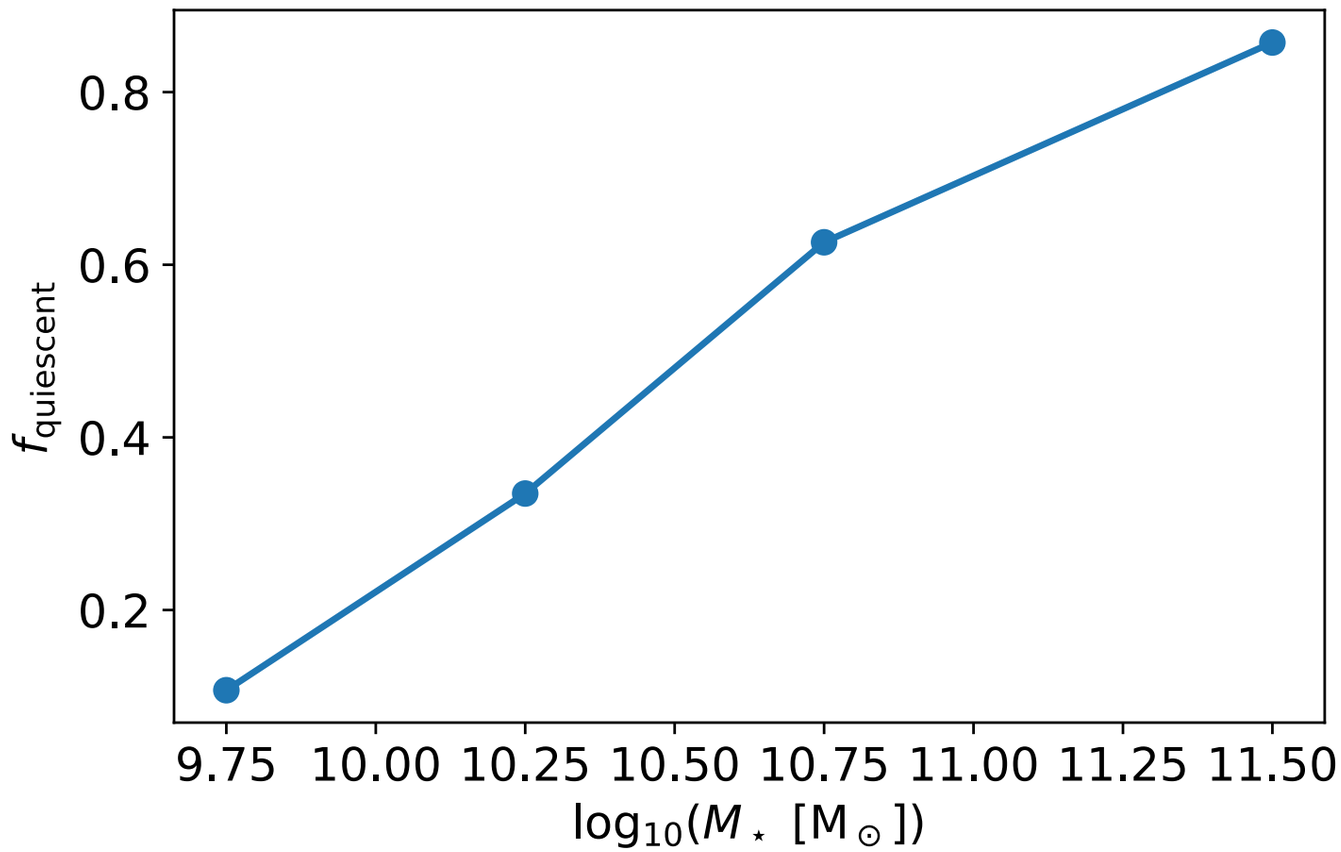


2. Distinguish star-forming from quiescent galaxies by using sSFR as a discriminant. Looking at the plot of question 1, what could be a good choice for the critical sSFR?

Good choice for the critical sSFR: log(sSFR [yr^-1]) = -11

Solutions — 5

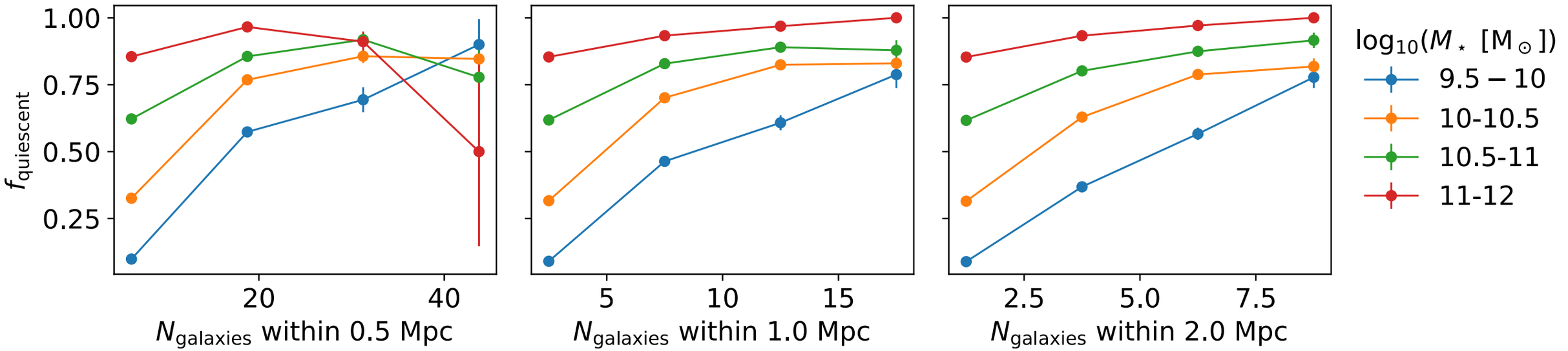
3. Plot the fraction of quiescent galaxies vs galaxy stellar mass, what do you observe and why?



The fraction of quiescent galaxies increases with galaxy stellar mass. This could be due to many reasons, e.g. depletion of gas, morphological quenching (making the gas gravitationally stable), gravitational shock heating, AGN feedback, etc.

Solutions — 5

4. Split your galaxy sample into different stellar mass bins, and plot the quiescent galaxy fractions versus different density estimates (Neighbour number count within a cylinder of 0.5, 1 and 2 Mpc). Interpret your results.



The fraction of quiescent galaxies increases with environmental density. This is due to environment quenching processes, such as ram pressure stripping, strangulation, etc.

EXTRA: You can estimate the uncertainty of the fraction of quiescent galaxies assuming a *Binomial distribution*, see e.g. https://docs.scipy.org/doc/scipy/reference/generated/scipy.stats.binom.html#scipy.stats.binom

Solutions — 5

5. What are potential caveats of the analysis above? If you want to better isolate environmental effects on SF quenching, what would be needed?

We don't distinguish between central or satellite galaxies, which can have an effect on the analysis since satellite galaxies are more effected by environmental quenching processes than central ones. Central galaxies are typically defined by being the closest galaxy to the centre of a parent dark matter halo (meaning that the remaining galaxies are then classified as satellites).

6. The analysis has been done for low redshift ($z<0.1$) galaxies. How would you expect the quiescent galaxy fractions at a given galaxy mass and density to evolve towards higher redshifts and why? [DeLucia, Hirschmann & Fontanot 2019 may provide some helpful insights].

At high redshift, the Universe is more gas rich (i.e. there is more gas to form stars with), meaning that you would expect lower fractions of quiescent galaxies.