GALAXIES SED FITTING ASSIGNMENT

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Introduction

SED analysis is done in galaxy spectra fitting by photometry because it is less time intensive, given we need flux from IR to UV etc. The emission from a galaxy is a result of the combination from the age of the galaxy, amount of dust, gas, stars, star formation rate, mass etc. All this can be derived by analyzing the observational data by fitting these as free parameters on the SED to get the desired results.

Here we are using BagPipes which is a state-of-the-art Python module for galaxy spectra analysis. In this we give the posterior distribution using which it tries to fit the data.

Procedure

- First, installation of BagPipes is done. Which took a lot of time to figure out the issue in the installation. It turns out that there is a compatibility issue. The current version of BagPipes is compatible up to Python 3.10 only. Since we all had 3.11+ due to which it was not working. I made a virtual environment where I installed Python 3.10 and then installed BagPipes which is used for the analysis in this assignment.

- To analyze the data, BagPipes uses PyMultiNest or Nautilus. In my case it was not able to build PyMultiNest and used Nautilus instead. Also, it was not able to find any latex distribution due to which the plotted graphs look a bit weird.

- Then the provided data for the 5 bands and 21 bands of flux and flux error is used.

- The filter response curves for all the required filters were downloaded from SVO Filter Profile Service (http://svo2.cab.inta-csic.es/svo/theory/fps/). The filter lists were created by writing the locations of the filter profile files in the same order in which their corresponding flux values are present in the 5 band and 21 band photometric data files.

- A function is created to load the flux and flux error values from the photometric data files in the formatting as is required by bagpipes . it was realized that bagpipes did not accept flux values in janskys. Entering the unit as janskys or jy led to the same results as entering a random string did. It was found that the package did accept microjanskys/mujy as a unit. Thus, the data was multiplied by 10^6 and the units were set to 'mujy'.

- Then two other functions are created. One for post fitting analysis to print and plot the fitted properties and the spectra, probability histofram etc. And the other one is a function which will iterate over the both 5 band and 21 band files and over each ID and do this full fitting and post fitting analysis.

- Compared to others, my code was running really slow so I was not able to fit the data into too many parameter combinations, especially that of sSFR. Only exponential and double powerlaw I was able to try. The code and the corresponding files are present in the zip file along with this report.

- The SED along with median values of the key parameters is mentioned here for both type of fitting and is shown below.

- We will mainly consider the exponential for further analysis because in the double power law, overflow was happening.

<u>For 5 band</u>

<u>ID = 130653</u>

1. Using exponential :

    - stellar_mass, log_10(M^*/M_{solar}): 13.7569
    - sSFR: -12.9
    - Redshift = 0.03
    - Mass weighted Age: 9.493 Gyr

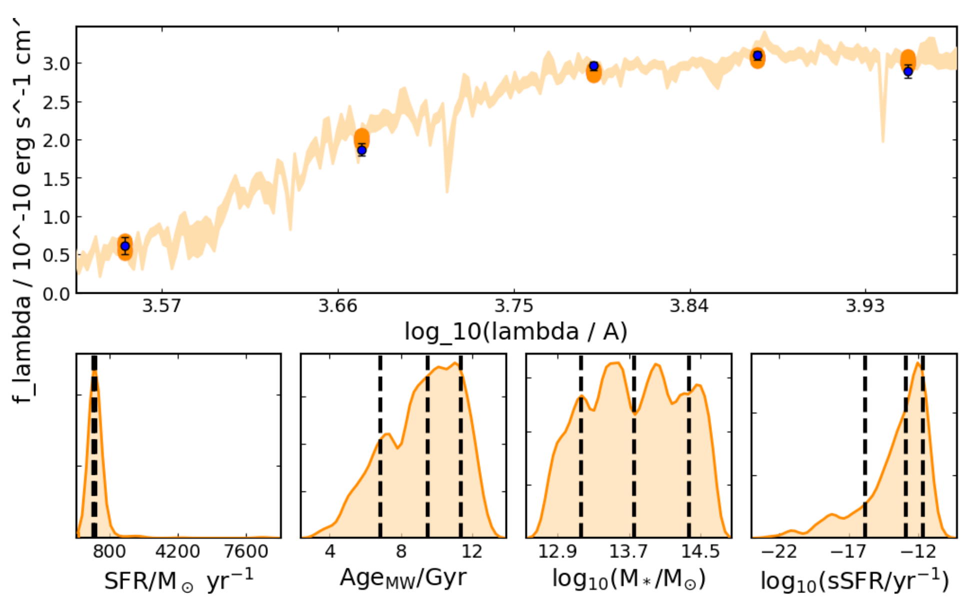

Fig1: SED and prior using exponential for ID =130653

2.Using double power law: (Overflow encountered)

- stellar_mass, log_10(M*/M_{solar}): 14.55
- sSFR: -33.96
- Redshift = 0.008
- Mass weighted Age: 10.0121 Gyr

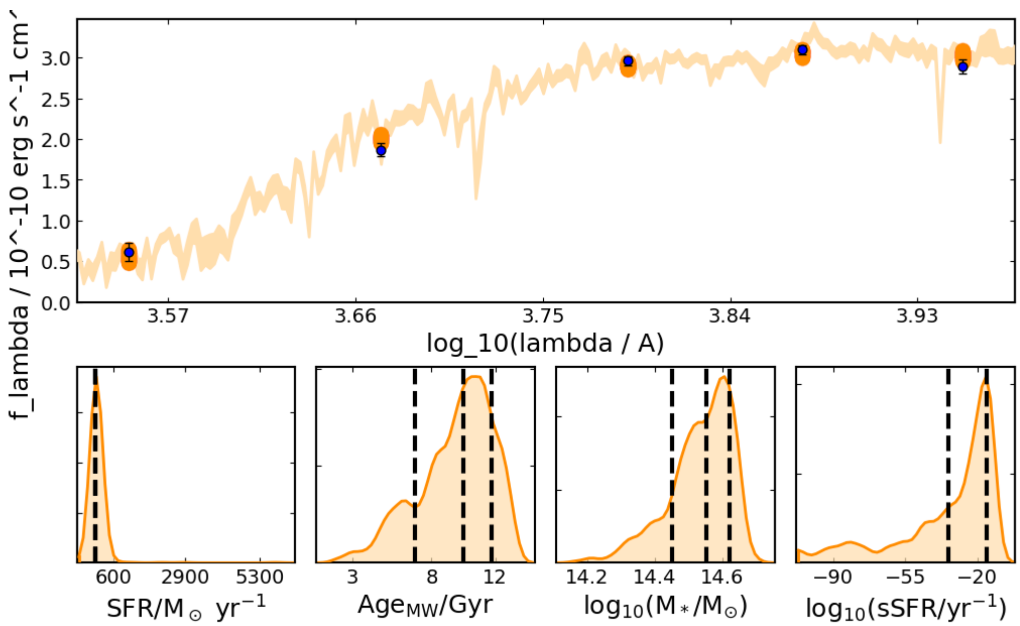

Fig2: SED and prior using double powerlaw for ID =130653

- **Morphology:** Due to the presence of absorption lines and absence of emission lines, it seems as though this galaxy could be an elliptical galaxy.

ID = 220955

1. Using exponential:
   - stellar_mass, log_10(M*/M_{solar}): 13.04559
   - sSFR: -9.5815
   - Reshift = 0.002
   - Mass weighted Age: 2.9233 Gyr

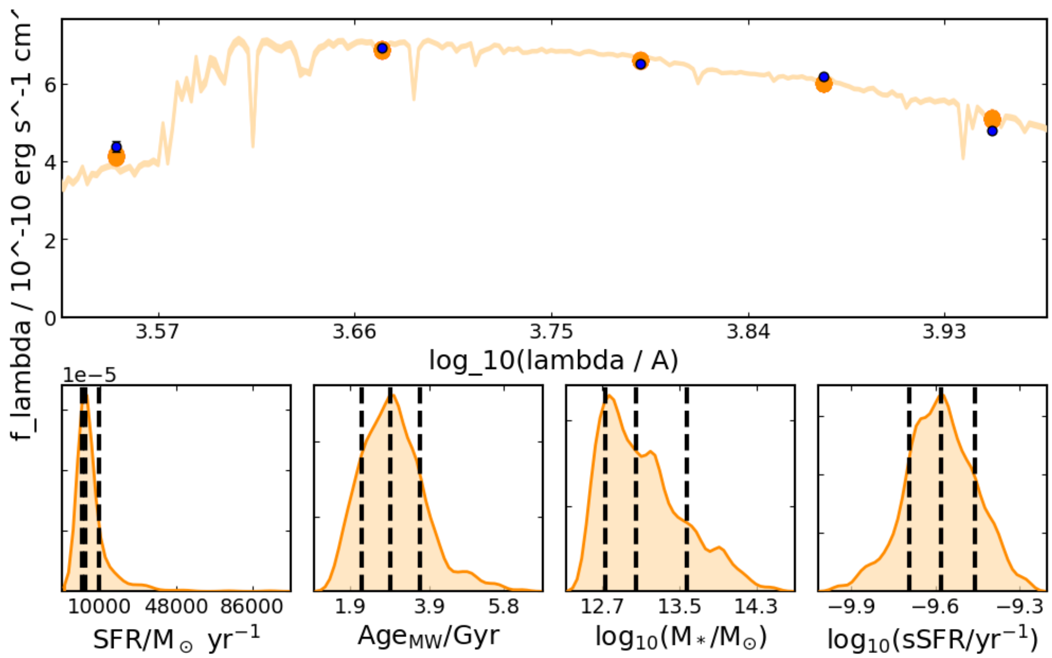

Fig3: SED and prior using exponential for ID =220955

2. Using double power law:

- stellar_mass, log_10(M*/M_{solar}): 14.4474
- sSFR: -10.2036
- Redshift = 0.007
- Mass weighted Age: 8.3736 Gyr

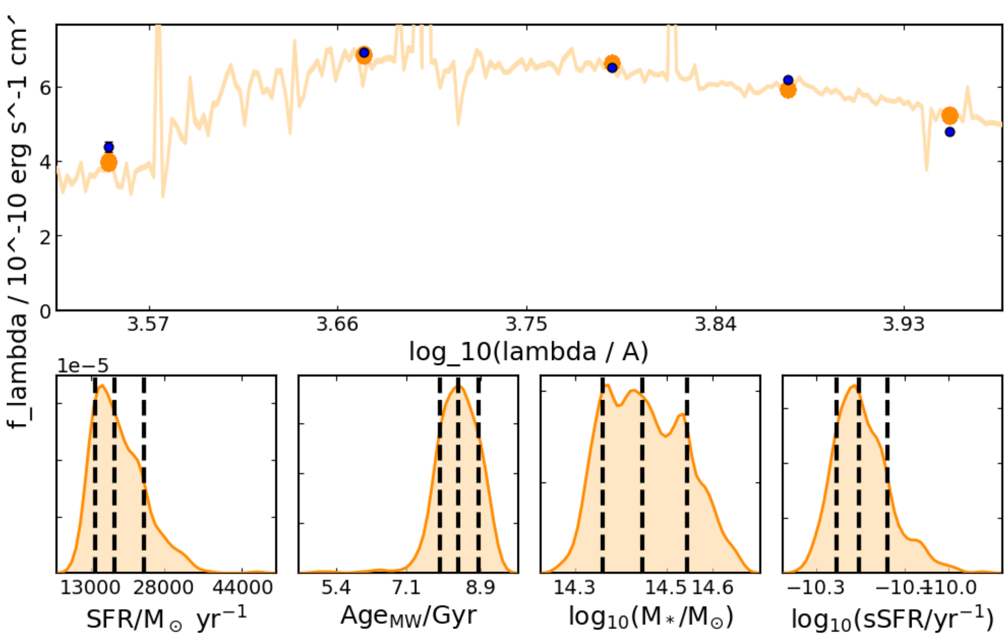

Fig4: SED and prior using double power law for ID =220955

- **Morphology:** Due to the presence of many emission lines, this galaxy looks like spiral galaxy in double power law but from exponential it looks like there are only absorption lines so it can be elliptical too. Since the properties are coming out to be similar in both.

For 21 band

ID = 382567

1. Using exponential :
    - stellar_mass, log_10(M*/M_{solar}): 14.242
    - sSFR: -13.825
    - Redshift = 0.004
    - Mass weighted Age: 10.757 Gyr

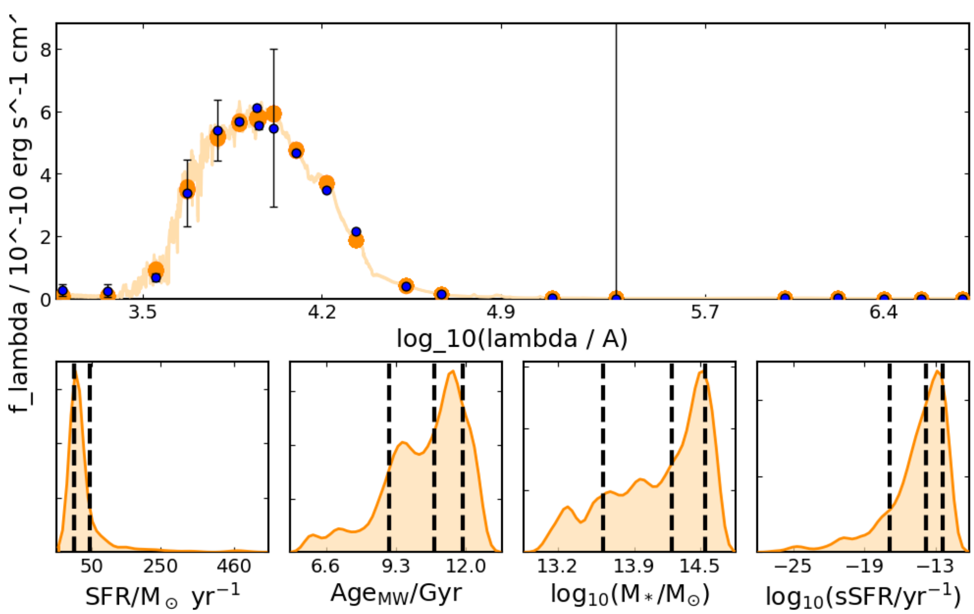

Fig5: SED and prior using exponential for ID =382567

2. Using double power law : (Overflow encountered)
    - stellar_mass, log_10(M*/M_{solar}): 14.561
    - sSFR: -67.1188
    - Redshift = 0.005
    - Mass weighted Age: 11.424 Gyr

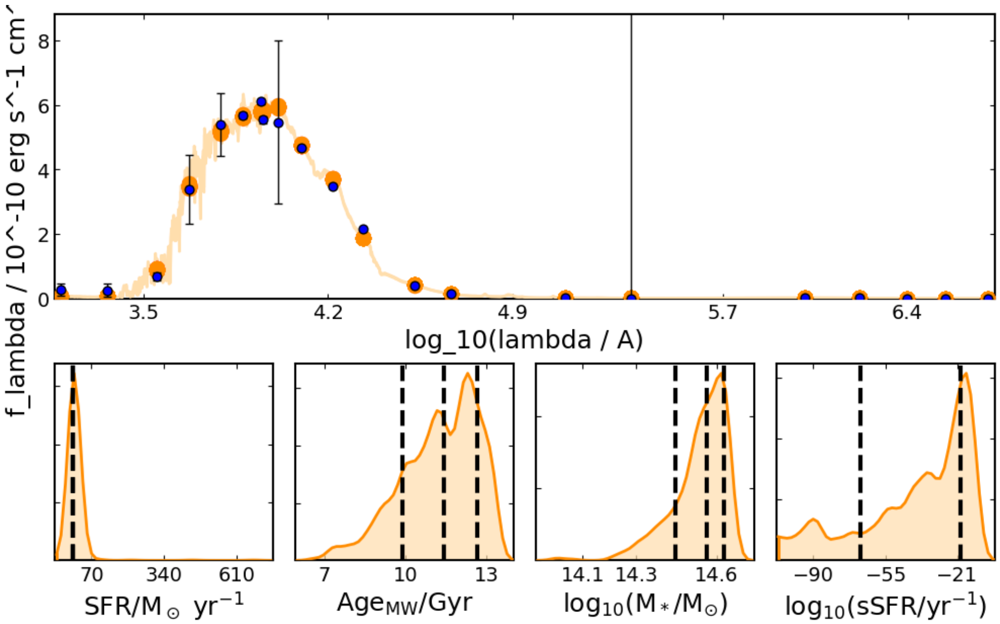

Fig6: SED and prior using double power law for ID =382567

- **Morphology:** No emission and absorption line is present. It is difficult to comment here.

ID = 229206

1. Using exponential:
   - stellar_mass, log_10(M^*/M_{solar}): 12.058
   - sSFR: -9.331
   - Redshift = 0.002
   - Mass weighted Age: 0.616 Gyr

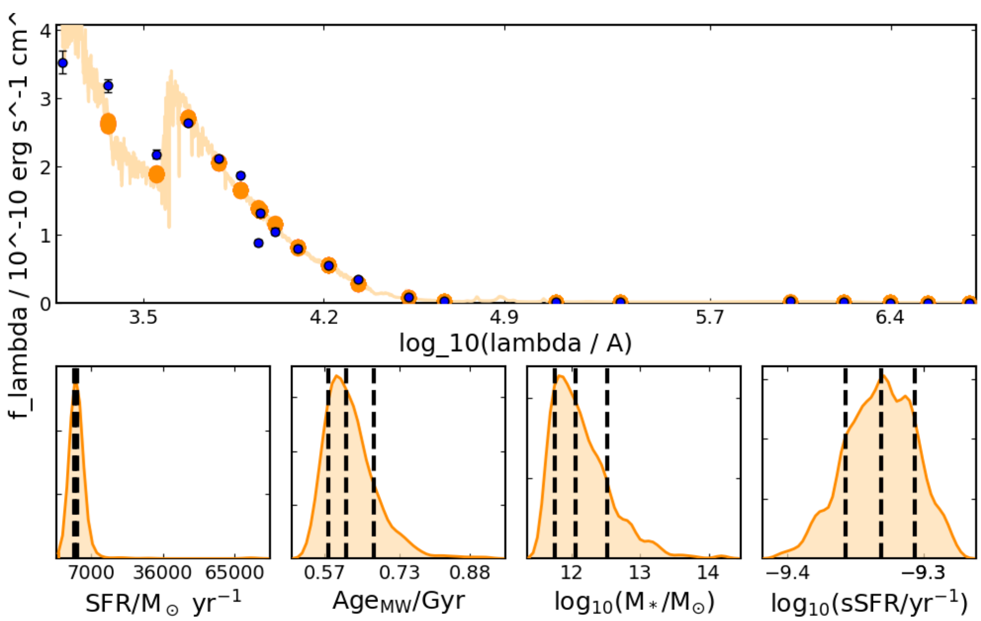

Fig7: SED and prior using exponential for ID =229206

2. Using double power law: (Overflow occured)

- stellar_mass, log_10(M*/M_{solar}): 14.718
- sSFR: -9.3078
- Redshift = 0.035
- Mass weighted Age: 0.6666 Gyr

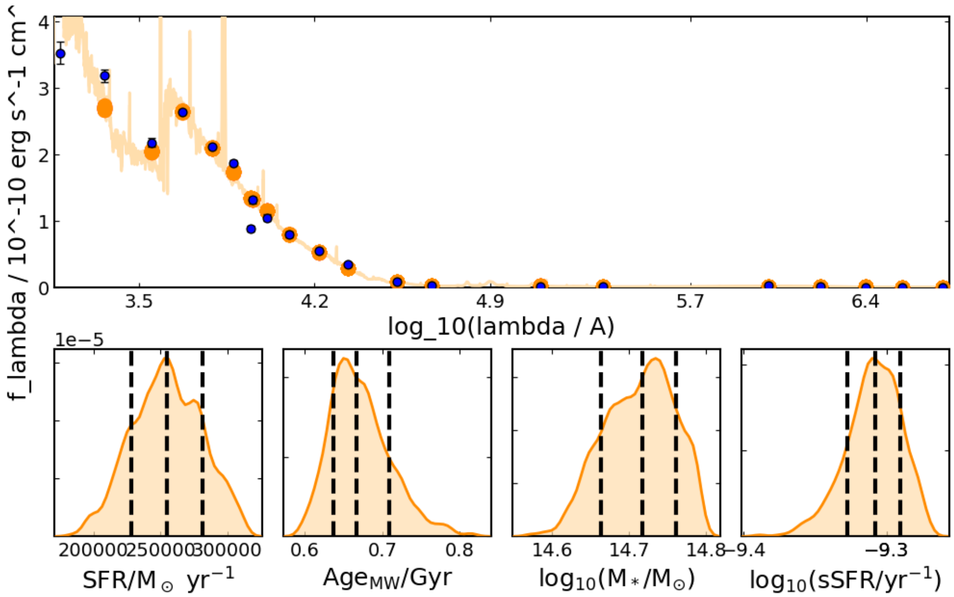

Fig1: SED and prior using double power law for ID =229206

- **Morphology:** The present of emission lines in the spectrum shows that this galaxy is likely a spiral galaxy.

Comment on whether 21-band photometry yields more exact results than 5-band photometry, or is it the other way, and the reason as to why?

The 21 band one covers a bigger part of the spectrum hence that can give us a lot of constraints compared to 5 bands only. This is due to the fact that their degeneracy can occur but with more data that might get reduced.