ASTR 400B Lab 2

1 First Step

Make sure to have a cloned copy of your own repository on your computer (or nimoy if you are using nimoy for Jupyter). Create a directory Labs/Lab2.

From the command line git clone the class repository. If you have already done this, git pull to update the repository. There is a directory Labs/Lab2/ with a file Lab2.ipynb, which is the template for this exercise.

Copy this template to your own repository directory Labs/Lab2

2 Schechter Function

The galaxy luminosity function in the nearby universe is well described by a Schechter Function:

$$\Phi(M)dM = (0.4\, ln10)\, \phi_*\, 10^{0.4(M_* - M)(\alpha+1)} e^{-10^{0.4(M_* - M)}} dM \tag{1}$$

With the following parameters from Smith+2009 for Field Galaxies in SDSS at z$\sim$0.1 in the Kband:

1. ϕ_* =1.66 $\times 10^{-2}$ h^3 Mpc^{-3}
2. α = -0.81
3. M$*$ = M$_k^*$= -23.19 - 5log(h)

h = the Hubble constant in units of 100 km/s/Mpc . At z=0 this is 0.7. But we are going to ignore it here. Units will then be in "comoving" coordinates.

2.1 Question 1

Utilizing the defined function in the template file, plot the Schechter Function using the above parameter values over a magnitude range of -17 to -26. Try to reproduce the black solid line in Figure 2.1, from Smith+2009

Plotting tips:

1. *import matplotlib.pyplot as plt* - this lets you use plotting functions.
2. np.arange(0,10,0.1) will return an array from 0 to 10 spaced in intervals of 0.1
3. plt.semilogy lets you plot the y axis as log.

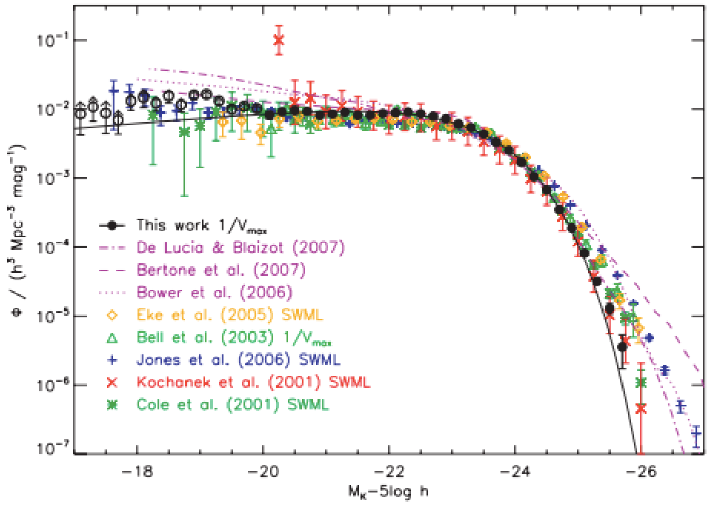

Figure 1: Luminosity Function from Smith+2009, UKIDSS + SDSS KBand

2.2 Question 2

Galaxies in the Virgo Cluster have different parameters, like α=-1.35 (Ferrarese+2016 ApJ 824) Overplot the Schechter Function with this new value of α. Try a smaller value of $\alpha = -0.6$. How does the function change? What does this mean?

2.3 Question 3

Build a function to compute the Schechter Function in terms of luminosity.

Use ‘quad‘ to determine the fraction of the luminosity that lies above L* in the following three cases: α=-0.7 (default), α=-0.6, α=1.85.

Schechter Function:

$$\Phi(L) = \frac{n_*}{L_*}\left(\frac{L}{L_*}\right)^{\alpha} e^{-L/L_*} \tag{2}$$

$n_* = 0.008\ h^3\ \mathrm{Mpc}^{-3}$
$L_\star = 1.4 \times 10^{10} L_\odot$

3 The IMF

Create a function called *Salpeter* that defines the Salpeter IMF:

$$\xi(M) = \xi_0 (M/M_\odot)^{-\alpha} \tag{3}$$

$\alpha = 2.35$ The function should take as input an array of stellar masses, M. You will need to determine the normalization, ξ_0, by integrating this equation over mass from 0.1 to 120 $\mathrm{M}_\odot$

and setting the value to 1. The function should then return $\xi(M)$, which will now represent the fractional number of stars.

- from scipy.integrate import quad
- quad(lambda x: fxn(x),xmin,xmax)
- quad returns an array with 2 values. you want the first value.

3.1 Question 1

Integrate your normalized function to compute the fraction of stars with stellar masses greater than the sun and less than 120 $M_\odot$. ** Double Check: if you integrate your function from 0.1 to 120 you should return 1.0

3.2 Question 2

How might you modify the above to return the fraction of *mass* in stars more massive than the Sun?

4 Last Step

Git push your Lab1.ipynb file to your repo. Recall steps:

1. git add filename
2. git commit -m "COMMENTS"
3. git push