Exercise B

Advanced Programming 2023

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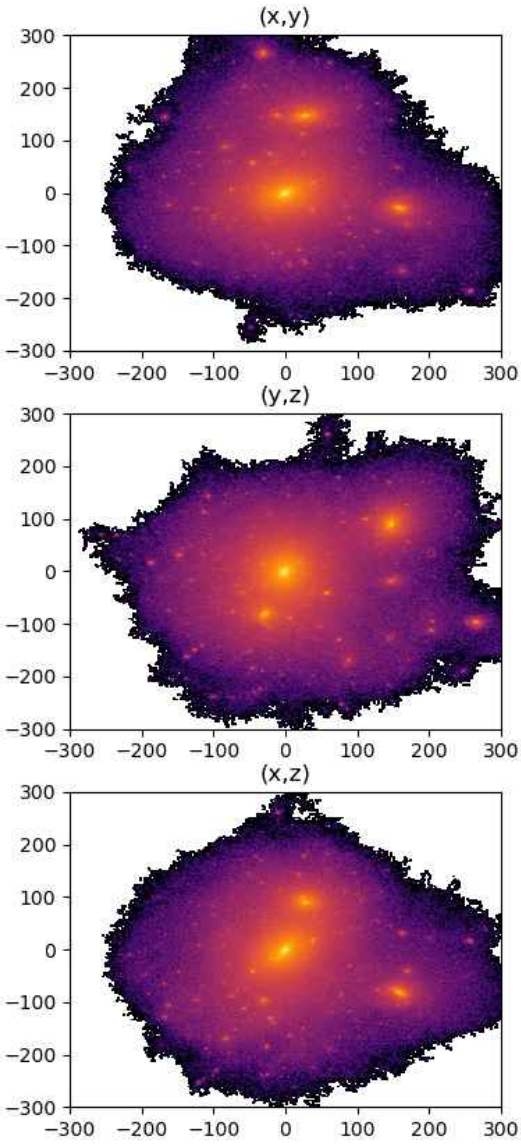
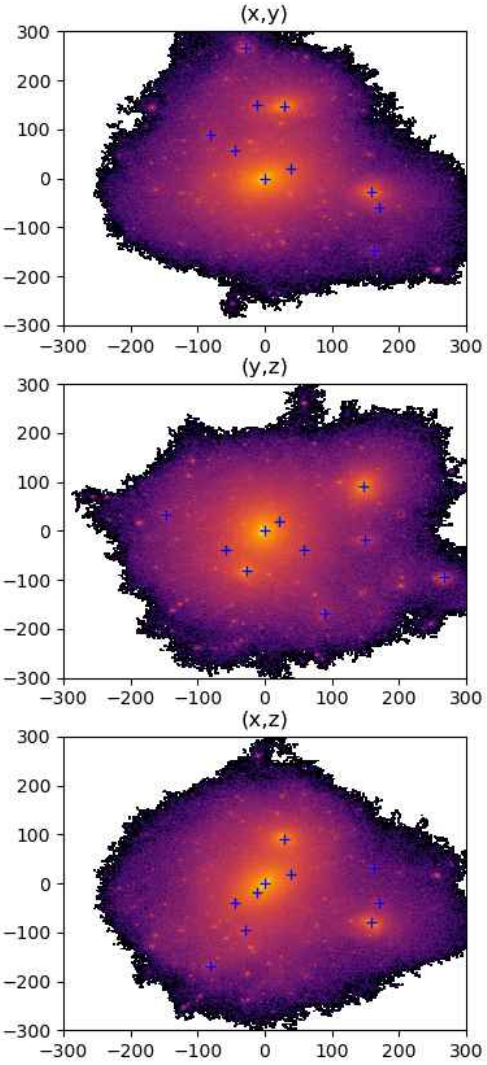
Task 1: Task 1 Plot DM mass projections of the galaxy halo (in units of M kpc−2). Do (x, y), (x, z) and (y, z) projections. Choose a box size of ±300 kpc. Hint: Use plt.hist2d to create the projections.



Task 2: Mark the locations of these galaxies in the projections from Task 1. Use circles or "x" symbols as markers.



Task 3 Calculate the DM mass in each of the spherical shells.

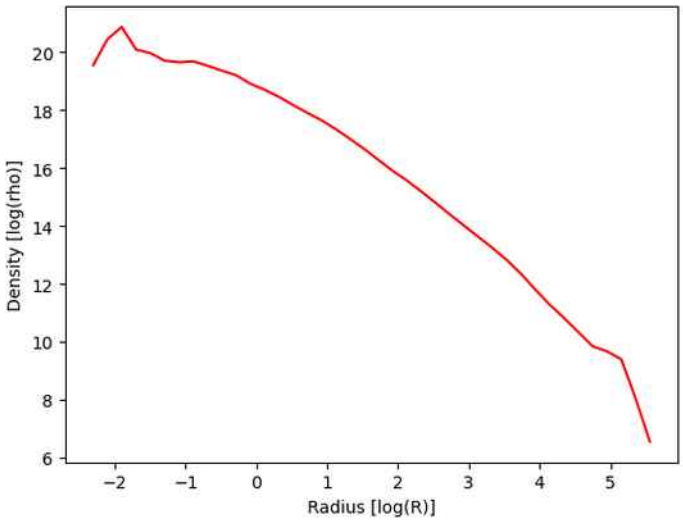
DM mass in each shell saved as a array

[1076928.3, 4846177.3, 13461604, 11307747, 18307781, 25846279, 44692524, 84538870, 1.3300064×108, 2.056933×108, 3.2146309×108, 4.3884828×108, 6.5046468×108, 9.3531221×108, 1.2890832×109, 1.7963164×109, 2.5447815×109, 3.4262473×109, 4.4735601×109, 5.7615663×109, 7.2138041×109, 9.0725823×109, 1.1869365×1010, 1.4897149×1010, 1.8458012×1010, 2.2603648×1010, 2.8035136×1010, 3.4924246×1010, 4.3395902×1010, 5.2271407×1010, 5.9456672×1010, 6.2918997×1010, 6.8827564×1010, 7.9736309×1010, 8.9749588×1010, 1.0088287×1011, 1.5559675×1011, 2.1598389×1011, 1.0254673×1011, 4.2358282×1010]$M_{\odot}$

Task 4: Calculate ρ as a function of R, and plot log ρ as a function of log R.

```
rho = Massdistribution/VolumeOfShell
rho = rho * u.M_sun
```

rho = [3.0967935×108, 7.6142085×108, 1.1556392×109, 5.303976×108, 4.6920342×108, 3.6192909×108, 3.4194822×108, 3.534125×108, 3.0379401×108, 2.5671167×108, 2.1920809×108, 1.6350832×108, 1.3241866×108, 1.0403562×108, 78344119, 59649705, 46171711, 33965982, 24231413, 17051635, 11665136, 8015975.6, 5729978, 3929421.6, 2660176.2, 1779934.4, 1206224.5, 821017.67, 557409.27, 366850.96, 227995.39, 131827.88, 78793.041, 49874.849, 30673.118, 18838.352, 15875.448, 12040.564, 3123.5414, 704.95891]$M_{\odot}$/ kpc^3



Task 5: Find the critical density, $\Omega_{crit,0}$, at redshift 0 in a Planck15 cosmology, for example by using the astropy package.

```
crit_dens = pl.critical_density(0)
crit_dens = crit_dens.to(u.M_sun/u.kpc**3)
crit_dens
```

$127.35344 \frac{M_\odot}{kpc^3}$

Task 6: Calculate the total mass (M_{tot}) inside a given radius (R) for the above dark matter halo.

Was not able to solve this one, which has affected the succeeding tasks as well, but I have included attempts and code in the notebook.

Task 7: Solve the equation $200\Omega_{crit,0} = M_{tot} /(34 \pi * R^3)$ for the above halo (numerically solve for R). Determine M200 and R200 .

```
R_M_tot = np.cbrt(M_tot /(200 * crit_dens * 4/3 * np.pi))

#M200 and R 200

R200 = np.interp(200*crit_dens, rho, R)
```

Task 8: Add a circle indicating R200 to the figure from Task 2.

```
circle = plt.Circle((0,0), 100, color = 'g', fill = False)
fig, ax = plt.subplots()
plt.hist2d(Pos[:,0], Pos[:,1], norm = LogNorm(), bins = 300, cmap = 'inferno')
plt.plot(Xx, Yy, "b+")
ax.add_patch(circle)
plt.show()
```