Homework2

January 30, 2025

[83]:
```
# importing necessary libraries
import numpy as np
import astropy.units as u
```

[191]:
```
def Read(filename):

    """
    This function will open and read any given data file according to this format,

        # Row 1: Time (Myr)
        # Row 2: Total number of particles
        # Row 3: Units for the following columns
        # Row 4: Column headers
        # Remaining rows contain particle data:
        #   Col 1: Type (1=DM, 2=Disk, 3=Bulge)
        #   Col 2: Mass (10^10 M )
        #   Col 3-5: Position (x, y, z) in kpc (MW center)
        #   Col 6-8: Velocity (vx, vy, vz) in km/s (MW frame)
        # Columns are tab-delimited

    Inputs: filename (string) Name of the file in which the data is stored in the correct format.

    Output : time is the time in Myr
             total_particles is the total number of particles
             data is the full data array
    """
    file = open(filename, 'r')
    line1 = file.readline()
    label, value = line1.split()
    time = float(value)*u.Myr

    line2 = file.readline()
    label, value = line2.split()
    total_particles = float(value)
    file.close()
```

```
    # Skips the first three lines and starts storing from the 4th line
    data = np.genfromtxt(filename,dtype=None,names=True,skip_header=3)


    return (time, total_particles, data)
```

[193]:
```
# Testing
time, total_particles, data = Read("MW_000.txt")
```

[194]:
```
data['vx'][2] # This gives out the velocity in the x direction of the 2nd␣
 ↪particle as a whole.
```

[194]: 11.3833

[197]:
```
# units of Myr (equivalent to SnapNumber x 10/0.7)
time # Should be 0
```

[197]: 0 Myr

[199]:
```
index = np.where(data['type'] == 2)     # This is a disk type particle
x = data[index] # Gives an array whose particle type is a disk
x[100]['x'] # 100th disk particles' x distance in kpc)
```

[199]: 14.87

[203]:
```
data[-1]['vz'] #should be 16.7124
```

[203]: 16.7124

[273]:
```
def ParticleInfo(filename, particle_type, particle_number):
    """
    This function will compute the magnitude of the distance, magnitude of the␣
 ↪velocity and mass of any given particle of
    any given type (Disk, Halo, etc.)

    Inputs: filename (string) Name of the file in which the data is stored in␣
 ↪the correct format.
            particle_type is the type of the particle, mapped to a number as␣
 ↪follows, Type 1 = Dark Matter,
            Type 2 = Disk Stars, Type 3 = Bulge Stars
            particle_number is the number of the particle

    Output : d (astropy units kpc)  Magnitude of the distance
             v (astropy units km/s) Magnitude of the velocity
             m (astropy units M_sun) Mass
    """
```

```
    time, total_particles, data = Read(filename)

    index = np.where(data['type'] == particle_type)
    data1 = data[index]


    # distance
    x = float(data1[particle_number]['x']) * u.kpc
    y = float(data1[particle_number]['y']) * u.kpc
    z = float(data1[particle_number]['z']) * u.kpc

    # velocity
    vx = float(data1[particle_number]['vx']) * u.km/u.s
    vy = float(data1[particle_number]['vy']) * u.km/u.s
    vz = float(data1[particle_number]['vz']) * u.km/u.s

    m = data['m'][index][particle_number] * 10**10* u.M_sun


    d = np.around((np.sqrt(x**2 + y**2 + z**2)), 3)
    v = np.around((np.sqrt(vx**2 + vy**2 + vz**2)), 3)

    d_3D = d.to(u.lyr)

    return (d, v, m, d_3D)
```

[275]:
```
d,v, m, d_3D = ParticleInfo("MW_000.txt", 2, 99)
d # The 3D Distance in kpc
```

[275]: 4.245 kpc

[277]:
```
v # The 3D Velocity in km/s
```

[277]: 312.135 $\frac{\mathrm{km}}{\mathrm{s}}$

[281]:
```
m # The mass of the 100th disk particle in the milky way
```

[281]: 1000000 $\mathrm{M}_\odot$

[257]:
```
d_3D # The 3D Distance in light years
```

[257]: 13845.338 lyr

[259]:
```
particle_type = 2
particle_num = 100
```

```
d, v, m, d_3D = ParticleInfo("MW_000.txt", particle_type, particle_num - 1)  #␣
 ↪Disk stars are type 2
print(f"The properties of the {particle_num}th particle of the {particle_type}␣
 ↪type")
print(f"Distance: {d}")
print(f"Velocity: {v}")
print(f"Mass: {m}")
print(f"3D Distance: {d_3D}")
```

```
The properties of the 100th particle of the 2 type
Distance: 4.245 kpc
Velocity: 312.135 km / s
Mass: 1000000.0 solMass
3D Distance: 13845.338234075754 lyr
```