Inbound- Task I

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1 Equatorial co-ordinate system

Equatorial co-ordinate system is commonly used system to find and place stars, galaxies and celestial objects. Earth is considered to be the origin of this system. By convention, the origin is fixed to be the orientation of Earth as of January 1st 2000 12:00 TT. In this reference frame x-axis is the equinox, z-axis is the Earth's axis of rotation and y-axis is perpendicular axis to both the axes.

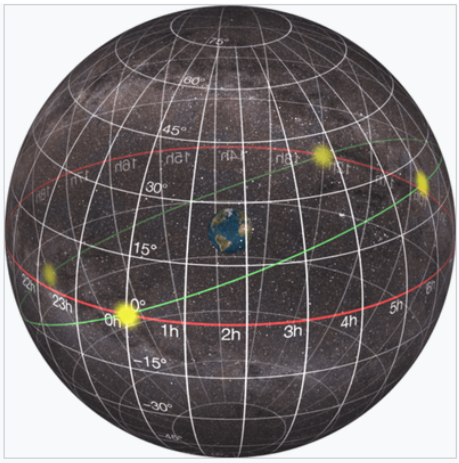
Elliptic plane is an imaginary plane across which the Earth rotates around the Sun. Therefore the Celestial North pole is tilted at an angle of 23.5° to the Elliptic North pole. Earth's axis shifts over time due to precession, but this is very slow and we update our reference frame every 50 years. Similar to Latitudes and Longitudes in geographic co-ordinate system we use Right Ascension and Declination in Equatorial Co-ordinate system.

1.1 Declination

Declination is angular distance of an object w.r.t North or South of the celestial equator. It is similar to latitude. Declination is measured in degrees. It ranges from -90°to 90°. The North Pole has 90°declination.

1.2 Right Ascension

Right Ascension is the angular distance measured from vernal Equinox towards East. Vernal Equinox is the point where sun crosses the Celestial equator. Vernal Equinox generally happens around March 20th. Right Ascension is measured in Hours Minutes and Seconds. It ranges from 0hrs to 24hrs. Right Ascension is the relative time difference when the star and sun arise across the Vernal Equinox. Since, every month Earth revolves 30°around the sun, The RA of the respective star decrease 2hrs every month from March i.e. If a star was rising at 6 A.M at a particular place, it will rise at 4 A.M the next month.



Model of the equatorial coordinate system. Declination (vertical arcs, degrees) and hour angle (horizontal arcs, hours) is shown. For hour angle, right ascension (horizontal arcs, degrees) can be used as an alternative.

Figure 1: Equatorial co-ordinate system

1.3 Usecases of RA-DEC co-ordinates

- RA and DEC co-ordinates are used to locate a star in space. For example the RA DEC co-ordiantes of Beteleguse Star are 05h 55min 10s and +7°24' 26" i.e. a person standing at this location on Earth can view the star Beteleguse right above his head.
- It is used in Astronomical Databases and star catalogs.

2 Task

From the given task, I plotted DEC vs RA in a linear scale through the written python code.

```
import numpy as np
import matplotlib.pyplot as plt
data = np.loadtxt("data.txt",usecols=(0,1,2,3), skiprows=1)
HIP = data[:,0]

Vmag = data[:,1] #require vmag to make size of stars not to show them identical;

RA= data[:,2] #RA values are given in degrees; will convert them to hours and make in 24 hou
RA = RA*24/360

DEC = data[:,3] #declination is given in degrees as required


fig, ax = plt.subplots()

fig.set_facecolor('black')  # Set the figure background color to black
ax.set_facecolor('black')  # Set the axis background color to black

ax.scatter(RA,DEC, color='white', marker='o',s=80*(np.power(10,Vmag/-2.5)))

#ax.grid(color='white', linestyle='--', linewidth=0.5)
ax.tick_params(colors='white')  # Set tick labels color to white

ax.set_xlabel('Right Ascension', color='white')
ax.set_ylabel('Declination', color = 'white')

ax.grid(False)
ax.set_xlim(0,24)
ax.set_ylim(-90,90)
plt.show()
```

From this I have obtained the figure attached below. Since I did not want to show all the stars with same size, I have given them relative sizes from a formula I have seen in this article.

Figure 2: Stars-normalized

Link to the Github Page.