HACETTEPE UNIVERSITY
DEPARTMENT OF
GEOMATICS ENGINEERING

GMT327

ORBITAL MECHANICS and ASTRONOMY

HOMEWORK -2

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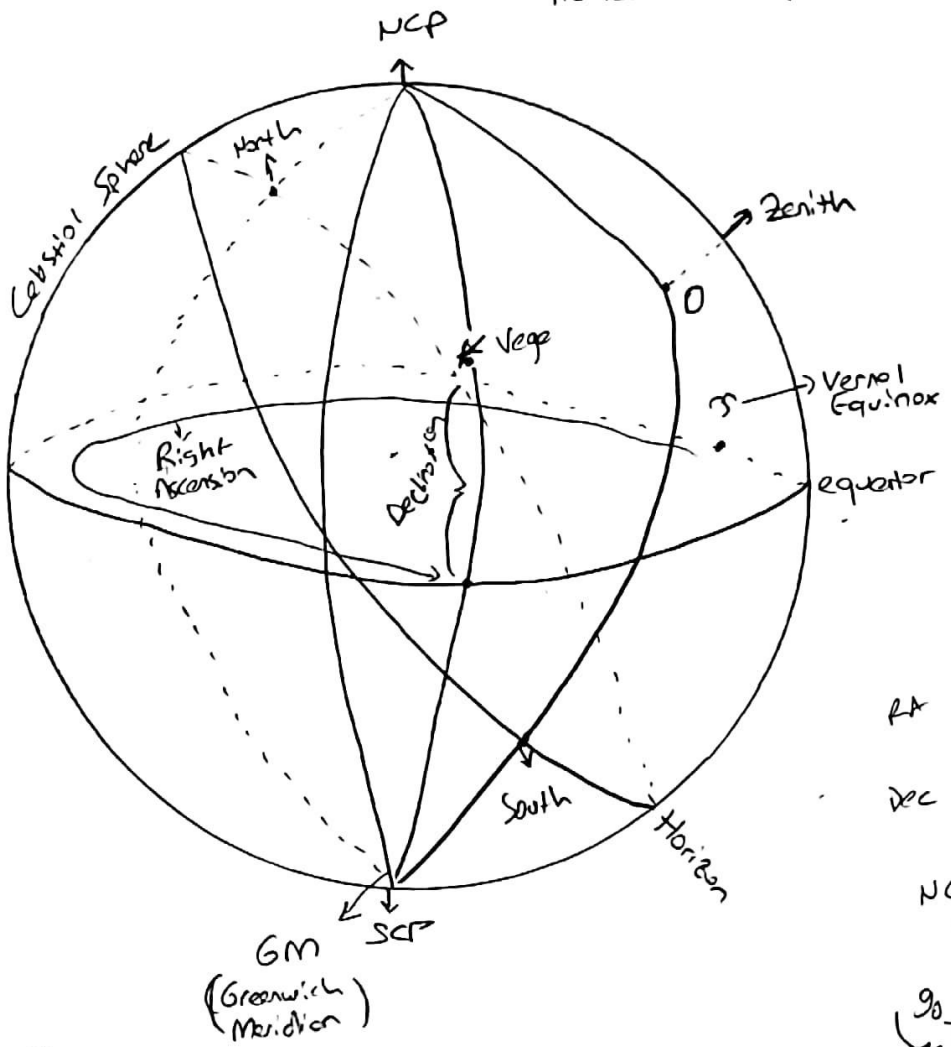


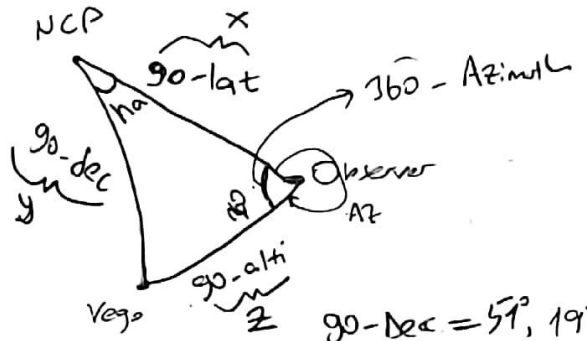
in degree RA: 279°, 4215
in degree Dec: 38°, 8076
in degree Azimuth = 66°, 7896
in degree Altitude = 36°, 8904

RA and Dec of Vega by Relevant Date

RA: 18h 37m 41.0s
Dec: +38° 48' 27.2"

RA $\left(18 + \frac{37}{60} + \frac{41}{3600}\right) \cdot 15 = 279°, 4215$

Dec $\left(38 + \frac{48}{60} + \frac{27,2}{3600}\right) = 38°, 8076$



90-Dec = 51°, 1924
90-alt = 57°, 1096
360 - Azimuth = 293°, 2104
90-lat = x

sin

$\cos(z) = \cos(y) \cdot \cos(x) + \sin(y) \cdot \sin(x) \cdot \cos(ha)$

$\cos(y) = \cos(x) \cdot \cos(z) + \sin(x) \cdot \sin(z) \cdot \cos(360 - Azimuth)$

$\frac{\sin(90-alti)}{\sin(ha)} = \frac{\sin(90-dec)}{\sin(360-Azimuth)}$

$ha = -70°, 6095$

$\cos^2(z) = \cos(y) \cdot \cos(x) \cdot \cos(z) + \cos(z) \cdot \sin(y) \cdot \sin(x) \cdot \cos(ha)$

$-\cos^2(y) = -\cos(x) \cdot \cos(z) \cdot \cos(y) - \cos(y) \cdot \sin(x) \cdot \sin(z) \cdot \cos(360 - Azimuth)$

$\cos^2(z) - \cos^2(y) = \left(\cos(z) \cdot \sin(y) \cdot \cos(ha) - \cos(y) \cdot \sin(z) \cdot \cos(360 - Azimuth)\right) \cdot \sin(x)$

$x = \arcsin\left(\frac{\cos^2(z) - \cos^2(y)}{\sin(y) \cdot \cos(z) \cdot \cos(ha) - \sin(z) \cdot \cos(y) \cdot \cos(360 - Azimuth)}\right)$

$x = 50°, 1350$ $\quad 90 - x = 39°, 8650$

LAST − GAST = Longitude

208°, 8120 $\quad$ 176°, 0878 = 32°, 7242

LAST = RA + HA
= 279°, 4215 − 70°, 6095
LAST = 208°, 8120

!!! GAST found with python code.

Observers Latitude: 39°, 8650

Observers Longitude: 32°, 7242

- GAST found using Astronomy library

In [26]:
```
import astropy
from astropy import units as u
from math import radians
from astropy.coordinates import SkyCoord
from astropy.time import Time
from astropy.time import TimeDelta

epoch=Time("2022-11-14T11:10:42", scale="utc")
epoch=epoch - TimeDelta(10800, format = "sec")

GAST = epoch.sidereal_time(kind = "apparent", longitude = 0)

print("GAST: ", GAST)
print("GAST in Degree: ", GAST.deg)
```

```
GAST:  11h44m21.07746515s
GAST in Degree:  176.08782277144246
```

- Controlling the solutions to be done manually in the homework with python code.
- There is a slight deviation in the results, this is due to the fact that I take 4 digits after the comma and do not round.

In [27]:
```
import astropy
from astropy import units as u
from math import radians
from astropy.coordinates import SkyCoord
from astropy.time import Time
from astropy.time import TimeDelta
from astropy.coordinates import Angle,SkyCoord
import numpy as np

A = Angle("66°47'22.6")
z = Angle(90,unit=u.deg) - Angle("+36°53'25.5", unit=u.deg)
betelgeuse = SkyCoord(ra="18h 37m41.0s",dec="+38°48'27.2",frame="icrs")
ra = betelgeuse.ra
dec = betelgeuse.dec
print (A,z,ra,dec)
# Epoch given in local time which is 3 hours after GMT
epoch = Time("2022-11-14T11:10:42",scale="utc")
epoch = epoch - TimeDelta(3*60*60, format='sec')
h = Angle(np.arcsin(-np.sin(A.rad)*np.sin(z.rad)/np.cos(dec.rad)),unit=u.rad)
print ("Hour angle is ", h.deg)
LAST = h + ra
GAST = epoch.sidereal_time("apparent",longitude=0)
lon = LAST - GAST
print ("Longitude is ",lon.deg)
```

```
66d47m22.6s 53d06m34.5s 279d25m15s 38d48m27.2s
Hour angle is  -70.60936622452317
Longitude is  32.7236443373677
```