SNTC

S.T.A.C IIT Mandi

# K.P.L. AstroThon

## Problem Statement

### 1) STAR Party!

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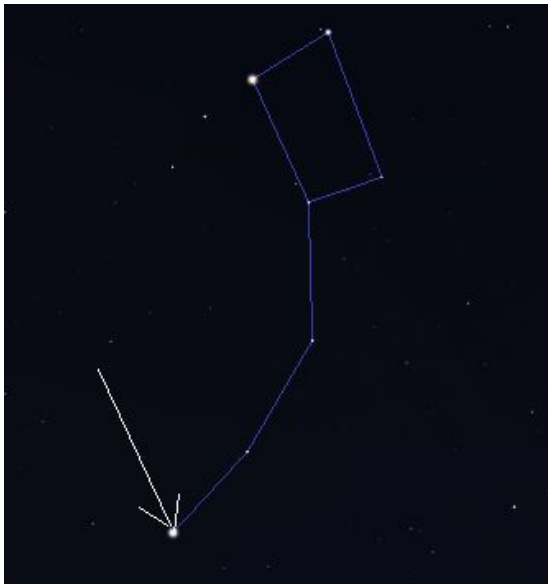
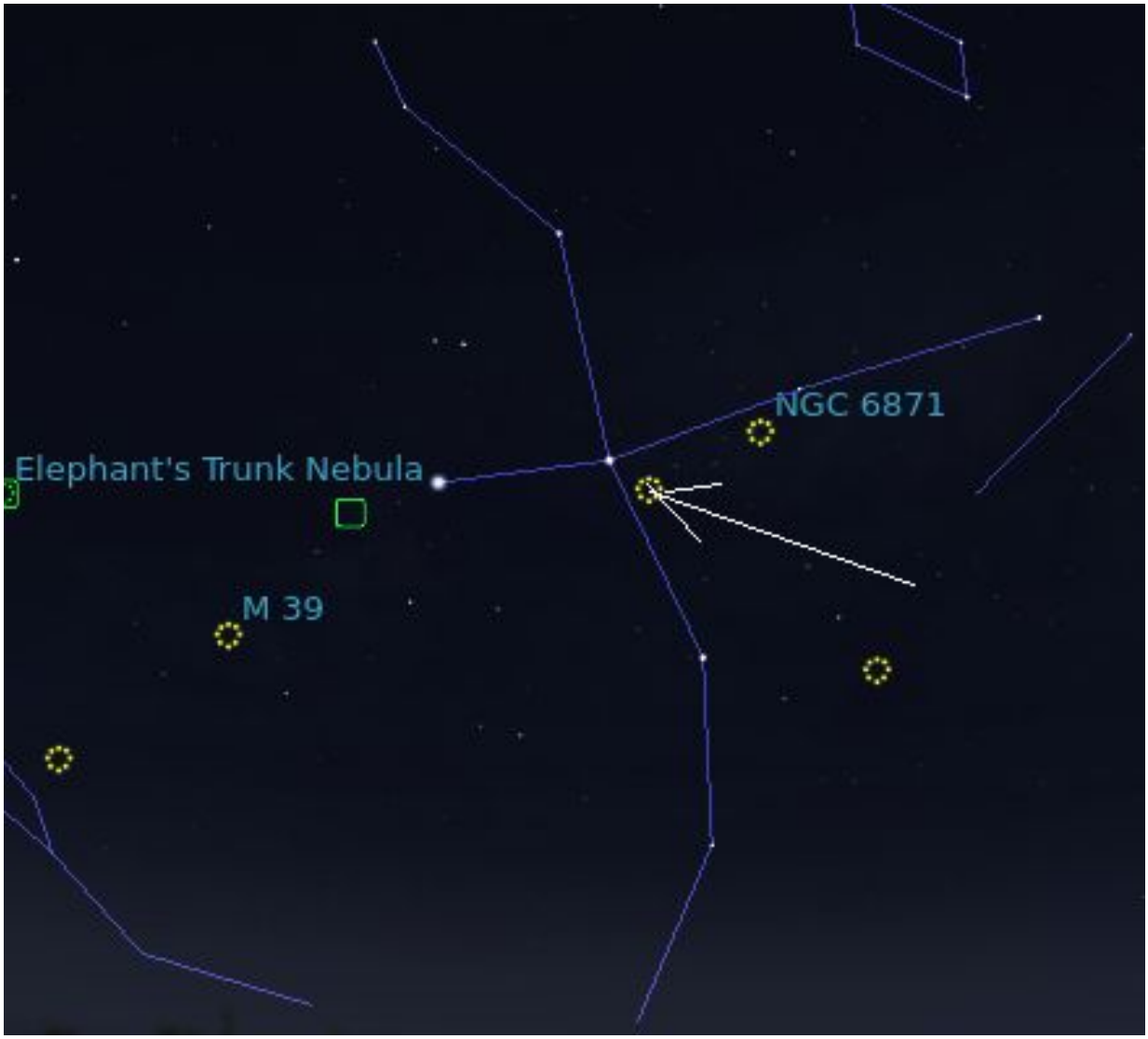
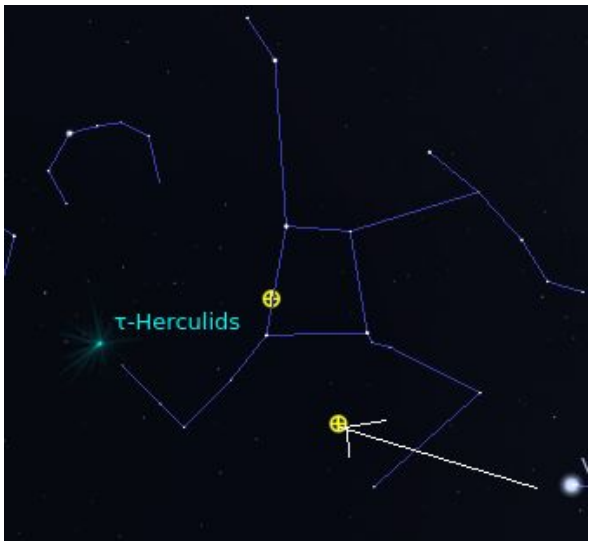
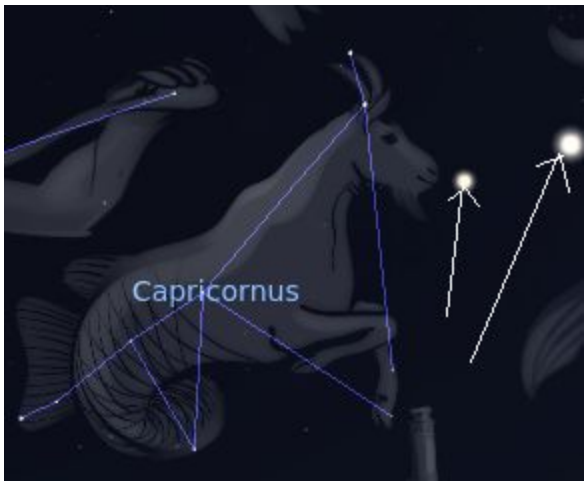
Seven Images shown below contain constellations which are visible in the summer sky of India. Name the indicated planet/star/messier objects. (2+2+2+2+2+3+2 = 15 marks)







## 2) Dark Future

According to the Hubble's Law, our universe is expanding. Extragalactic objects are moving far away from us and in the far future, they would be so distant that even their light won't reach us. We won't be able to see them and thus our Future is in Dark. Recessional velocity is defined as the rate at which an extragalactic astronomical object recedes away from an observer as a result of Universe's Expansion. Find the proper distance of a Galaxy using its recessional velocity. (10 marks)

*Assume the object's peculiar velocity be 0. Ignore time dependency of Hubble's constant, take it as 71 km/s/ (Mpc); Mpc is Million Parsec. The function shall take recessional velocity of the galaxy in km/s as input (in float) and return its proper distance (in light years).*

## 3) SpaceZ Satellites

SpaceZ is deciding to launch 100 satellites to compete with GMaps. Let T be the time light takes to travel the distance between the Earth's surface and the satellite. You as a SpaceZ Engineer have to find the time delay of the Earth-Satellite system. It is defined as the nanoseconds gained by the satellite w.r.t Earth's clock due to relativistic time dilation effects in a duration of T.

*Mass of Earth* = $5.974\times10^{24}$, *Speed of Light* = $2.998\times10^{8}$, *Gravitational Constant* = $6.674\times10^{-11}$, *Radius of Earth = 6,357,000 (all in SI units). You have to come up with a function which will have only the radius of satellites (in m from centre of earth) as input. The function should give the time delay (as float) in output.* (15 marks)

## 4) Saturn Rings

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It has been so long since you enjoyed looking at beautiful Saturn Rings through the STAC's telescope. Luckily tonight you are at campus with one scope on SAC terrace near Gravity (STAC Room) so you decide to make observations till tomorrow morning. You know due to mountains you can't see anything which is below a certain altitude At0.

*Assume elevation of SAC terrace = 1000m, At0 = 20 degrees. Find the start time and end time of Saturn observation. Also make a function which would return (Altitude, Azimuth) tuple for Saturn given time of observation. Note: time here should be instance of python `~datetime.datetime`.*

`(2+3+5 = 10 marks)`

## 5) Scrapers for Astronomy

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Astronomy is a big data generator; some observatories generate data at a rate 100 times more than current internet traffic. Astronomers need ways to query the data archives, download files and view them. You are one of the computer scientists at XRT (X-Ray telescope). A primary purpose of the XRT is to observe the generation, transport, and emergence of solar magnetic fields. You have to come up with 3 functions; `query`, `get` and `view` for XRT fits files.

*Directory containing all files: [http://solar.physics.montana.edu/HINODE/XRT/QL/syn_comp_fits/](http://solar.physics.montana.edu/HINODE/XRT/QL/syn_comp_fits/) The files are in format `XRT_{typeof_file}_{yyyymmdd_HHMMSS}.{n}.fits` where n can be any digit. Implement a class initializing objects using three arguments, typeof_file (a string), start time and end time. All times are instances of python `~datetime.datetime` and has three functions as described below:*

1. `**query**` should return the url of all matching files.
2. `**get**` should download all queried files and return a list of paths of file location.

3. `**view**` should take the argument file_path (a string) and show an image contained in its file. There is data in all files which can be retrieved as a numpy array. The image should be in gray colormap. `(10+5+10 = 25 marks)`

## 6) Lydra Weapons

### Lydra, a terror group has a secret base on the top of Mt. Everest. From the summit, they are firing special cannonballs to various international cities. You hacked into their system and got the launch velocities of all 100 balls. But soon you lose access and can't get the names of target cities. Can you help international authorities to know the location of potential cannon strikes so that evacuation of defense measures can be planned?

*Ignore the effect of Earth Rotation, relativistic effects. Assume that cannonballs don't experience air resistance. Let V be magnitude of velocity in m/s, Al be the altitude of strike and Az be the Azimuth angle of strike (all angles in degree). Come up with a function which takes V, Al, Az (all floats) as input and returns a tuple of (latitude, longitude) of strike location.* `(25 marks)`