# Inter IIT Tech Meet 2018

Star Cluster Identifier

December 18, 2018

## 1 Rules of the Great Game

- Using internet is allowed, but you will be disqualified if found using any medium of communication. **Phones are not allowed**.
- You may use standard packages and softwares like numpy, pandas, astropy, matplotlib and scipy for data handling and plotting if required.
- Your answers will be given credit on two criteria (The exact objective marking scheme will be provided after the event) -:
  - ◇ The offset of your answer from the actual answer; some questions/sub-parts will be graded on a binary scheme.
  - ◇ Some credit is assigned for crucial data preprocessing steps in relevant questions.
- You need to submit your answers through a google form. The link to the google form and the dataset will be given at the start of the competition. Do have a close look at the form to make a note of the quantities you are expected to calculate and submit for every question!
- Comment your code in brief. Display your calculations and approach through the code, since it determines some part of the credit.
- The most important of all, have fun! :D

## 2 The Final Problem

You have been given a dataset for a globular cluster at a distance of 10.4 kpc from the solar system. The columns of the data are explained in the header of the text file. Read the dataset description very carefully. Throughout this problem you may assume a Kroupa (2001) Initial Mass Function (IMF) for single stars to calculate the distribution of stars w.r.t mass, a mass-luminosity relation $L \propto M^{3.8}$, and $M_{606W,\odot} = 4.66$ (Magnitude of the Sun ($\odot$) in 606W band) and assume the magnitude in $F_{606W}$ band to be its bolometric magnitude (i.e. ignore bolometric corrections and extinction). Ignore the stars fainter than $m_{F606W} = 22$.

**Please note that the photometry of faint stars isn't precise, hence it is important to limit the range of magnitudes and color indices for real stars. Use the dataset to find the appropriate limits to make data interpretation easier.**

1. Calculate the half-light radius of the cluster. Consider only the stars with probability of membership greater than 90%. Report your answer in light years [15 pts]

2. Estimate the age of the cluster from its turn off point. Assume that the time spent by a star in the main sequence phase is proportional to ratio of its mass and luminosity. The main sequence lifetime of sun is 10 billion years. Report the turn off point magnitude as well as the estimated age of the cluster [20 pts]

3. Based on the number of sub-giant stars in the cluster, estimate the timescale between main-sequence turn off and the beginning of the red giant branch. To estimate this timescale, you may like to proceed in the following manner. [35 pts]

   - Estimate the stellar density constant $\xi_0$ of the given IMF for this cluster
   - Derive the expression for the lifetime of a star in sub gaint phase depending on the number of sub-giant stars, $\xi_0$ the turn off luminosity.
   - Find the number of stars in the subgiant phase, and use all these three results to estimate the sub-giant timescale.

4. X-ray observations of this cluster bring to light quite a few prominent X ray sources. Find the optical counterparts corresponding to the given 2 X ray sources in the cluster. The RA Dec and Error Radius are all in degrees. [30 pts]

| S. no. | RA° | Dec° | Error Radius° |
|---|---|---|---|
| 1 | 205.5407 | 28.3798 | 1e-4 |
| 2 | 205.5729 | 28.359 | 4.4e-4 |