Department of Physics and Astronomy

University of British Columbia

Astronomy 205:

Assignment 2: Due February 4 2019 before class in ASTR205 Box outside Henn 312

An Introduction to Gaia Data

Gaia is an astrometric satellite that is providing superb data on almost 1.3 billion stars in our Galaxy. The satellite is still taking data and will do so for several more years. In April 2018, Gaia released their largest set of observations to date (Data Release 2), and in this assignment we will be examining a subset of these data.

Download the data file from the course website: ass2_data.npy. This file contains Gaia data for stars within a rectangular field located in the plane of the Milky Way in the direction of the constellation Gemini.

The columns in the data set are: RA (in degrees), Dec (in degrees), parallax (π in milliarcseconds), error in the parallax (in milliarcseconds), proper motion in RA (in milliarcseconds/year), proper motion in Dec (in milliarcseconds/year), g magnitude, and b-r colour (blue – red).

1. Plot x = (RA-centre(RA))*cos(Dec) vs y = Dec-centre(Dec) for all the stars, where the centre of the field is at centre(RA)=92.225 deg, centre(Dec)=+24.333 deg. Explain why plotting RA vs. Dec alone will produce a distorted-looking field. You should see a dense clump near the edge of your image.

2. Plot the proper motions of the stars in the field. You will need to zoom in to the central distribution, giving your plot a scale of around 10 milliarcseconds/year on each axis. A broad, wide clump should be seen, and this is composed of the Milky Way field stars. Clusters will be seen as tighter distributions in proper motion space, as all of the stars are moving together. Record the approximate mean proper motion of any clusters seen.

3. Define circular regions in proper motion space in which any clumps reside, and use these circles as cuts to separate cluster stars from the Milky Way. Plot the (x, y) locations of stars that satisfy your proper motion cuts.

4. Use the parallax data to compute distances for each star in each clump. Make a histogram of the results. Any real clusters should have a somewhat Gaussian peak, with some Milky Way contamination, which will depend on your prior restrictions to the data set. Estimate the location of the peak and approximate width, and use this to compute a mean distance and a cut in parallax. Plot the

locations of the stars that remain after applying your cuts for both distance and proper motion. There will still be some contamination from the Milky Way, but it will now be greatly reduced.

5. Based on their relative proper motions and distances, do you believe that the clusters you found are related? Explain.

6. Create a color magnitude diagram of Absolute G Magnitude vs. b-r colour, and plot all clusters you have identified on it (each with a different colour). It is fine to assume that all stars reside at the mean distance to the cluster when computing absolute magnitude, as the variation in parallax for a single cluster at these distances is primarily driven by uncertainties in the measurements, and not a physical distance range.

7. Based on the color-magnitude diagram you have created, what is the oldest cluster in the field? What is the youngest? Explain how you know this.