Identifying ATLAS stream members with a Baysian mixture model

Goal: Identify a list of high probable member stars using proper motion from Gaia and velocities and metallicities from S5. And compare with the results in Li et al (2021) paper for comparison.

Step by step instruction:

1. Select all the stars in ATLAS stream observed by S5 and make proper quality selection to get stars with good velocity measurements.
2. Transform the stars in stream coordinates (phi1, phi2)
3. Convert heliocentric velocity to Galactic Standard of Rest (GSR).
4. Obtain the member stars of ATLAS stream from Li et al (2021) and try to reproduce Figure 2 in the paper, highlighting member stars in Li et al (2021).
5. Build a mixture model
    a. Only select stars with metallicity [Fe/H] < -1.5. Other data cleaning might need to be done too, e.g. some cut in proper motions and velocities.
    b. The model should be built based on 3 measurement quantities, velocity (in GSR), pmra, pmdec.
    c. The model should contains one component for ATLAS stream, one component for the background.
    d. The ATLAS stream component should contain a mean and intrinsic scattering for each measurements, and the mean is a function of phi1. You can try either linear or quadratic form.
    e. The background could start as a uniform background.
    f. Note1: Think about, how many parameters do you have in total in this model, and why? What are they? Choose the parameter range wisely.
    g. Note2: Ignore the covariance matrix for now between pmra and pmdec
6. Use parameter optimization and MCMC to find the best fit parameters for the mixture model -- this might take a good chunk of computing time and you may start with a small number of steps. You also want to see if your parameters converge or not.
7. Use the best fit parameter, calculate the membership probability of each stars in the ATLAS field.
8. Plot the high probably members again in the Figure in Step 4, and compare with the members selected in Li et al (2021).