Astronomy 5830 – Observed Properties of Astronomical Systems

Autumn Semester 2017

Homework #3 – Due October 30, 2017

Complete this problem set in a `jupyter` *notebook with sciserver.org, then print out and hand in your notebook. You should annotate your work as needed to explain what you have done, as well as to comment on your results.*

1. The Galaxy and Nearby Galaxies: This series of questions is designed to give you more familiarity with the observational properties of the Milky Way and nearby galaxies, and how those properties are determined.
    a. What RA and DEC correspond to the North Galactic Pole (b=90°)? The Galactic Anti-Center (l=180°, b=0°)? Note that you could (but are not required to) use `SkyCoord` in `astropy.coordinates` to compute this in your notebook.
    b. Identify a sample of stars from APOGEE near the NGP that have well measured [α/Fe] and [Fe/H]. Describe the choices you make to select this sample, such as choice of area to determine sample size and requirements on data quality. *Hints: You will need to combine data from more than one APOGEE table, and you should use DR13 and the Schema Browser to choose the columns to select in your SQL query. Also, Hayden et al. (2015) is a good reference for selection criteria.*
    c. Create a figure that shows [Fe/H] vs. [α/Fe] for stars in the region of the NGP.
    d. Identify a sample of stars that are toward the Galactic Anti-Center, and create a figure that shows [Fe/H] vs. [α/Fe] for these stars and those in the NGP (use different symbols or contour colors). Comment on the differences between the populations.
    e. Identify a sample of galaxies from SDSS near the NGP that have good redshift measurements and photometry. Describe the choices you make to select this sample. *Hint: Look at figure 1 and the accompanying text in Blanton & Moustakas (2009).*
    f. Create a figure that shows M_r vs. g-r for these galaxies and comment on the distribution of galaxies in the figure.
2. Galaxy Surface Brightness Profiles. Download the data file peletier.dat from the class website. This file contains a K-band surface brightness profile of NGC4486 (M87) from Peletier's Ph.D. thesis (1989, University of Groningen). The two columns are radius in arcseconds and K-band surface brightness μ_K in K mag arcsec^{-2}.
    a. Plot the surface brightness profile in mag arcsec^{-2} as a function of radius.
    b. Fit a $R^{1/4}$ profile to the data using a least-squares fit. Plot your model on top of the observations. What are the best-fit values of Σ_e and r_e?
    c. Calculate the χ^2 parameter for the fit. Is the model a good fit to the observations?
    d. The typical 2.2μm sky level is 12.5 mag arcsec^{-2}. If the sky surface brightness were overestimated or underestimated by 0.5%, what effect would this have on the observations? Plot curves showing this effect and label each of them.
    e. Fit a Sérsic profile to these data, report the fit parameters, and comment on whether or not this is a better fit than then $R^{1/4}$ profile. Add this model fit to your plot from (b).