ZAH - Astronomisches Rechen-Institut
Galactic and Extragalactic Astronomy (MVAstro3) - Winter semester 2021
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Exercise Sheet #7
Submit by Friday 26-03-2021

Exercise 1. - The Tully-Fisher relation

In this exercise we will use publicly available spectroscopic data from the Sloan Digital Sky Survey (SDSS) in order to estimate the rotation velocities of a sample of galaxies in the Virgo cluster. Together with photometric information retrieved from the NASA Extragalactic Database (NED), this will allow us to derive an approximation of the Tully-Fisher relation.

(a) Go to `https://ned.ipac.caltech.edu/` and look up the coordinates of NGC 4216, NGC 4302, NGC 4402, NGC 4634, and NGC 4762. (5 points)

(b) Go to `http://skyserver.sdss.org/dr12/en/tools/chart/navi.aspx` and insert J2000 coordinates into the field of RA and Dec on the left of the page. Click on "search" to retrieve the image of the specified galaxy, and zoom in if needed. (5 points)

(c) On the left side of the page, under "Drawing options" there is the possibility of displaying objects whose spectra have been observed in the survey. If you select this option, several red squares should appear on the image. Clicking on the red squares, additional information will appear on the right-hand side of the page. In particular, if you click on the thumbnail of the spectrum, you will find the redshift z, from which you can derive the systemic radial velocity v_r. Find for each object two spectra at the opposite sides of the galaxy. (10 points)

(d) Calculate the rotational velocity of each galaxy. Try to take into account the inclination of the galaxies ($v_{\text{true}} \sim v_{\text{obs}}/\cos(i)$), although most of them should have $\cos(i) \sim 1$. (10 points)

(e) Go to the `http://ned.ipac.caltech.edu/forms/byname.html` and type the name of each galaxy in the field "Object Name", then click on "Submit Query". Click on the blue image and for each galaxy, search the total B(B_T^0)) magnitude in the table below the image. Then use Tully-Fisher relation for Sb galaxies (HINT: Lecture 7) and get the absolute magnitude using the rotational velocity. Then calculate the distance towards each galaxy and compare them with distances listed at the same URL. Finally convert the absolute magnitude into the logarithm of the luminosities in solar units (L_B / $L_{B,\odot}$), where $M_{B,\odot} = 5.48$ mag. Summarize your results for part c, d and e in a table. (20 points)

(f) Use your data to produce a plot of $\log L_B$ vs $\log v_{rot}$. Can you see the Tully-Fisher relation? Draw for comparison the best-fit from the literature $\log L_B = 3.42 + 3.09 \log v_{rot}$ (De Rijcke et al. 2007). (20 points)