Emission Lines with Marvin

July 27, 2017

The purpose of this exercise is to use Marvin to determine star formation rate (SFR) and star formation rate surface densities (SFRD) for a galaxy or list of them. It is strongly based on the emission line session during the Shanghai MaNGA School led by Christy Tremonti. Slides with information useful to solve the exercise can be found at `https://trac.sdss.org/attachment/wiki/MANGA/MaNGA/Meetings/Shanghai_Nov2016/SchoolMaterial/MaNGA_School_Emission_Lines_Slides.pdf`.

1. Using the tools or the web, run a query to select MPL-5 galaxies in which more than 20% of the spaxel have Hα flux greater than 25. Retrieve a list of plate-ifus. Hint: do check the documentation to find how to run that query.

2. Using Marvin web, explore a few of those galaxies until you find one that gives you a warm feeling and is relatively face-on.

3. If you are not able to make the query work, use Marvin web to select a face-on, star forming galaxy.

4. Using the tools, load the Maps object for your galaxy. Generate the BPT diagram for the galaxy using a S/N cutoff of 5 for Hα, 3 for [N II], and 1 for [O I]. If those cuts do not work for your galaxy, feel free to play with them. Confirm that your galaxy is star forming based on the plot of the diagrams. Retrieve the BPT masks.

5. Using the star forming mask, select all spaxels that are star forming. Using Marvin plotting functions, plot the Hα map masking out all the non-star forming spaxels.

6. Apply the star forming mask to the Hα and Hβ maps for your galaxy. Hint: consider using Numpy masked arrays. For each spaxel not masked out, calculate the dust attenuation-corrected Hα flux. As a reminder, the formula you need is $F_{\mathrm{H}\alpha,0} = F_{\mathrm{H}\alpha}\, 10^{\mathrm{k}(H\alpha)\, E(B-V)}$ where $F_{\mathrm{H}\alpha}$ is the measured Hα flux, $F_{\mathrm{H}\alpha,0}$ is the intrinsic (dust corrected) flux, $k(\mathrm{H}\alpha) = 2.468$, and the colour excess can be calculated as $E(B-V) = 0.934\ \ln[(F_{\mathrm{H}\alpha}/F_{\mathrm{H}\beta})/2.86]$. Check the MaNGA School slides for more details.

7. Calculate the Hα, dust-corrected luminosity as $L_{\mathrm{H}\alpha} = F_{\mathrm{H}\alpha}\, 4\pi D_L^2$. To get the luminosity distance, use Marvin to access the redshift of the galaxy. From there, you can use astropy or a web-based cosmology calculator. In addition to getting the luminosity distance, remember to also obtain the angular size distance.

8. For each spaxel, determine the SFRD in units of $\mathrm{M}_\odot\, yr^{-1}\, kpc^{-2}$. From Kennicutt's, SFR = $5.5 \times 10^{-42}\, L_{\mathrm{H}\alpha}$. Use the angular size distance to get the surface density. Remember that `BIN_AREA` gives you the area, in arcsec^2, of each bin.

9. Obtain the effective radius R_e for your galaxy (in a Maps for your galaxy, use `.header['reff']`) and use the `SPX_ELLCOO` map to get the radius in arcsec. Using both, determine R/R_eff for each spaxel.

10. Using matplotlib, plot SFRD vs R/Re. What can you say about your galaxy from that plot? Are the gradients smooth?

11. Repeat for as many galaxies as you want.

Some useful links:

- Marvin docs: http://sdss-marvin.readthedocs.io/en/stable/
- DRP datamodel: https://trac.sdss.org/wiki/MANGA/TRM/TRM_MPL-5/datamodel
- DAP datamodel: https://trac.sdss.org/wiki/MANGA/TRM/TRM_MPL-5/DAPDataModel