Galaxy surface brightness profile through photometric analysis

MSc - II Practical

I. Galaxy surface brightness profile

The surface brightness of a galaxy follows the Sérsic profile, and is characterized by the Sérsic index. It indicates how the surface brightness of a galaxy falls off as a function of distance from the centre. A few sample profiles are shown in the image below.

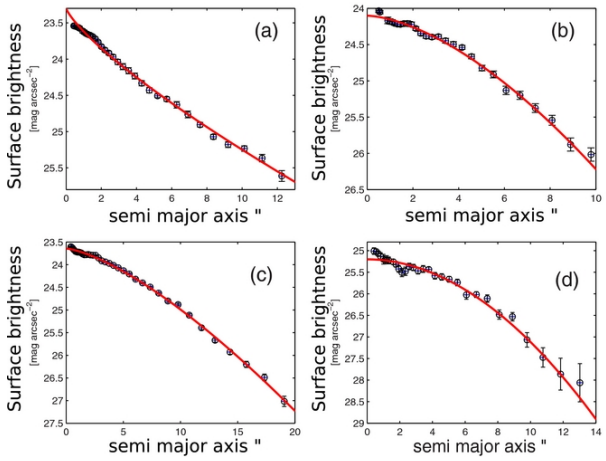

Figure 1: Surface brightness profiles of galaxies; Credit: Ludwig, Pasquali, et al. (2012)

II. Practical exercise

- The aim of this practical is to use Python to obtain the geometric parameters of a galaxy from its FITS image, use these to fit ellipses and thus obtain the surface brightness profile of the galaxy.
- This exercise will require the *astropy* and *photutils* packages in addition to *numpy* and *matplotlib*.
- Read the FITS image provided to you.
- Use the *EllipseGeometry* and *EllipticalAperture* functions, available in *photutils.isophote* and *photutils* respectively, to determine the geometric shape of the galaxy.
- The input parameters of the *EllipseGeometry* function are the central x and y coordinates, semi-major axis length, ellipticity and position angle. These input parameters should then be passed on to the *EllipticalAperture* function, and so that it can define a suitable aperture accordingly.
- For a particular set of input parameters of the *EllipseGeometry* function, observe the predicted aperture by making a plot.
- Vary the parameters till the most appropriate aperture is obtained.
- Now, use the FITS image data and the best-fitting geometric parameters as inputs to the *Ellipse* function, which is available within *photutils.isophote*.
- Use the *fit_image()* method to fit isophotes.

- All the data generated from the fit can be accessed as a table using *isolist.to_table()*, where *isolist* is the list of isophotes from the fit.
- Save the data in this table into an external data file for later retrieval.
- The first and second columns of this table/file correspond to length along semi-major axis, and intensity respectively. Make a plot of these two quantities, with the surface brightness axis normalized.
- Further, also make plots of ellipticity and position angle as a function of distance from the galaxy centre.
- In your results, list clearly the values of the geometric parameters used.

Figure 2: NGC 1199

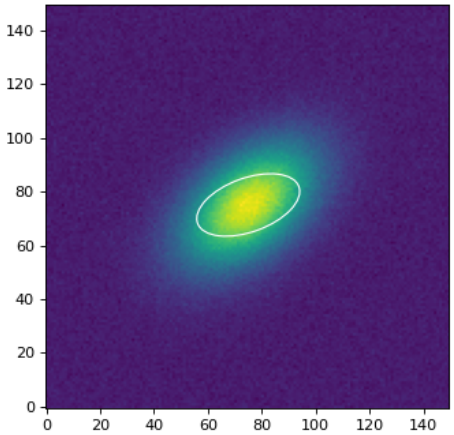

Figure 3: Fitting an ellipse

III. Reference

`https://photutils.readthedocs.io/en/stable/isophote.html`

***