# Informatics for Astronomers - WS2020

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# Exercise sheet 11 - Astronomical Data Analysis

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*The following will be also part of the assessment:*

*(1) Try to present exercises in a way that everyone can understand (even those who didn't do the exercises), so please explain the vital parts of your solution in a clear way.*

*(2) Try to also include some background information where applicable, and/or explain the possible context/motivation for the given exercise.*

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1. Describe the `astropy` project (origin, purpose, etc) as well as its most important components.
2. The `FITS` file `MACSJ0416_HAWKI.fits` contains a near infrared (*Ks*-band) image of the center of the cluster of galaxies `MACS J0416.1-2403` at $z = 0.4$. It was taken with the HAWK-I instrument at the VLT as part of the ESO contribution to the FrontierFields program).
   - Using the `astropy` library, load that file in python and show us the most important parameters, like image size and headers.
   - Display the previous image with `matplotlib` in a way that the objects can be distinguished by eye (by adjusting the contrast). Find the pixel with the maximum value and draw a circle around it. Finally save the image as a PDF file.
3. Do some statistics (mean, median and standard deviation) of the previous image using `numpy` statistical functions. Create an histogram of the pixel values and plot it with `matplotlib`.

   Now, using `curvefit` from `scipy.optimize` fit a Gaussian to the histogram values and determine the center (mean) and the sigma (standard deviation) from the fit. Discuss the differences with values derived by `numpy`.
4. Consider the data table `rotcurve.txt` provided with this exercise. It contains data for a rotation curve for a galaxy with columns `r` for radius, `vel` for velocity and the error in `vel`. Please read the file (with `astropy`) and plot that information (including the errors) with `matplotlib`.

What is the maximum rotation velocity of this galaxy? Try to determine it by fitting the following function to the data (but other ideas are also welcome)

$V(r) = \frac{2}{\pi} V_{max} \arctan(r/r_d)$,

where $r_d$ is the disk scale length, $\sim 5$ in this case, but can also be left as a free parameter.

5. The file `SDSS_spec_galaxy.csv` contains the spectrum of a star forming galaxy observed as part of the Sloan Digital Sky Survey. Load the spectra with `astropy` and make a plot with `matplotlib`.

   Knowing that the H$\alpha$ line at $\lambda = 6562.8$ `Angstrom` (restframe) is the most intense line in this spectrum, determine the redshift of this galaxy.

   Overplot now the redshift corrected spectrum.