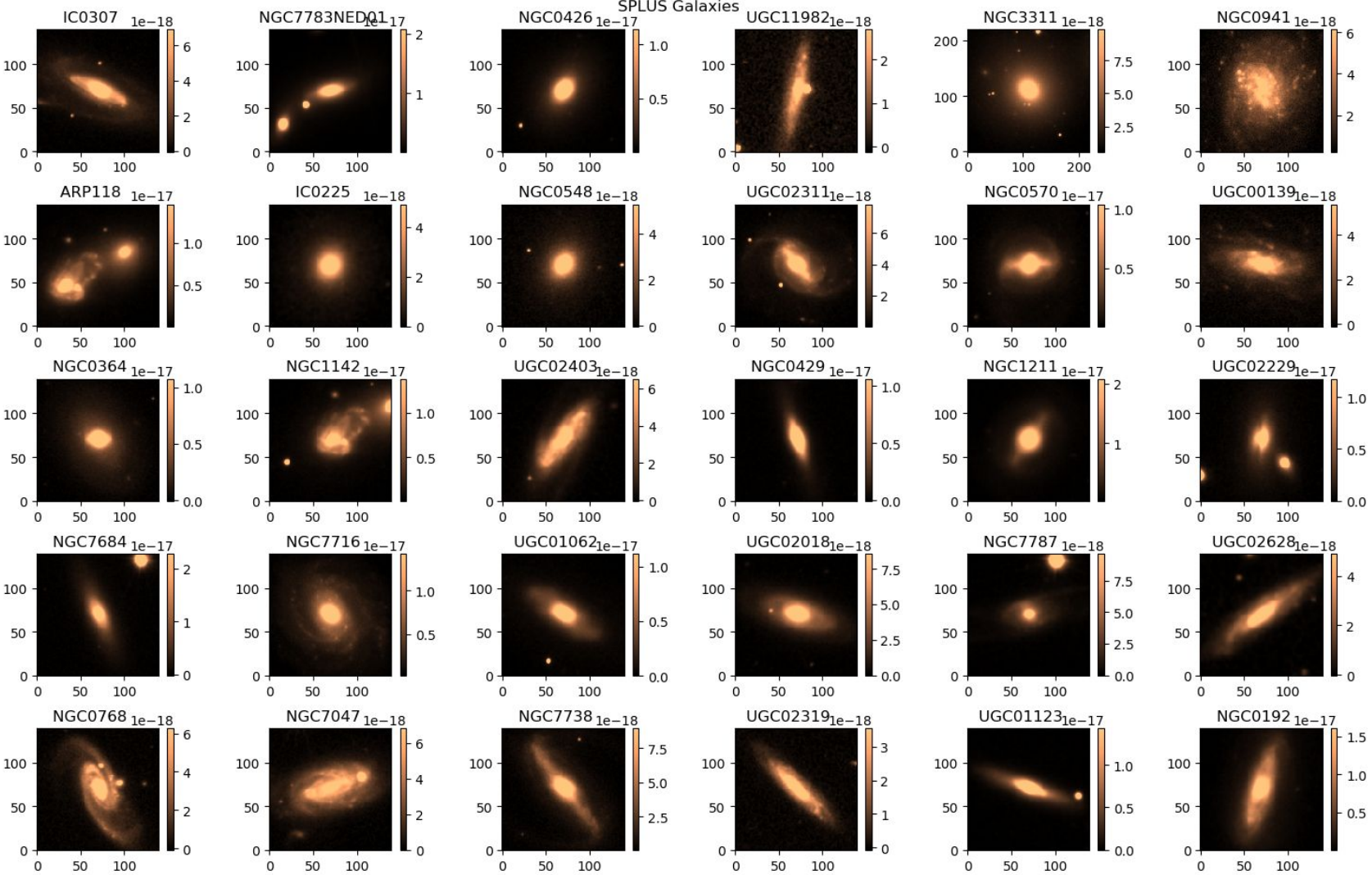
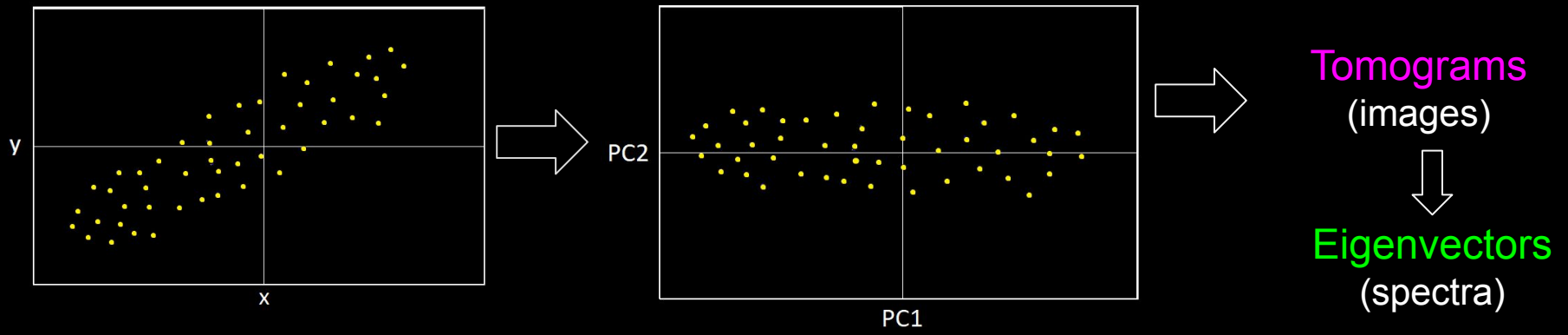
PCA tomography to analyze S-PLUS data cubes

Júlia Thainá Batista
Supervisor: Roberto Cid Fernandes


SPLUS Galaxies
IC0307
NGC7783NED01
NGC0426
UGC11982
NGC3311
NGC0941
ARP118
IC0225
NGC0548
UGC02311
NGC0570
UGC00139
NGC0364
NGC1142
UGC02403
NGC0429
NGC1211
UGC02229
NGC7684
NGC7716
UGC01062
UGC02018
NGC7787
UGC02628
NGC0768
NGC7047
NGC7738
UGC02319
UGC01123
NGC0192

PCA tomography



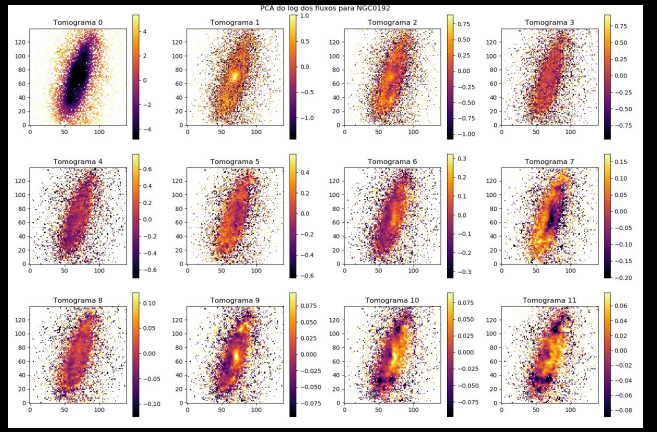
PCA (Principal Components Analysis) change the coordinates of the system by the variance (decreasing)

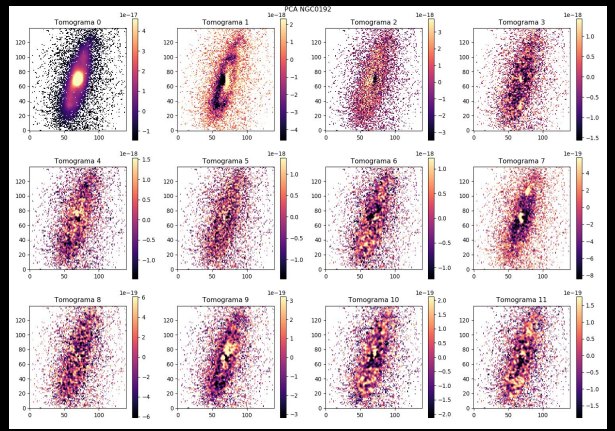
$$Flux = Flux_{mean} + PC_1 \times E_1(\lambda) + PC_2 \times E_2(\lambda) + PC_3 \times E_3(\lambda) + \ldots$$

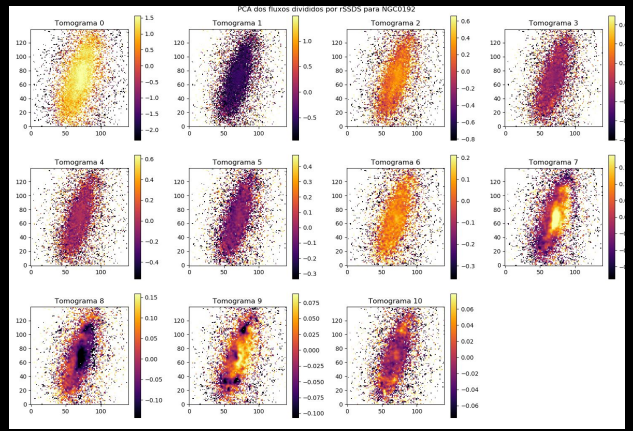
PCA tomography NGC0192

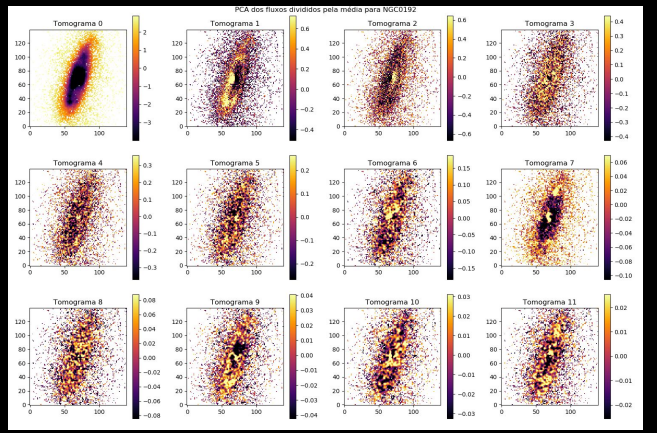
- **Normalization:**
  - mean flux
  - rSDSS filter
- **Scaling:**
  - log of the flux

➢ changing the variance ➡ different “flavors” of PCA









PCA tomography NGC0192

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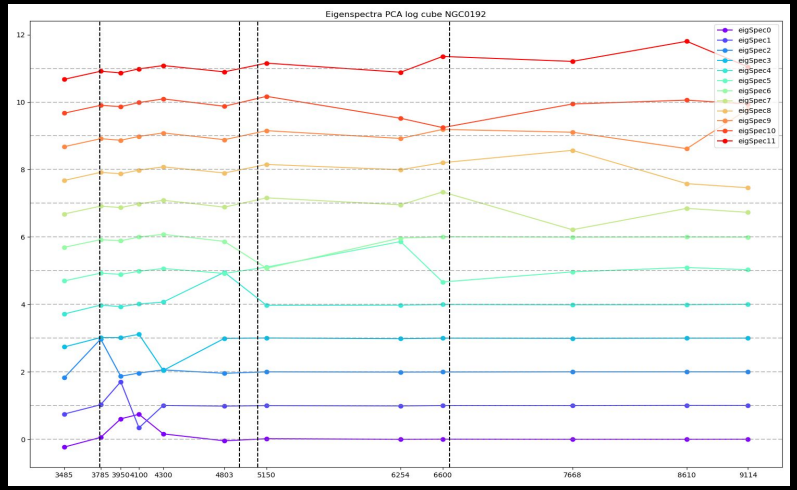
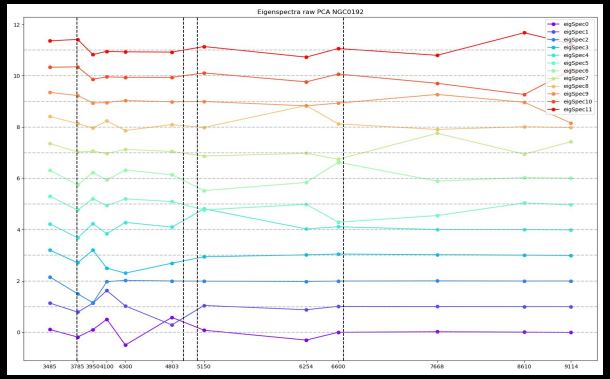
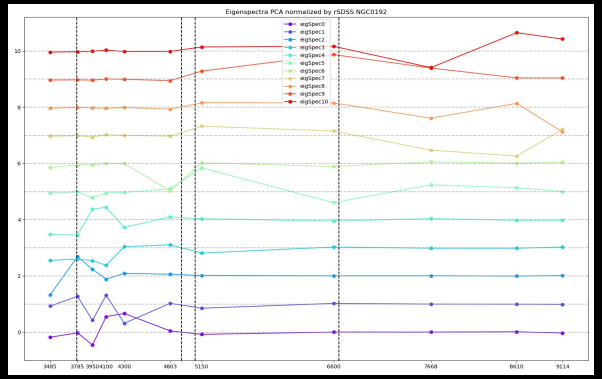
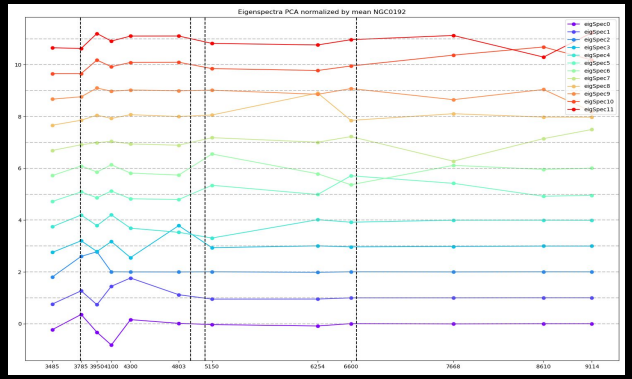




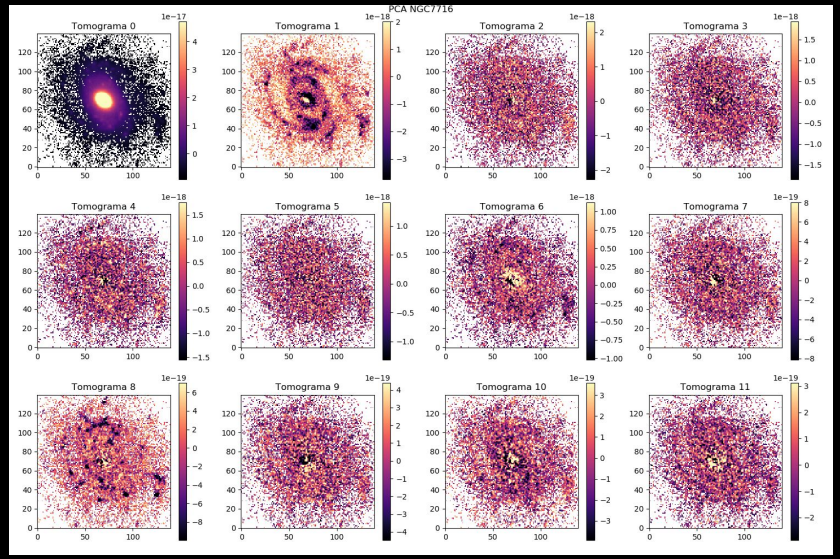




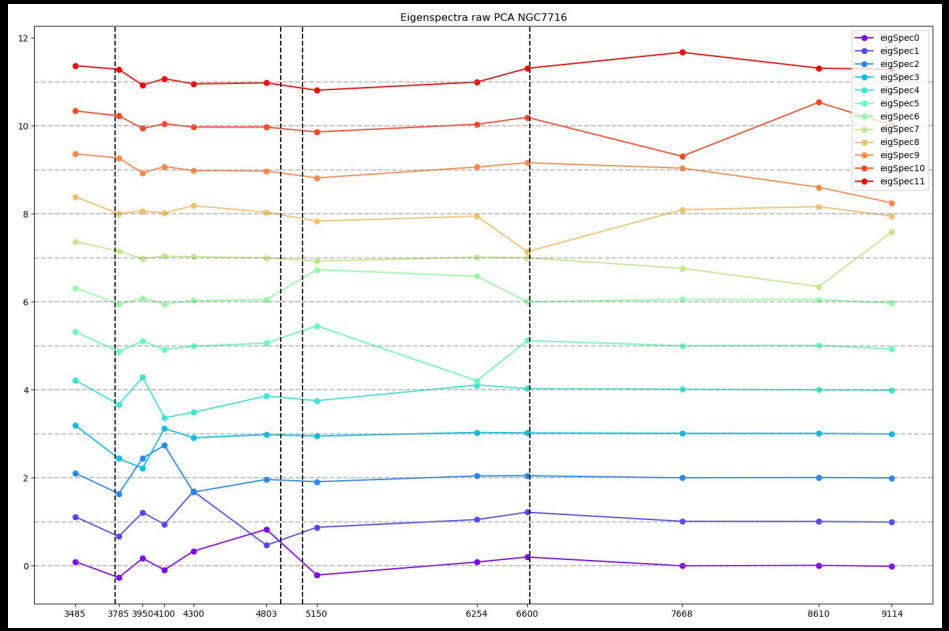
PCA tomography NGC7716

The tomograms + eigenspectra can emphasize features, extract noise, compress data ...

Tomograms - PCA cube



Eigenspectra - PCA cube



PCA Tomography: how to extract information from data cubes★

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appropriate choice of coordinates may help. PCA is a non-parametric analysis. This means that there are no parameters or coefficients to adjust that somehow depend on the users' experience and skills, or on physical and geometrical parameters of a proposed model. PCA provides a unique and objective answer. In the traditional scientific method, one formulates questions and looks to the data for answers. In this new strategy, PCA produces the answer; the user's challenge is to interpret the results. This process is not always difficult, but often plain of subtleties.

PCA has been used many times in the astronomical literature. For instance, Deeming (1964) used this technique to analyse and classify stellar spectra; this approach was improved by Whitney (1983). Applications to modern stellar spectroscopy can be found

It is important to note at this point that all emission with null variance across the spatial pixels (for a given wavelength or spectral energy) are incorporated into the mean and subtracted out. This is the case, for instance, for the sky emission that is constant over the field of view (FoV).

Now we organize the new data cube $I_{ij\lambda}$ (which has zero mean) into a matrix $\mathbf{I}_{\beta\lambda}$ of n rows (spatial pixels, referred to here as objects) and m columns (spectral pixels, referred to here as properties). Then β can be expressed as

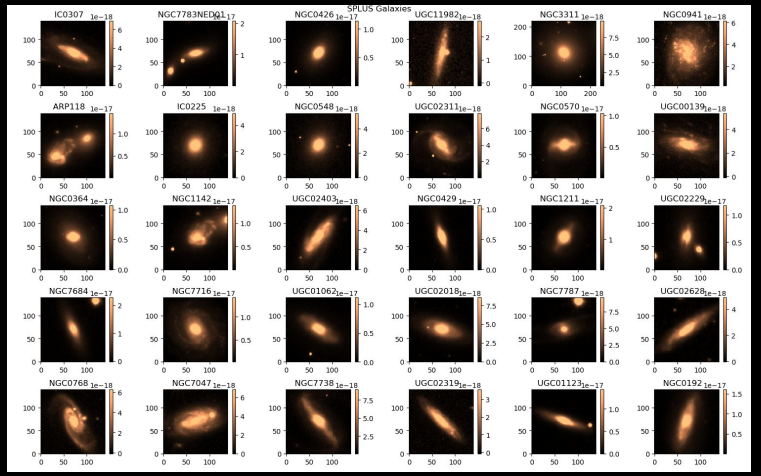
$$\beta = \mu(i-1) + j. \tag{3}$$

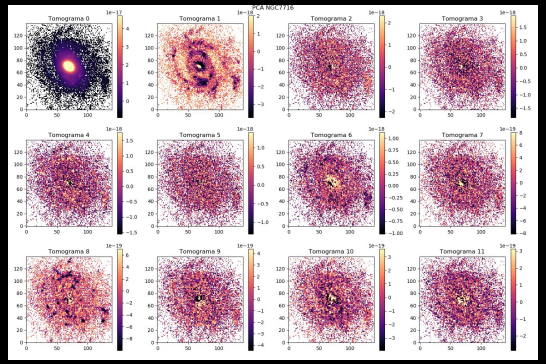
The data cube transformed into the matrix $\mathbf{I}_{\beta\lambda}$ will be the subject of the PCA Tomography method.

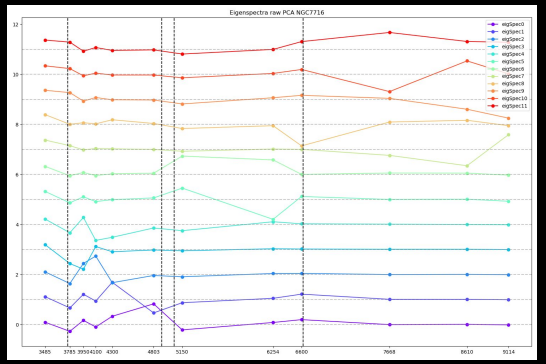
PCA tomography to analyze S-PLUS data cubes

Abstract

We present preliminary results of the application of PCA tomography to a set of 30 S-PLUS data cubes. Several different "flavours" of PCA are experimented with (with x without normalization, scaling, etc). The eigenspectra and corresponding images (tomograms) reveal interesting but hard-to-interpret features. To aid in the interpretation we plan to combine these results with those of the spectral fitting code AlStar.







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