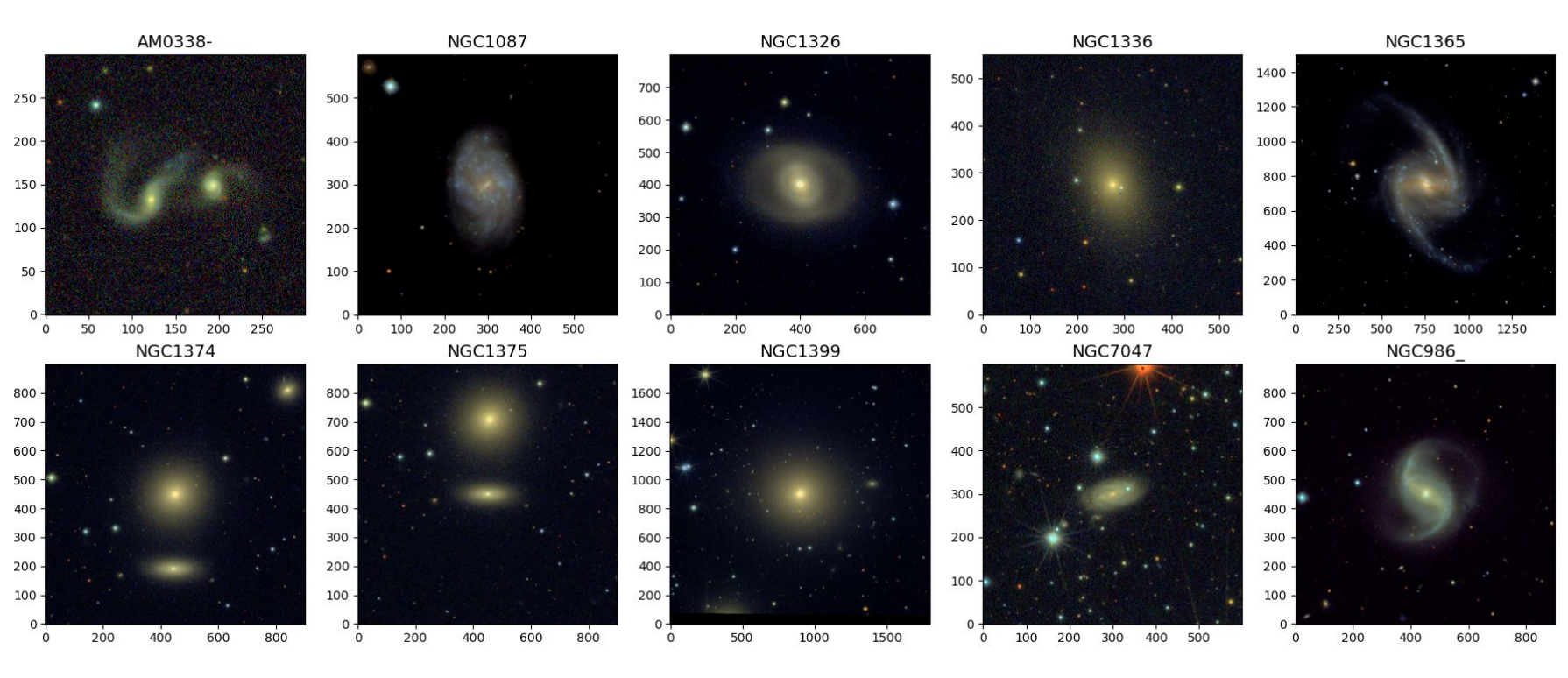
First experiments with S-PLUS galaxies data cubes

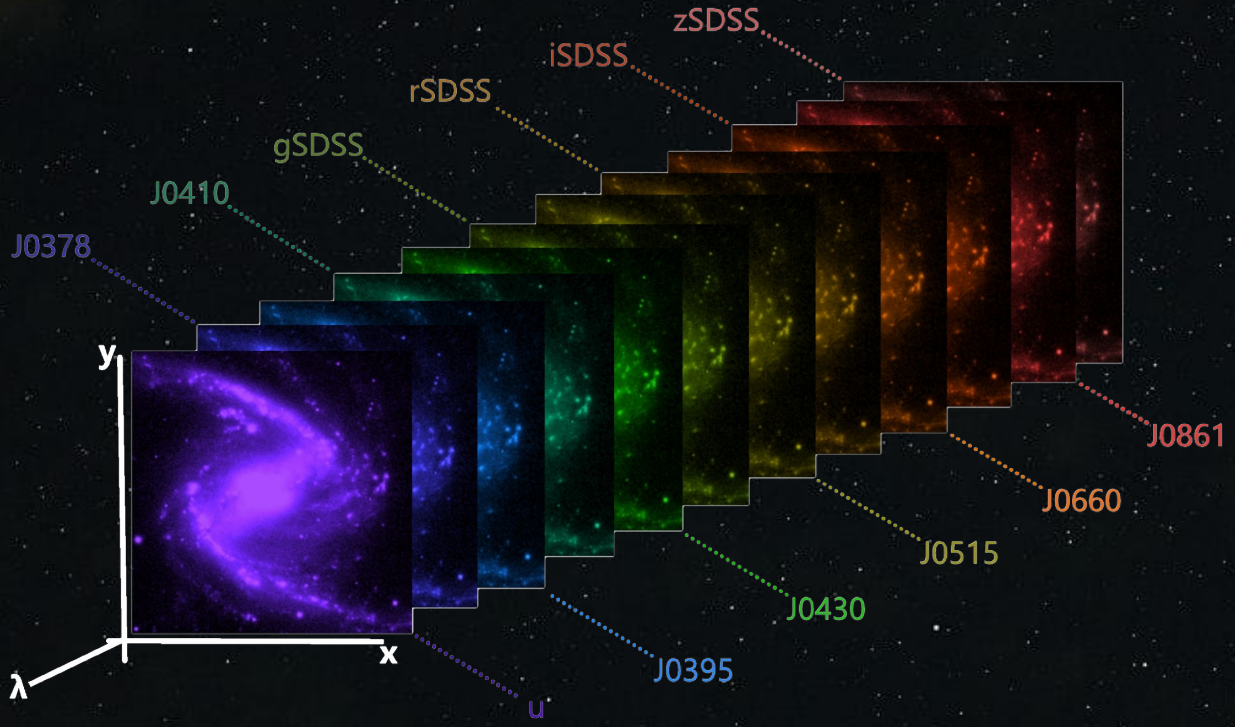
Júlia Thainá Batista
Supervised: Roberto Cid Fernandes

10 Galaxies



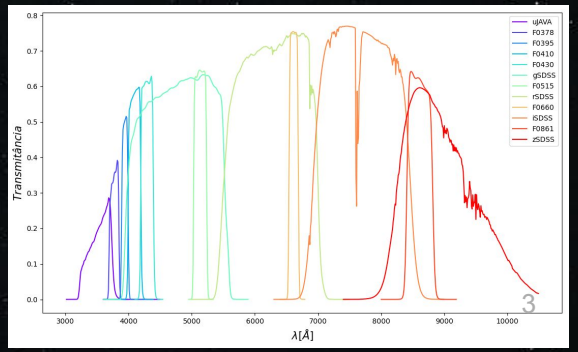
RGB from S-PLUS filters

J-PLUS data cubes

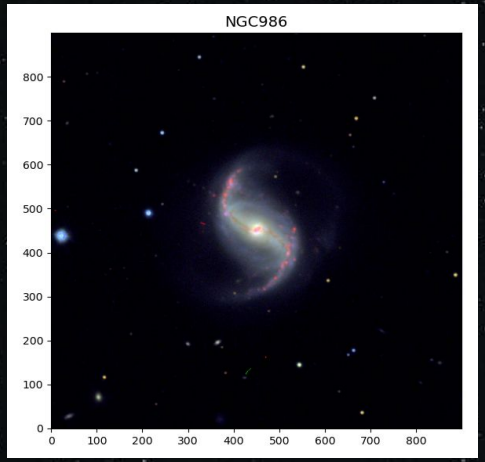


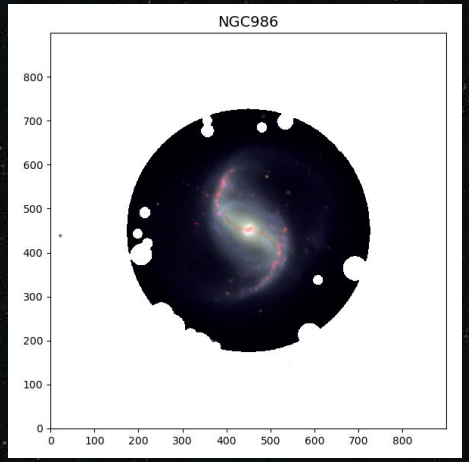
12 filters

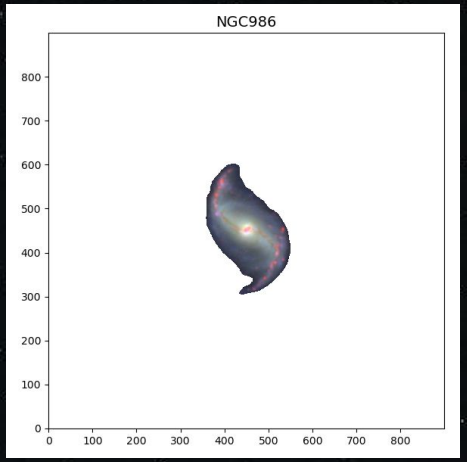
12 images



Masking the data NGC 986





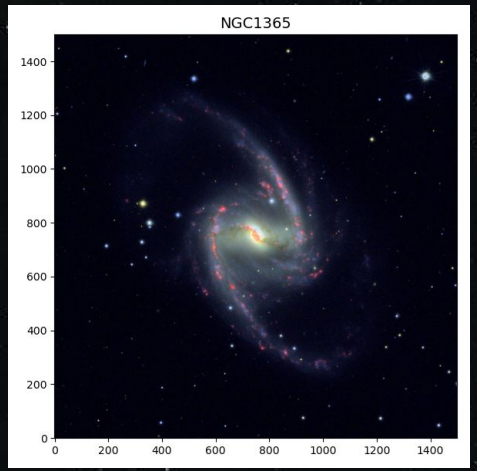


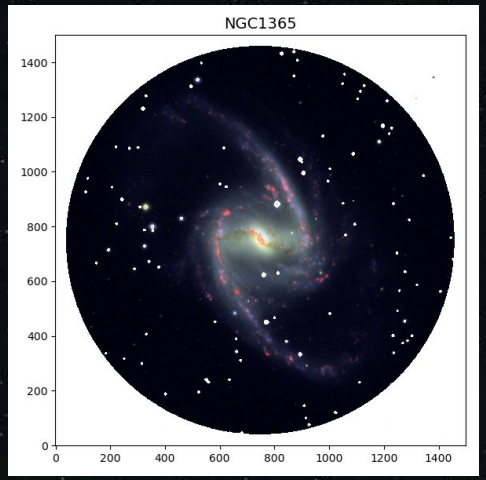
810 000 pixels

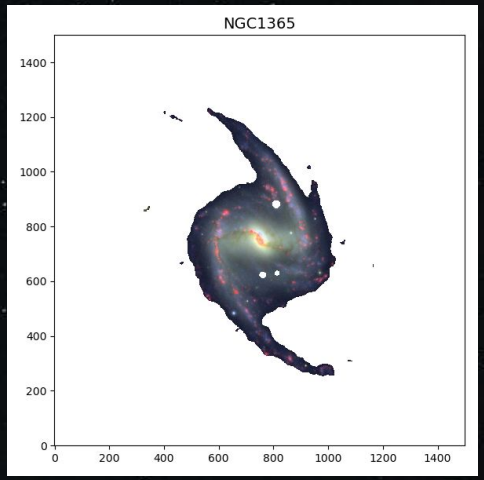
Reduction of 73%

223 645 pixels

Masking the data NGC 1365







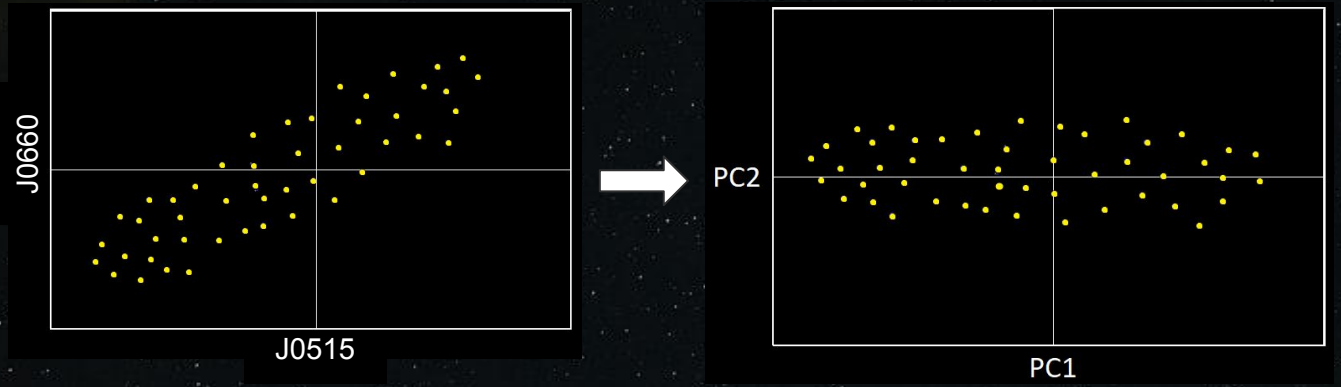
2 250 000 pixels

Reduction of 88.6%

255 327 pixels

PCA Tomography
Data
Mask
AIStar's Spectral Fitting

PCA Tomography



Tomograms
(images)

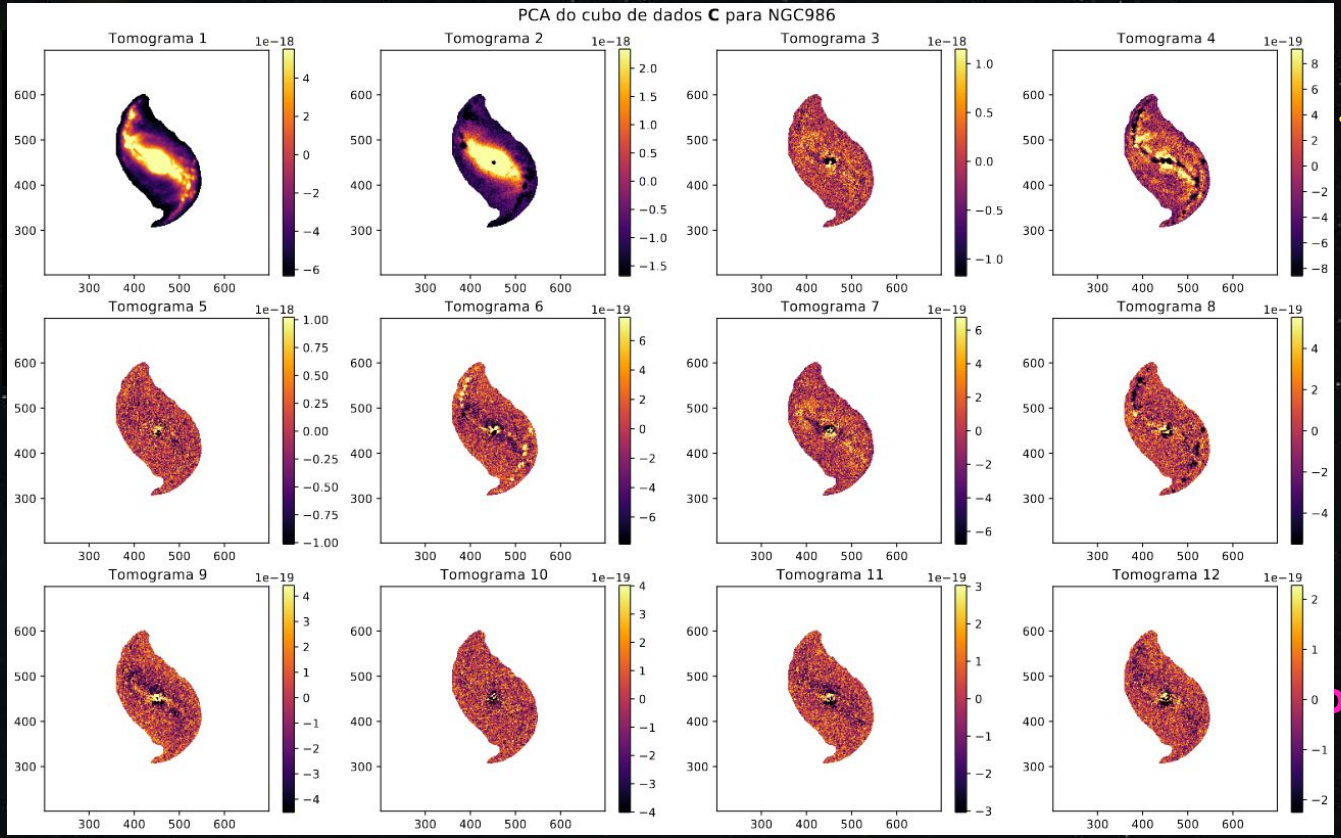
Eigenspectra
(spectra)

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

$$\text{Flux}(\lambda) = \langle \text{Flux} \rangle + PC_1 \times E_1(\lambda) + PC_2 \times E_2(\lambda) + PC_3 \times E_3(\lambda) + \ldots$$

(Tomogram) (Eigenspectrum)

PCA Tomography

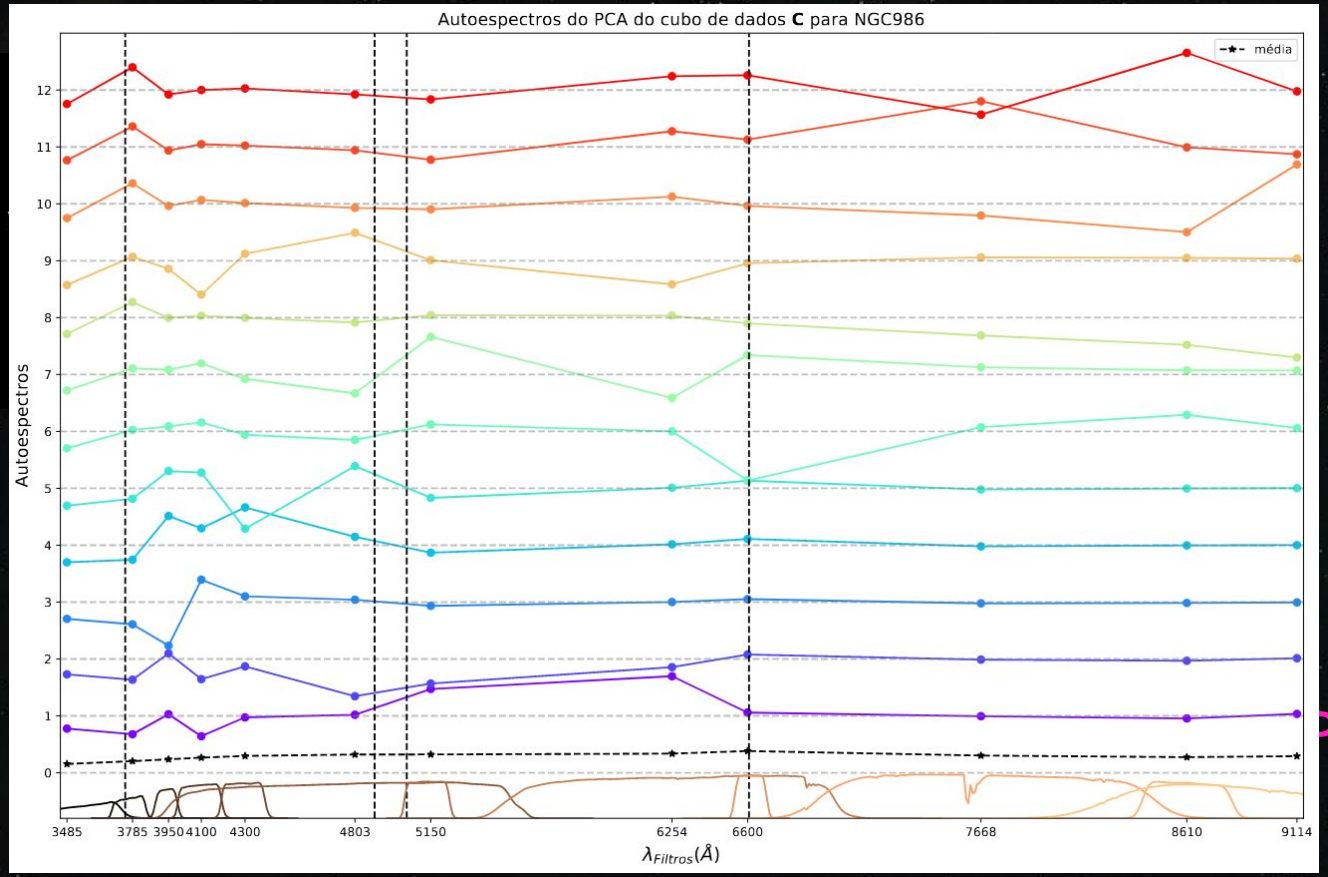


Tomograms
(images)

Eigenspectra
(spectra)

$PC_3 \times E_3(\lambda) + \ldots$

PCA Tomography



Tomograms
(images)

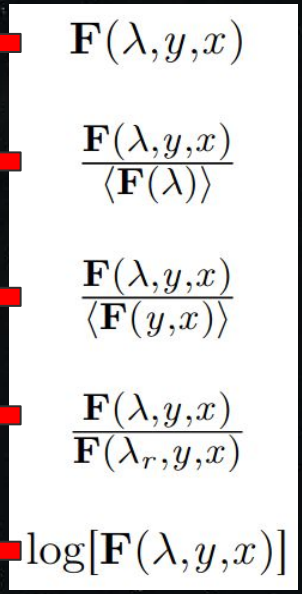
Eigenspectra
(spectra)

$PC_3 \times E_3(\lambda) + \ldots$

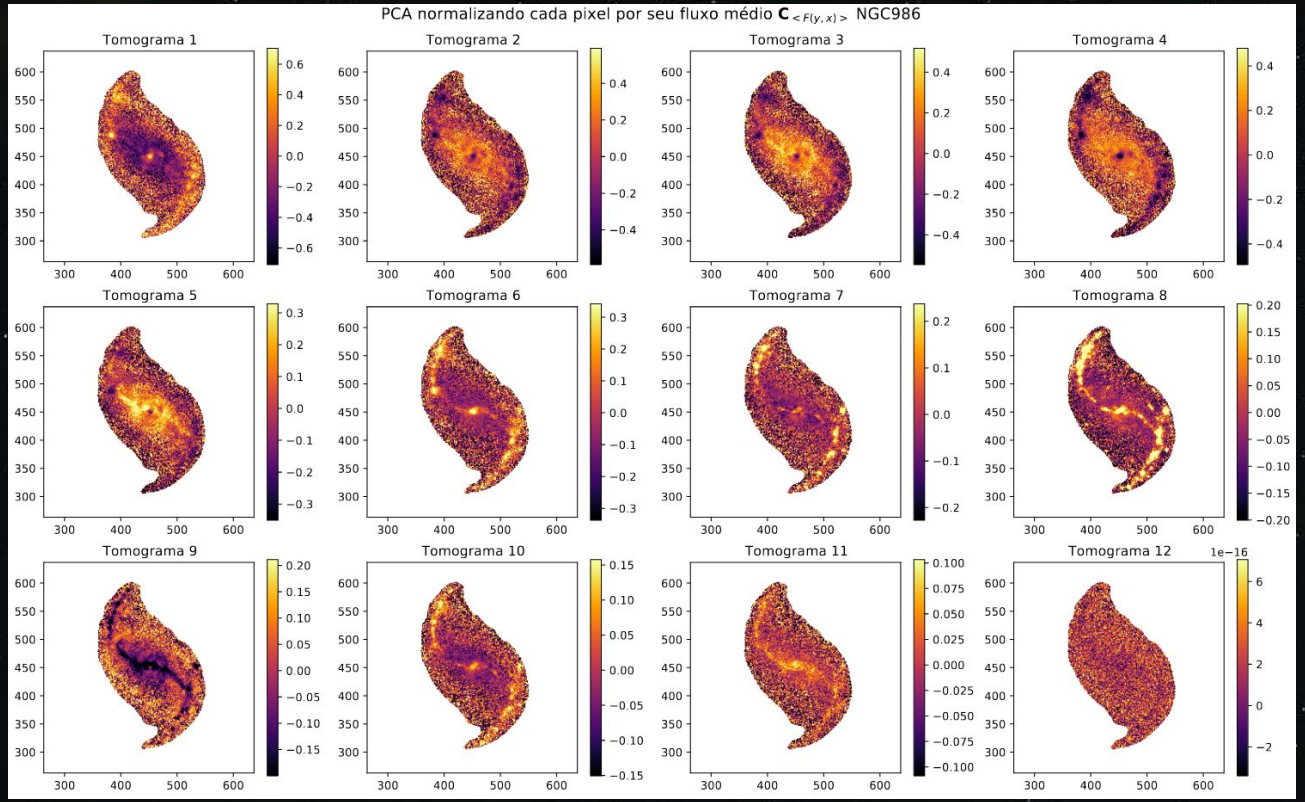
PCA configurations

➢ changing variance ➡ different results of PCA

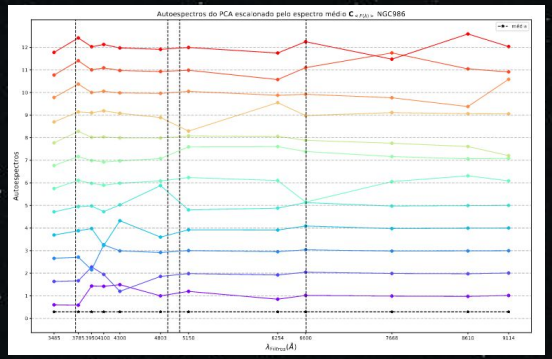
- PCA of data cube
- PCA scaled by the mean spectrum
- PCA normalized each pixel by its mean flux
- PCA normalized by the filter r
- PCA of log of the cube



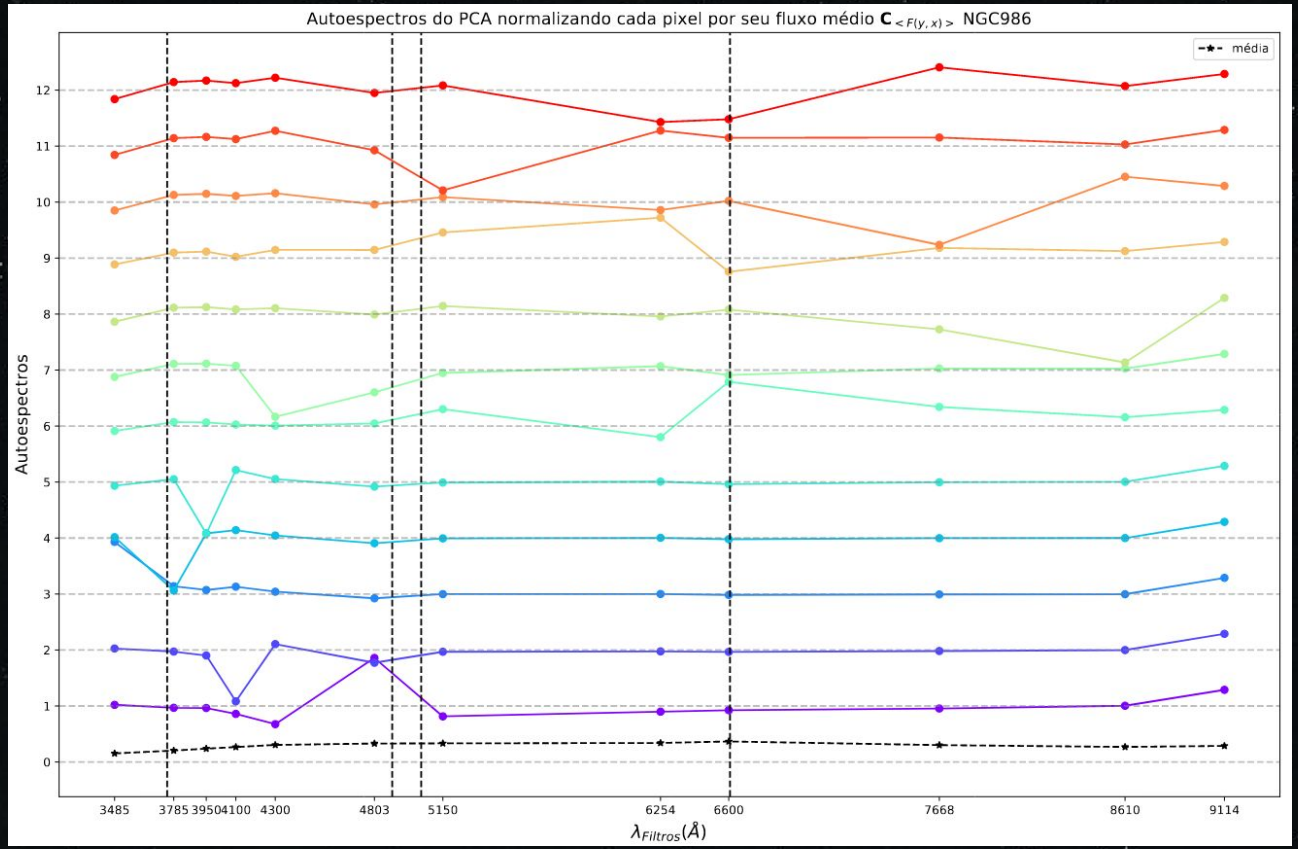
PCA normalized each pixel by its mean flux NGC 986



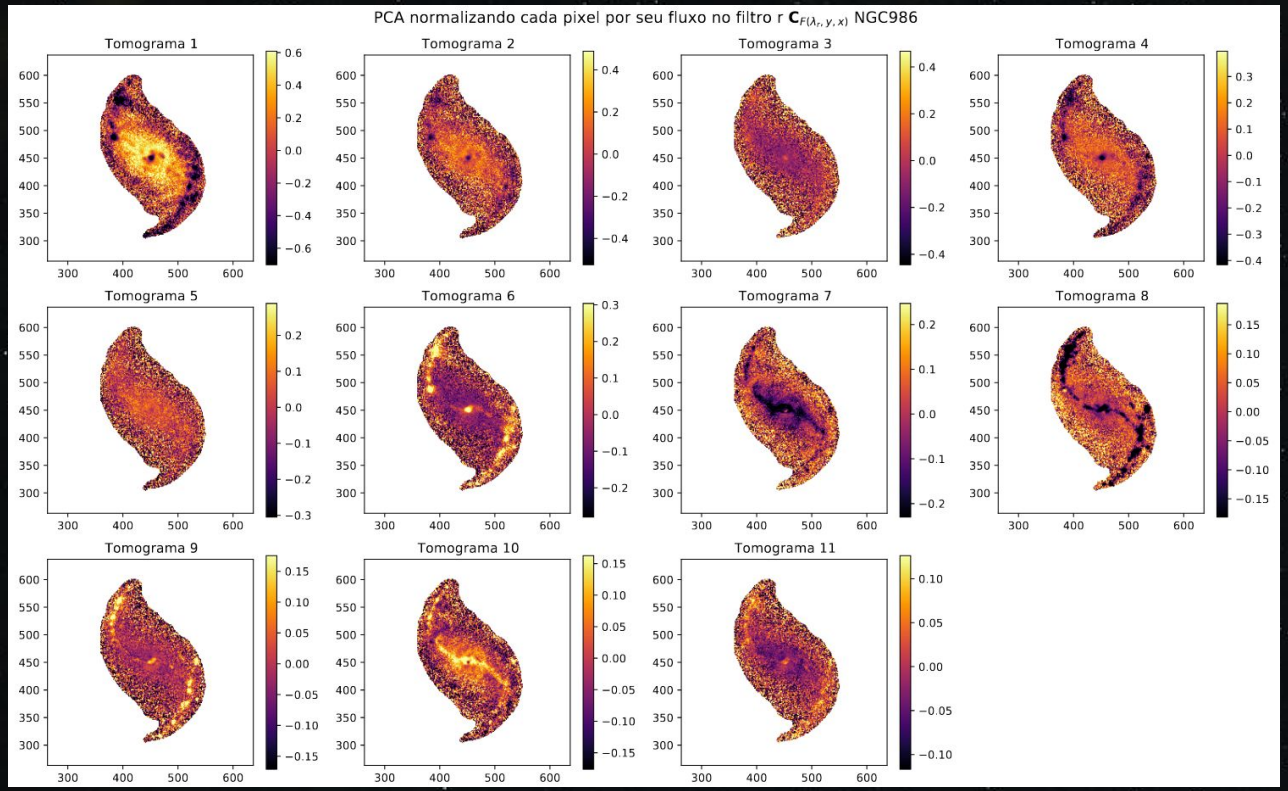
Eigenspectra



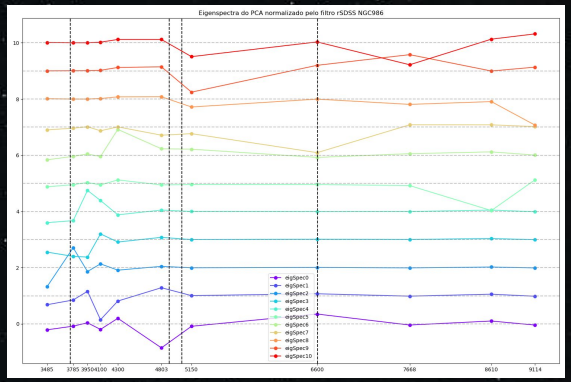
Interpreting the eigenspectra



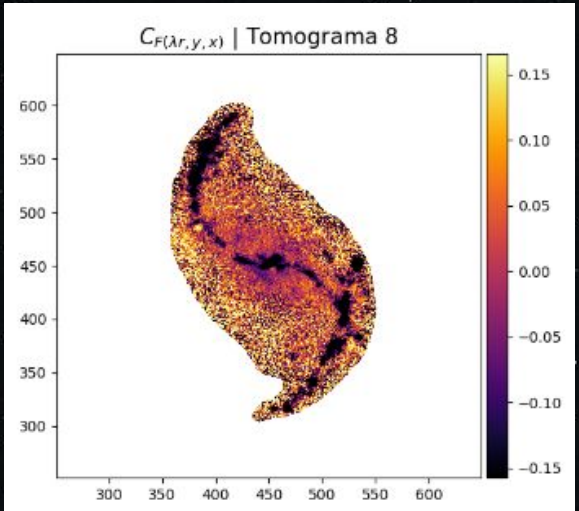
PCA normalized by the filter r NGC 986

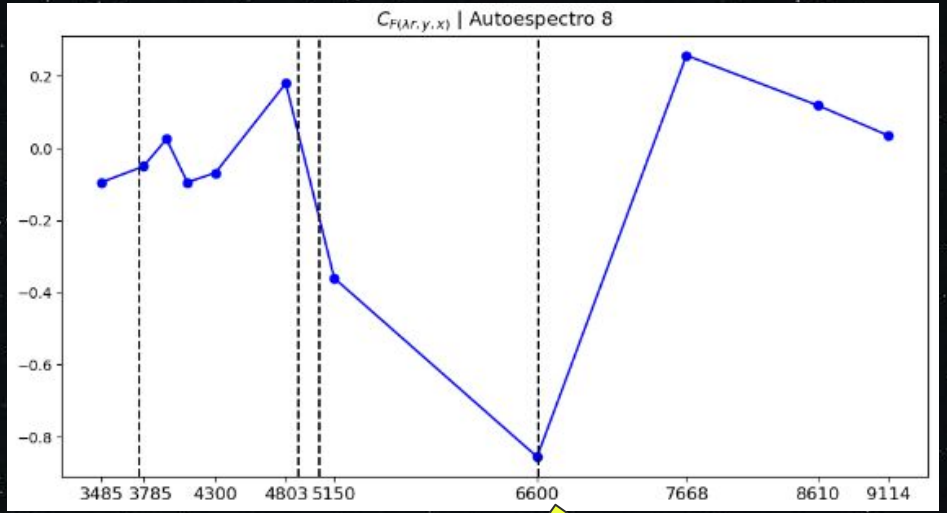


Autoespectros



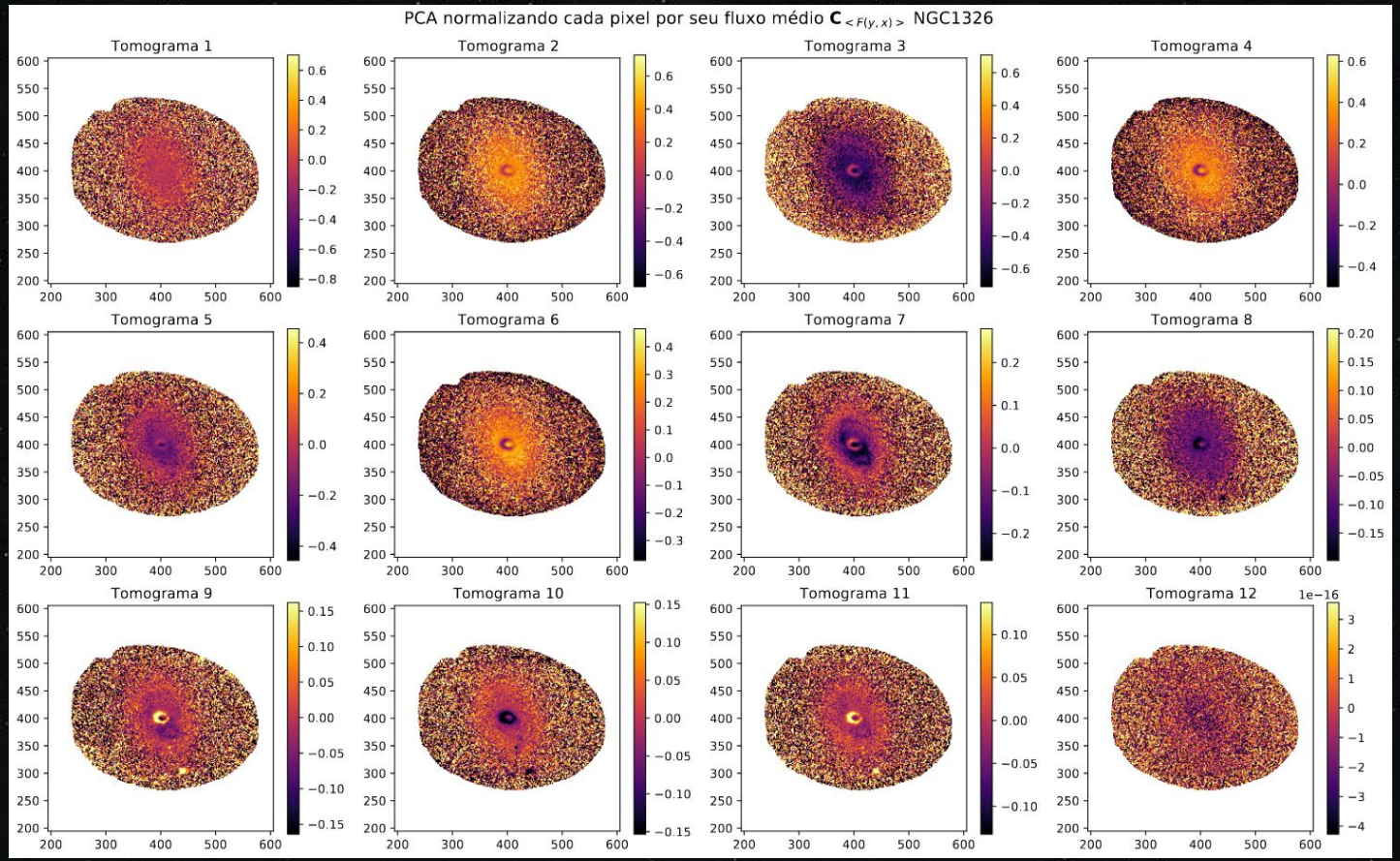
Interpreting the Eigenspectra



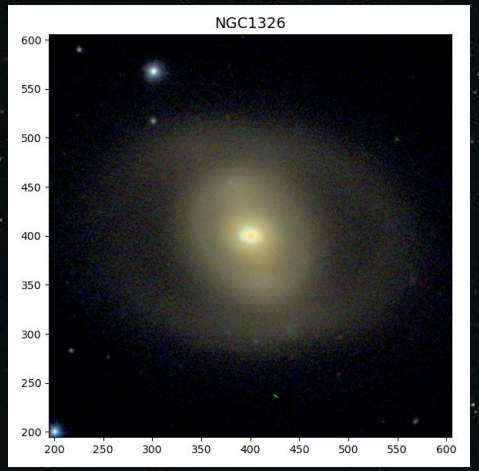


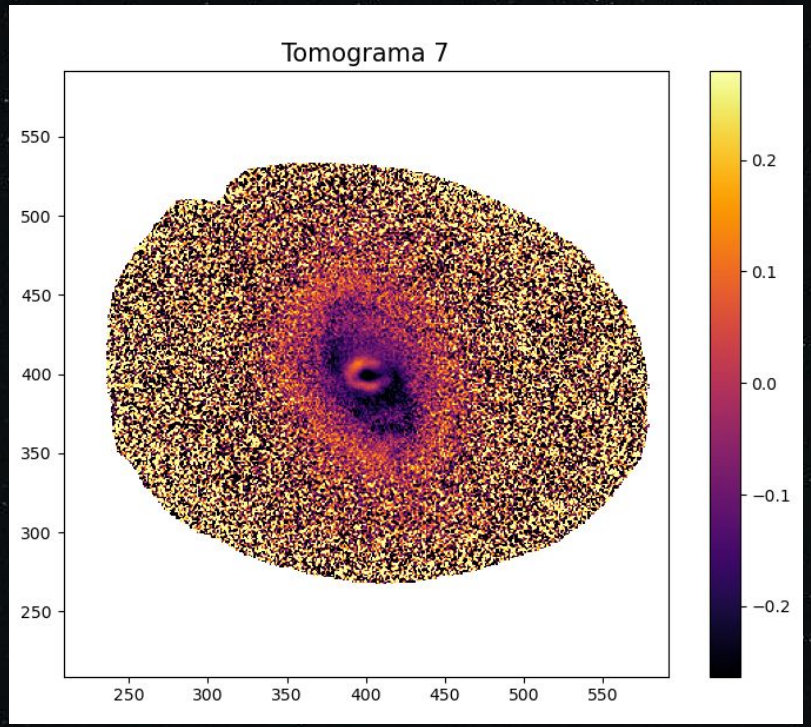
Hα

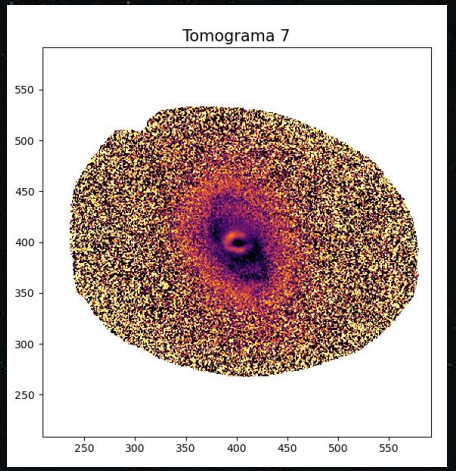
PCA Tomography for $\mathbf{C}_{\langle F(y,x)\rangle}$ NGC 1326



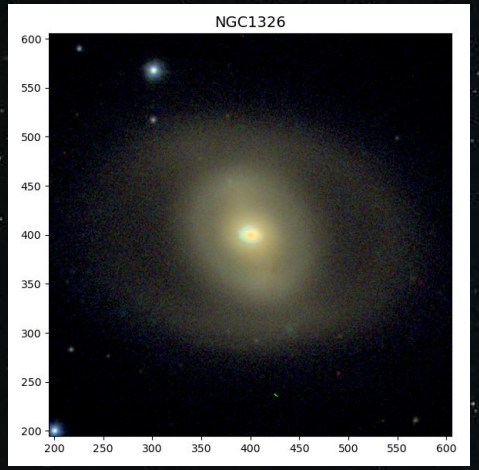
Tomogram 7 for $\mathbf{C}_{\langle F(y,x)\rangle}$ NGC 1326

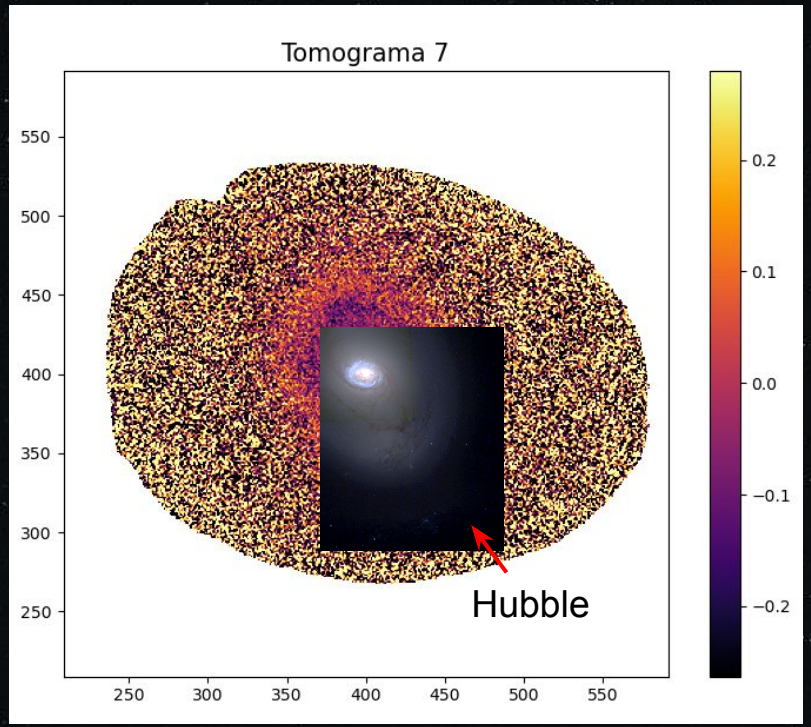


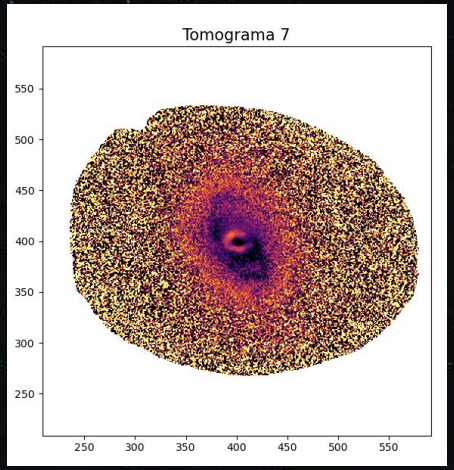




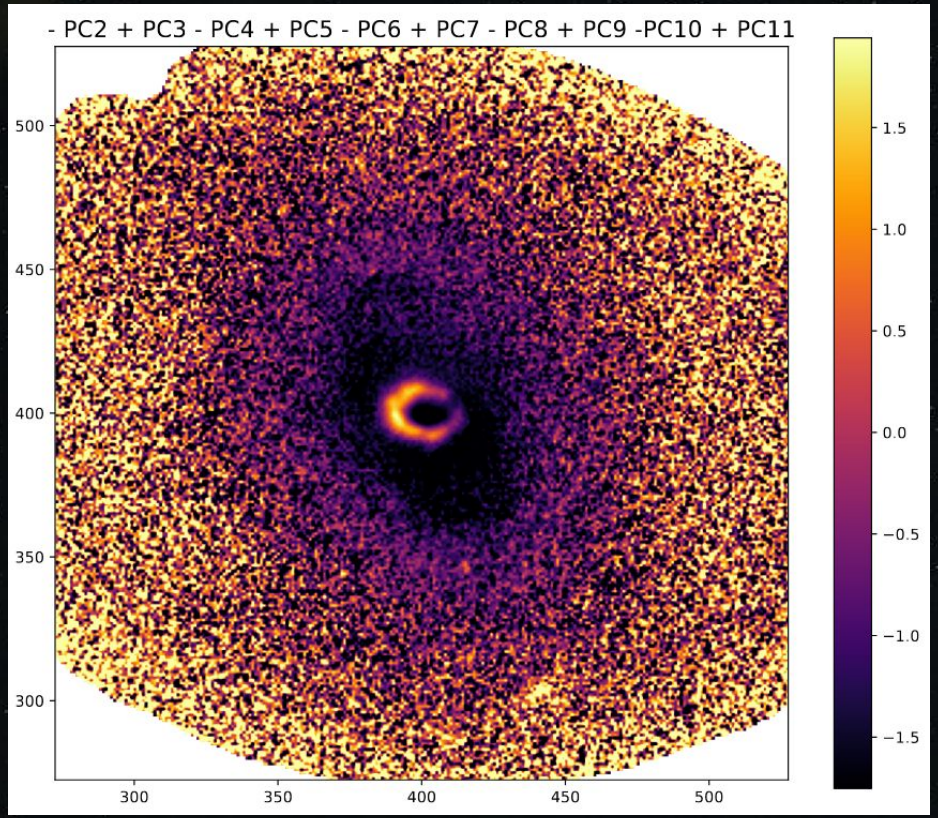
Tomogram 7 for $\mathbf{C}_{\langle F(y,x)\rangle}$ NGC 1326



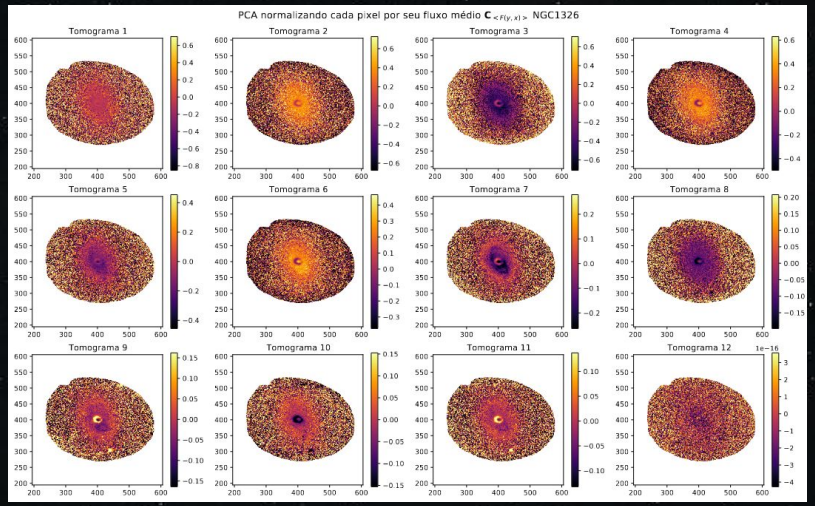




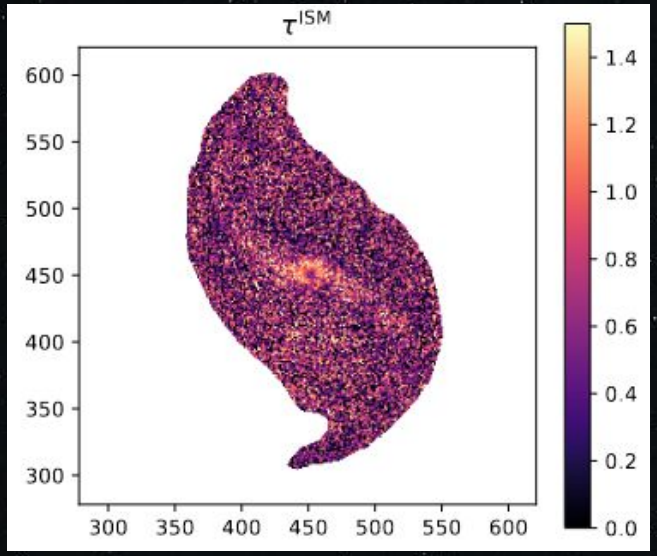
PCA for $C_{\langle F(y,x)\rangle}$ NGC 1326



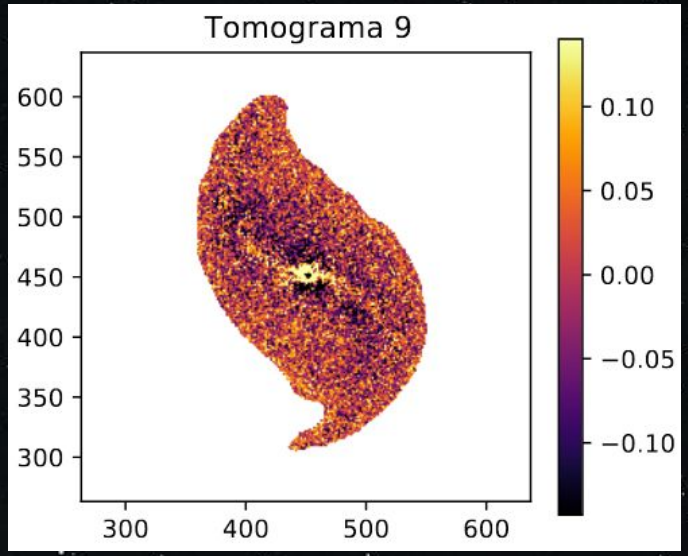
–PC2 + PC3 – PC4 + PC5 – PC6 + PC7 – PC8 + PC9 – PC10 + PC11



AlStar + PCA NGC 986

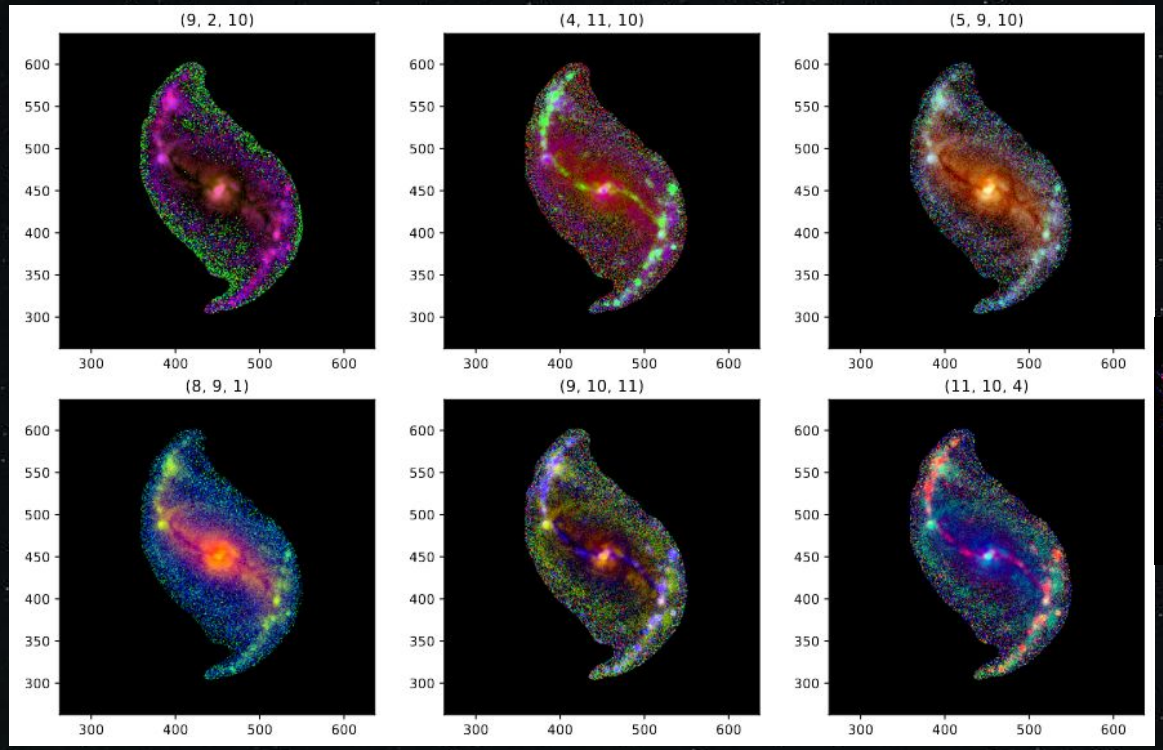


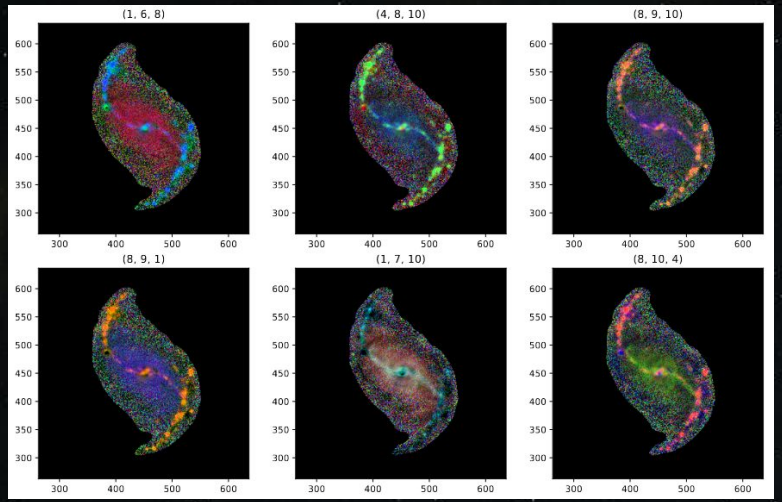
Dust optical depth

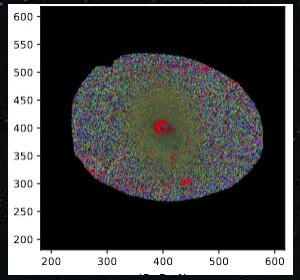


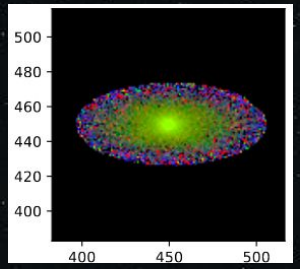
PCA of the cube - tomogram 9

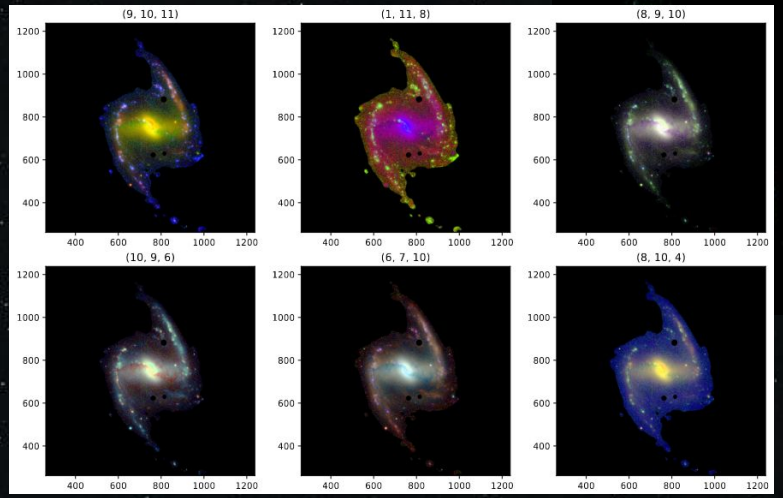
RGB compositions of the tomograms

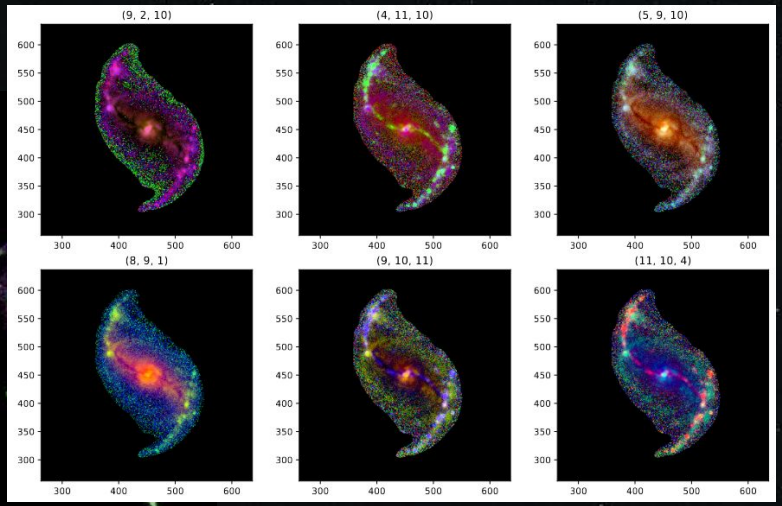


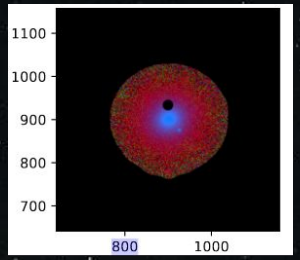

(1, 6, 8)
(4, 8, 10)
(8, 9, 10)
(8, 9, 1)
(1, 7, 10)
(8, 10, 4)

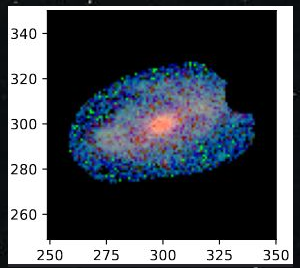


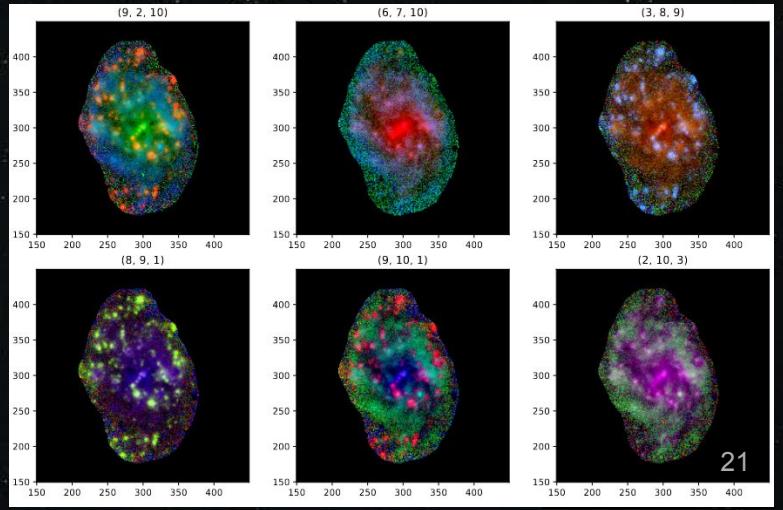



(9, 10, 11)
(1, 11, 8)
(8, 9, 10)
(10, 9, 6)
(6, 7, 10)
(8, 10, 4)


(9, 2, 10)
(4, 11, 10)
(5, 9, 10)
(8, 9, 1)
(9, 10, 11)
(11, 10, 4)






(9, 2, 10)
(6, 7, 10)
(3, 8, 9)
(8, 9, 1)
(9, 10, 1)
(2, 10, 3)

AlStar

Fits and Maps from `AlStar`

- Spectral fits
- Photometric fits
- Fits of (recombination) emission lines: [OII] 3727, Hb, [OIII], Ha, [NII], [SII] 6716+6731
- Maps of mass
- Maps of ages
- Maps of dust optical depth
- ...

Spectral synthesis `AlStar`

$= x_1$ $+ x_2$ $+ x_3$ $+ \ldots$

(t_1, Z_1, T_1) (t_2, Z_2, T_2) (t_3, Z_3, T_3)

Spectral sythesis `AlStar`

$= x_1$ $+ x_2$ $+ x_3$ $+ \ldots$

(t_1, Z_1, T_1) (t_2, Z_2, T_2) (t_3, Z_3, T_3)

Observed

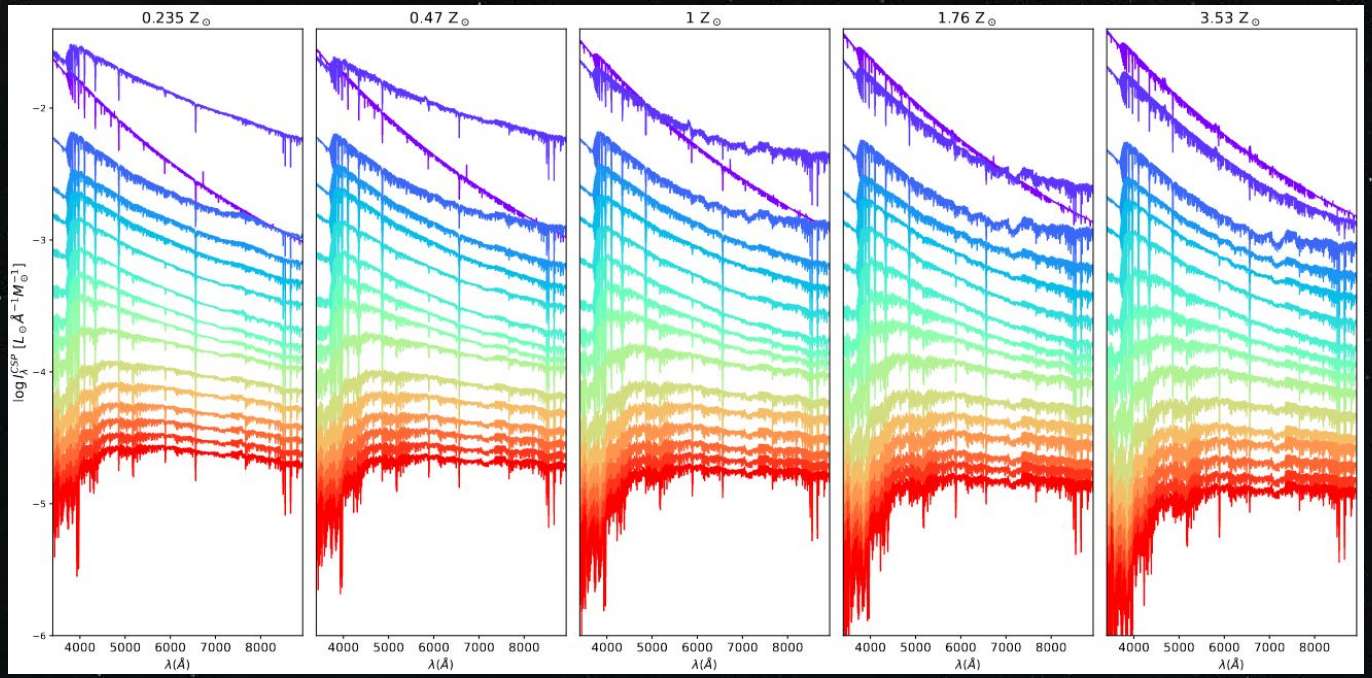
O_λ

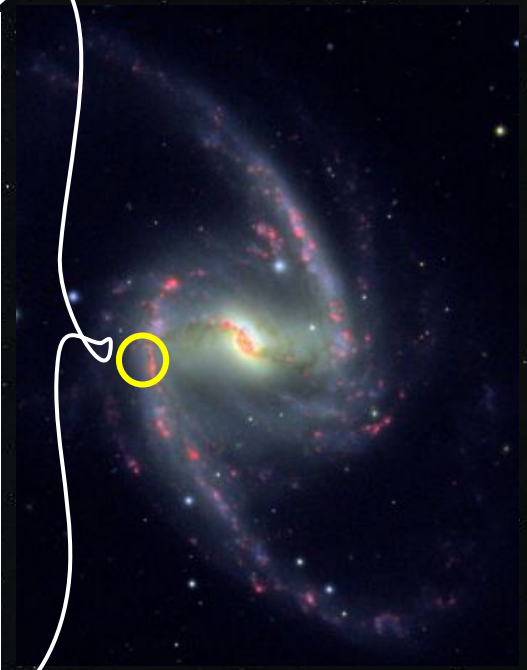
Model

M_λ

AlStar's stellar base

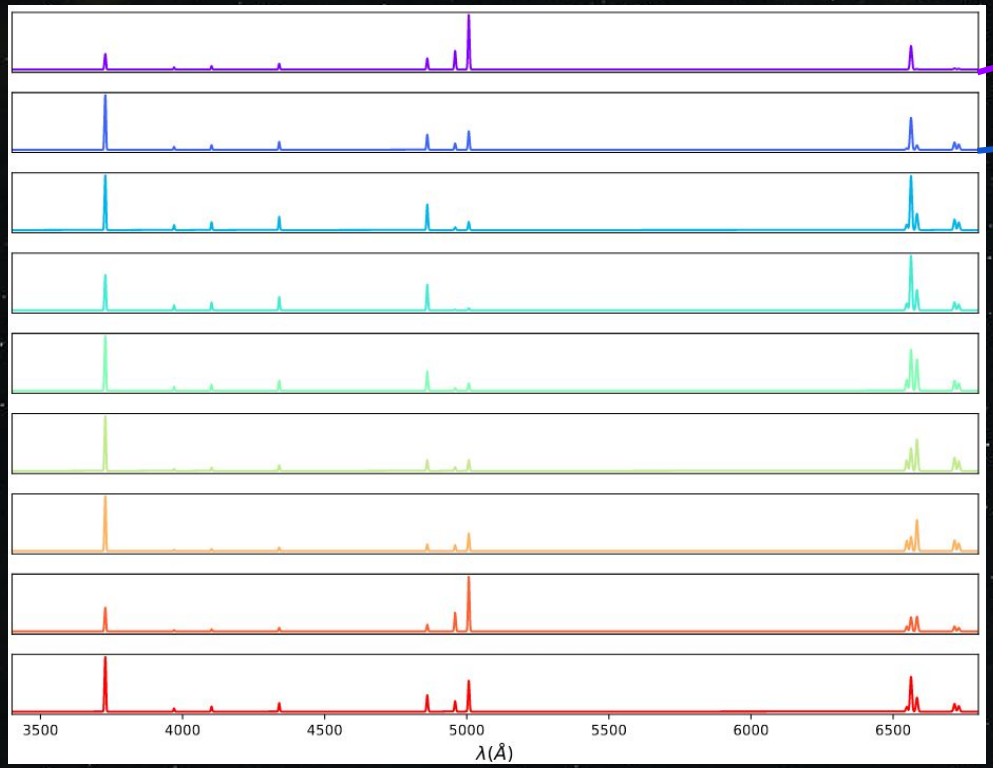
t = 0, 3, 10, . . . 14 Gyr





80 stellar populations = 16 ages x 5 metalicities

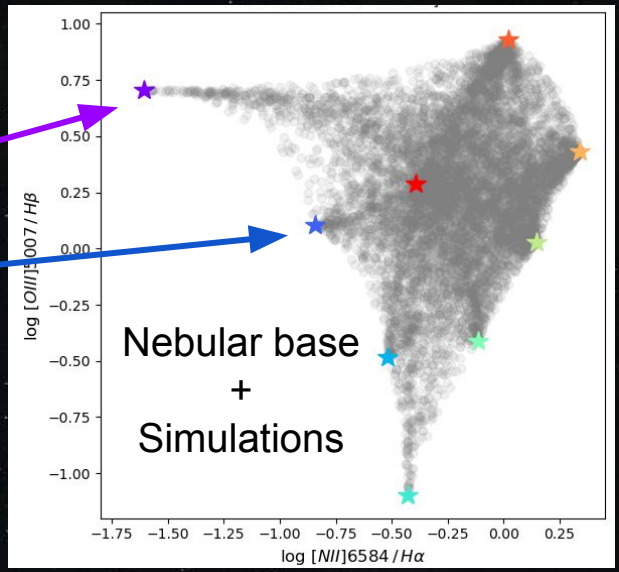
AlStar's emission line base

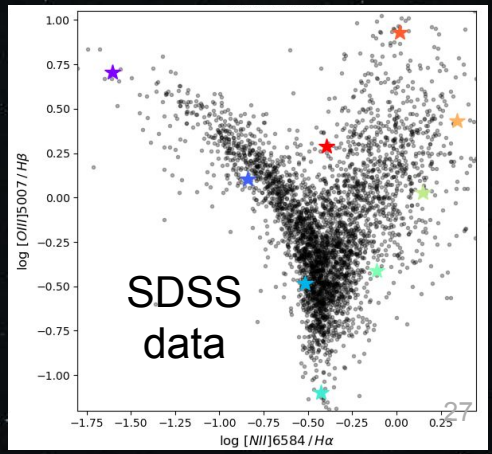


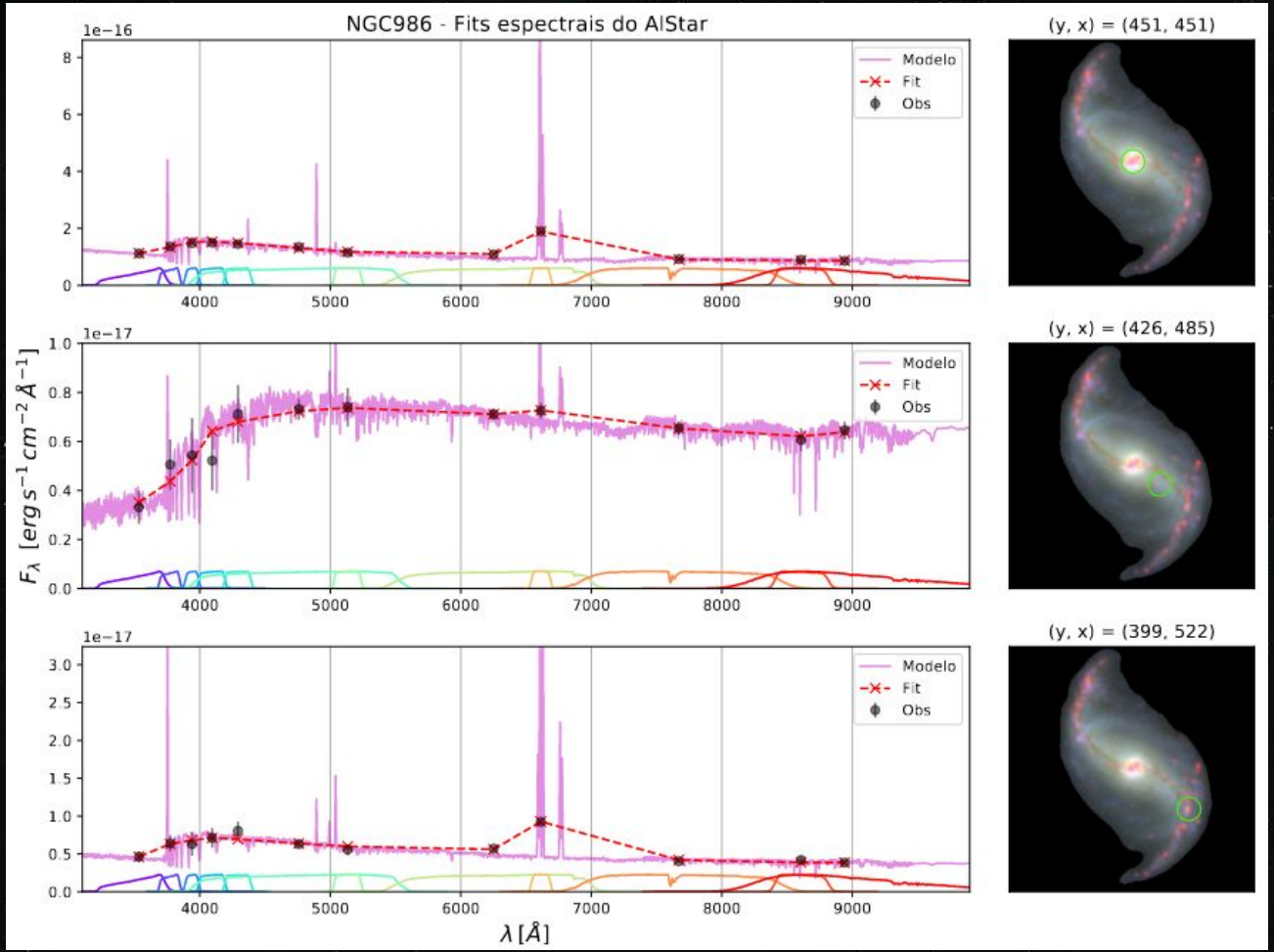
[OII]3727 , [OIII]4959+5007 , [NII]6548+6584 ,
[SII]6716+6731 , Hα+Hβ+Hγ ...

9 components

BPT Diagram







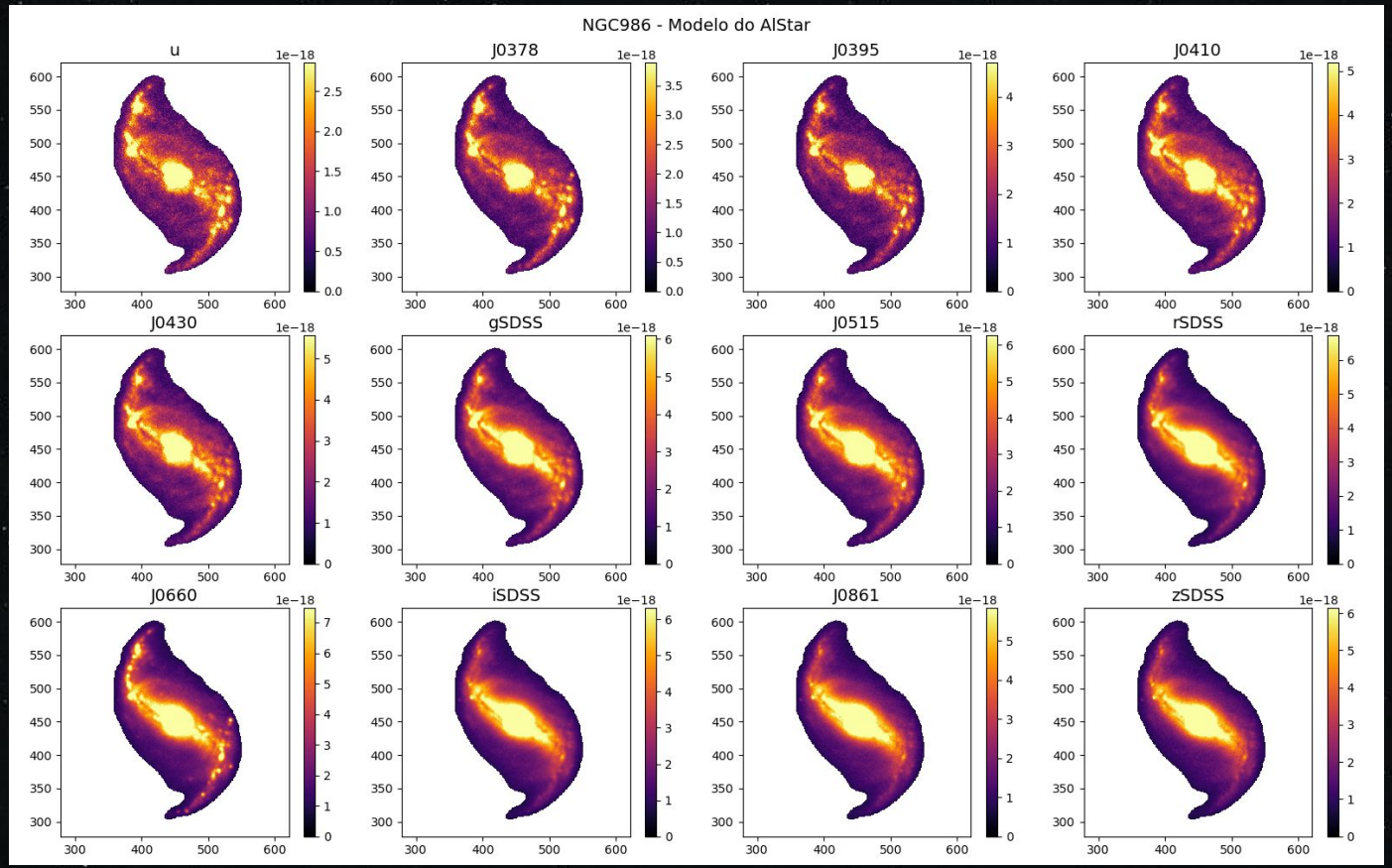
Fits AlStar

NGC 986

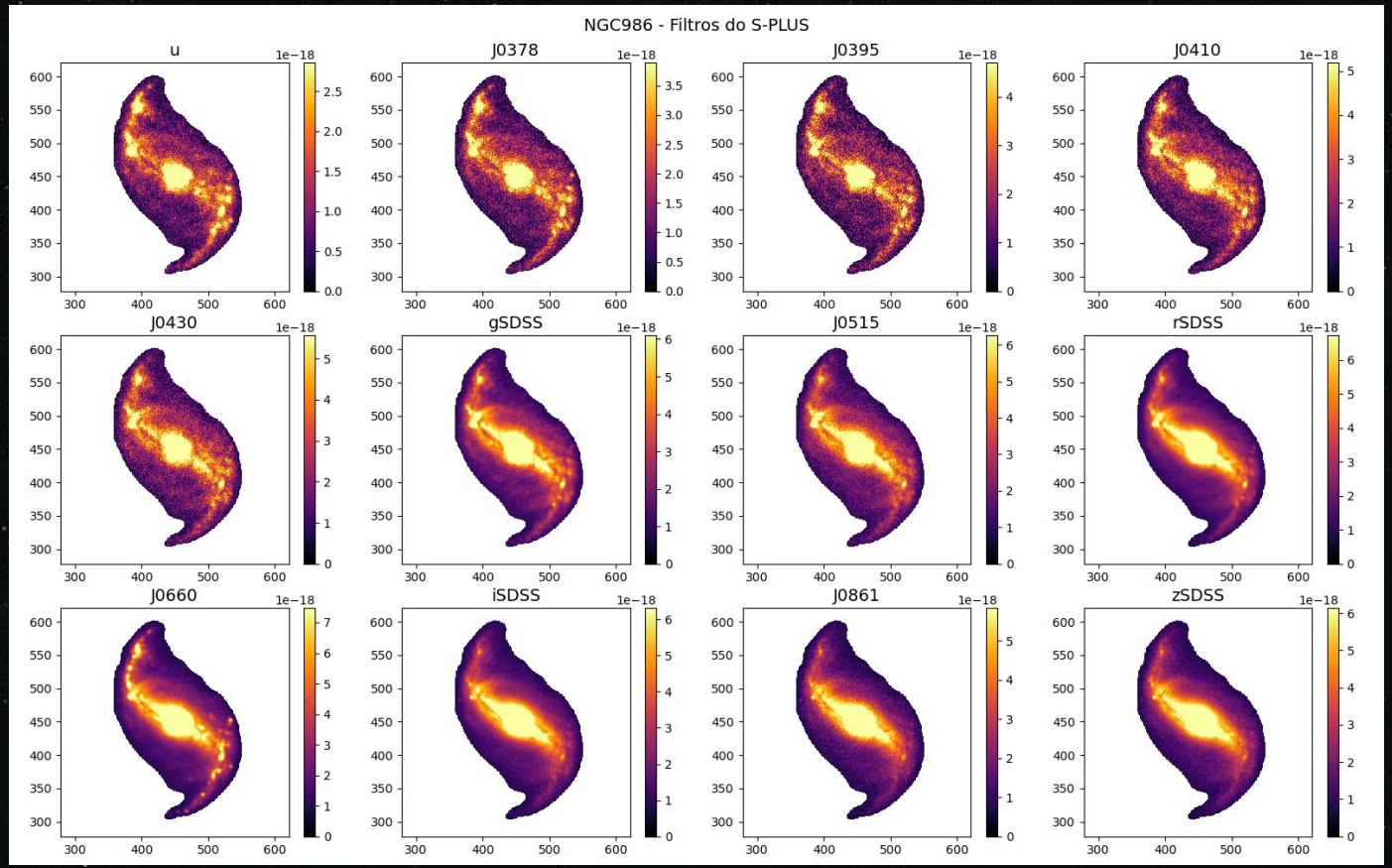
Comparison:

Real data
x
Model

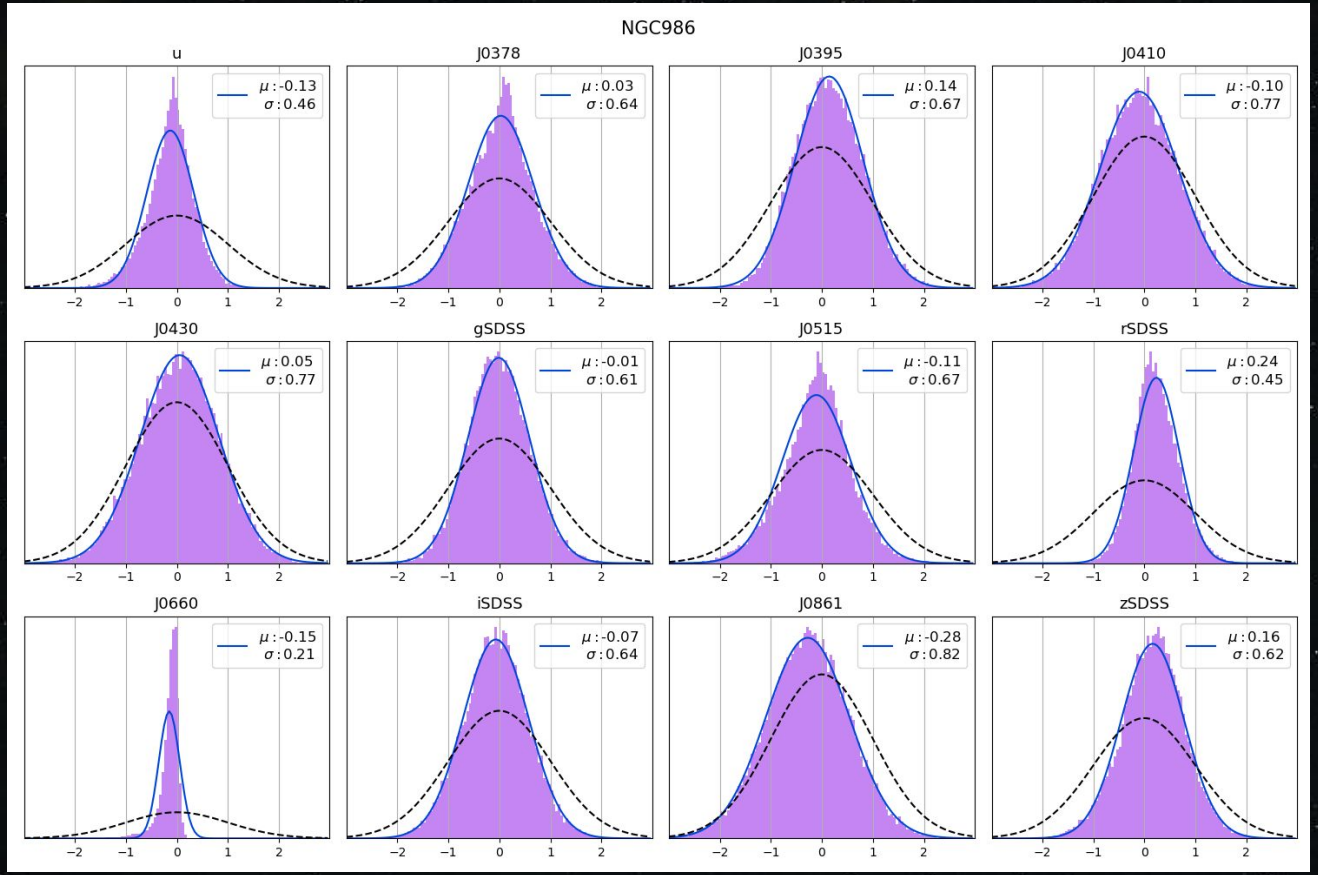
Model from AlStar NGC 986



S-PLUS data NGC 986



Test of photometric errors

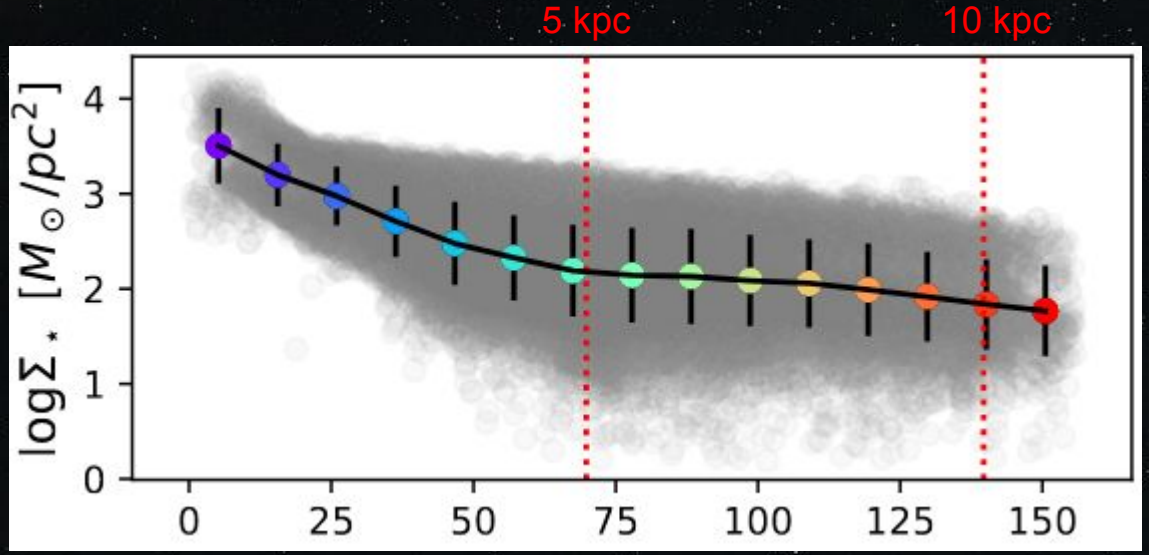


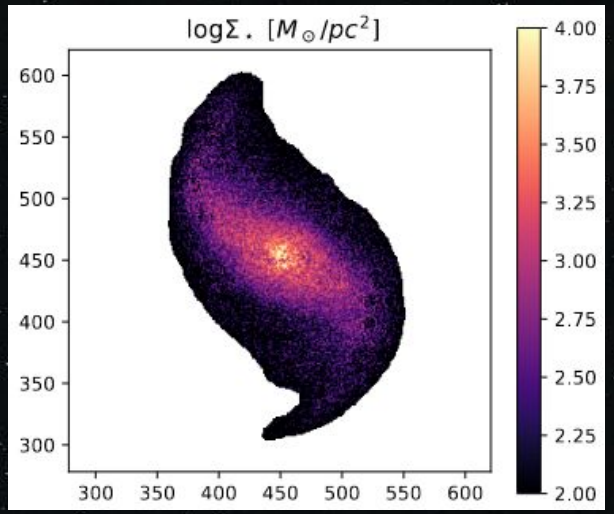
NGC 986

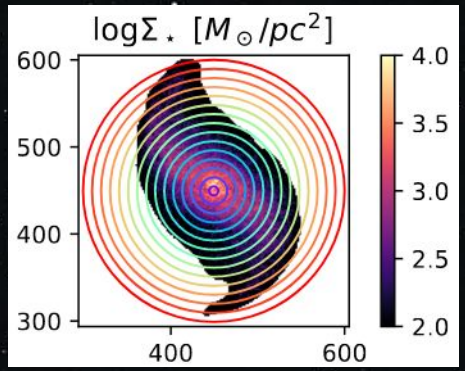
Statistics of the Residuals

$$\frac{(O_\lambda - M_\lambda)}{\varepsilon_\lambda}$$

Maps and radial profiles from AIStar NGC 986

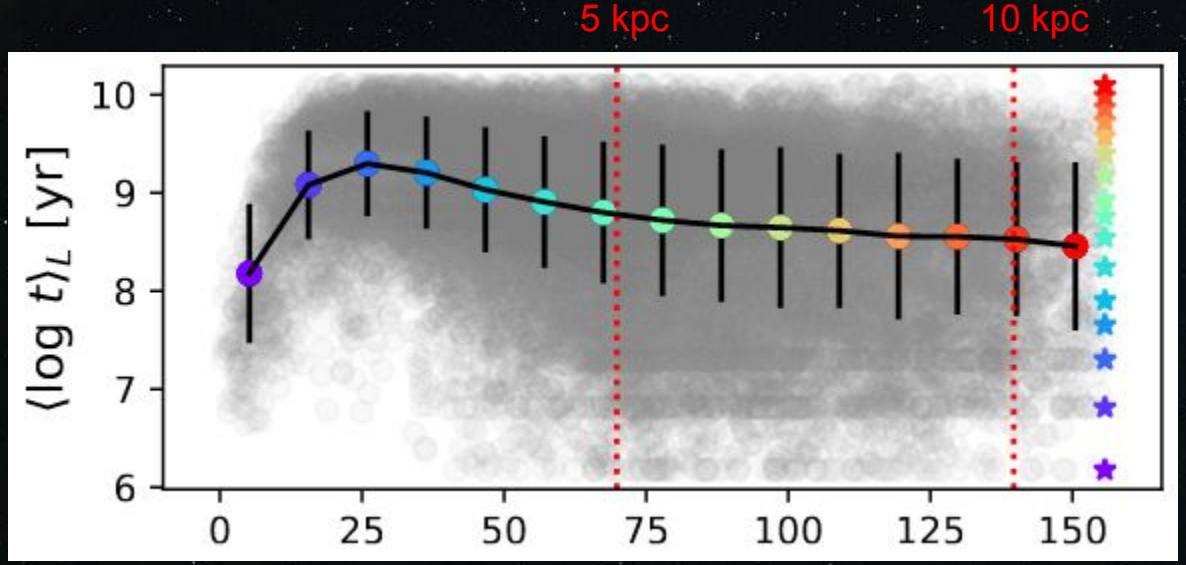


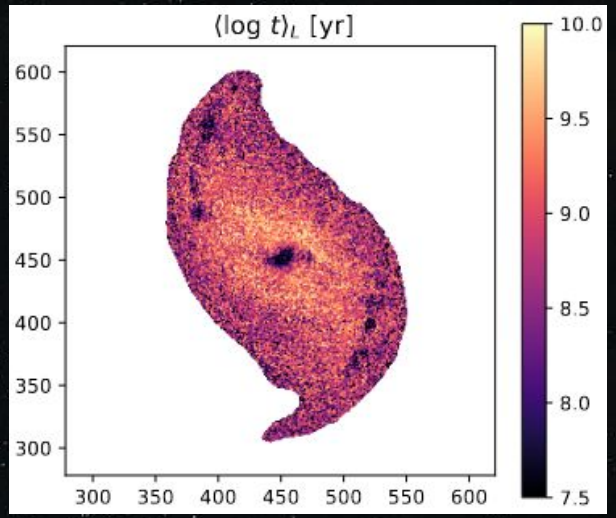


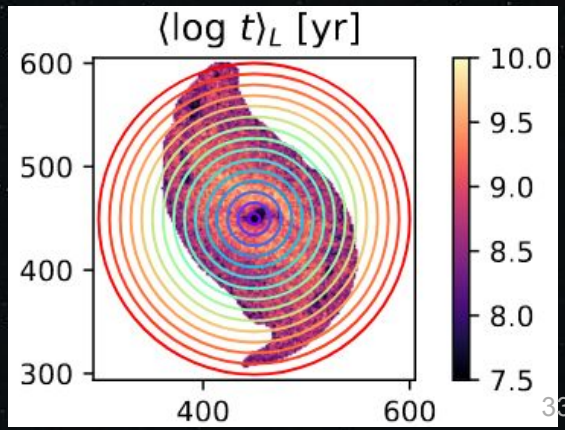


stellar mass surface density

Maps and radial profiles from AIStar NGC 986

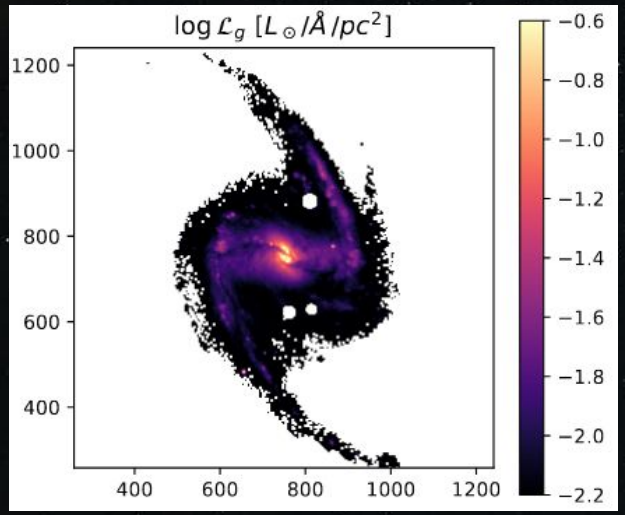


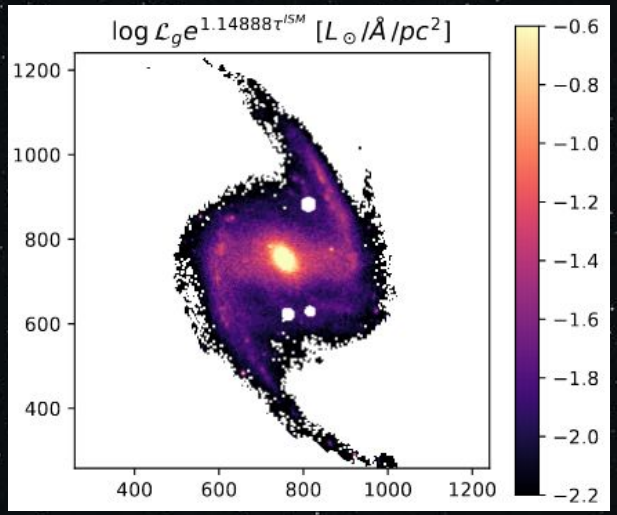


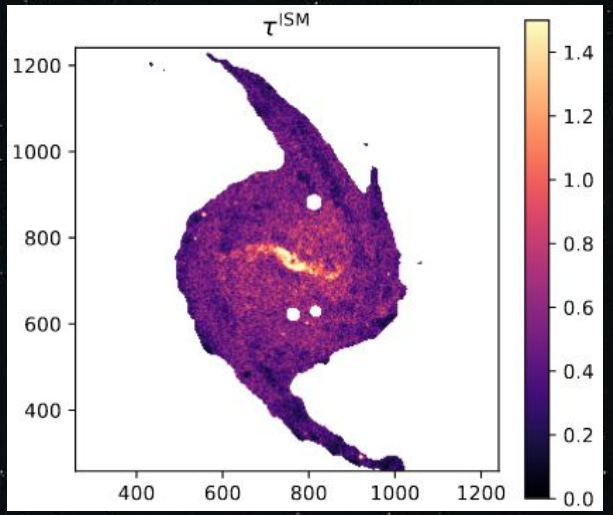


average of the age log weighted by the light

Maps from AIStar NGC 1365





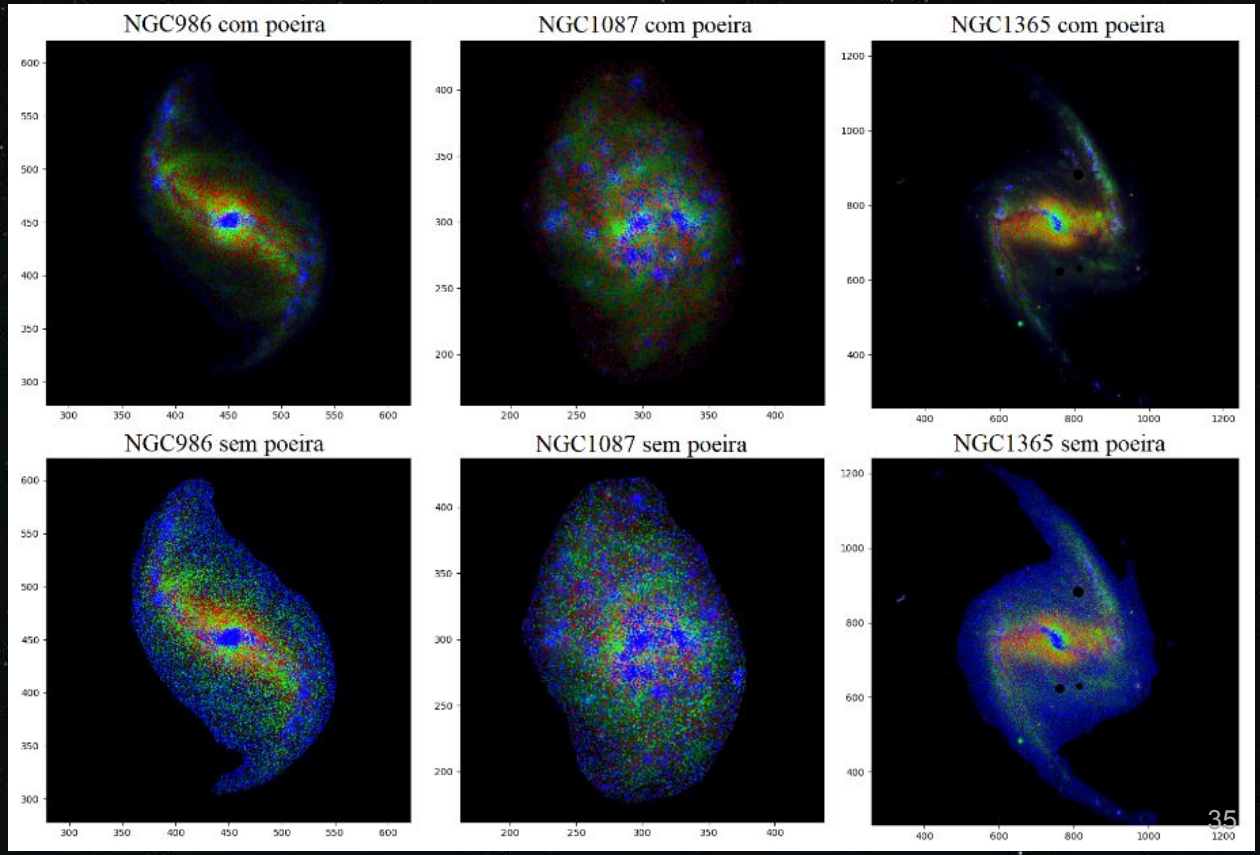


Observed Luminosity

Dust optical depth

RGB of ages - AlStar

- **R - old**
  t > 2 Gyr
- G - intermediary
  10^8 < t < 2 Gyr
- B - young
  t < 100 Myr



Link of the dissertation:

https://tede.ufsc.br/teses/PFSC0405-D.pdf

Conclusion

- Improve pre-processing, especially in regions with low surface brightness
- PCA: Tomograms indicate good potential, but the interpretation of the eigenspectra needs further work
- AlStar: We got great spectral fits, maps and consistent radial profiles for various properties
- Promising study to be applied to other S-PLUS galaxies

Acknowledgment

PPGFSC

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CAPES

S-PLUS