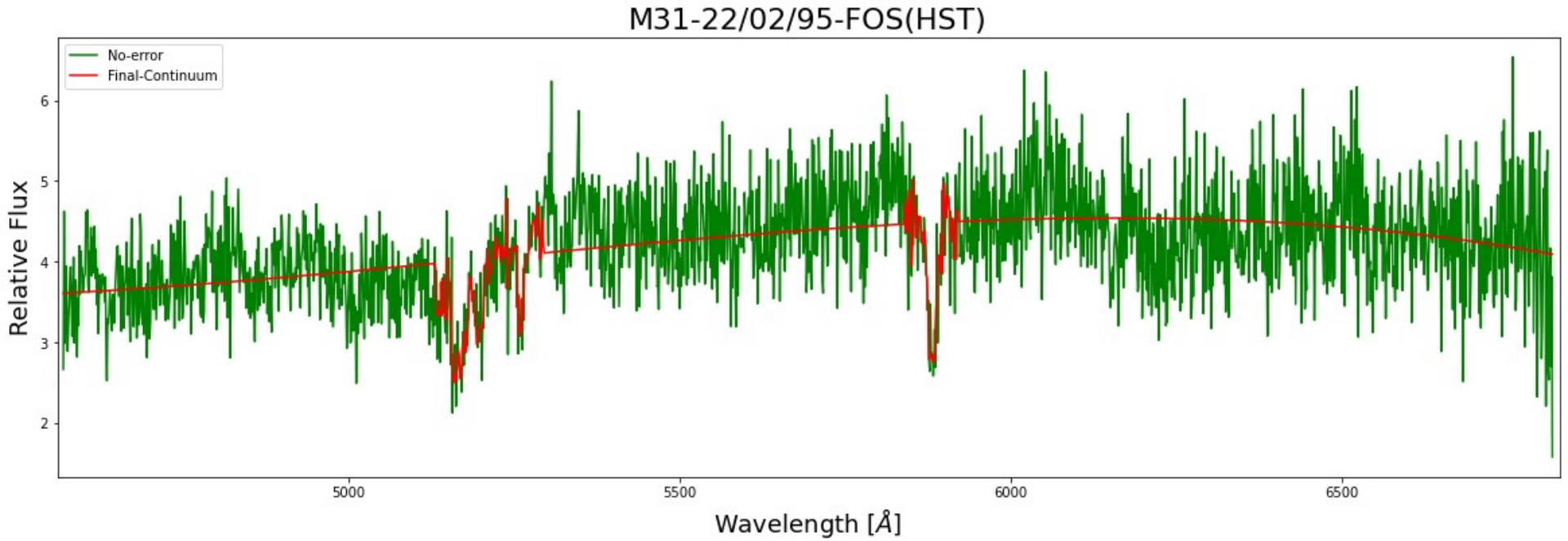
M31 Spectra Analysis



Vampy

Why care about Spectra?

It's the only thing we have in most cases!

Spectra can tell us about...

- Type of the object
- Contents of the object
- Motion of the object
- How active the is region around the object

What is Project about?

- Spectral Data from the central region of M31 was analyzed and fitted

- Absorption Lines were also identified

- SciPy suite and AstroPy were used for reduction and analysis of the data

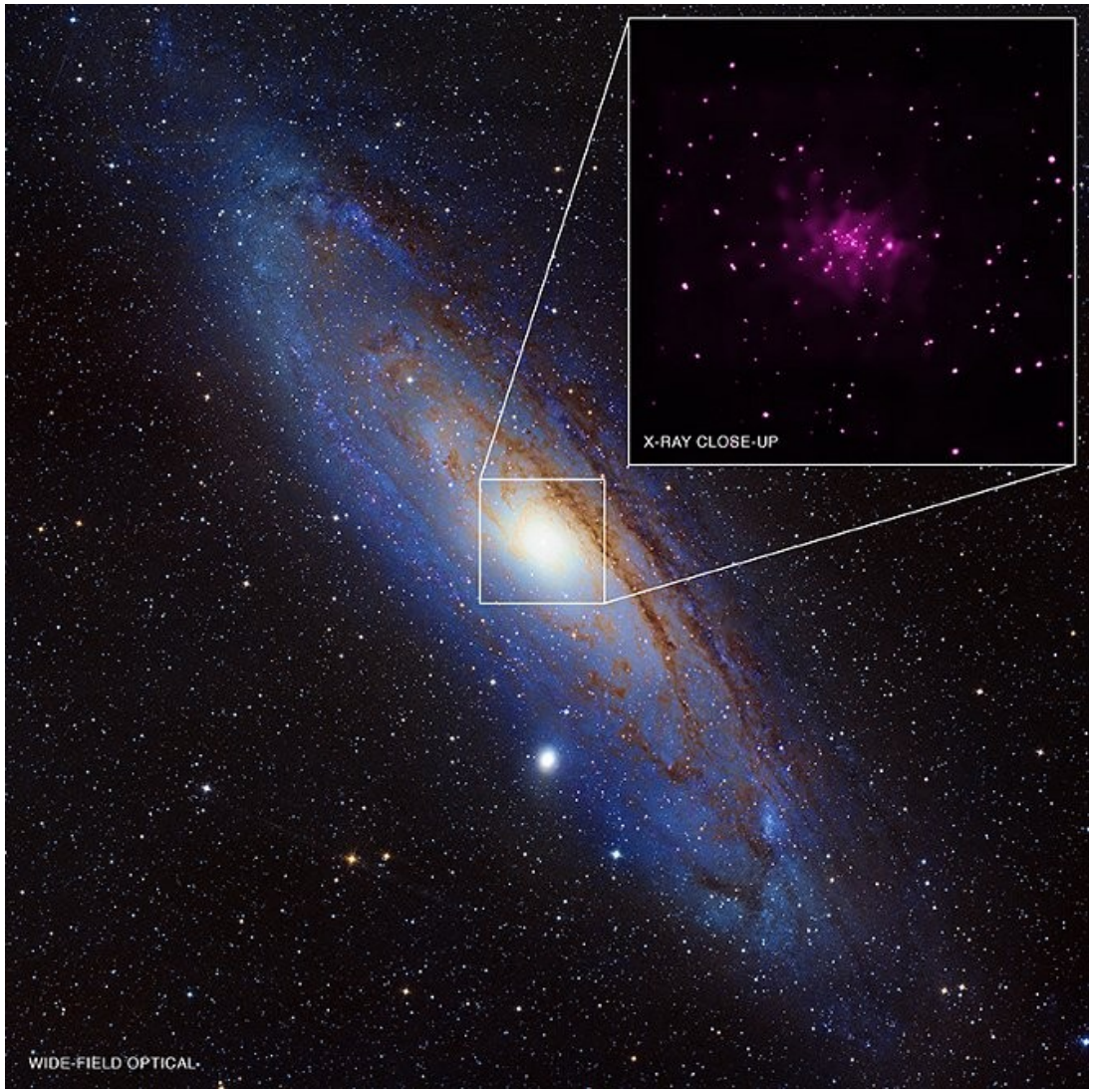
SciPy.org

What is M31?

- Type: Spiral Galaxy(Sab)
- Distance from Earth: 2.53Mly
- Age: 10.01 Byr

Where is the Data from?

Location: Galactic Center of Andromeda

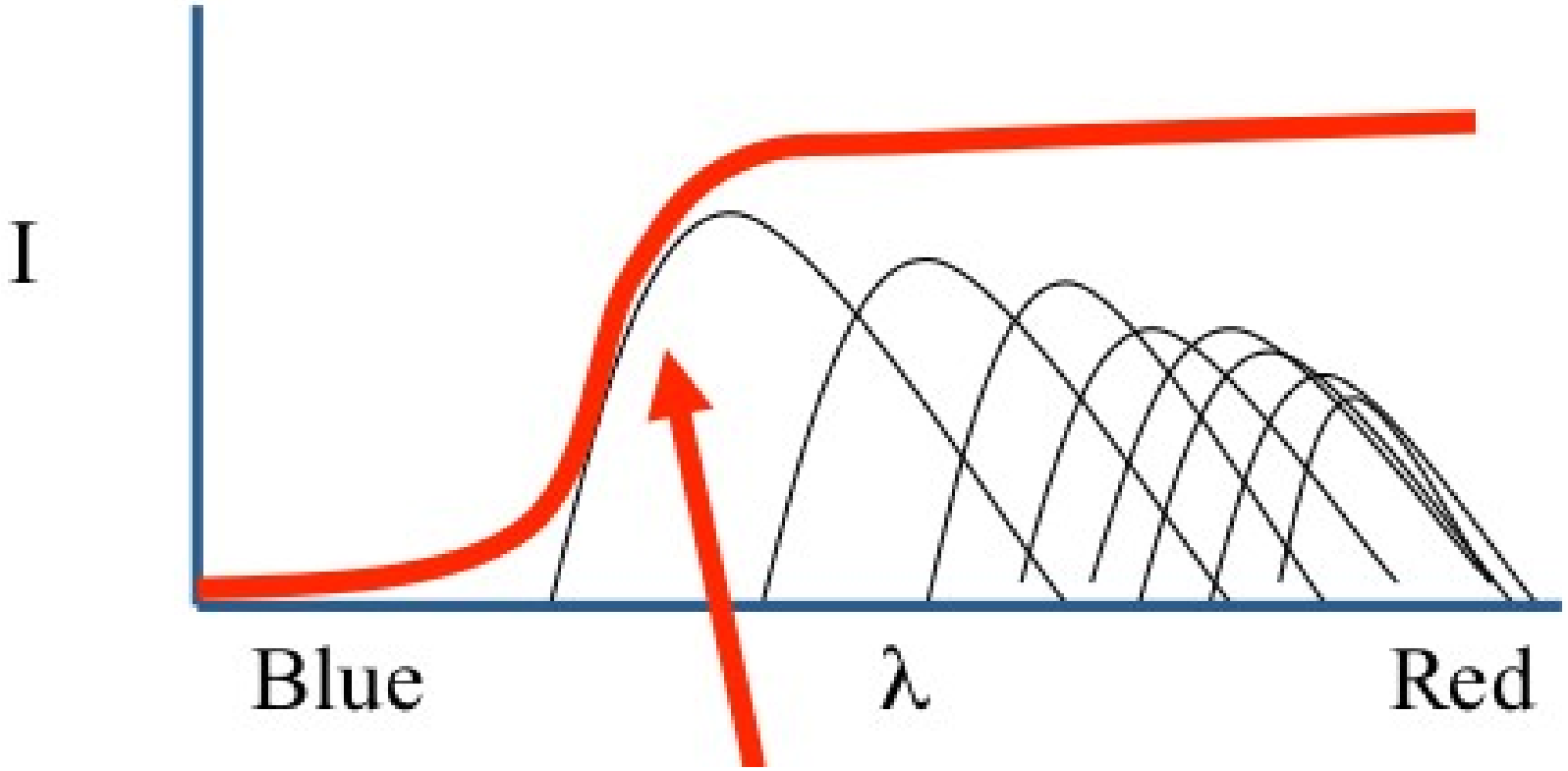


About the Data-set

- Instrument: FOS(HST)
- Wavelength: 4569.102 Å-6817.517Å
- Date-OBS: 22/02/95

What do we expect Galactic Spectra to look like?

Galactic Spectra



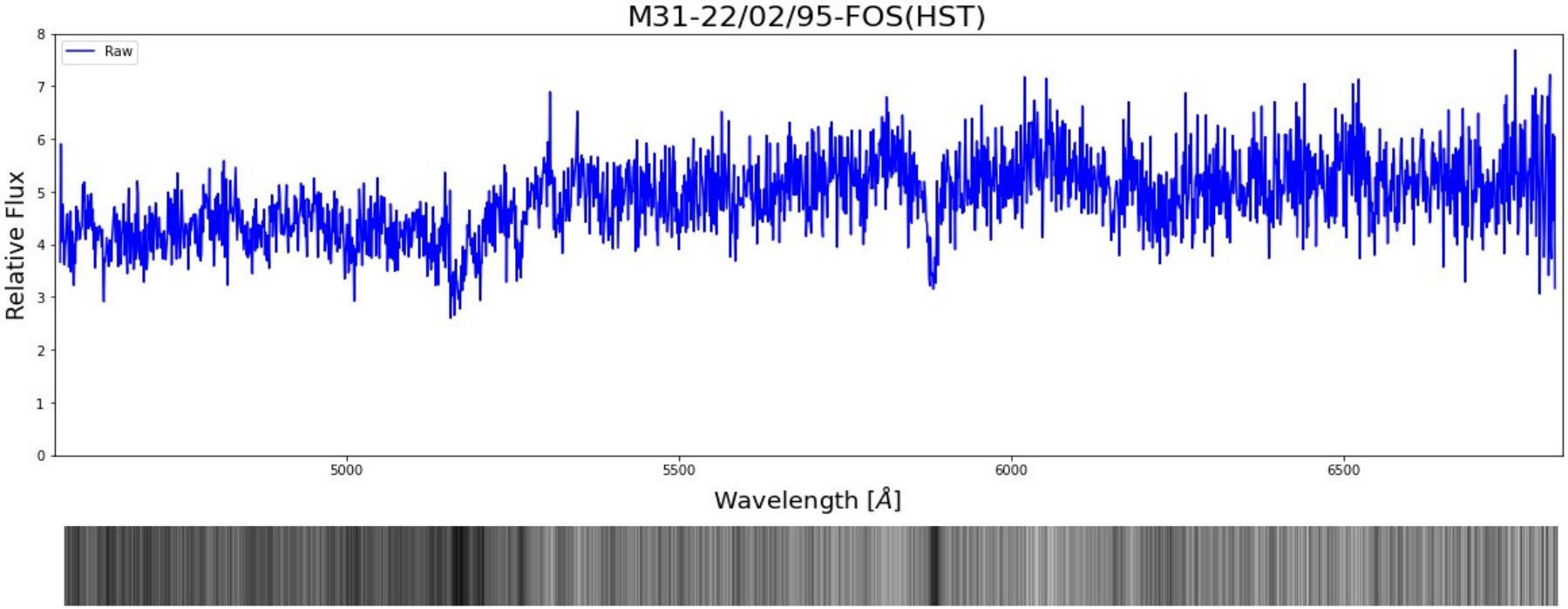
4000Å break

Why we expect 4000Å break?

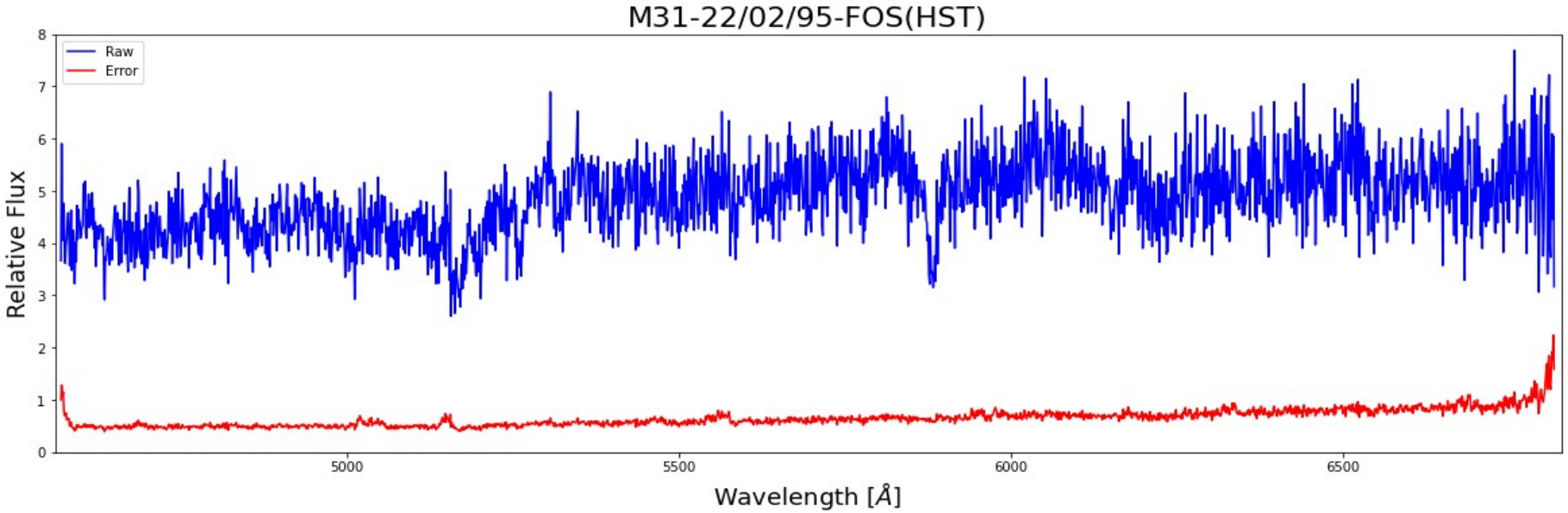
- Lack of Hot blue Stars because they are short lived

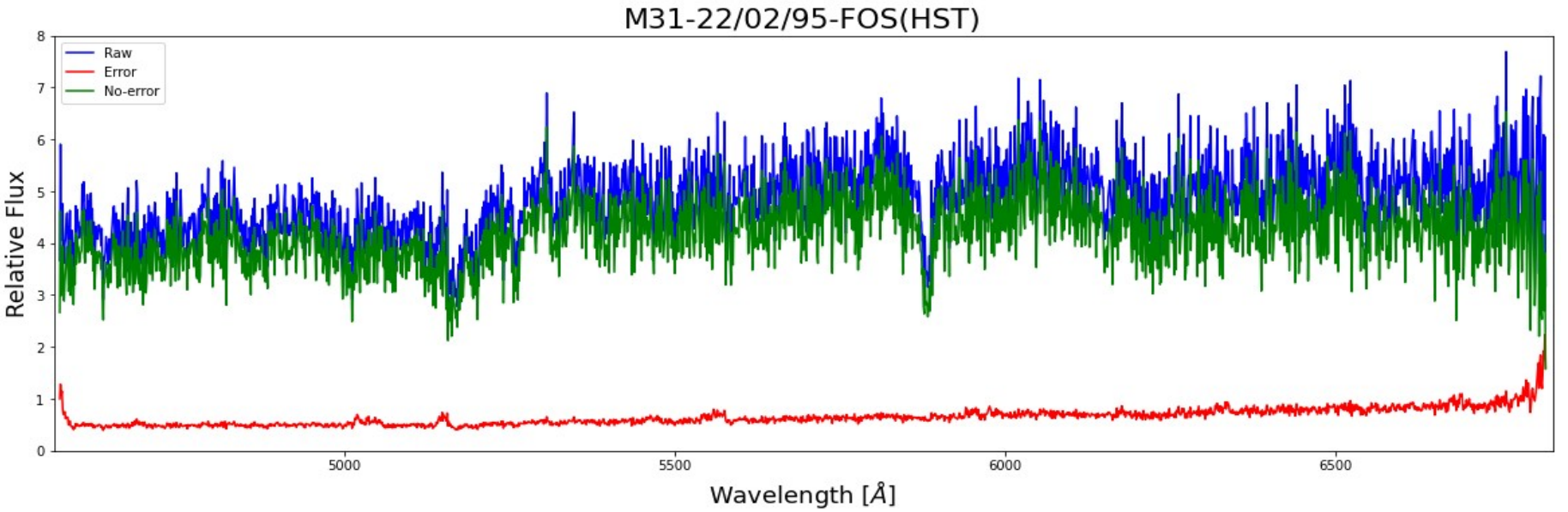
- In metal rich region higher energy light is absorbed by the metals

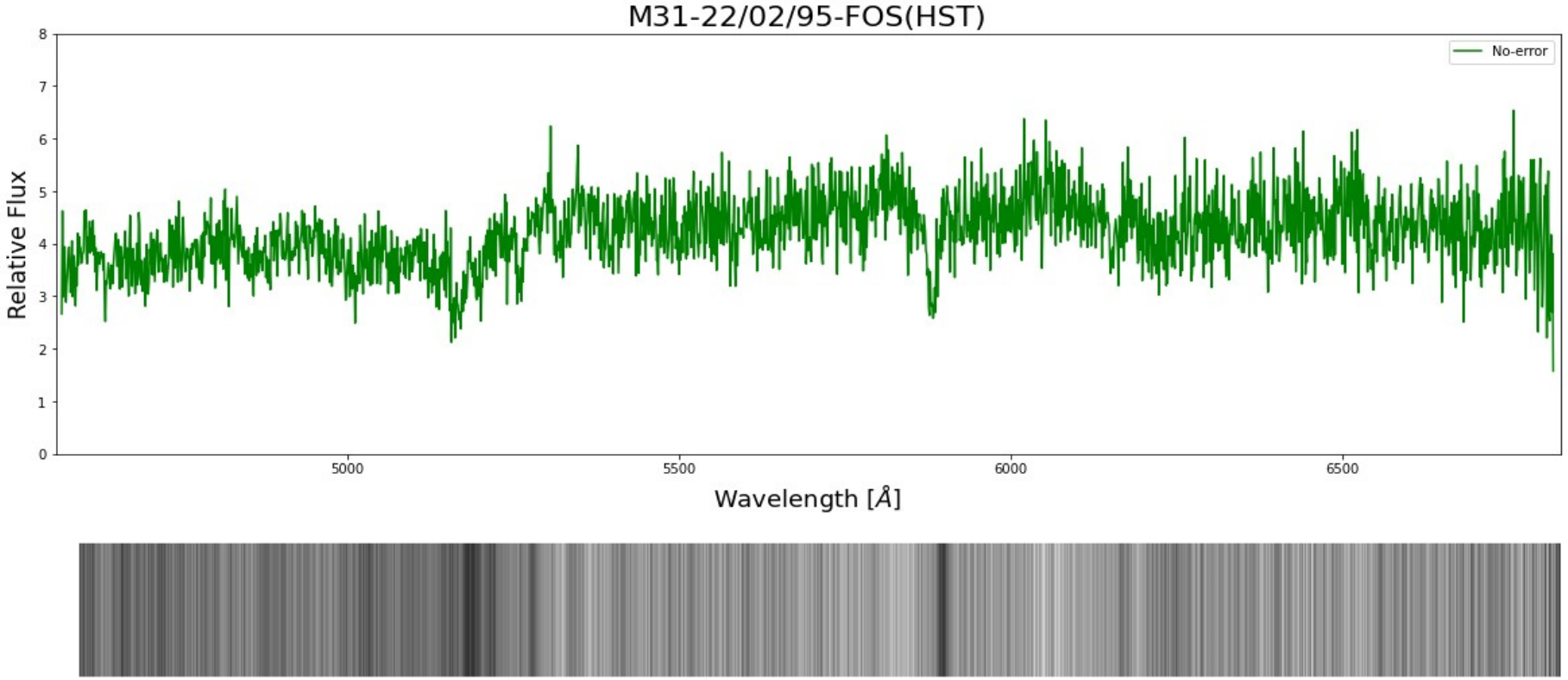
What does the raw data looks like?



Removing the Error


M31-22/02/95-FOS(HST)
Raw
Error
Relative Flux
Wavelength [Å]
0
1
2
3
4
5
6
7
8
5000
5500
6000
6500


M31-22/02/95-FOS(HST)
Raw
Error
No-error
Relative Flux
Wavelength [Å]
0
1
2
3
4
5
6
7
8
5000
5500
6000
6500

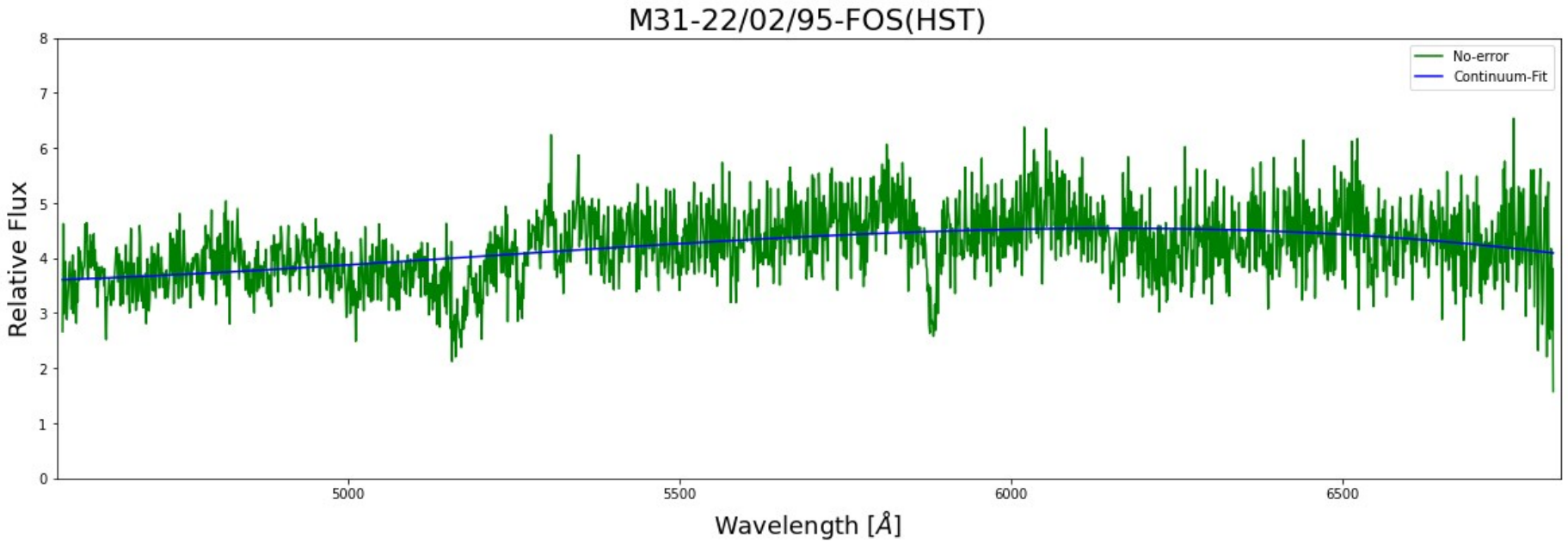

M31-22/02/95-FOS(HST)
No-error
Relative Flux
Wavelength [Å]
0
1
2
3
4
5
6
7
8
5000
5500
6000
6500

Raw Data

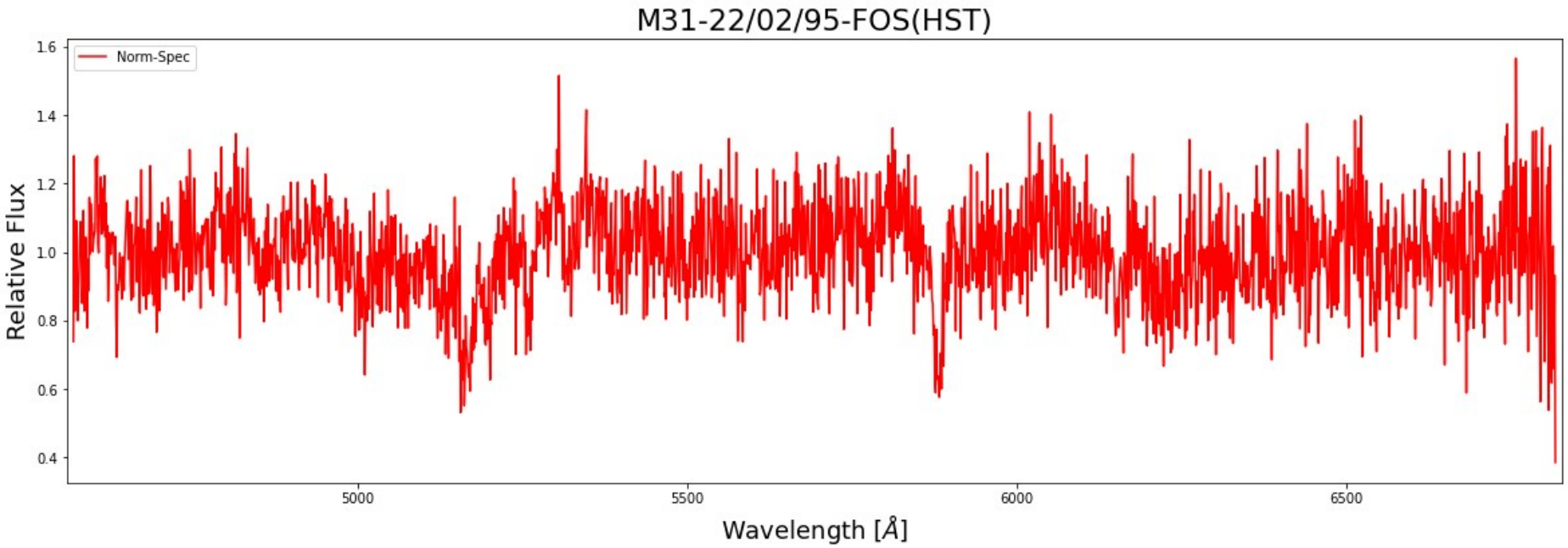
No Error

Spectrum Fitting Process

Continuum Fit



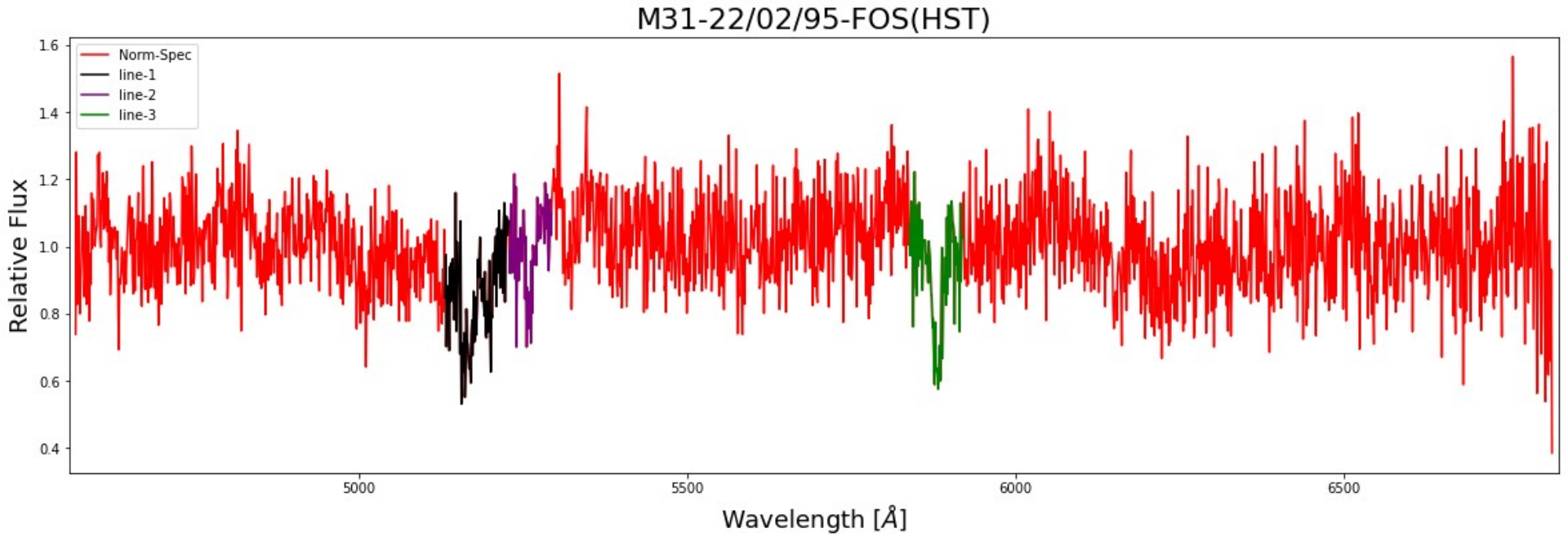
Normalized Spectra



Identifying and Modeling the Spectral lines

Identification of Absorption lines

- Identification was done manually

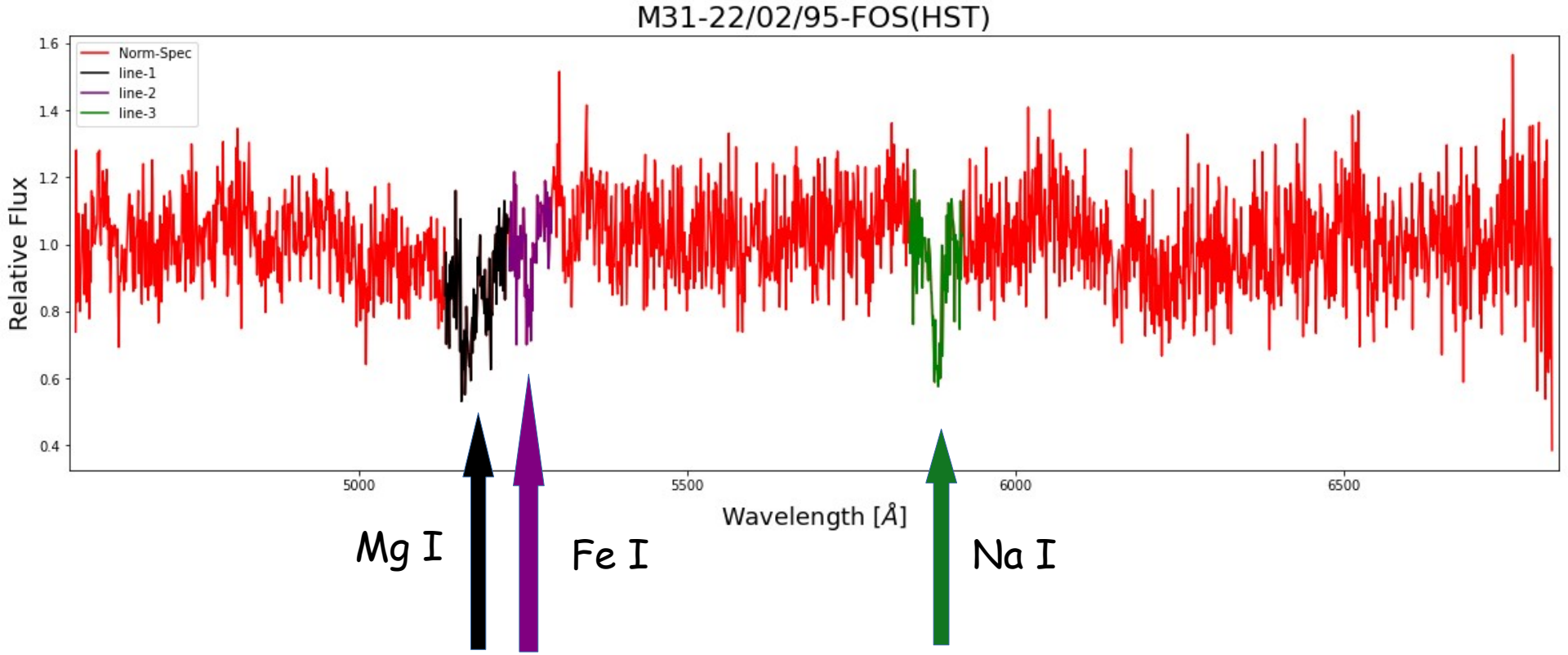


Why was identification done manually?

Typical Spectral Feautures

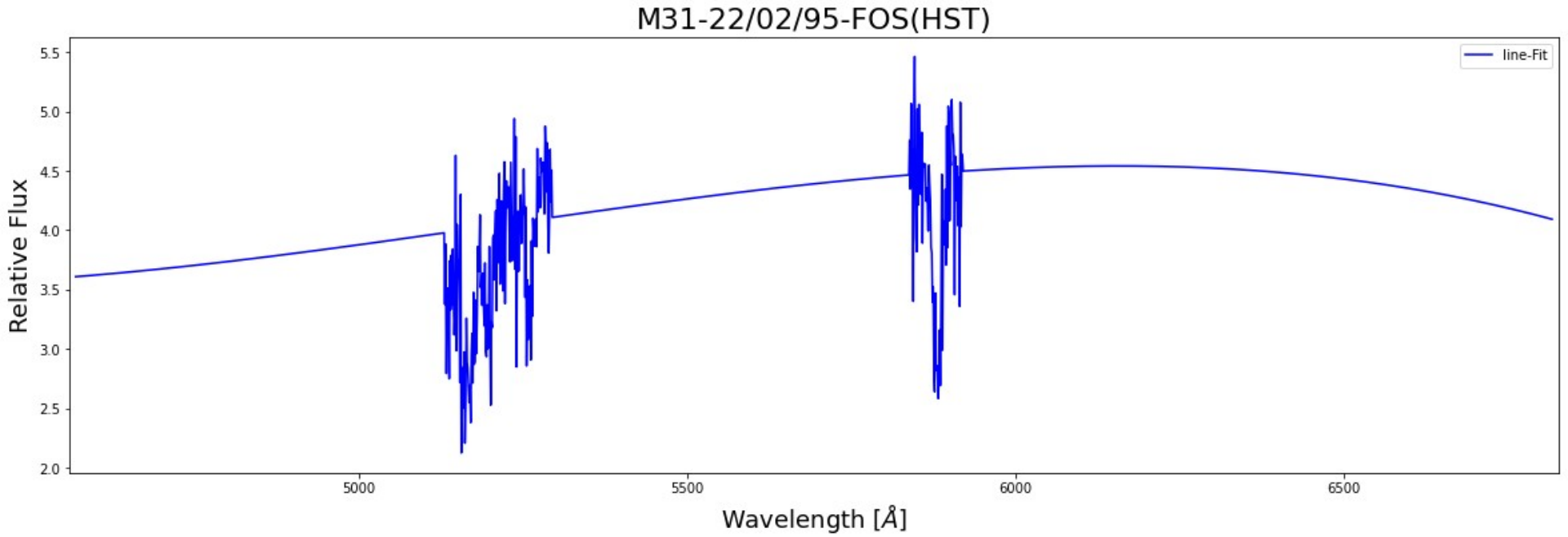
- Absorbtion lines
- Ca[H] = 3933.7Å
- Ca[K] = 3968.5Å
- G-band = 4304.4Å
- Mg[I] = 5175.3Å
- Fe[I] = 5270.3Å
- Na[I] = 5894.0Å

- Emission lines
- O[II] =3727.3Å
- Hδ = 4102.8Å
- Hγ = 4340.0Å
- Hβ = 4861.3Å
- O[III] = 5006.8Å
- Hα = 6562.8Å
- S_2 = 6716.0Å


M31-22/02/95-FOS(HST)
Norm-Spec
line-1
line-2
line-3
Relative Flux
1.6
1.4
1.2
1.0
0.8
0.6
0.4
5000
5500
6000
6500
Wavelength [Å]
Mg I
Fe I
Na I

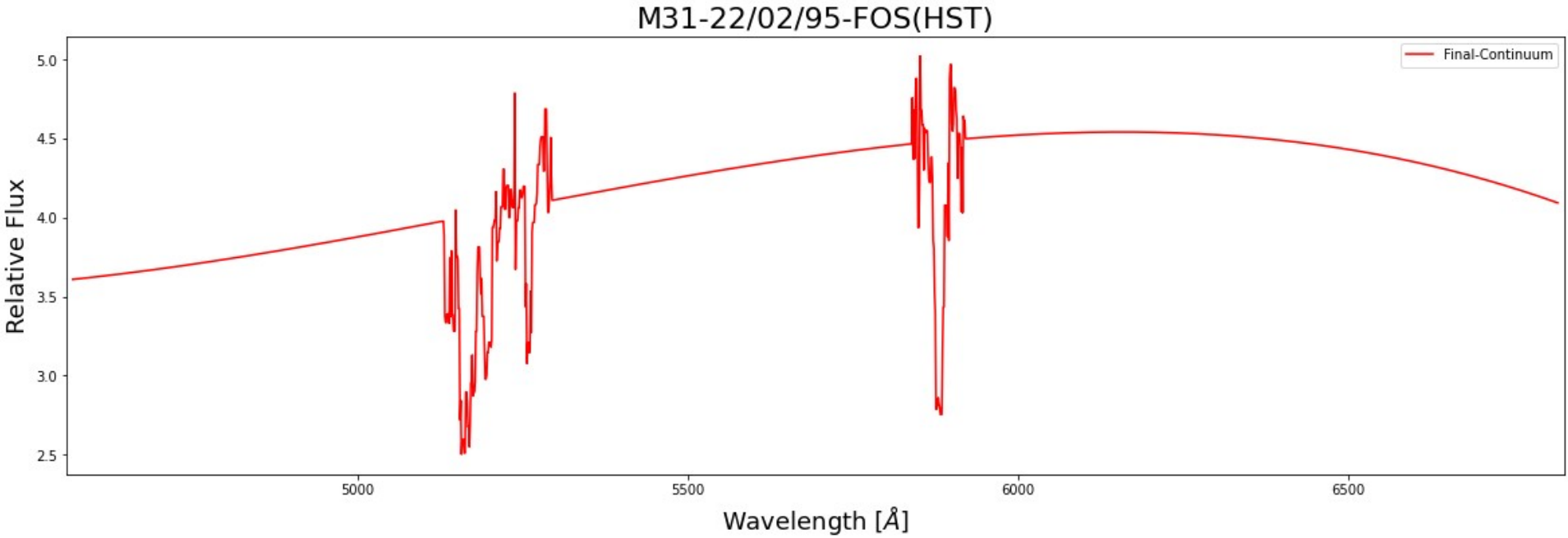
How was Line Fitting done?

- Absorption lines were Superimposed on the continuum fit

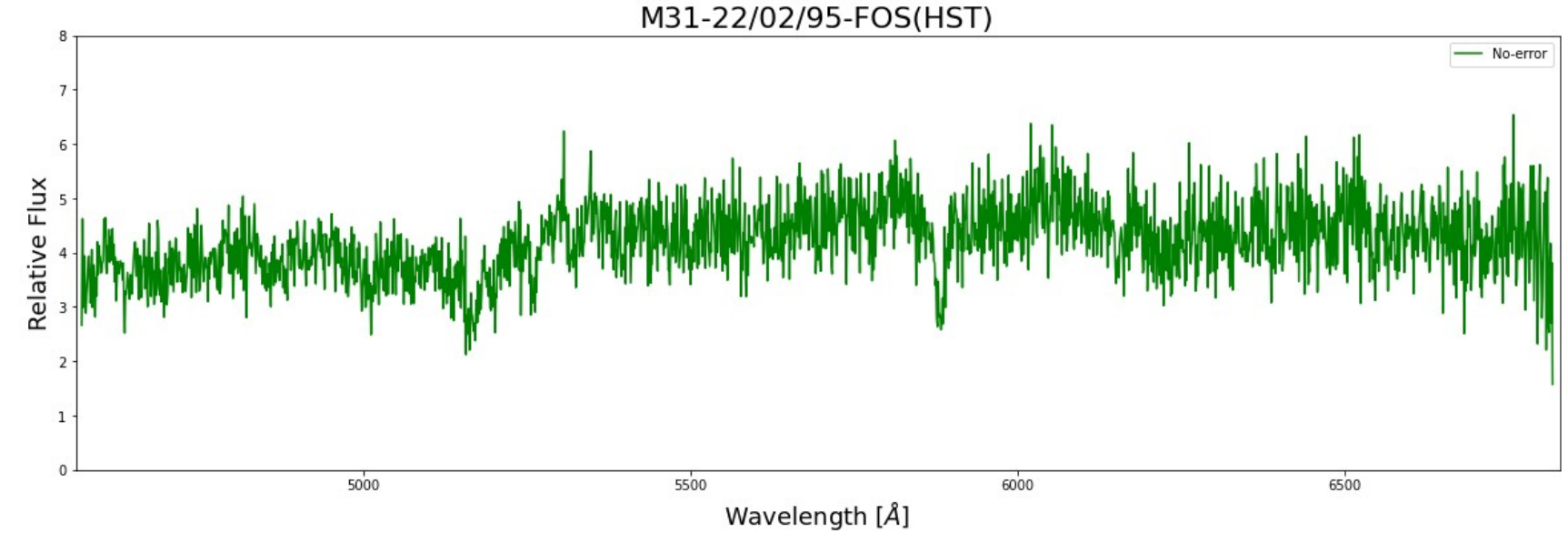


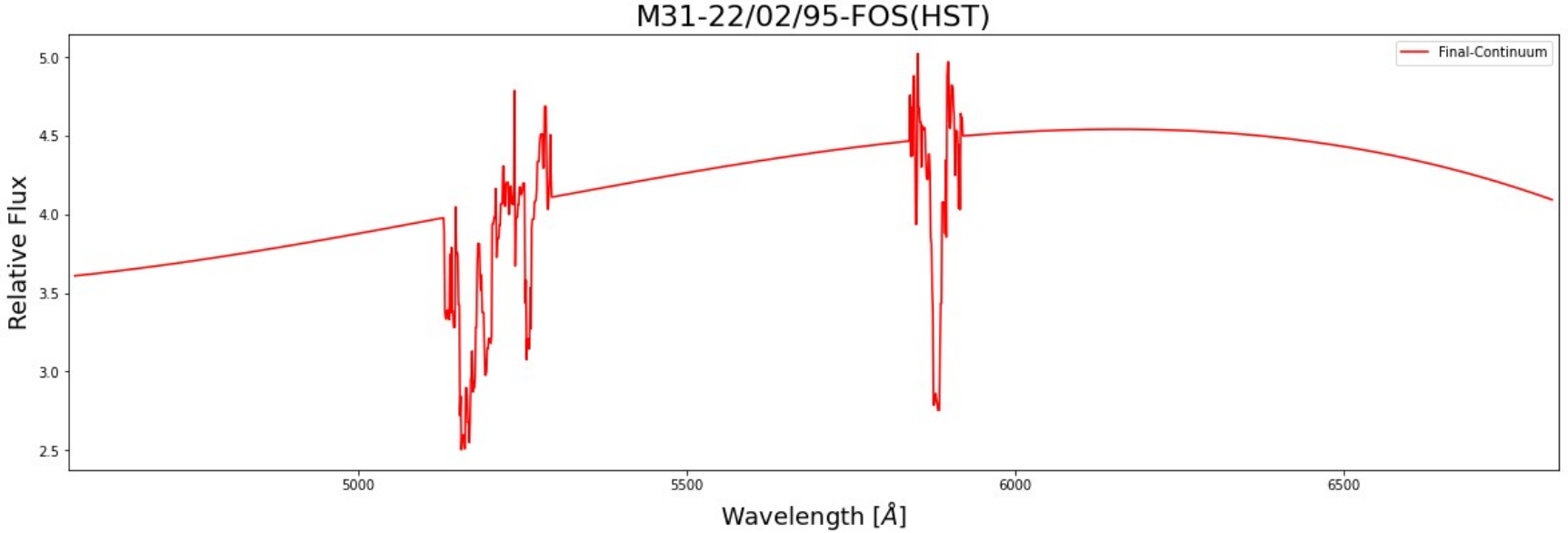
Smoothing of the Continuum

- The Spectra was passed through 1D-median-filter to smooth it out

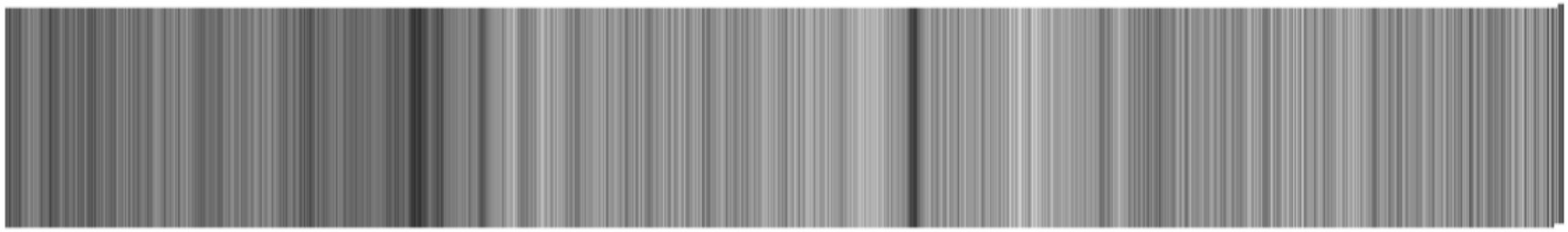


Comparison of Final Continuum with the Original Spectra

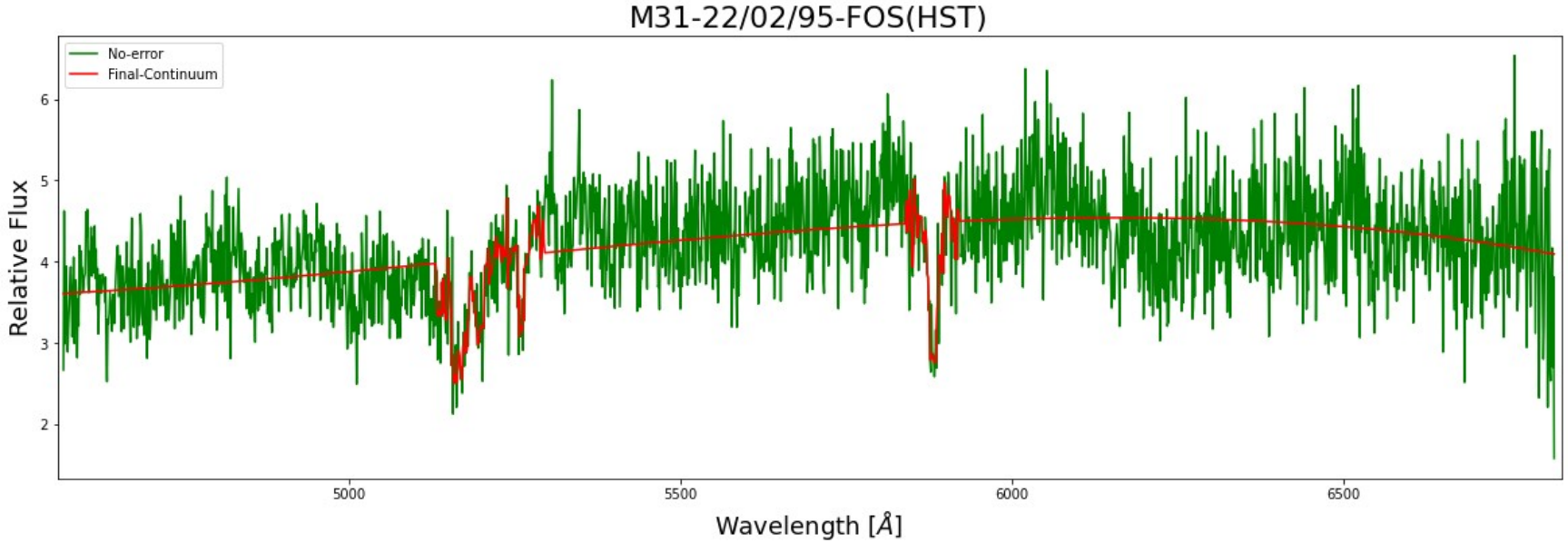

M31-22/02/95-FOS(HST)
No-error
Relative Flux
Wavelength [Å]
0
1
2
3
4
5
6
7
8
5000
5500
6000
6500

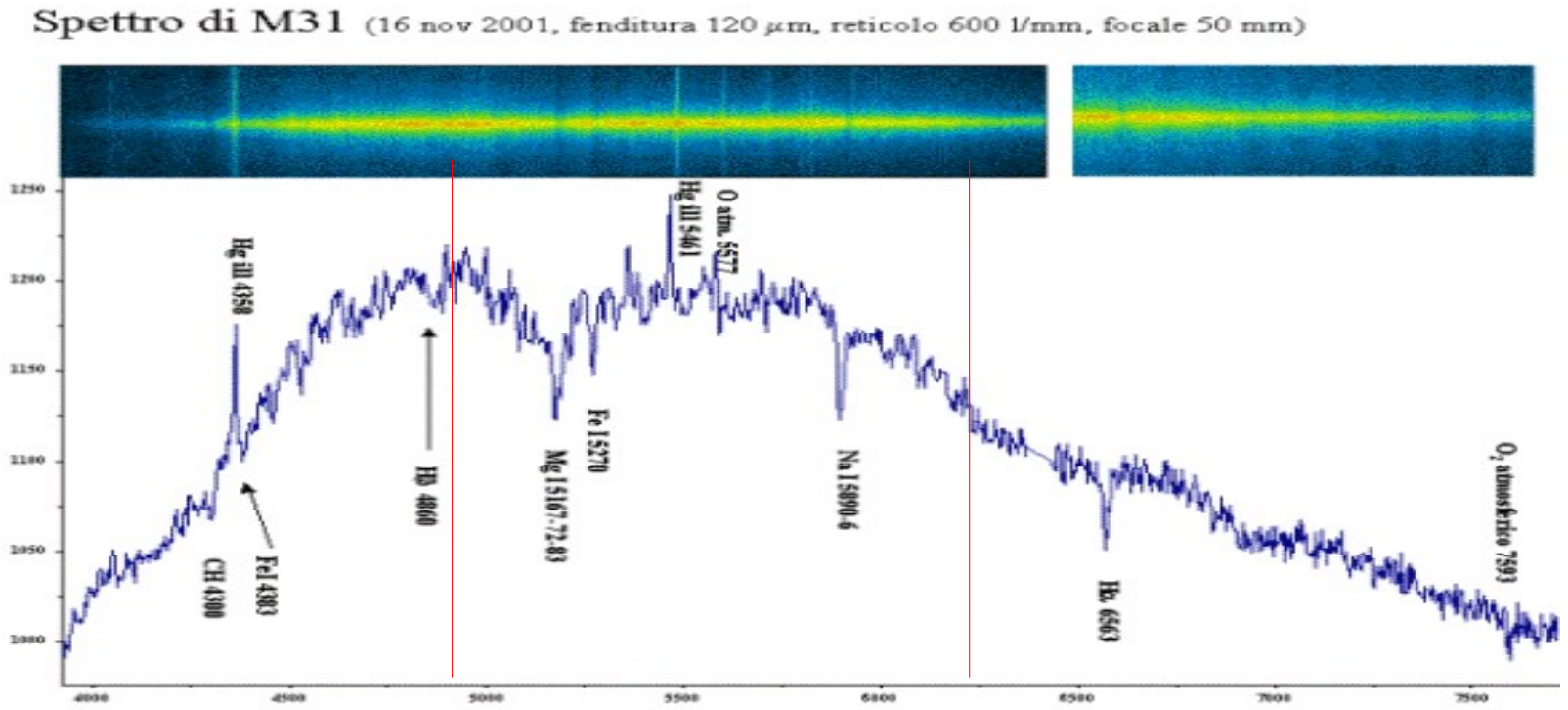

M31-22/02/95-FOS(HST)
Final-Continuum
Relative Flux
Wavelength [Å]
2.5
3.0
3.5
4.0
4.5
5.0
5000
5500
6000
6500

Original Spectra



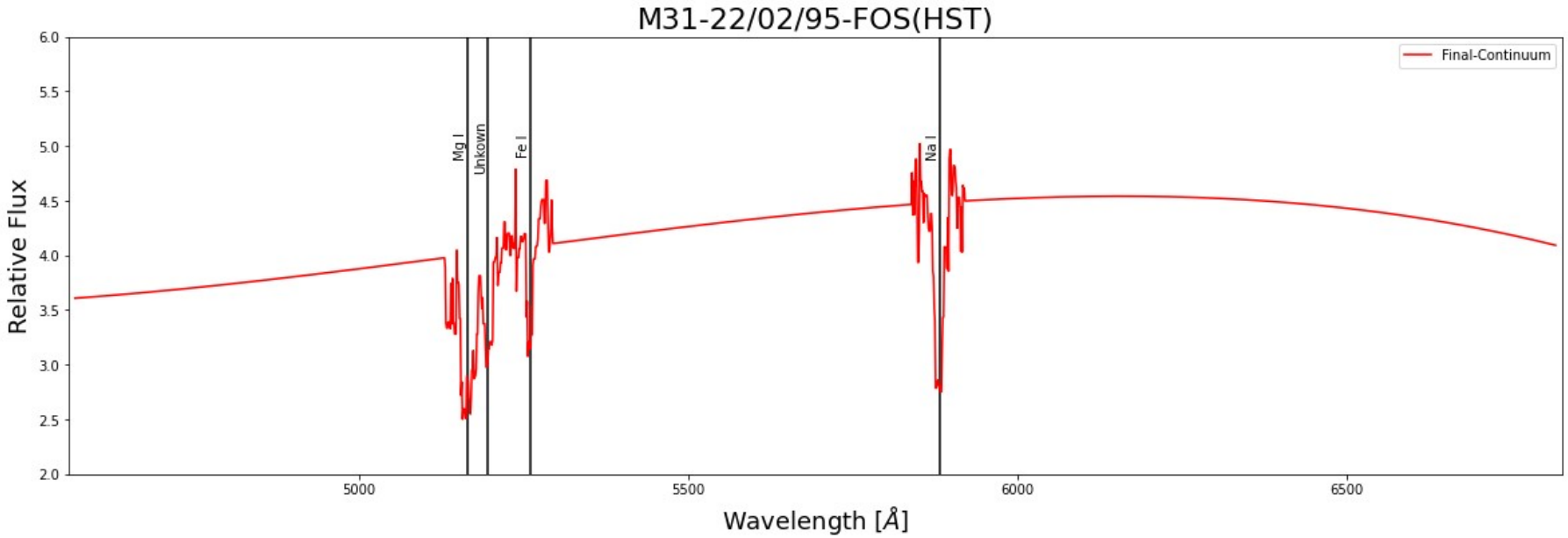
Final Continuum


M31-22/02/95-FOS(HST)
No-error
Final-Continuum
Relative Flux
Wavelength [Å]


Spettro di M31 (16 nov 2001, fenditura 120 μm, reticolo 600 l/mm, focale 50 mm)
Hg III 4358
CH 4300
Fe I 4383
Hβ 4860
Mg 15167-72-83
Fe 5270
Hg III 5461
O atm. 5577
Na 15890-6
Hα 6563
O2 atmosferico 7593

Spectral Lines

- 4 Absorption lines were found
- 3 lines were expected!!



Why is the 4^{th} line present?

- Could be due to fluctuation in the instrument
- Could be due the process used for fitting
- Could be a Random error

Deduction from the Analysis

Element finding

- 3 elements were identified in the region

  1)Mg I[5165Å]

  2)Fe I[5261Å]

  3)Na I[5881Å]

Properties of the region

- Old and red stars are present in the region because no emission lines were found
- Qualitative overview of the Spectra suggest that Popullation II stars are present in the region
- No evidence Ha was present. This implies no active star formation is going on in the region

How can the process be improved?

Gaussian modelling

- We can model the absoption lines as a 'Gaussian Distribution' becuase the broadening of the line is due to 'Thermal Doppler', meaning that the thermal jittering of molecules is producing the 'Line Broadening' effect

- This implies that the brodening will follow 'Central Limit Theorem', thus the distribution will be a Gaussian

What can further be done with the results?

- We can use the concept of 'Thermal Doppler' to get the Gas temperature and Velocity distribution of the region

- Redshift can be calculated which can be further used to get radial velocity of the Galaxy

- If the inclination of the Galaxy is known we can get the motion of the Galaxy

Further results coming soon :)

Thank You