Observational evidence of star formation stochasticity in the CALIFA dataset

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Stochasticity in star formation

Where does stochasticity arise?

- Star formation
  - Initial Mass Function (IMF)
    - $m_{min} - m_{max}$
    - Relative abundance
  - Cluster Mass Function (CMF)
  - Sampling of mass functions – SFR
  - Low SFR $\rightarrow$ Stochasticity[1]

[1] Fumagalli et. al. 2011

Stochasticity in star formation

- Example: weighted die
  - Smaller numbers are more likely

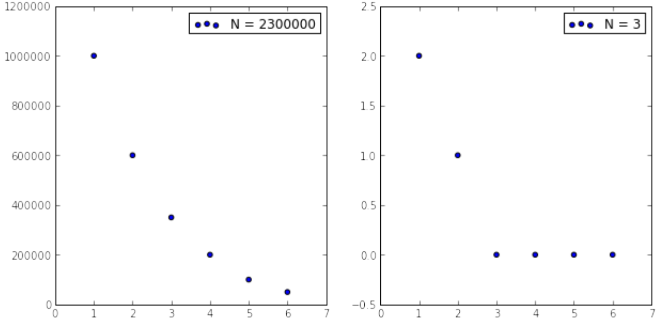

Figure: Caption

Motivation

General objective

"Look for observational evidence of stochasticity in star formation processes in the data published by CALIFA".

Specific objectives

- Develop a simple theoretical model to measure the effects of stochasticity in the EW of the H_α and O_{II} emission lines
- Analize data from the CALIFA survey collaboration
- Compare results between the observed data and the theoretical model
- Conclude if there is enough evidence to claim that stochastic effects have been detected in CALIFA data

Measuring stochasticity

How does stochasticity translate into observable quantities?

- Stochasticity causes fluctuation $\frac{H_\alpha}{H_\beta}$[2]
- SLUG: Stochastically Light Up Galaxies
- "We find that stochasticity alone induces a broad distribution in L_α and EW at a fixed SFR, and that the widths of these distributions decrease with increasing SFR" [3]

[2] Fumagalli et. al. 2011

[3] Forero-Romero, Dijkstra, 2012

Measuring stochasticity

- Balmer decrement
  - Interstellar dust
  - $\frac{H_\alpha}{H_\beta} = 2.85 \rightarrow \frac{H_\alpha}{H_\beta} \geq 2.85$[4]
  - Interstellar reddening

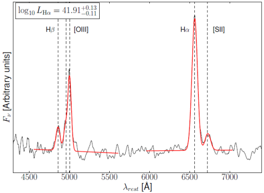

Figure: https://arxiv.org/pdf/1206.1867v2.pdf[5]

[4] Osterbrock, Astrophysics of Planetary Nebulae and Active Galactic Nuclei, University Science Books, 1989

[5] Domínguez et. al. 2012

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The CALIFA survey

- $\sim$ 600 galaxies
- "Largest and most comprehensive wide-field IFU survey of galaxies carried out to date"[6]

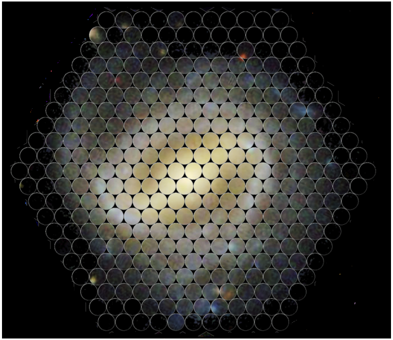

Figure: http://califaserv.caha.es/CALIFA/DATA/Figs/CALIFA_HexDR2.png

[6] Sánchez, et. al. 2011

The CALIFA datacubes

- 2 setups[7]
- V500
  - 3745 – 7500 Å
  - $^{\lambda}/_{\Delta\lambda} \sim 850$
- V1200
  - 3700 – 4800 Å
  - $^{\lambda}/_{\Delta\lambda} \sim 1650$

[7] Sánchez et. al. 2011

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Data analysis

- Fit spectral lines
  - Strong emission lines
  - Weak emission lines

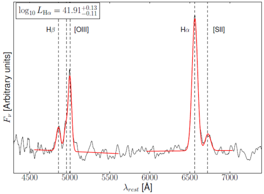


Figure: Spectral fit

Data analysis

- Pipe3D: analysis pipeline[8]
- *"The final product of the data reduction from both surveys is a regular grid datacube, with x and y coordinates that indicate the right ascention and declination of the target, and the z coordinate a common step in wavelength..."*

[8] Sánchez et. al. 2016

Preliminary results

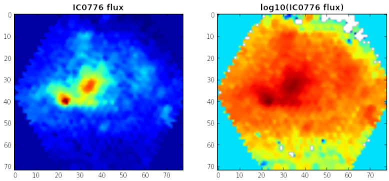


Figure: IC0776

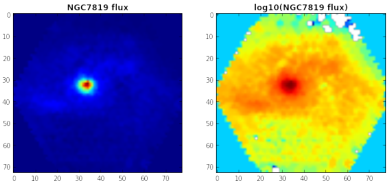


Figure: NGC7819

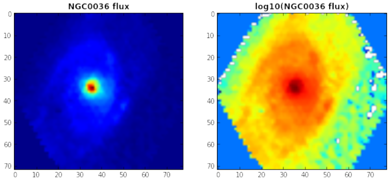


Figure: NGC0036

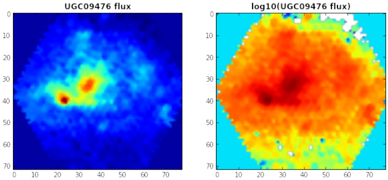


Figure: UGC09476

Preliminary results

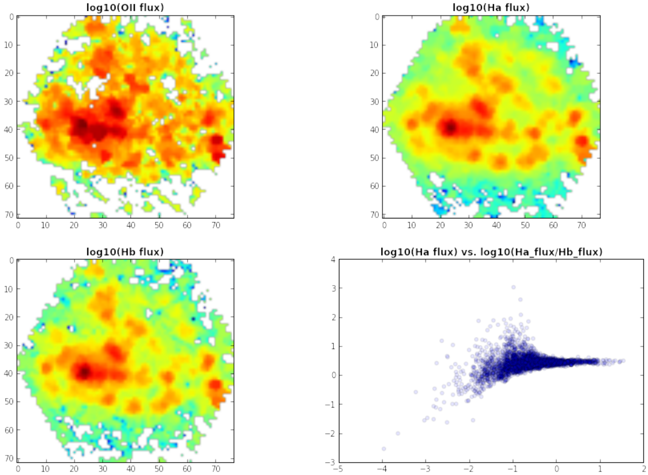


Figure: IC0776

Preliminary results

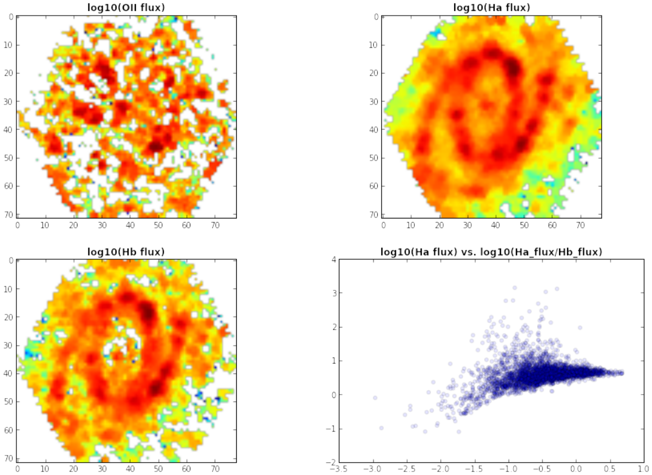


Figure: NGC0036

Preliminary results

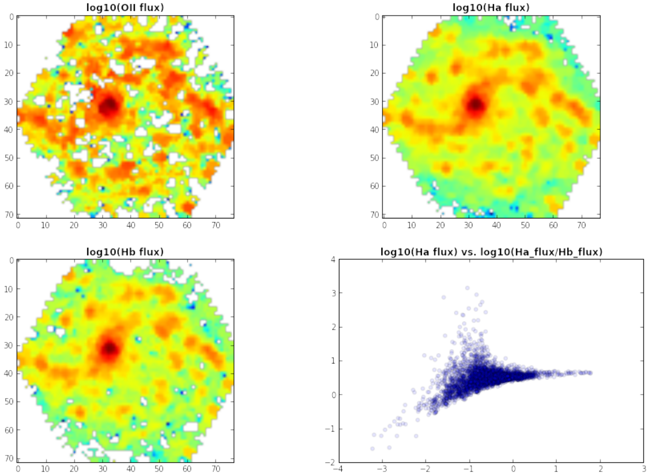


Figure: NGC7819

Preliminary results

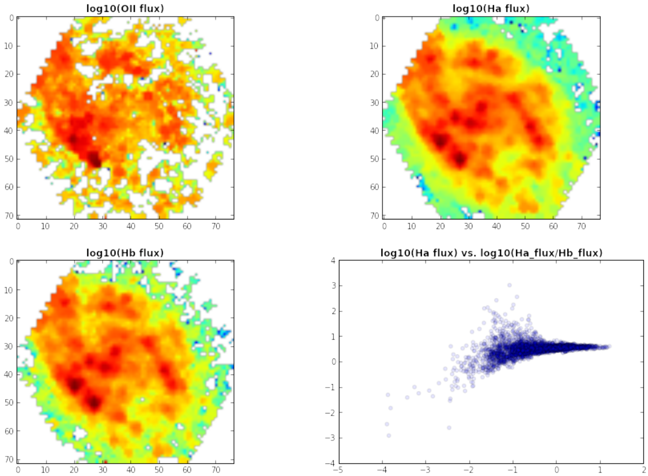
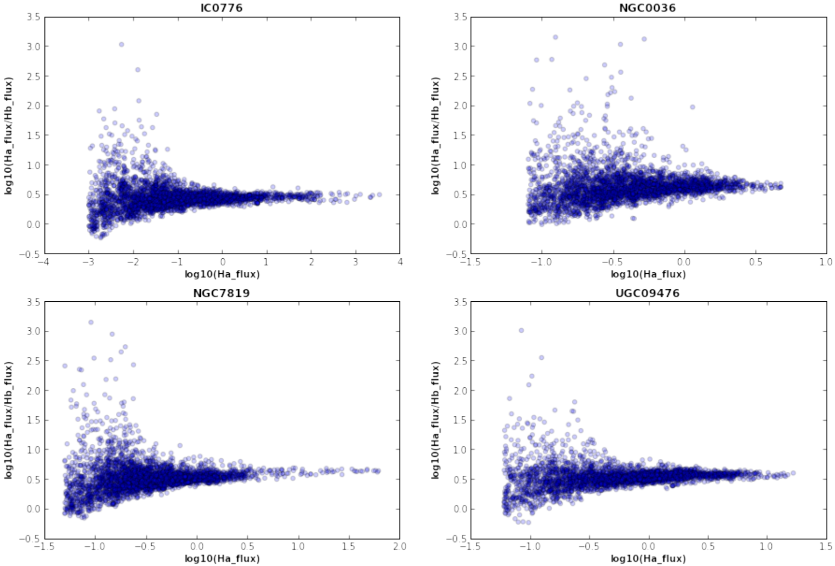
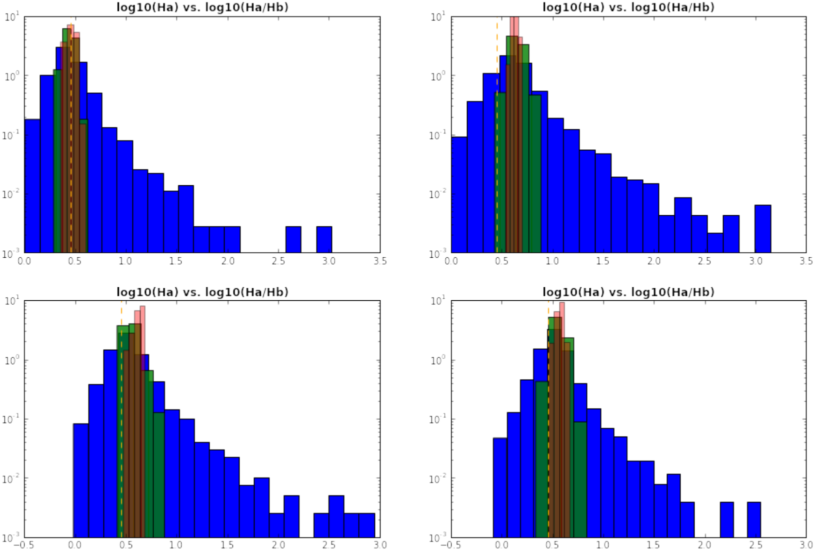


Figure: UGC09476

Preliminary results



Preliminary results



Remaining work

Tareas \ Semanas	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	X	X	X													
2			X	X	X											
3					X	X	X									
4								X	X	X	X					
5												X	X			
6													X	X	X	
7											X	X	X	X	X	X

- Task 1: Learn to work with CALIFA data
- Task 2: Calculate intensity ratios for a single galaxy
- Task 3: Redact first draft
- Task 4: Analyze results for all galaxies
- Task 5: Compare results found with theoretical predictions
- Task 6: Conclude if stochastic effects are observed
- Task 7: Redact final document