

Observational evidence of star formation stochasticity in the CALIFA dataset

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Undergraduate thesis advance
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 - Stochasticity in star formation
 - Measuring stochasticity
- 2 The CALIFA survey
 - CALIFA datacubes
- 3 Data analysis
 - Preliminary results



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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 Stochasticity¹

¹Fumagalli et. al. 2011



Stochasticity in star formation

- Example: weighted die
 - Smaller numbers are more likely

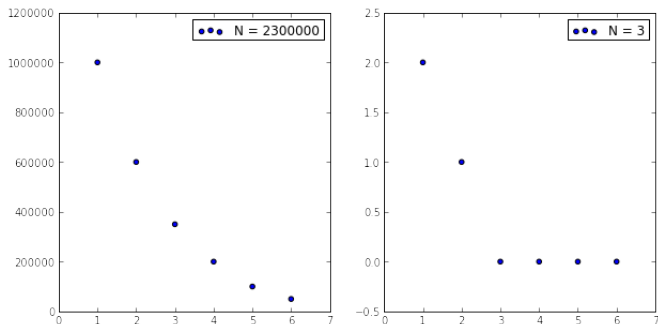


Figure: Left: Die is cast many times. Right: Die is cast 3 times



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
- Analyze 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



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

²Fumagalli et. al. 2011

³Forero-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

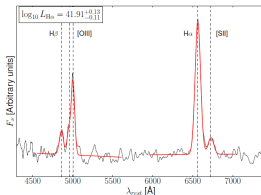


Figure: <https://arxiv.org/pdf/1206.1867v2.pdf>⁵

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

⁵Domínguez et. al. 2012



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The CALIFA survey

- ~ 600 galaxies
- “Largest and most comprehensive wide-field IFU survey of galaxies carried out to date”⁶

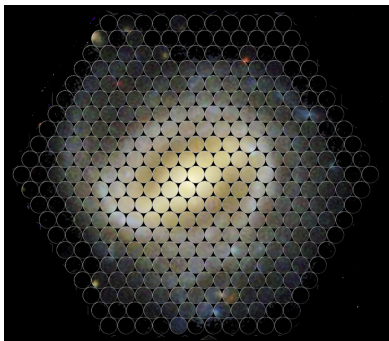


Figure: http://califaserv.caha.es/CALIFA/DATA/Figs/CALIFA_HexDR2.png

⁶Sánchez, et. al. 2011

The CALIFA datacubes

- 2 setups⁷
- V500
 - 3745 – 7500 Å
 - $\lambda/\Delta\lambda \sim 850$
- V1200
 - 3700 – 4800 Å
 - $\lambda/\Delta\lambda \sim 1650$

⁷Sánchez et. al. 2011



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Data analysis

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

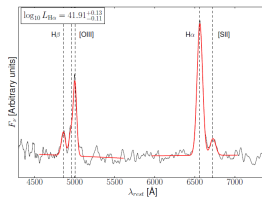


Figure: Spectral fit



- Pipe3D: analysis pipeline⁸
- *“The final product of the data reduction from both surveys is a regular grid datacube, with x and y coordinates that indicate the right ascension and declination of the target, and the z coordinate a common step in wavelength...”*

⁸Sánchez et. al. 2016



Preliminary results

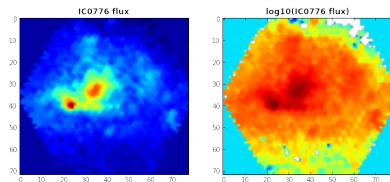


Figure: IC0776

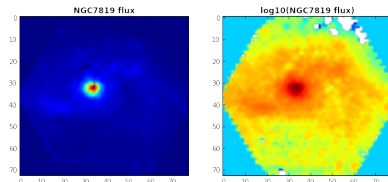


Figure: NGC7819

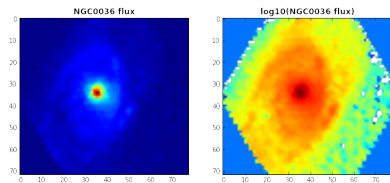


Figure: NGC0036

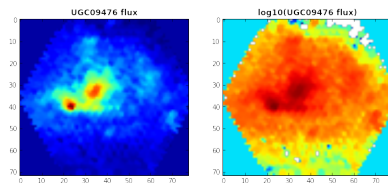


Figure: UGC09476

Preliminary results

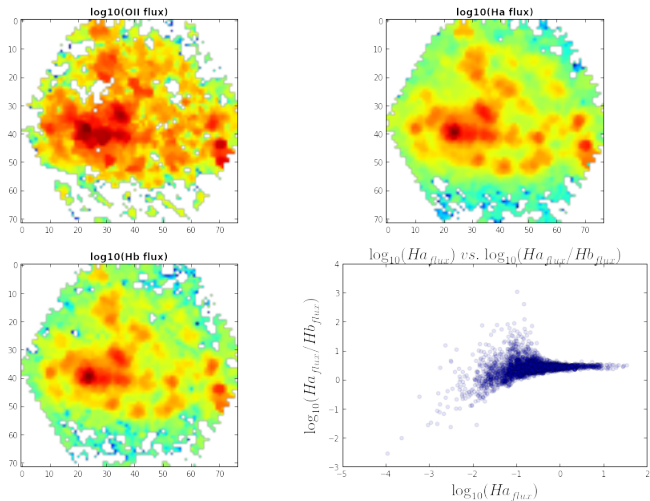


Figure: IC0776



Preliminary results

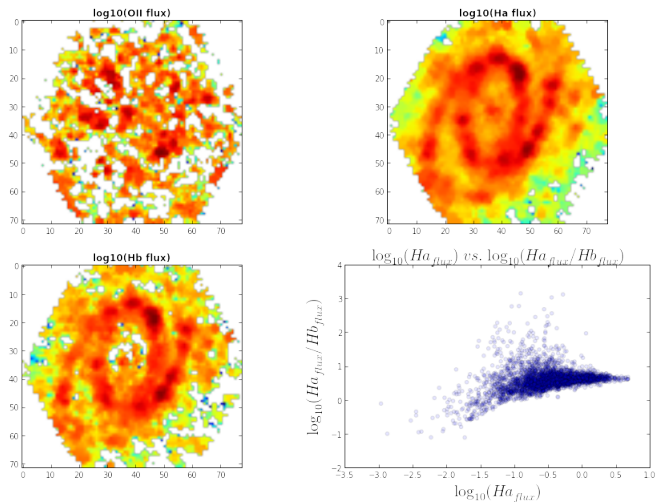


Figure: NGC0036



Preliminary results

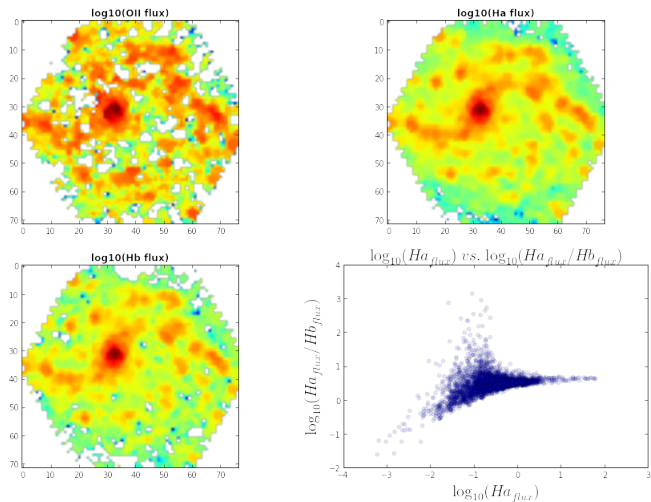


Figure: NGC7819



Preliminary results

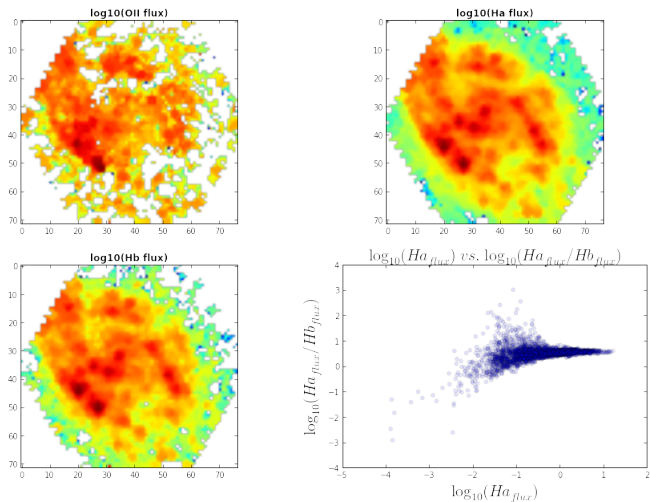
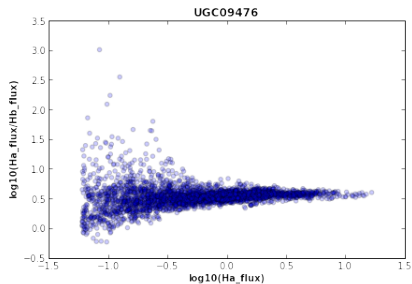
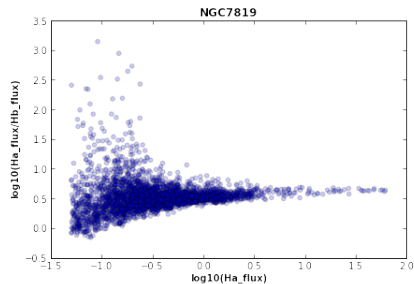
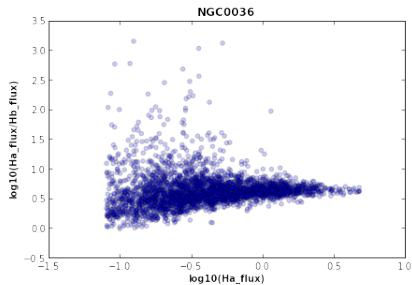
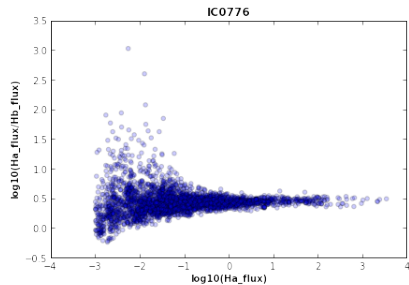


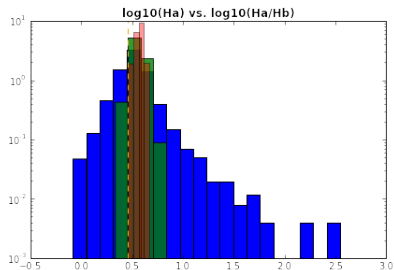
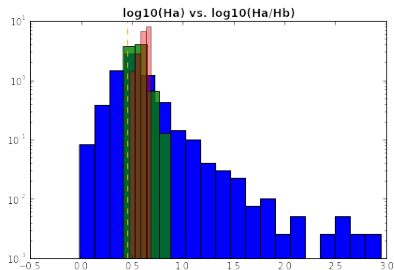
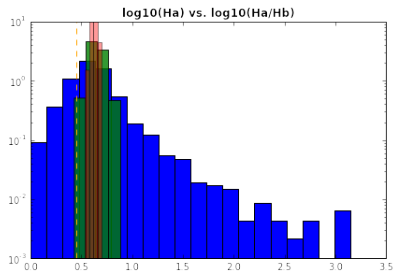
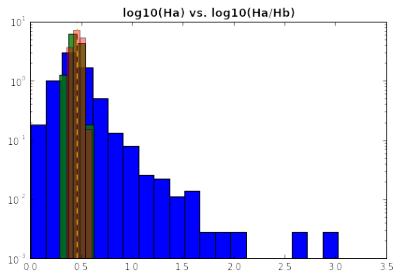
Figure: UGC09476



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

