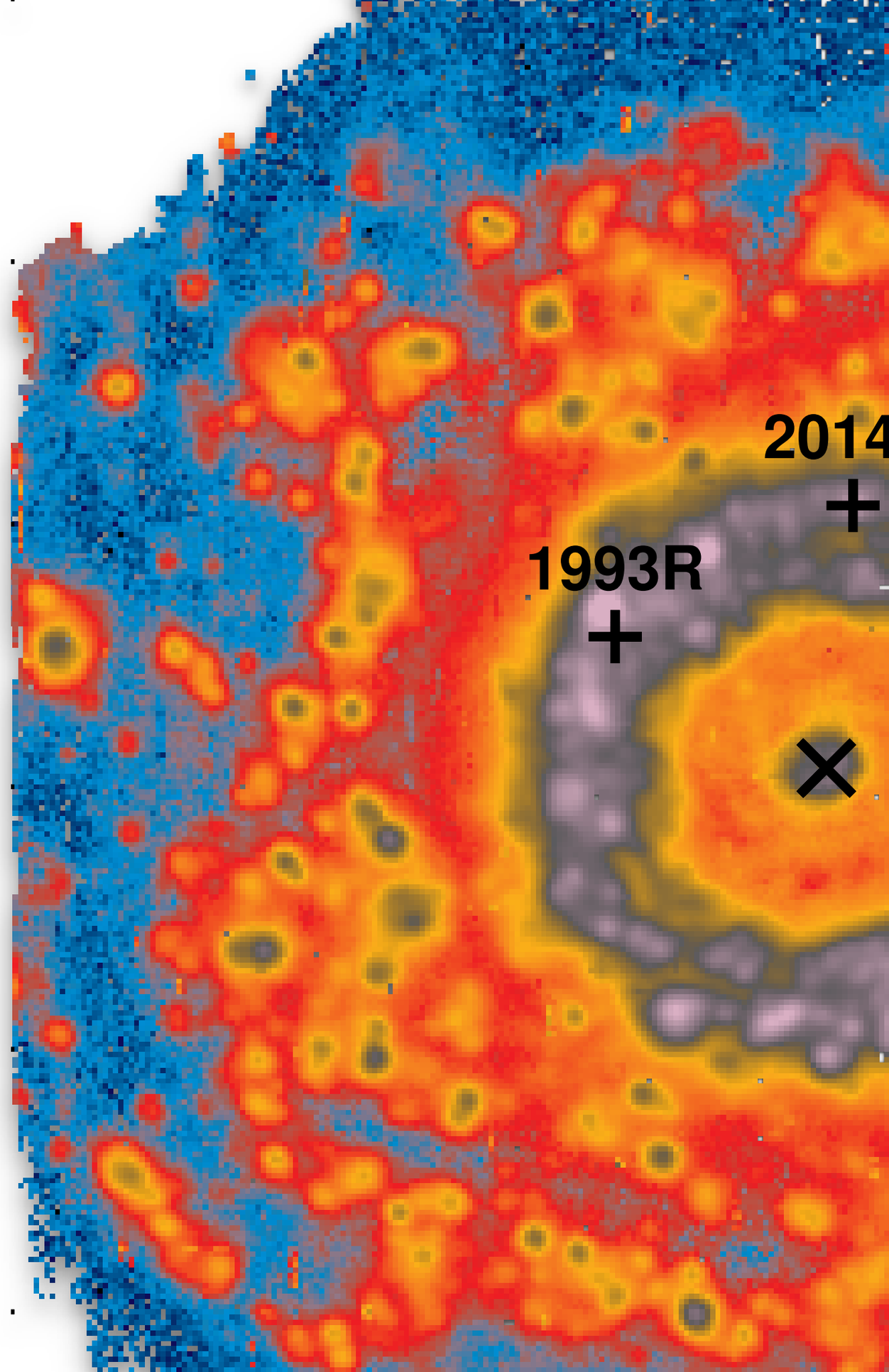
IFS SN host surveys: Dones and TODOs

Lluís Galbany (MSCA, U. Granada)

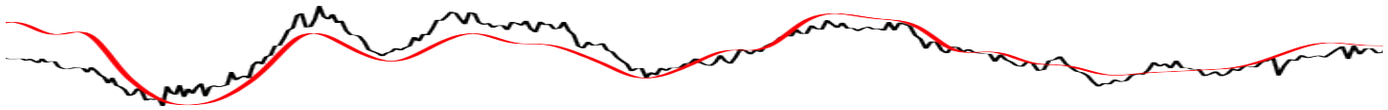
Southampton, 23 September 2019

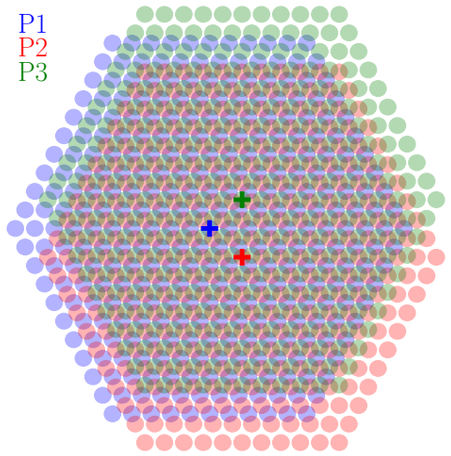


Marie Skłodowska-Curie Actions

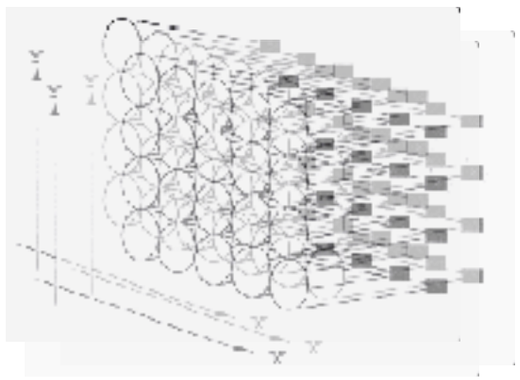
UNIVERSIDAD DE GRANADA

Integral Field Spectroscopy

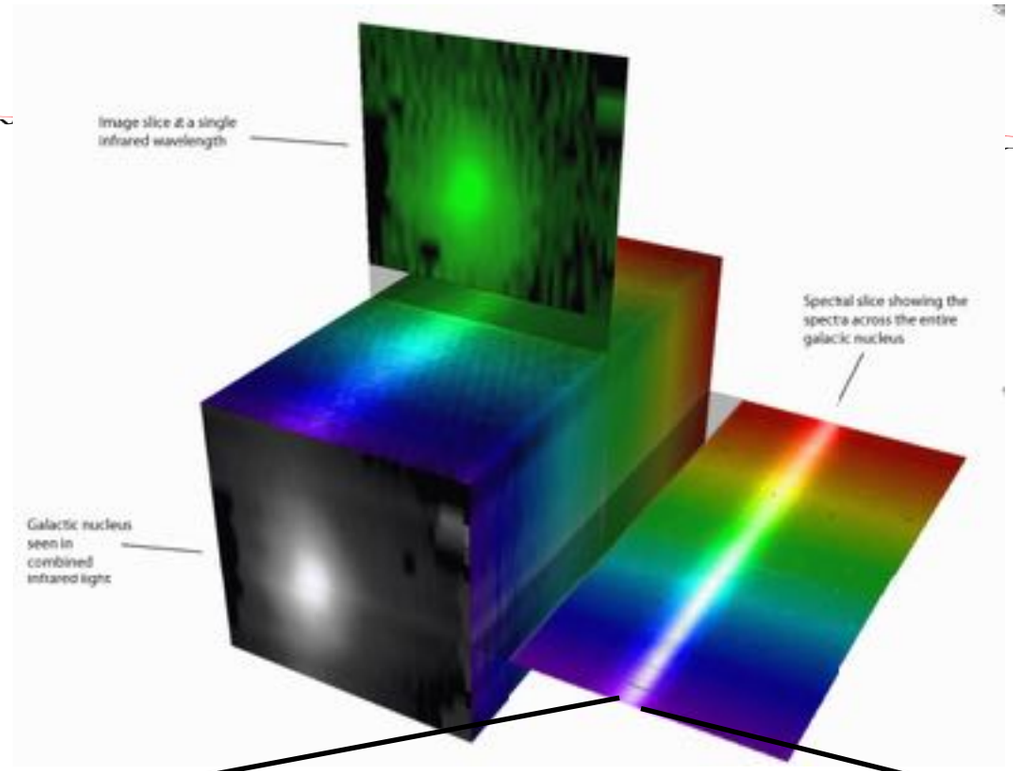


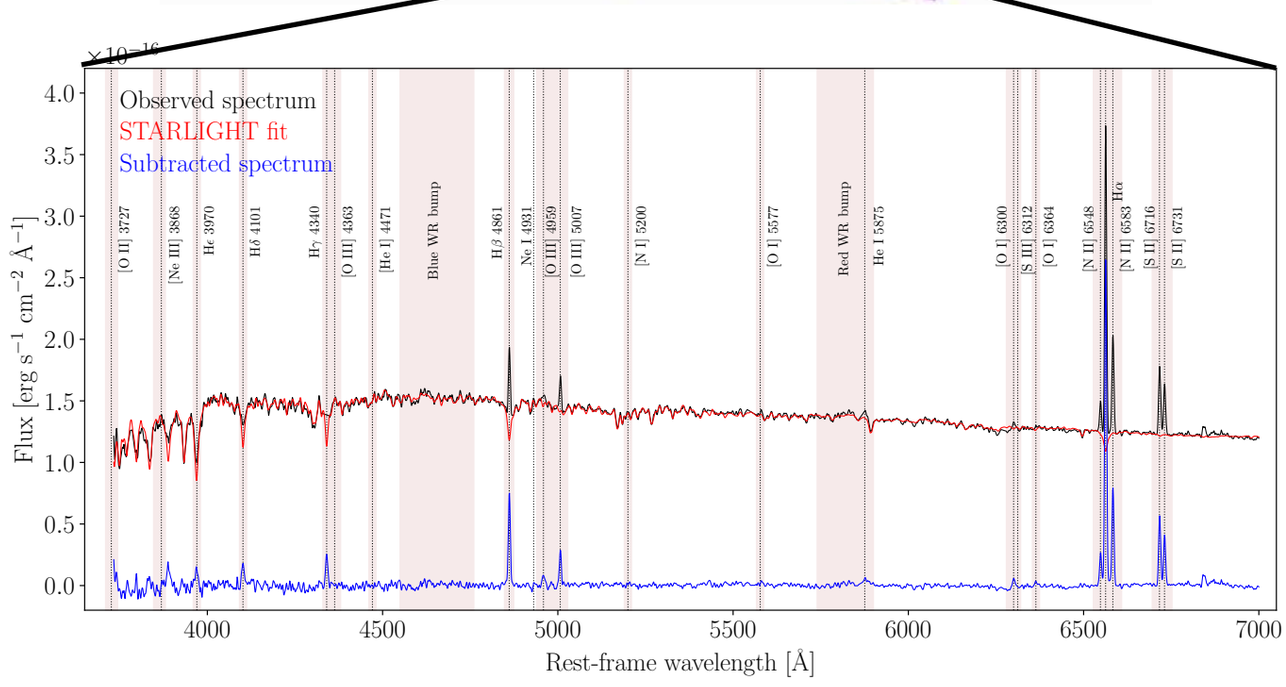


Fiber bundle

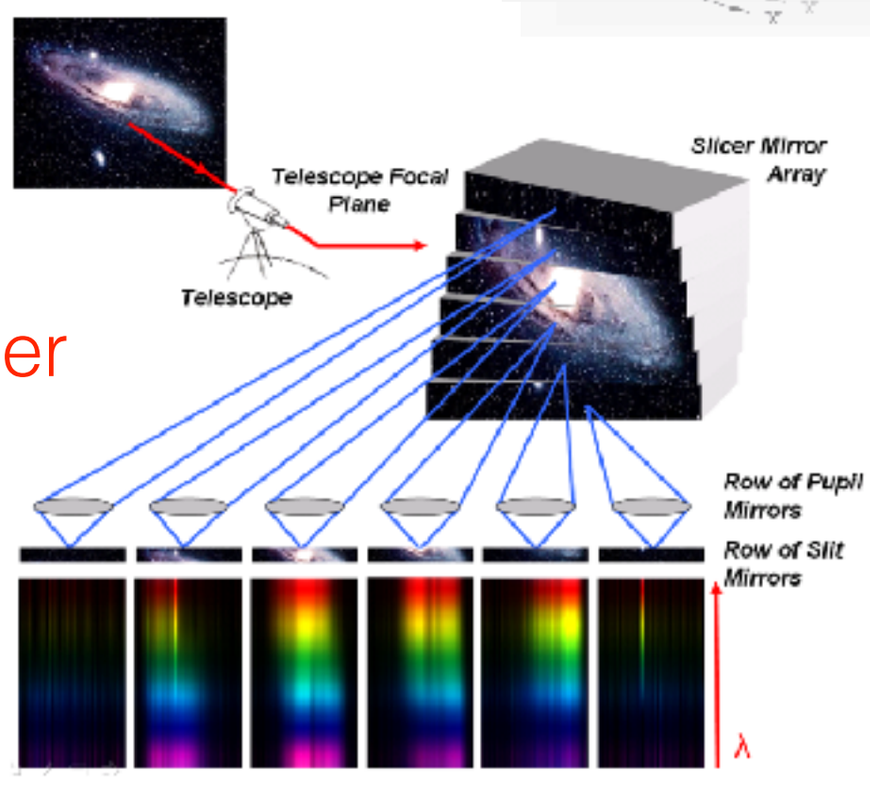


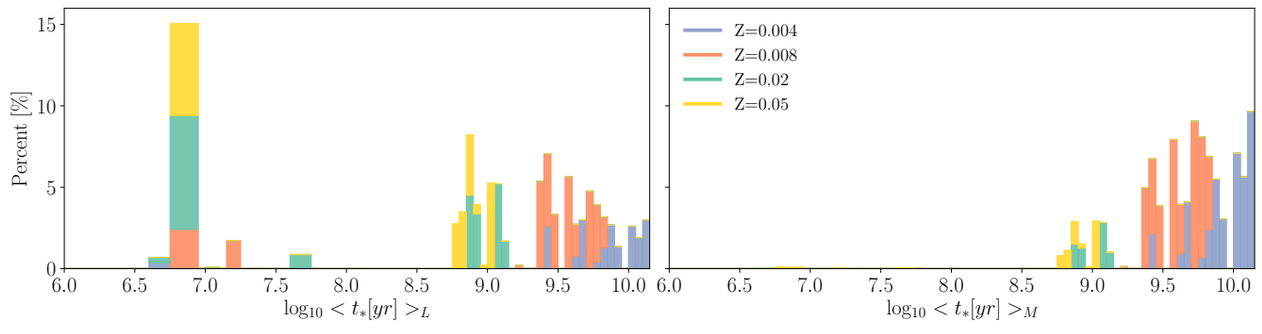
Lenslet

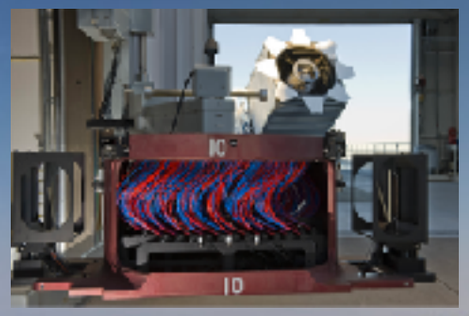




Slicer







BOSS

APO 2.5m

PMAS

Calar Alto 3.5m

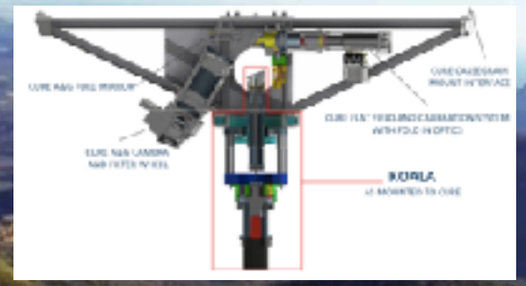
VIMOS

MUSE

KMOS

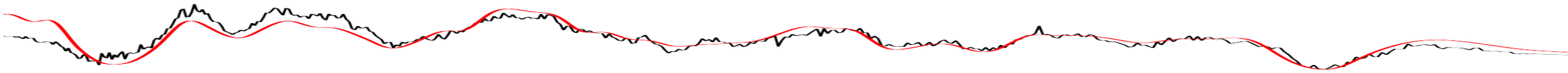
Paranal 8.2m

KOALA

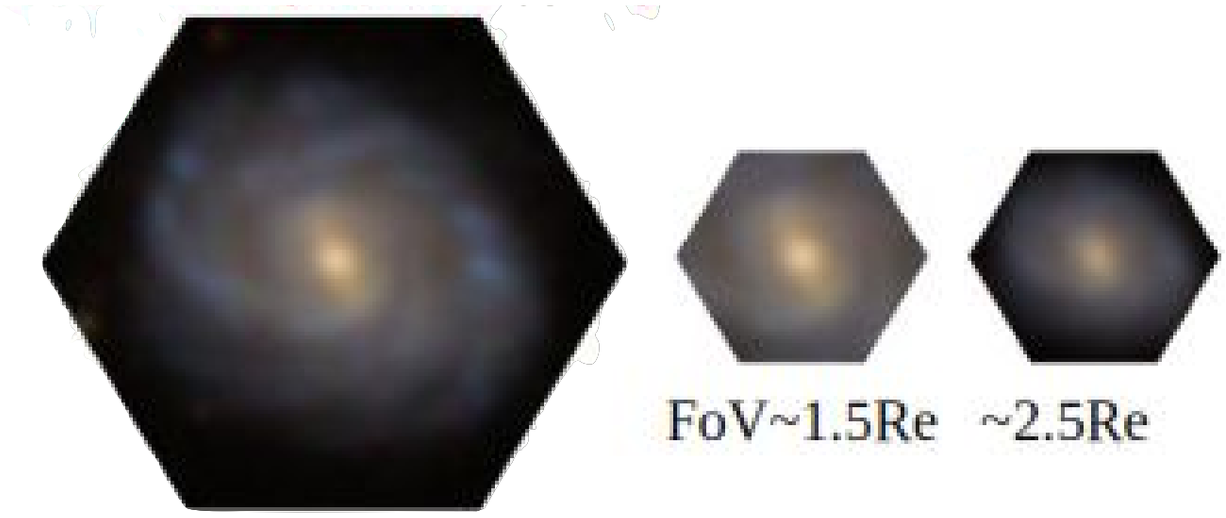


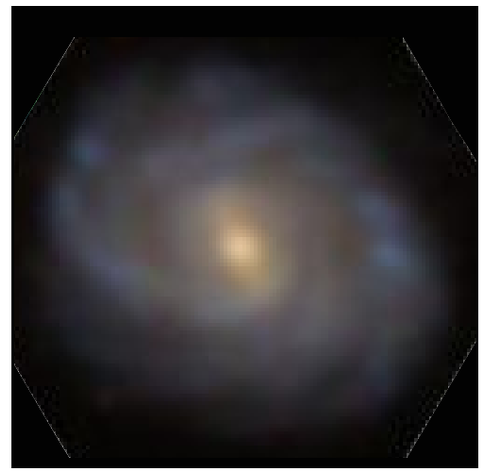
Siding Spring 3.9m

IFS data available



	PMAS	MaNGA	MUSE	KOALA
Field of view	70”x70”	30”x30”	60”x60”	30”x60”
Spectral Resolution	R~500-1200	R~2000	R~1700-3500	R~1300-3700
Number of spectra	~5,000 sp	~2,000 sp	~90,000 sp	~1,000 sp
Spatial Resolution	1”/spaxel	0.5”/spaxel	0.2”/spaxel	0.5”/spaxel
Wavelength coverage	3700-7500	3600-10000	4650-9300	3700-8000





	PMAS	MaNGA	MUSE	KOALA
#	375/942	129/~6000	443/427	44+
	Includes CALIFA DR3 and unpublished extensions, archival data, and **PISCO**	MaNGA public data, ancillary program for SN host galaxies (PI Galbany)	**AMUSING** survey and archival data	Includes Hi-KIDS and 1 (18A) semester data

PiSCO

the Pmas/ppak Integral-field Supernova host COmpilation

HG/SNe

- 110/129 from CALIFA DR3
- 4/4 from the CALIFA pilot study (PI: Sánchez)
- 8/12 from the PINGS Survey (PI: Rosales-Ortega)
- 4/5 from H09-3.5-068 (Local SNIa prop.; PI: Stanishev)
- 24/31 from CALIFA-extensions

150/181

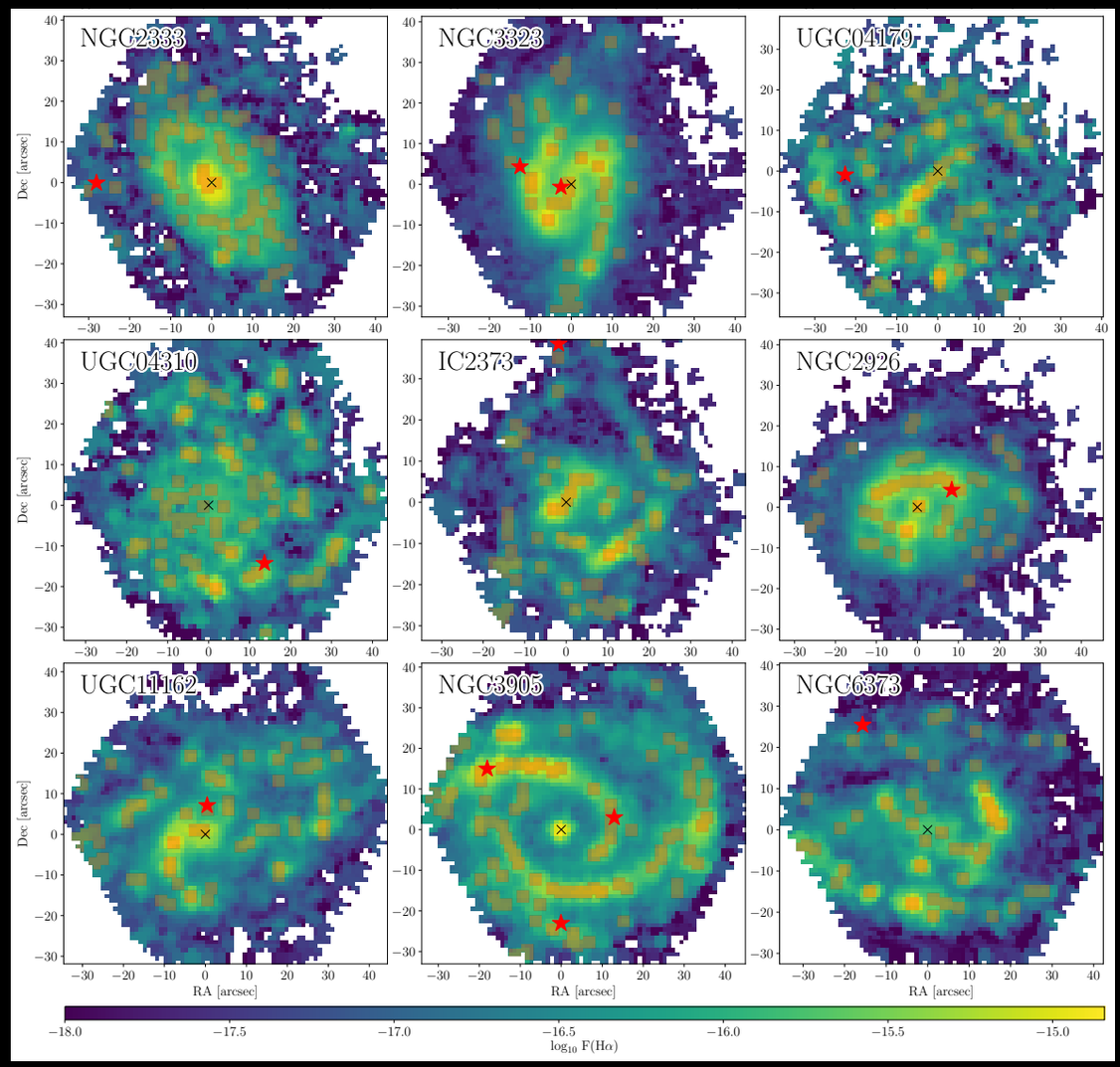
9 semesters

- 46/55 from H15B-3.5-004: Low-mass CC SNe hosts
- 29/36 from F16A-3.5-006: SNe with strong Na I D
- 7/8 from H16B-3.5-012: SNe Ia in the NIR
- 7/10 from F17A-3.5-001: SNe Ia in the NIR II
- 13/13 from H17B-3.5-001: SNe Ia in the NIR III
- 16/16 from F18A-3.5-013: CSP SNe Ia
- 50/50 from H18B-3.5-008: CSP SNe Ia
- 9/13 from F19A-3.5-001: CSP SNe Ia
- 11/12 from H19B-3.5-002: CSP SNe Ia

188/213

338/394 galaxies/SNe

214 Ia, 180 CC: 116 II (incl. 25 n), 64 SE (21 b 24 c 13 IIb)



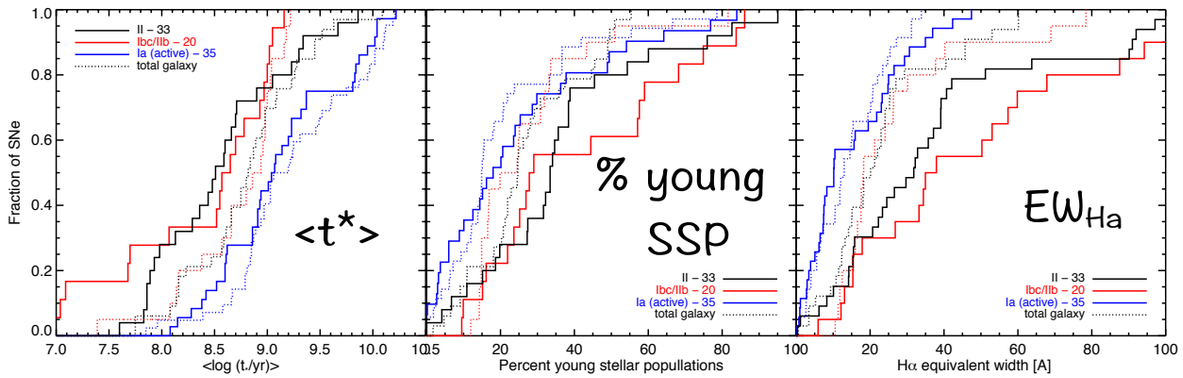
LG et al. 2018, ApJ 855:107

PISCO results

Nearby supernova host galaxies from the CALIFA Survey:

I. Sample, data analysis, and correlation to star-forming regions

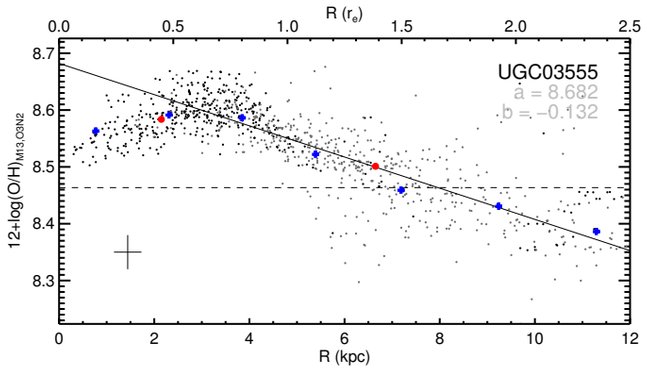
LG et al. 2014, A&A, 572, A38

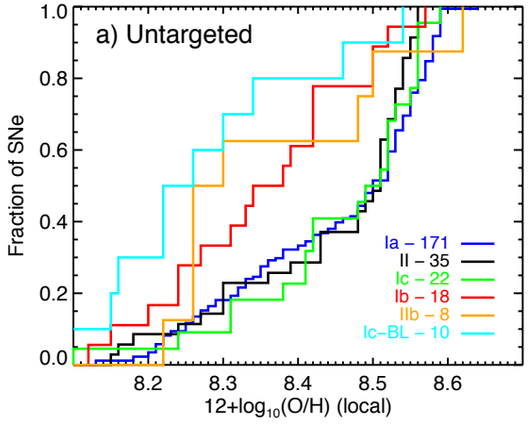


Nearby supernova host galaxies from the CALIFA Survey:

II. SN environmental metallicity

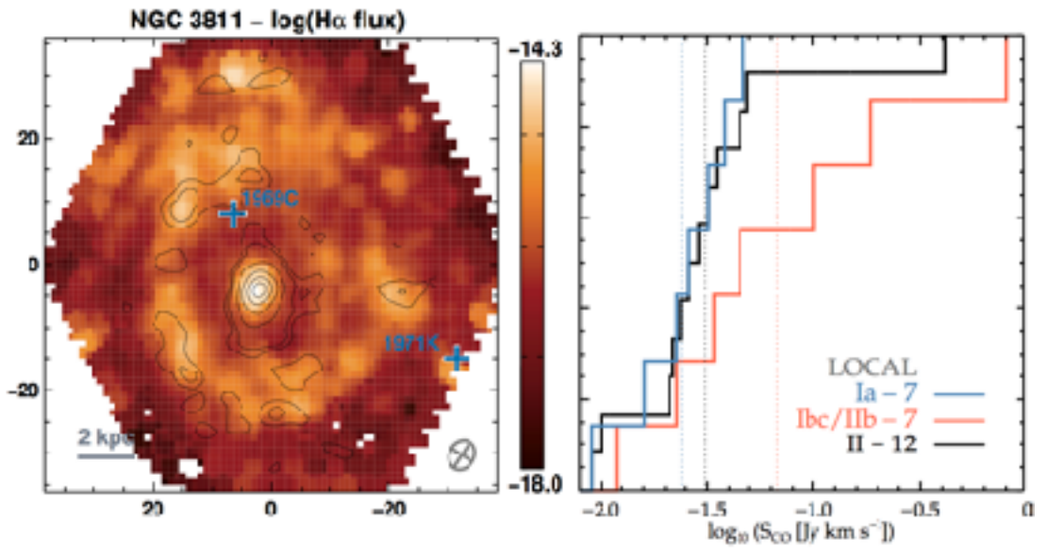
LG et al. 2016a, A&A, 591, A48





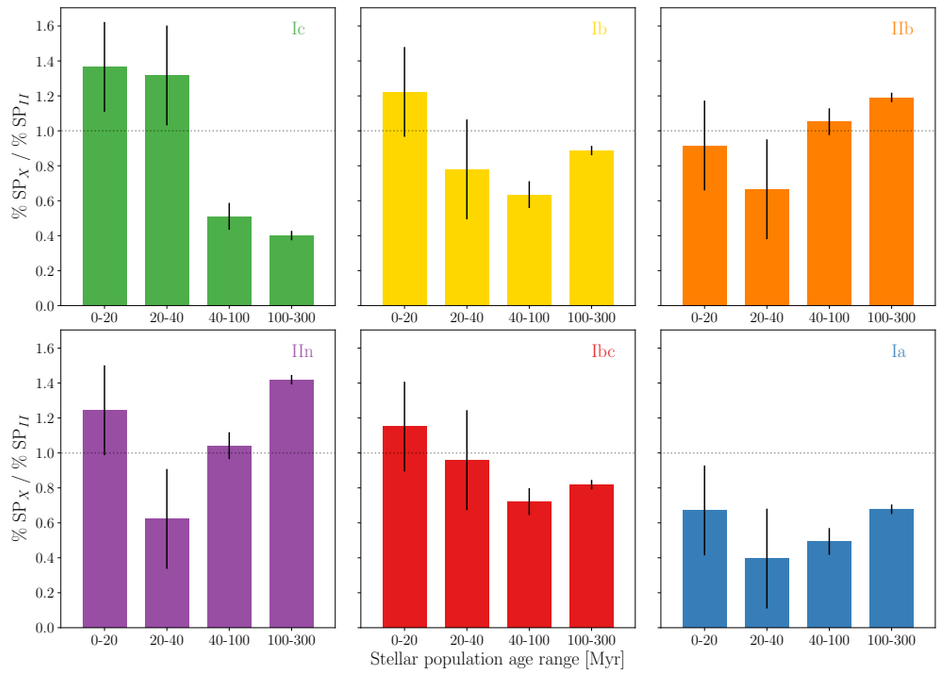
Molecular gas in supernova local environments unveiled by EDGE

LG et al. 2017, MNRAS, 468, 628

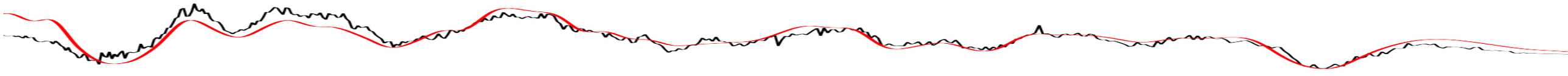


PISCO: The PMAS/PPak Integral-field Supernova Hosts Compilation

LG et al. 2018, ApJ, 855, 107

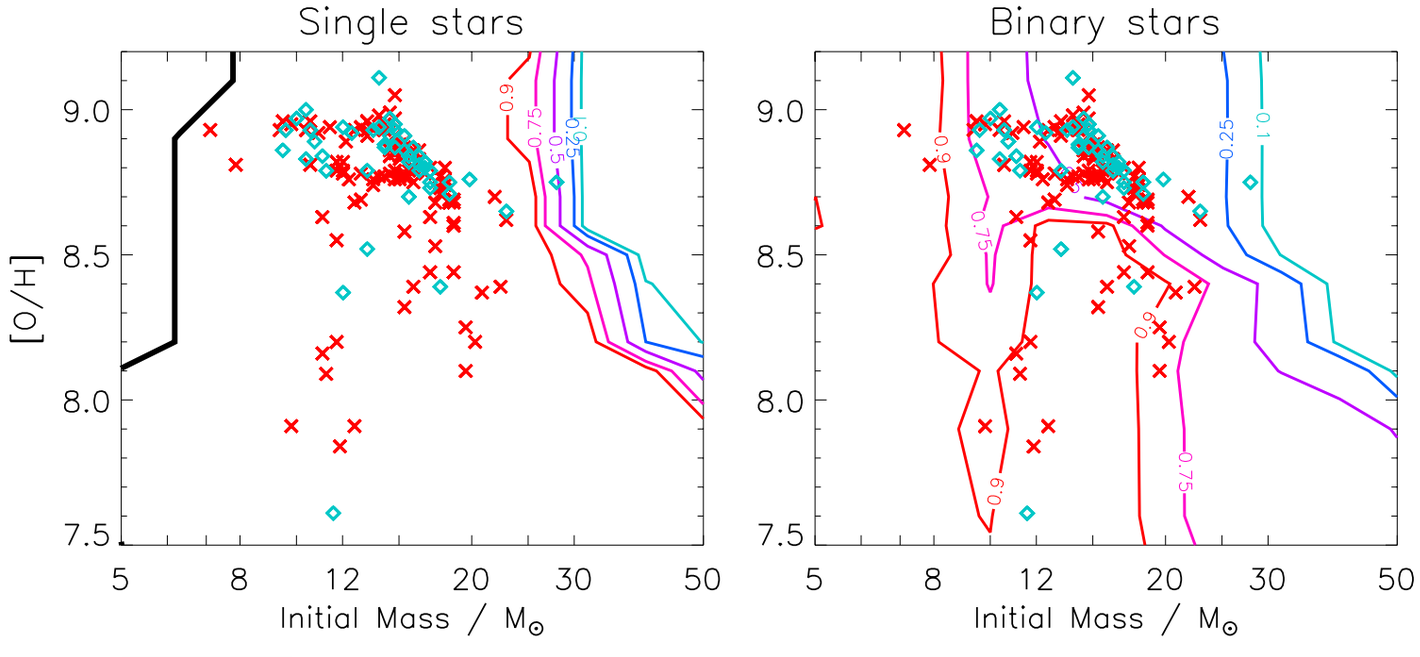


PISCO results



CCSN binary models

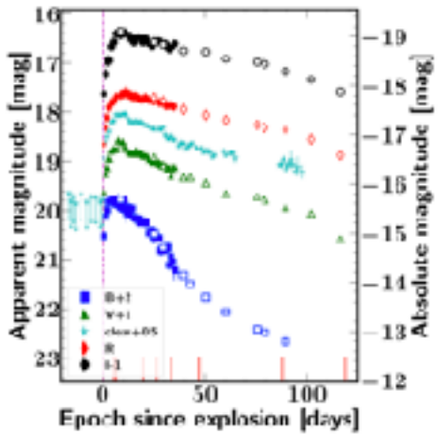
Lin Xiao, LG, JJ Eldridge +2019

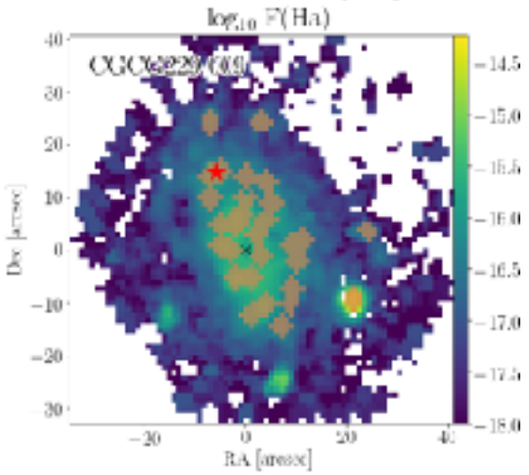


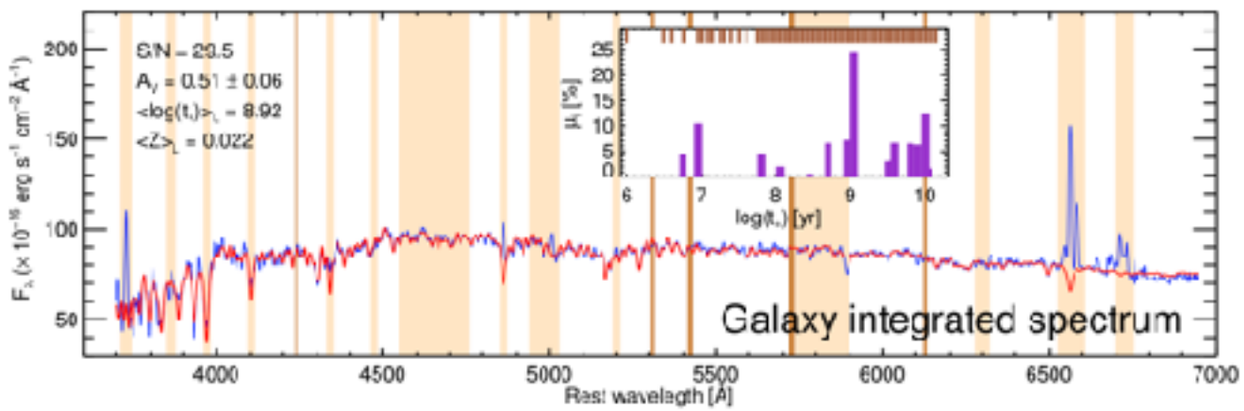
Single SN papers

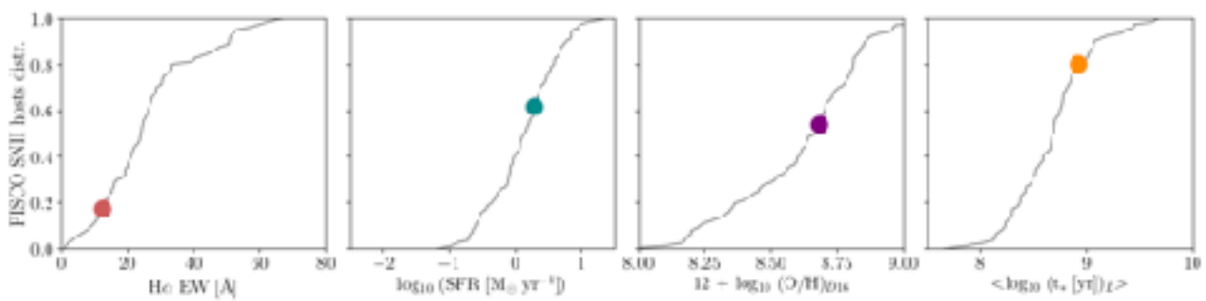
SN 2016esw

Thomas de Jaeger +2018



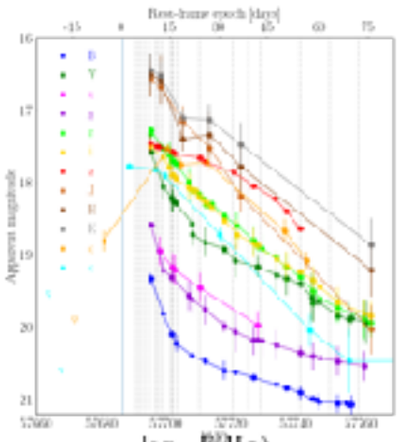


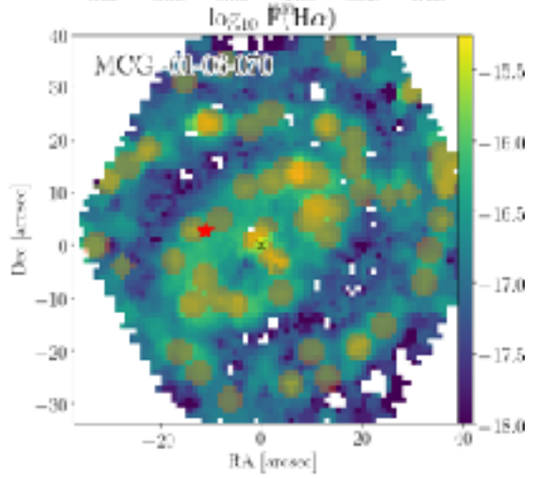




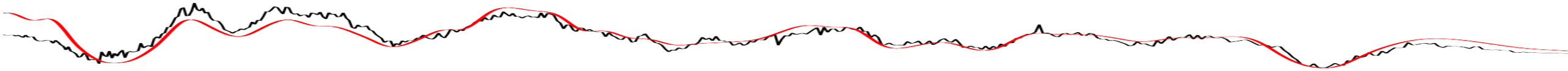
SN 2016hnk

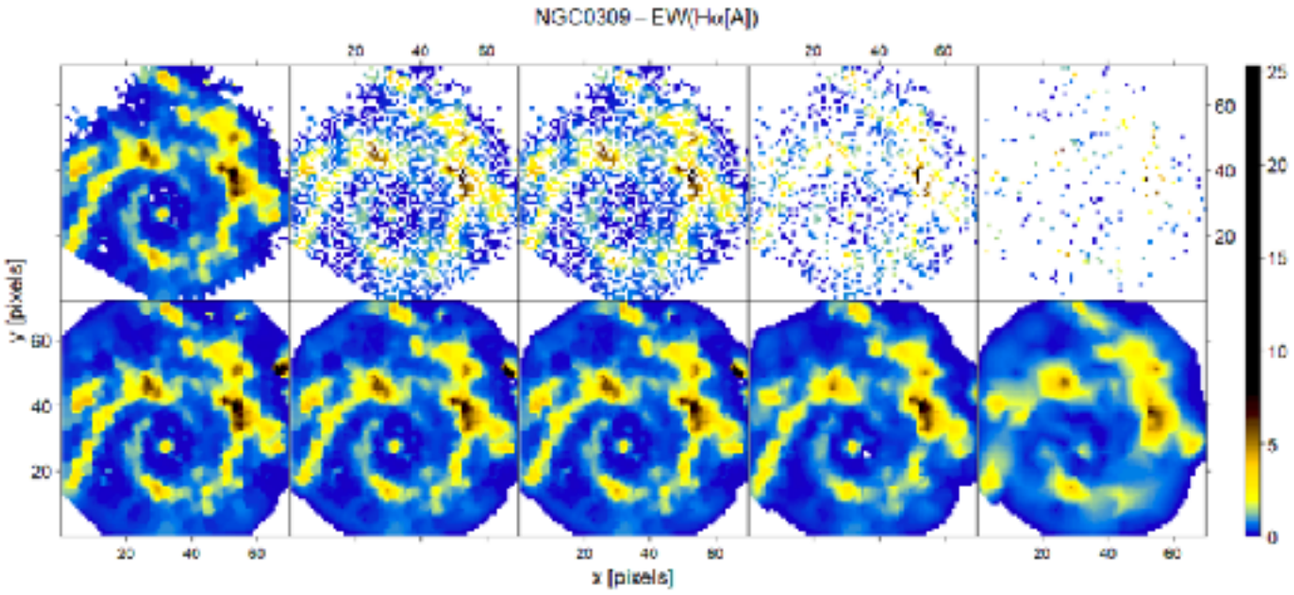
LG +2019





PISCO results



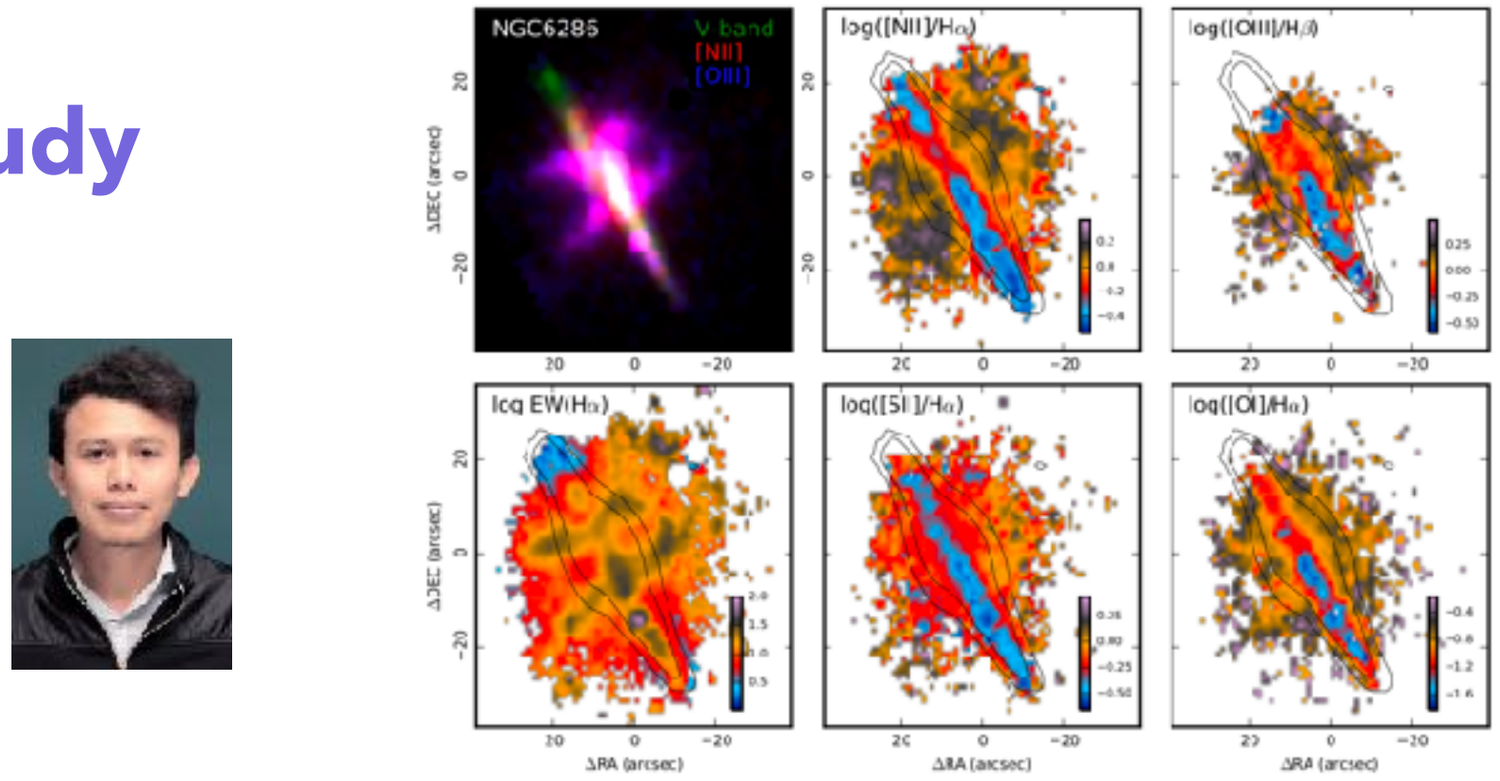


INLA: Integrated Nested Laplace Approximation

Santiago González-Gaitán +2019

Systematic study of outflows

Carlos López-Cobá +2019



THE AMUSING SURVEY

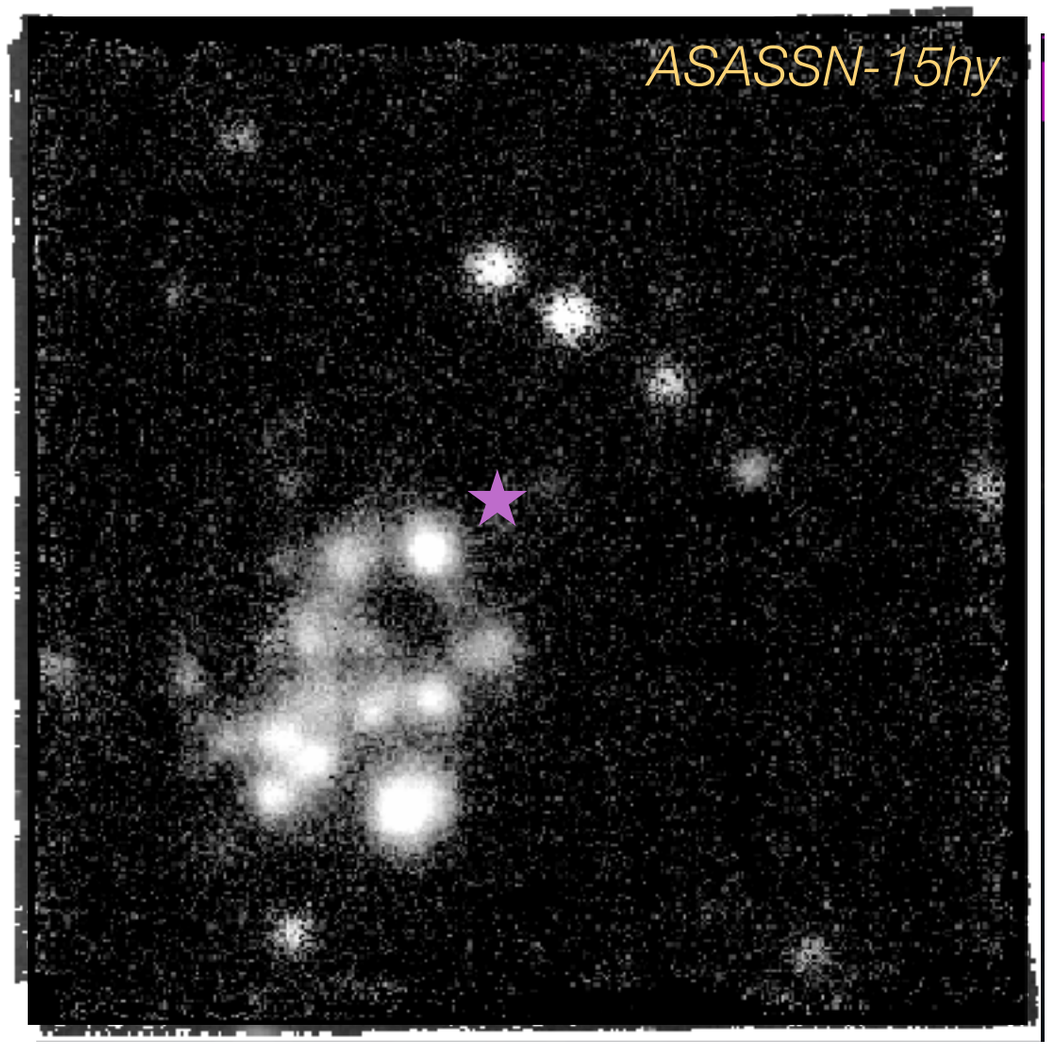
PIs: Anderson (ESO) & Galbany (Pitt)

- All-weather: using non-optimal weather of Paranal (avg. seeing 1.1", from 0.7" to 1.5").
- MUse: very efficient instrument. 3GB per cube, >4800 A. Basis for driving big data spectroscopic astronomy.
- Supernova: Overall aim is to further understand supernova progenitors/explosions. Study SN environment and all other regions within the host.
- Integral-field: 1'x1' FoV, 0.2" pixel scale. Image-like resolution but with 'spaxels'.
- Nearby: Allows in-depth study of gas and stellar populations.
- Galaxies: Allows cross-field collaborations. Galaxy studies: evolution, dynamics, stellar populations...

9 semesters: P95 to P103

+99h approved for P104

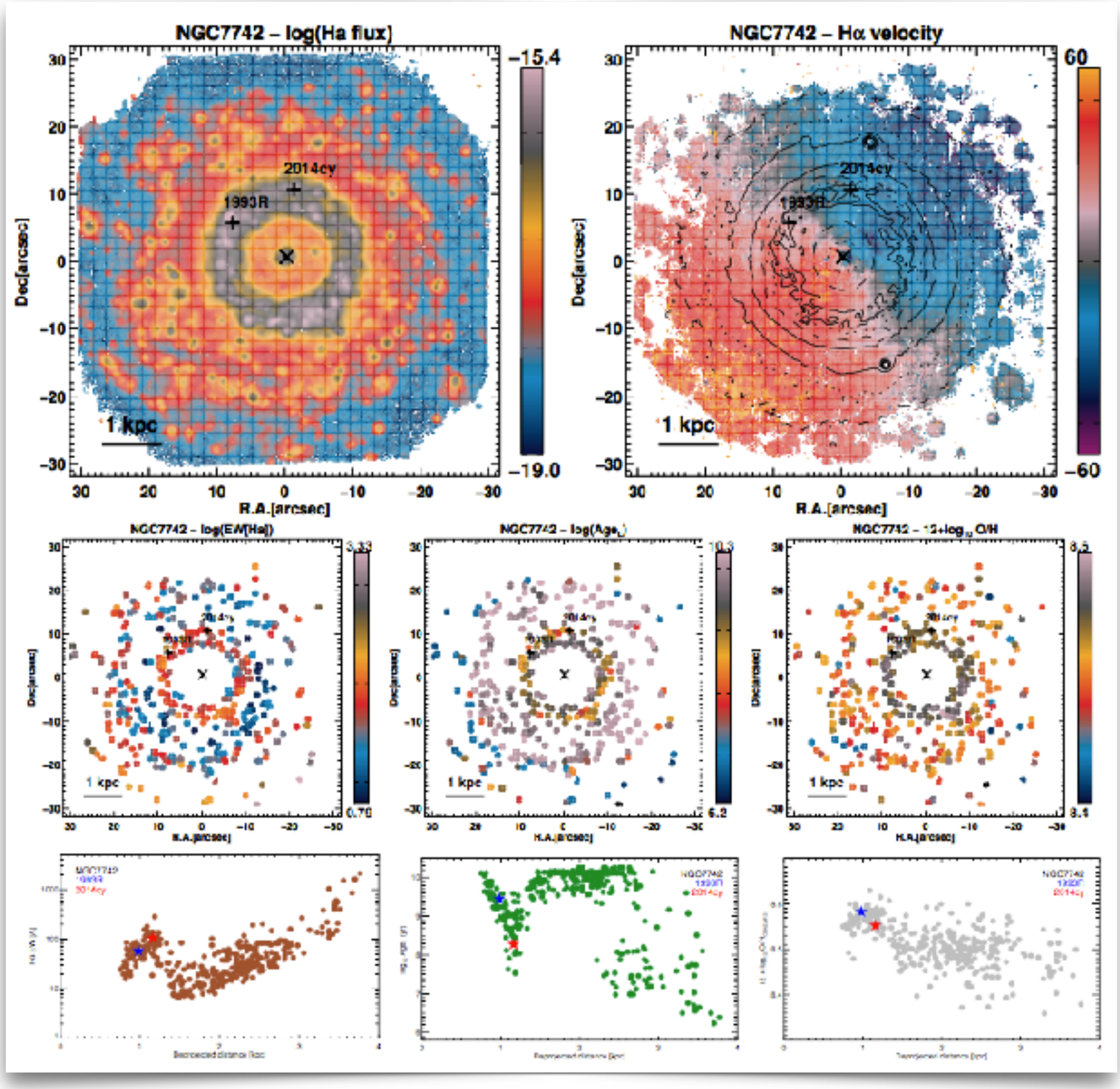
427 SN hosts (443 SNe)

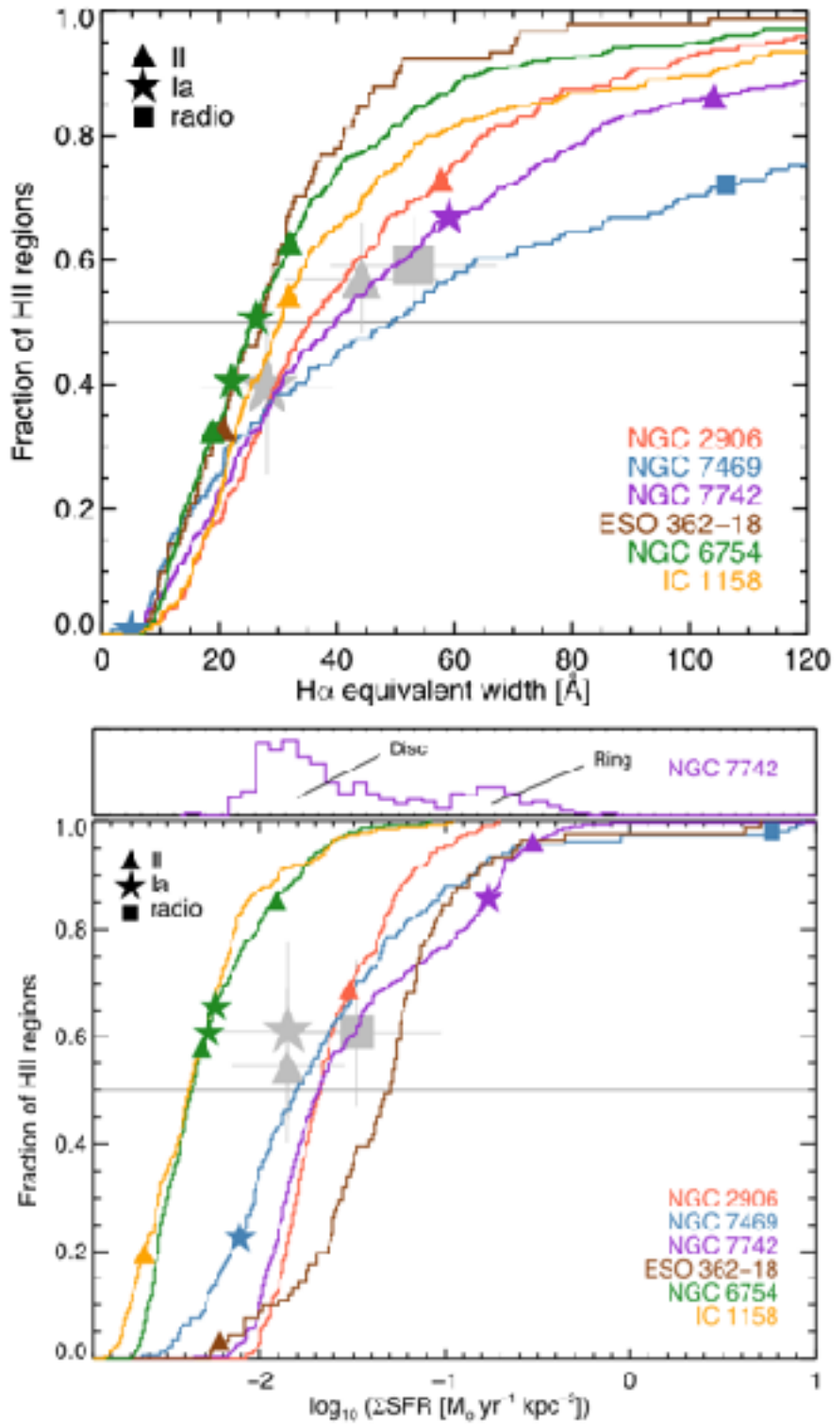


Aimed to be an open collaboration with regular data releases including all kinds of data products

1st data release expected for 2020! Will include ~200 cubes

MUSE-SV: Pilot study of 6 galaxies that hosted 11 SNe

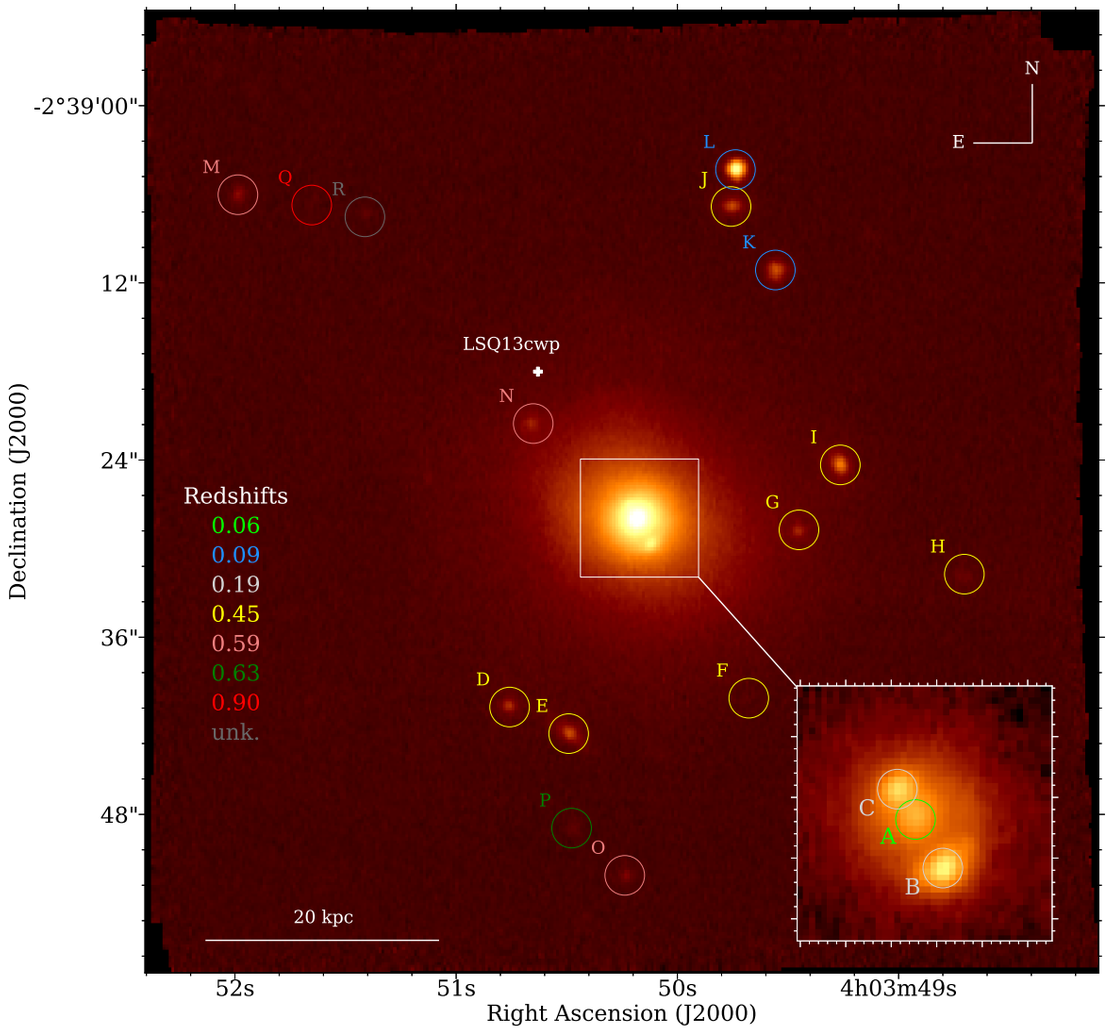




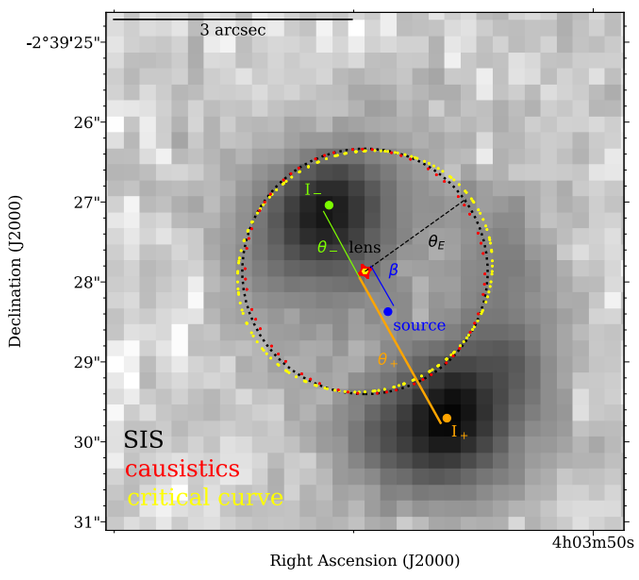
LG et al. 2016b, MNRAS, 455, 4099

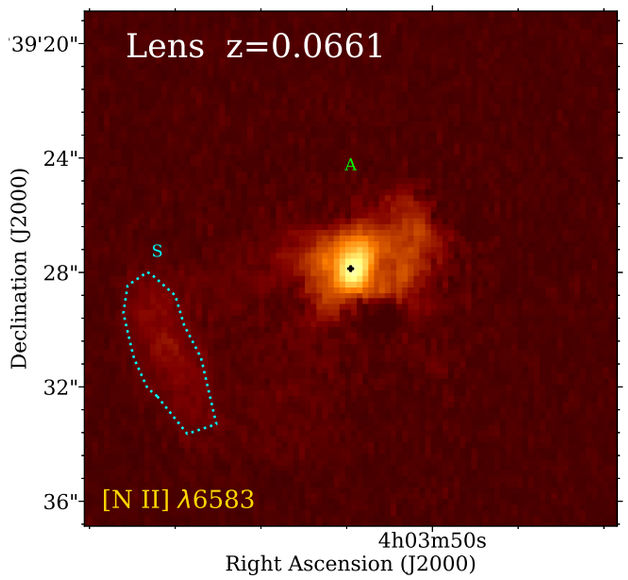
LG+ 2018, MNRAS, in press

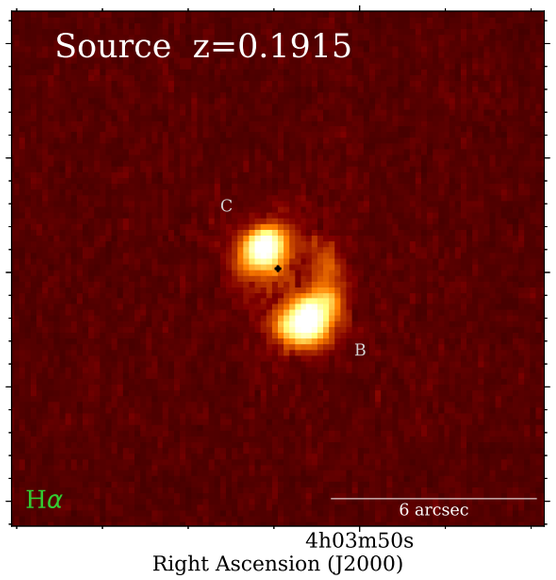
Discovery of a strong lensed galaxy in IFS data

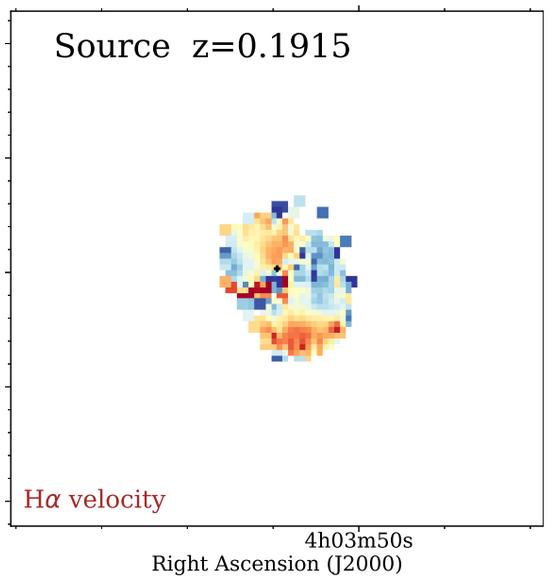


- Report the discovery of a background lensed galaxy at redshift 0.1915
- plus other 15 background galaxies at redshifts ranging from z=0.09 to 0.9
- Einstein radius of 1. 45±0. 04“, which corresponds to 1.9 kpc
- dark matter fraction of 18 ± 8 % within the Einstein radius.

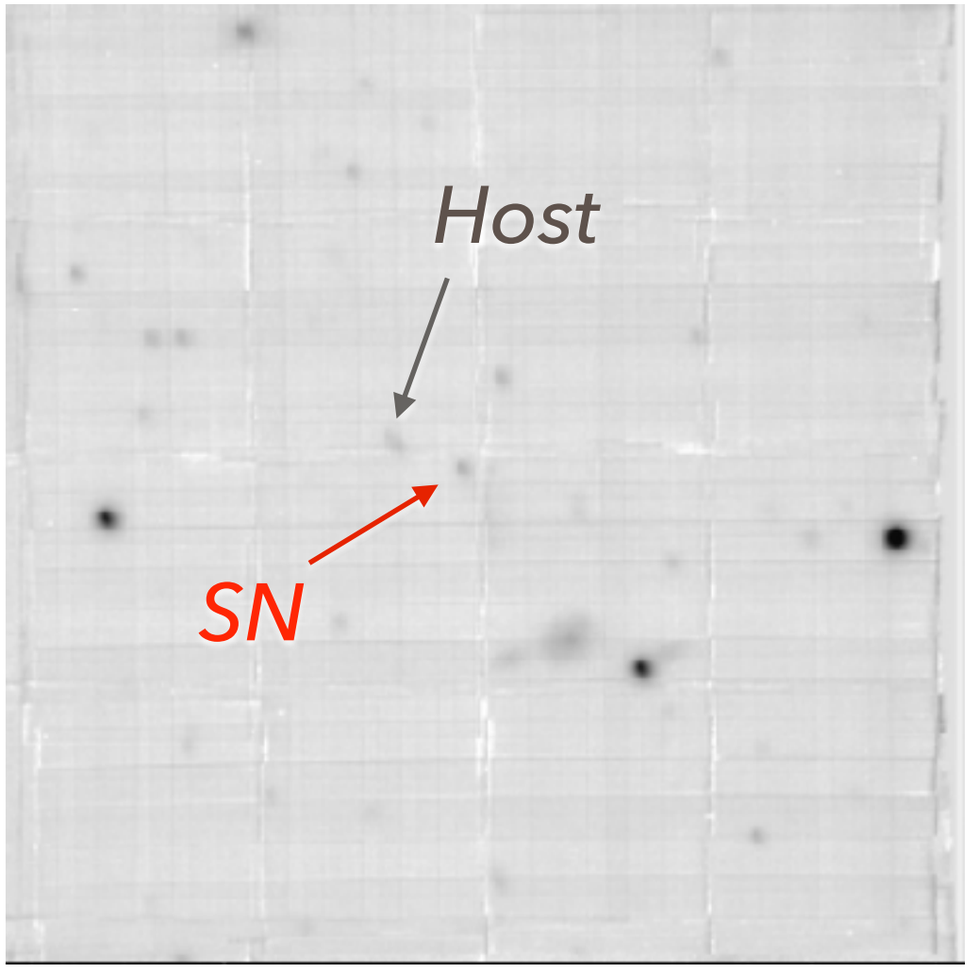




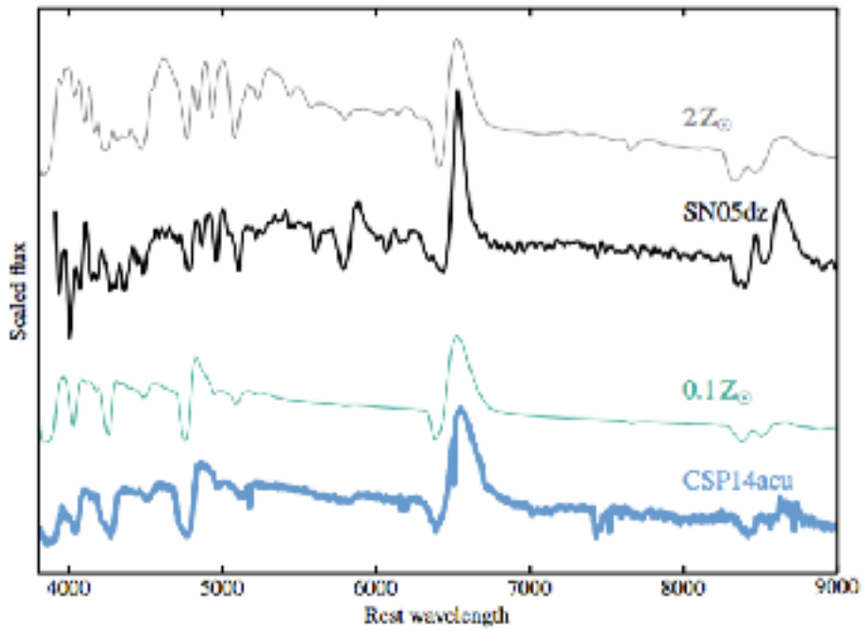


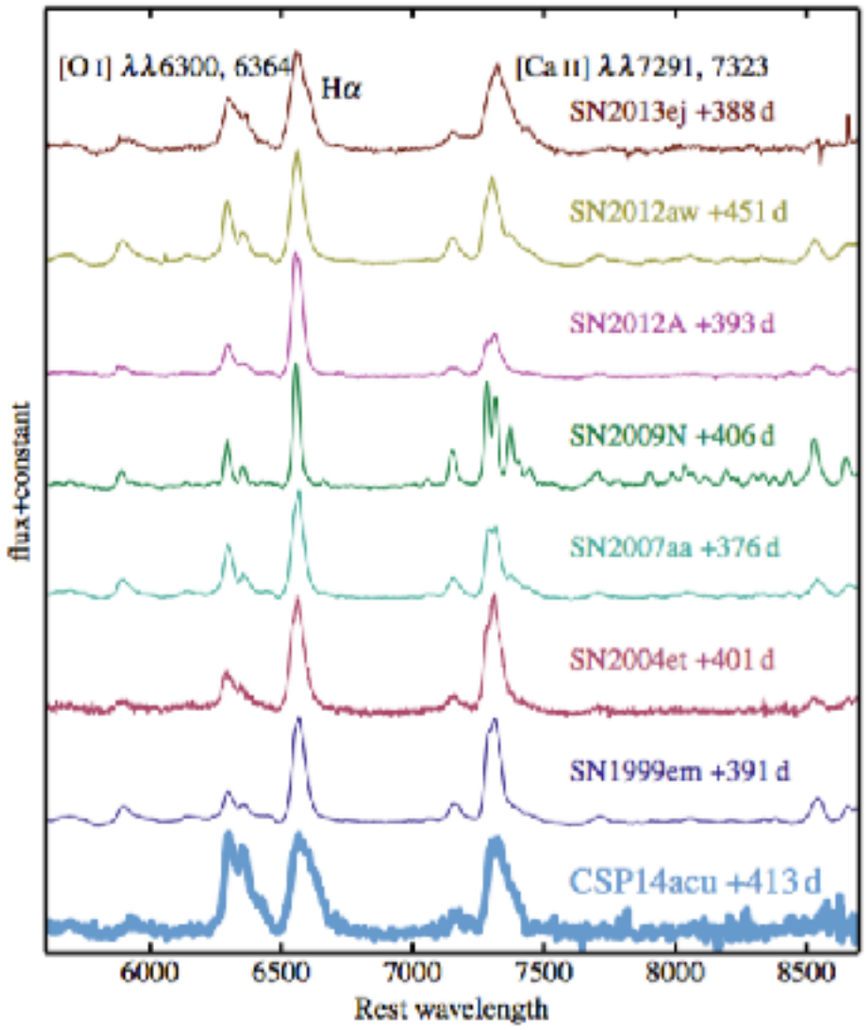


SN2015bs: high-M low-Z progenitor



- MUSE constrained its host galaxy
- the SNII with the lowest Z to date
- strong [OI] w.r.t Ha (very broad) and [CaII], which means means more massive Helium core and more massive initial progenitor mass

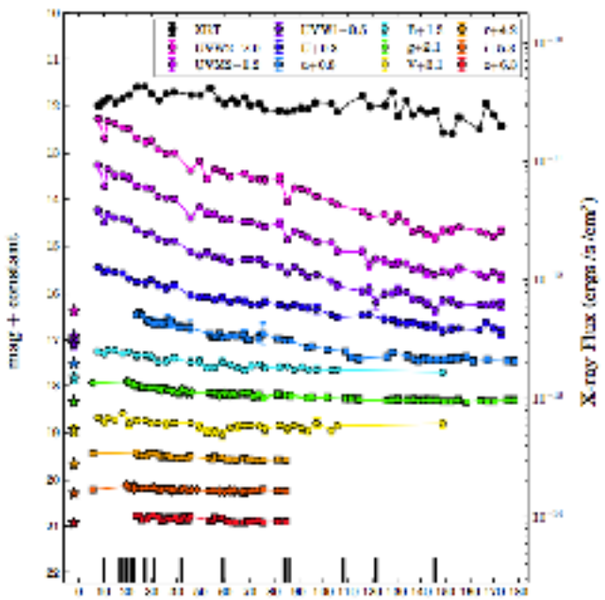


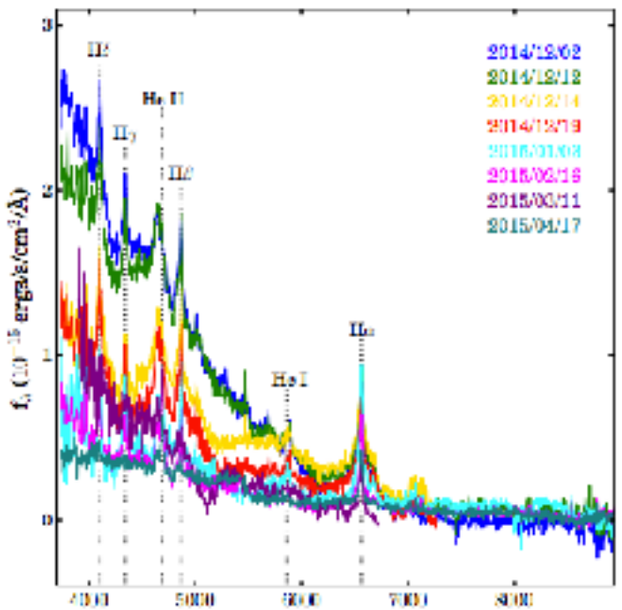


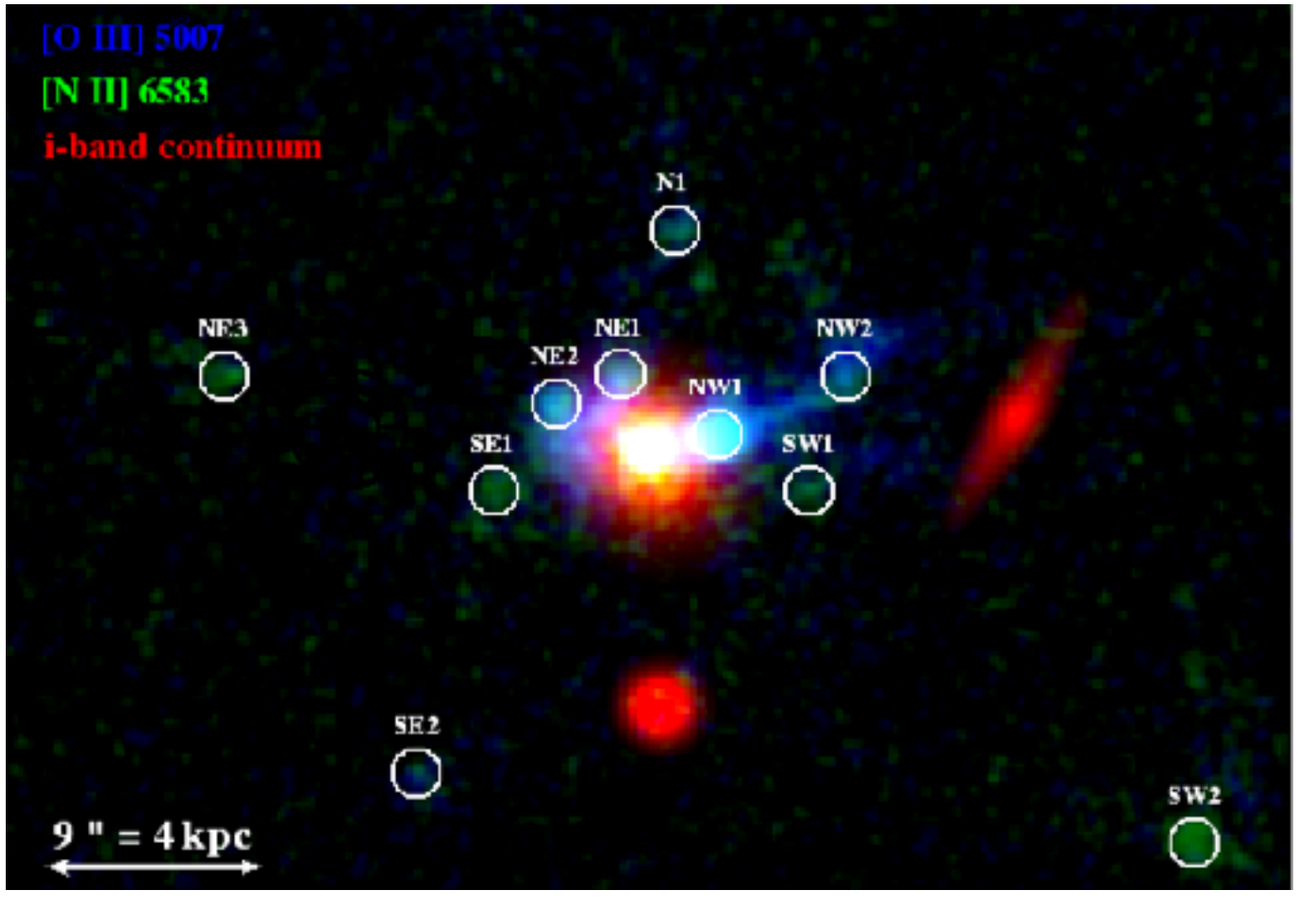
Joseph P. Anderson

José L. Prieto

ASASSN-14li: a nearby Tidal Disruption Event

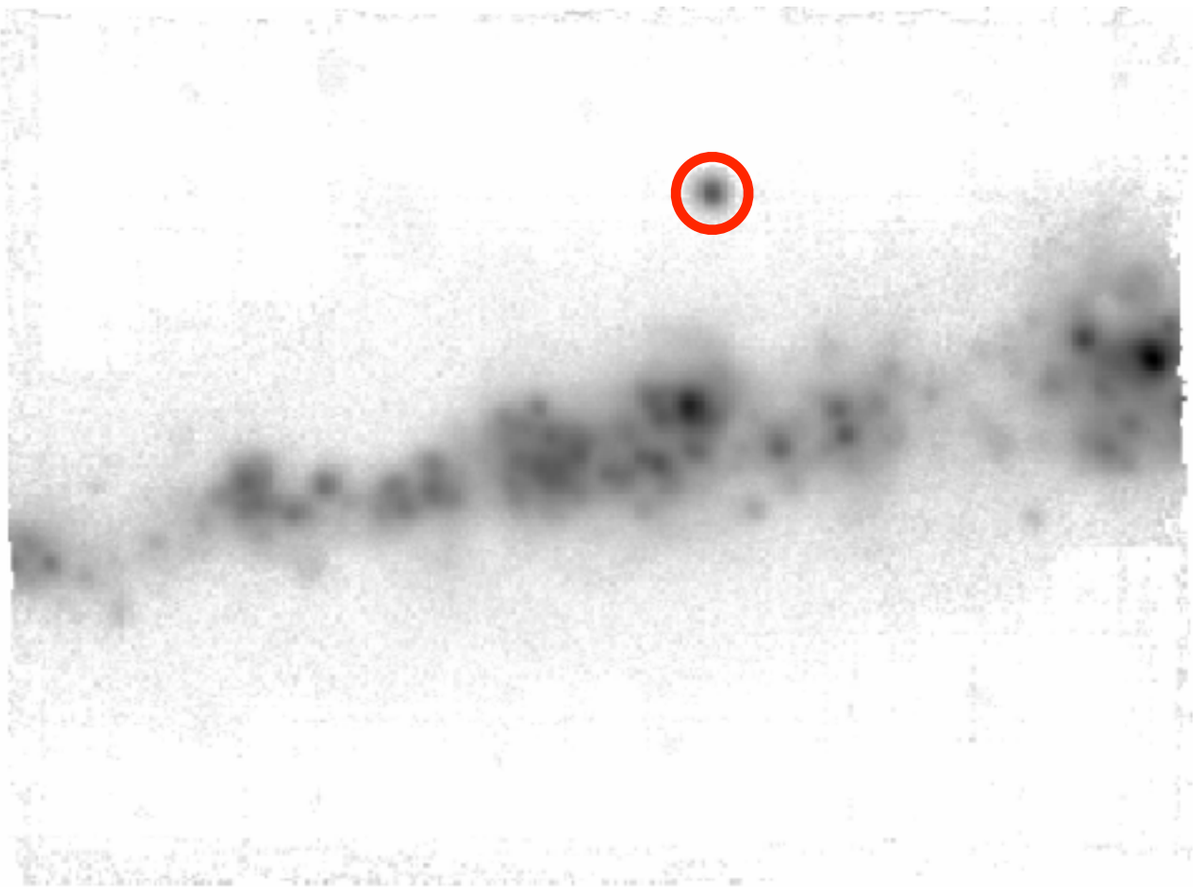


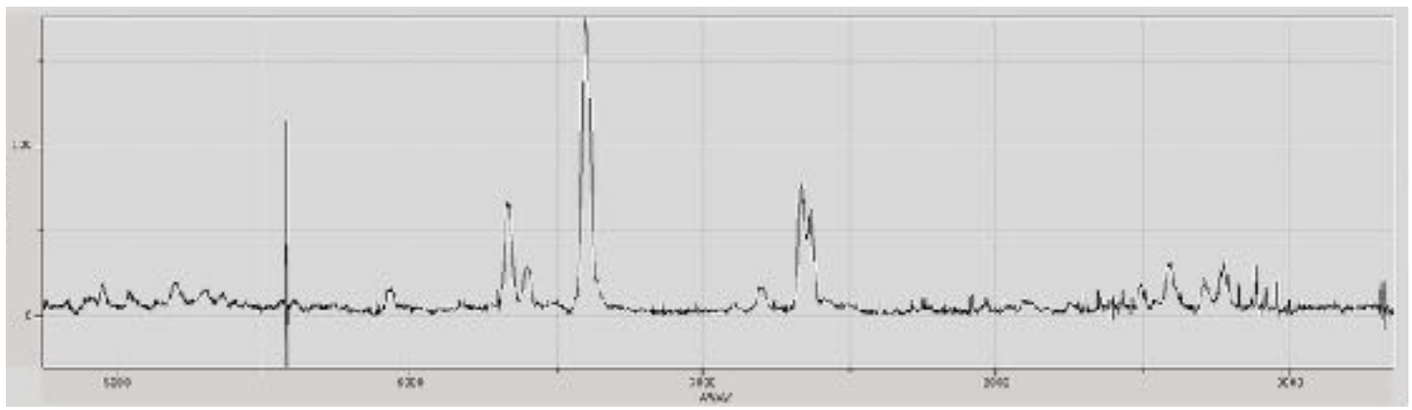




- One of the closest TDE, and the best studied ever (from X-ray to radio)
- post-starburst galaxy (TDE rate is 30 times higher in E+A galaxies)
- Recent interaction (merger triggered the starburst)
- Gas ionized by an AGN

ASASSN-14jb: normal SNII very far from any SF region





- Edge-on galaxy (scale height ~400pc)
- SN progenitor exploded at >2kpc (lifetime of ~10Myr)
- needs a pec. vel. of 50 km/s

- Options?
  - kick from a SN in a binary system
  - triple interaction
  - …
- It also has low Z

Nico Meza

So far 18 articles from AMUSING, but more coming…

Sánchez15, Galbany16, Kuncarayakti16, Prieto16, Sánchez-Menguiano16, Kruehler17, López-Cobá17, Sánchez-Menguiano18, Kuncarayakti18, Anderson18, Galbany18, Boselli18, Phillips19, Bellochi19, Meza19, Schady19, Bostroem19, Tucker19…

HI-KIDS

(HI KOALA IFS Dwarf galaxy Survey)

- Under-represer
  galaxies in othe
- Complement re
  interferometric
  21 cm HI emiss
- Selection from
- + program for S
  (PI L. Galbany)

20)

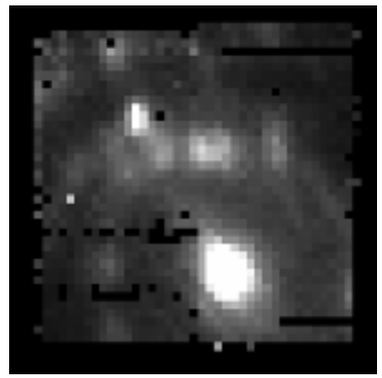
ent sizes

2.5 Re

N hosts (LG) + 1
e)

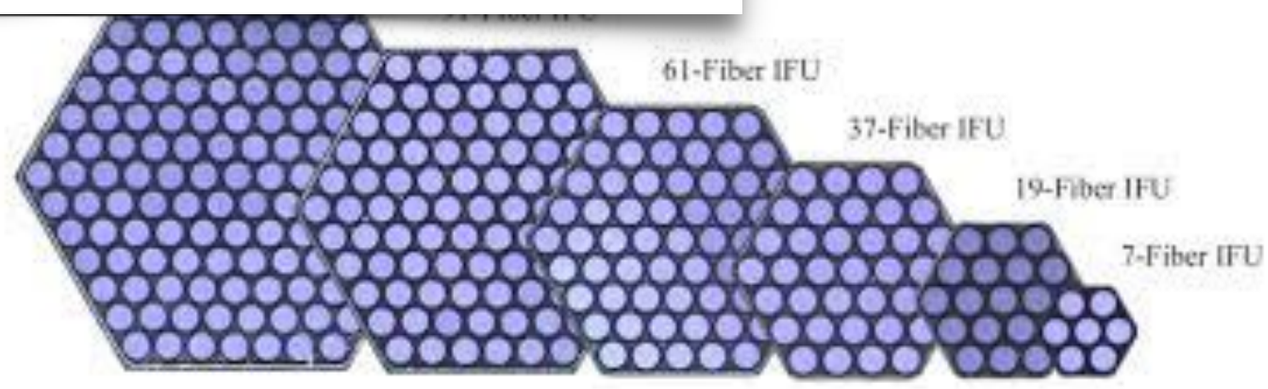
VIMOS

- 084.D0212(A),
  PI: Anderson



- 39 SNIa locations (literature)
- 15 ‘new’ SNe
- No valid for total, but for local

Ángel R. López-Sánchez

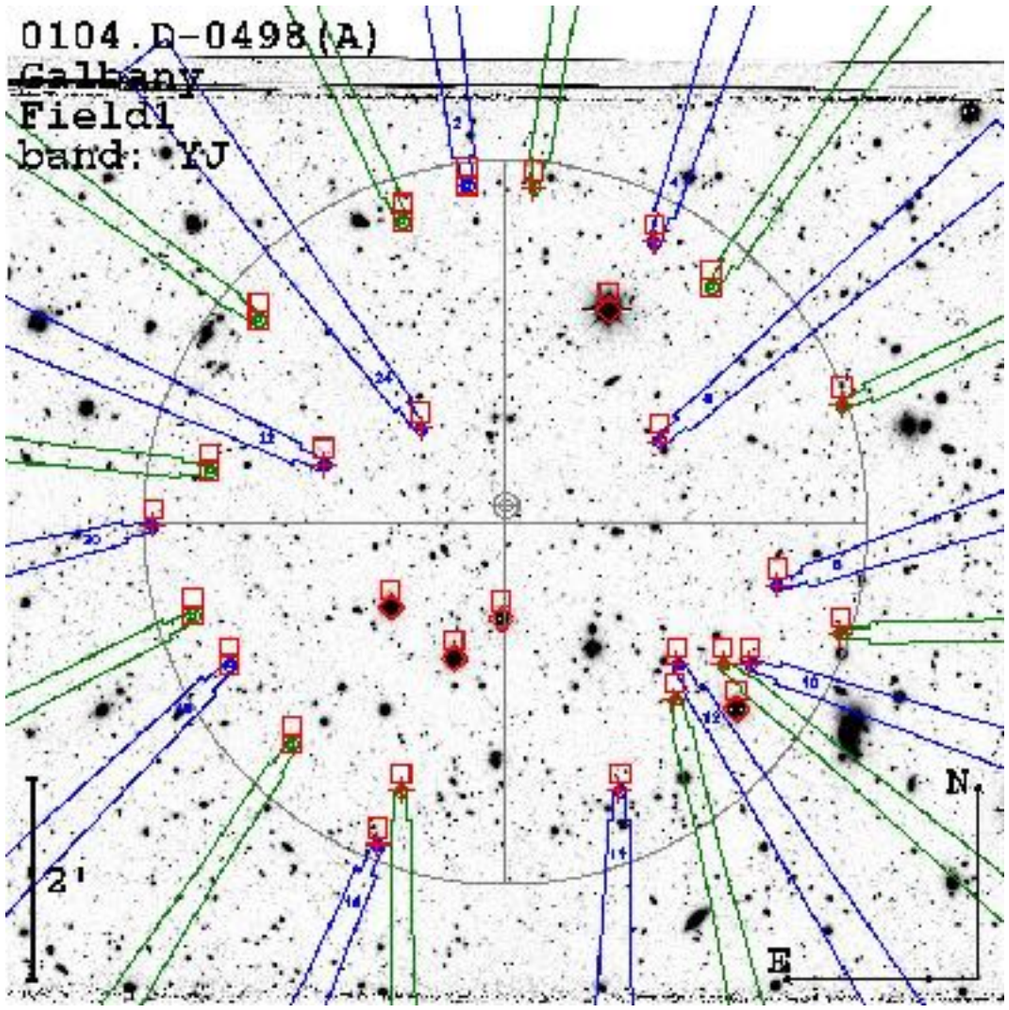


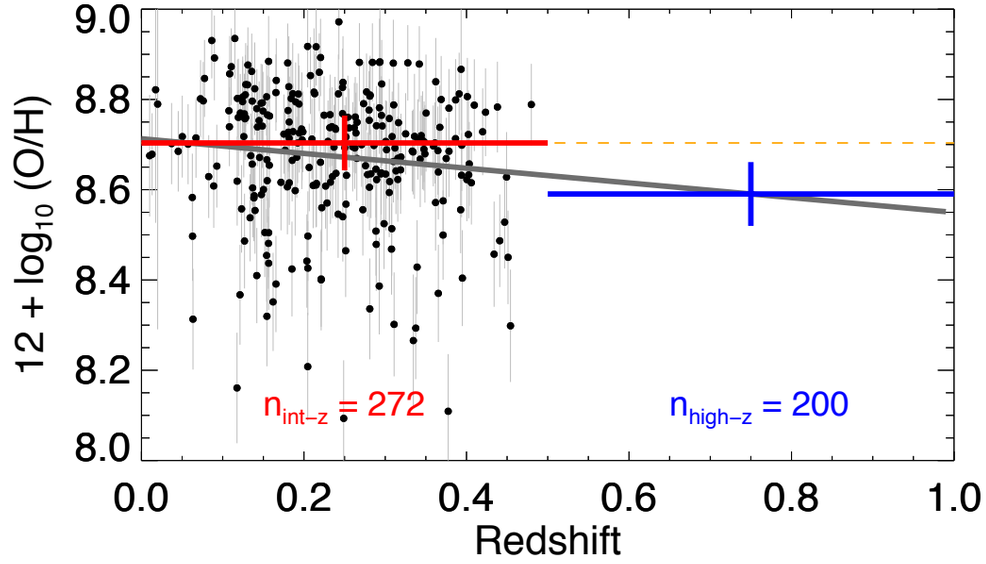
What about high-z?

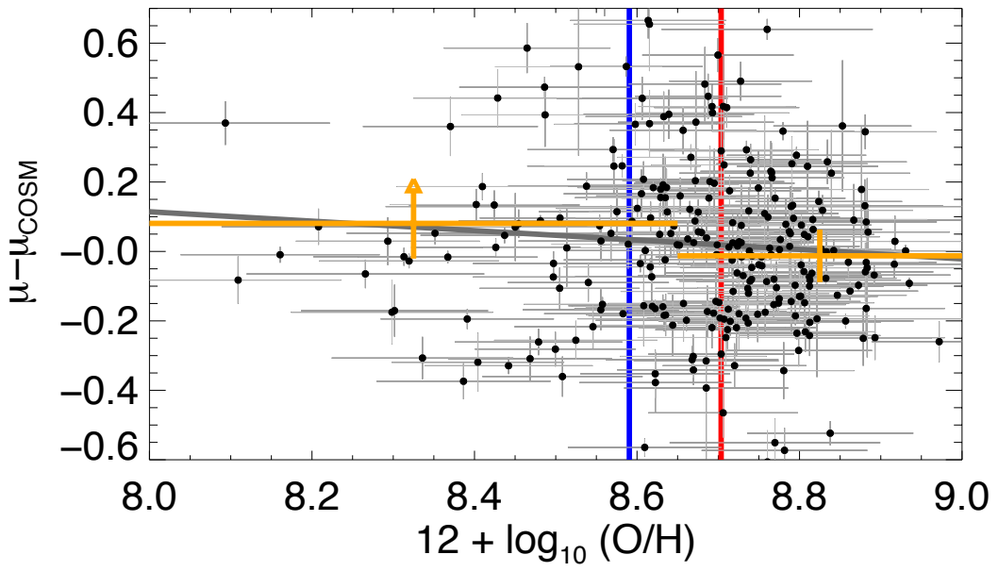
@ UT1 Very Large Telescope

DARK ENERGY SURVEY

- 24 arm spectrograph, 7.2’ diameter
- 24 ~3”x3” IFU (0.2” spx)
- >200 SN hosts at z>0.5 from DES





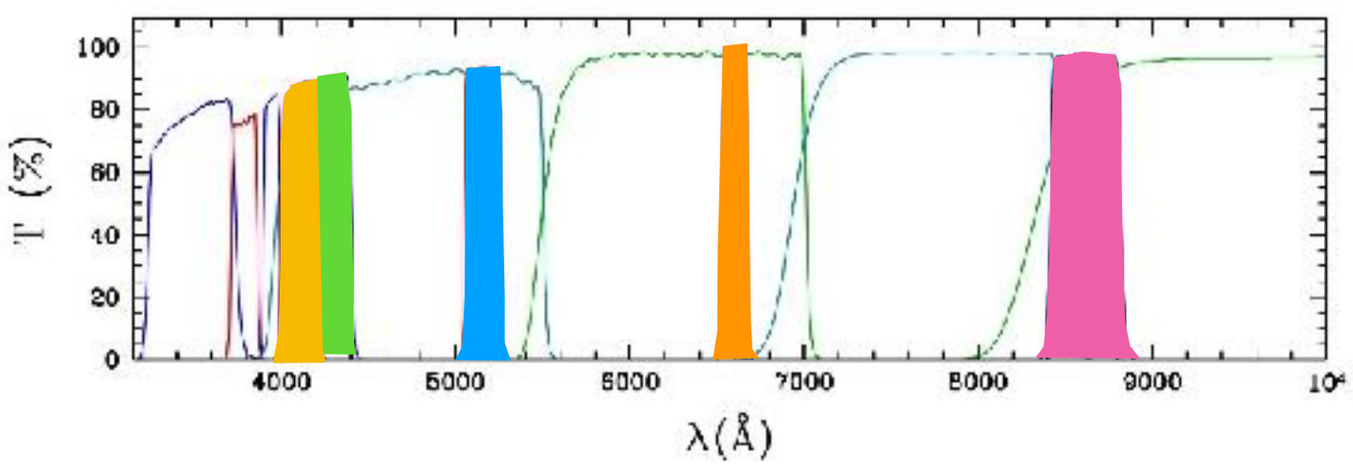


J-PLUS / J-PAS

Miguel A. Pérez-Torres
(IAA/CEFCA)

Tuomas Kangas
(STScI)

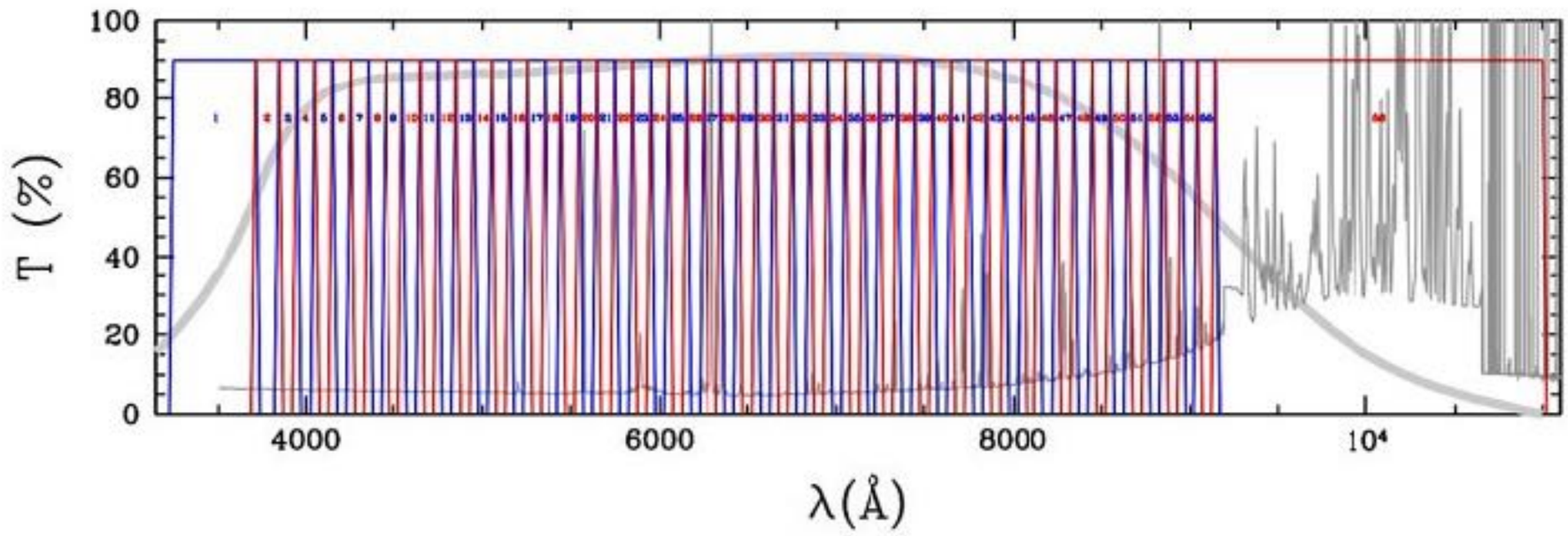
- J-PLUS: 8500 sqdeg. 12 filters: More than 2000 objects expected



Redshift cut is at 0.0163, corresponding to a maximum of 6670Å for the Ha line.
(The Ha filter function goes from 77% at 6670Å to 20% at 6680Å).

- NCR analysis, but… the width of the Ha filter constrains the usable redshift range. We expect 100s in J-PLUS, 1000s in J-PAS (2 step project)

- J-PAS:
  8500 sqdeg.
  59 filters



Dones

Reduction pipeline set (v2.2 CALIFA)

Analysis (IDL) pipeline set

DR1 out

9 papers

P95 -> P99 reduced (+ZAP)

Analysis (IDL->python) almost set

But improving a few steps

Sample characterization

Astrometry correction

SDSS ph/sp comparison

Quality control

Segmantation

18 papers

MaNGA reduction

MaNGA analysis (=PISCO)

J-P cube construction

TODOs

Finishing completing CSP hosts

last semester? finishing? rethinking?

DR2 (MSCA), where?

P100.. ESO reduction

Finalising analysis pipeline

DR1 (P95->P99)

Multiwavelength ancillary data

New multiwavelength data

Spatial masks

Finishing completing CSP hosts

last semester? finishing? rethinking?

DR2 (P100-P105?)

KOALA reduction

VIMOS reduction

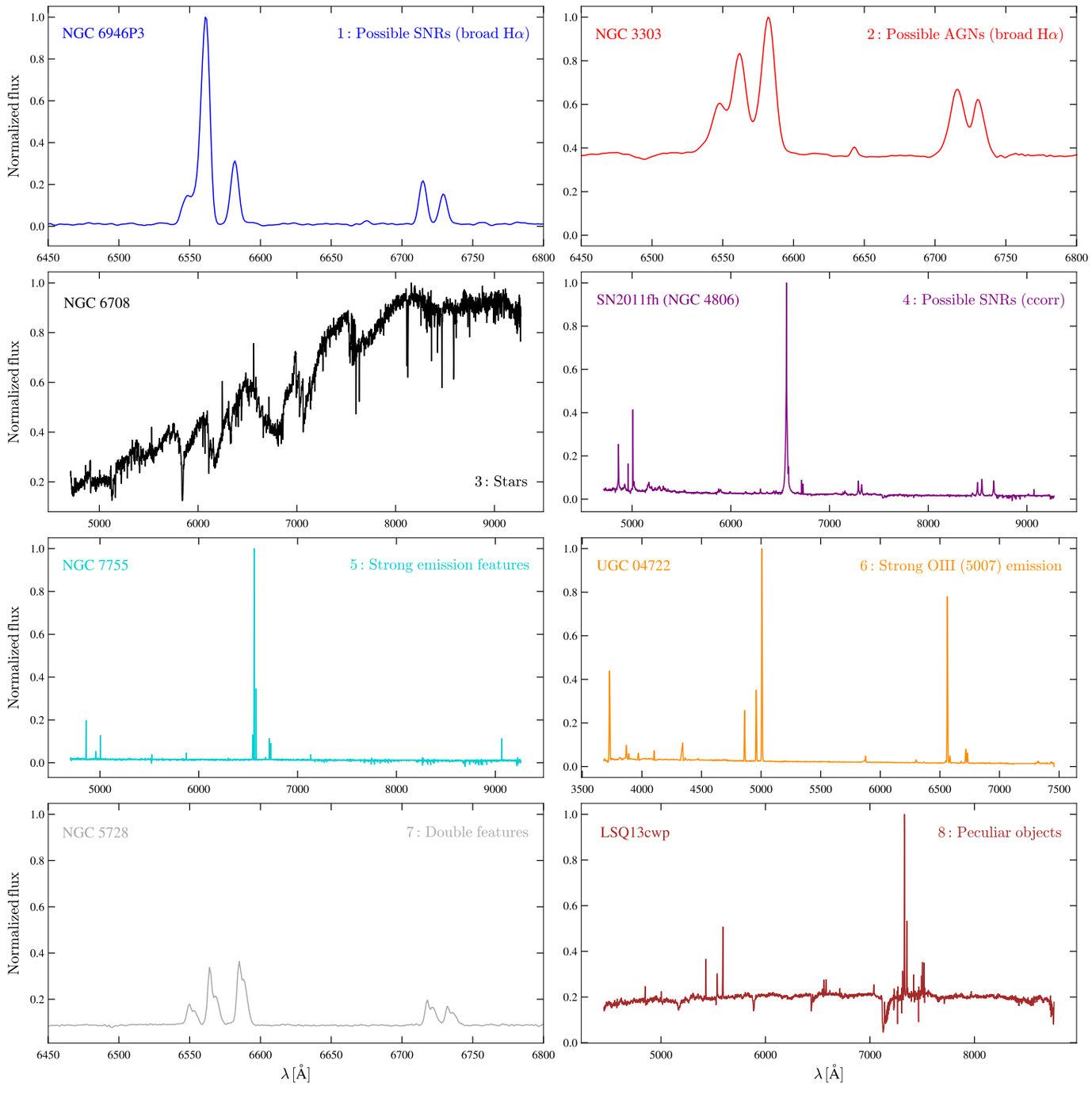
KMOS data

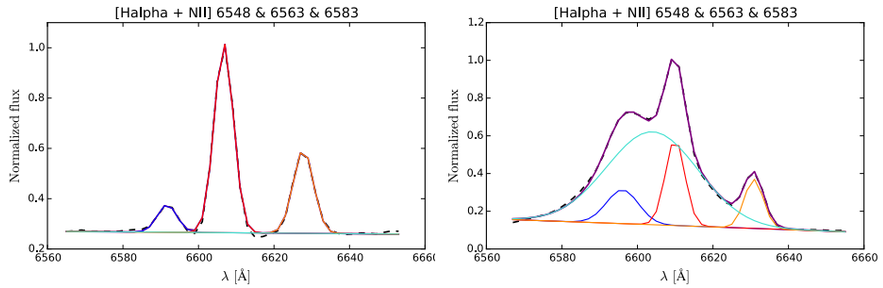
J-P analysis pipeline

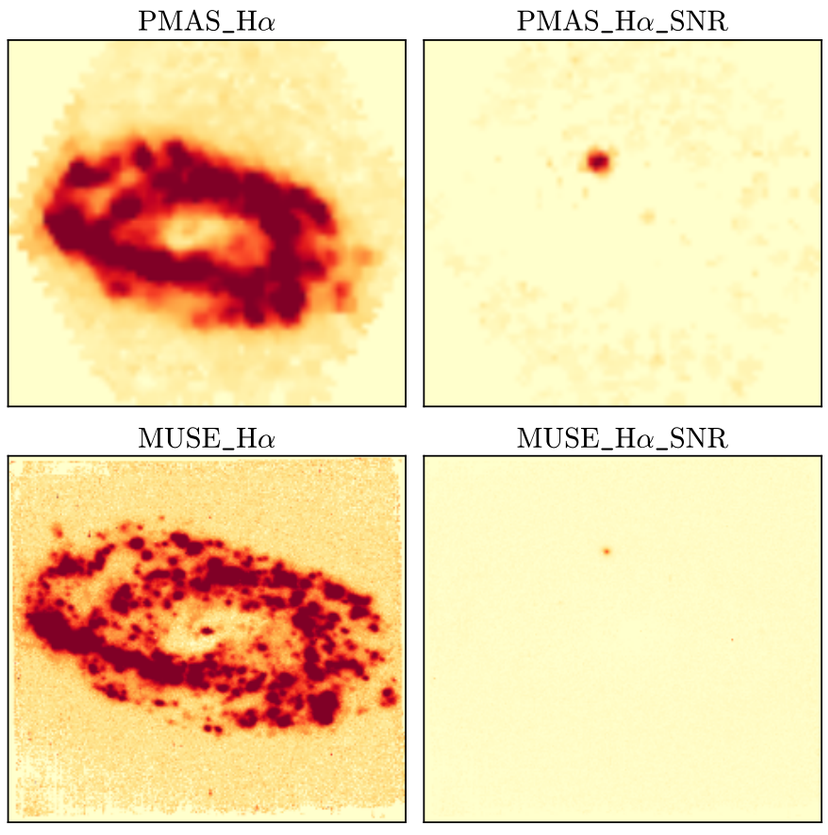
PISCO
AMUSING
MaNGA
KOALA
VIMOS
KMOS
J-PLUS/PAS

Young SN remnant detection/discovery

Héctor Martínez Rodríguez

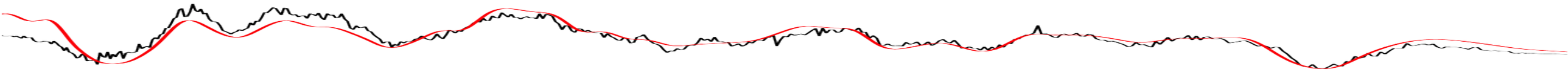






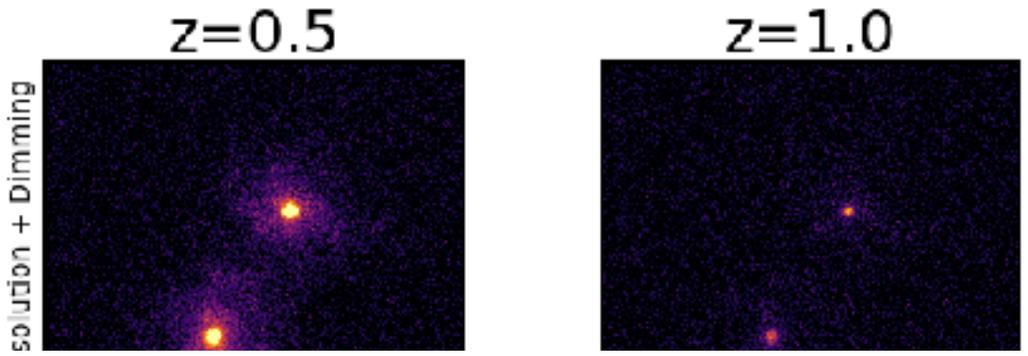
Simulating galaxies at high-z

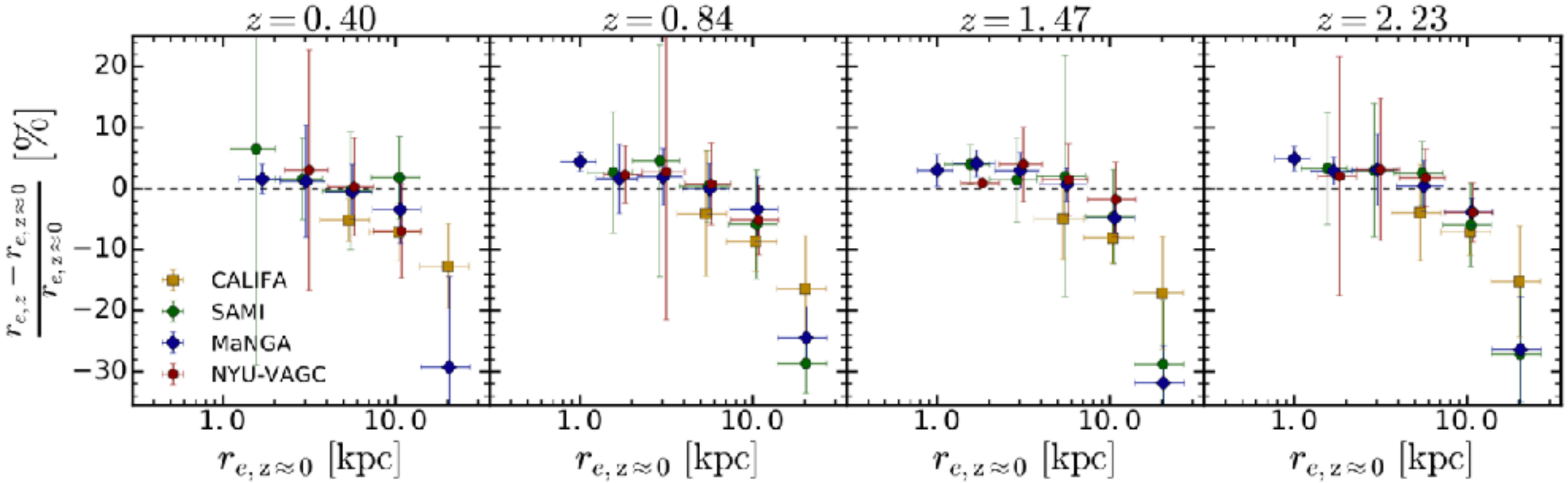
CRISP: Correcting Reddening Intelligently for cosmological Supernova Probes



Ana S. Paulino-Afonso (ULisboa)
in prep.

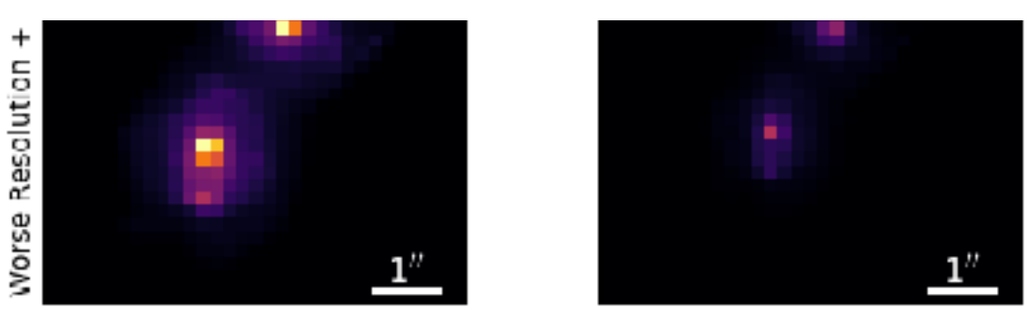
See also Paulino-Afonso+17
MNRAS 465.2717





Determine biases in galaxy properties when working in a wide range of redshifts

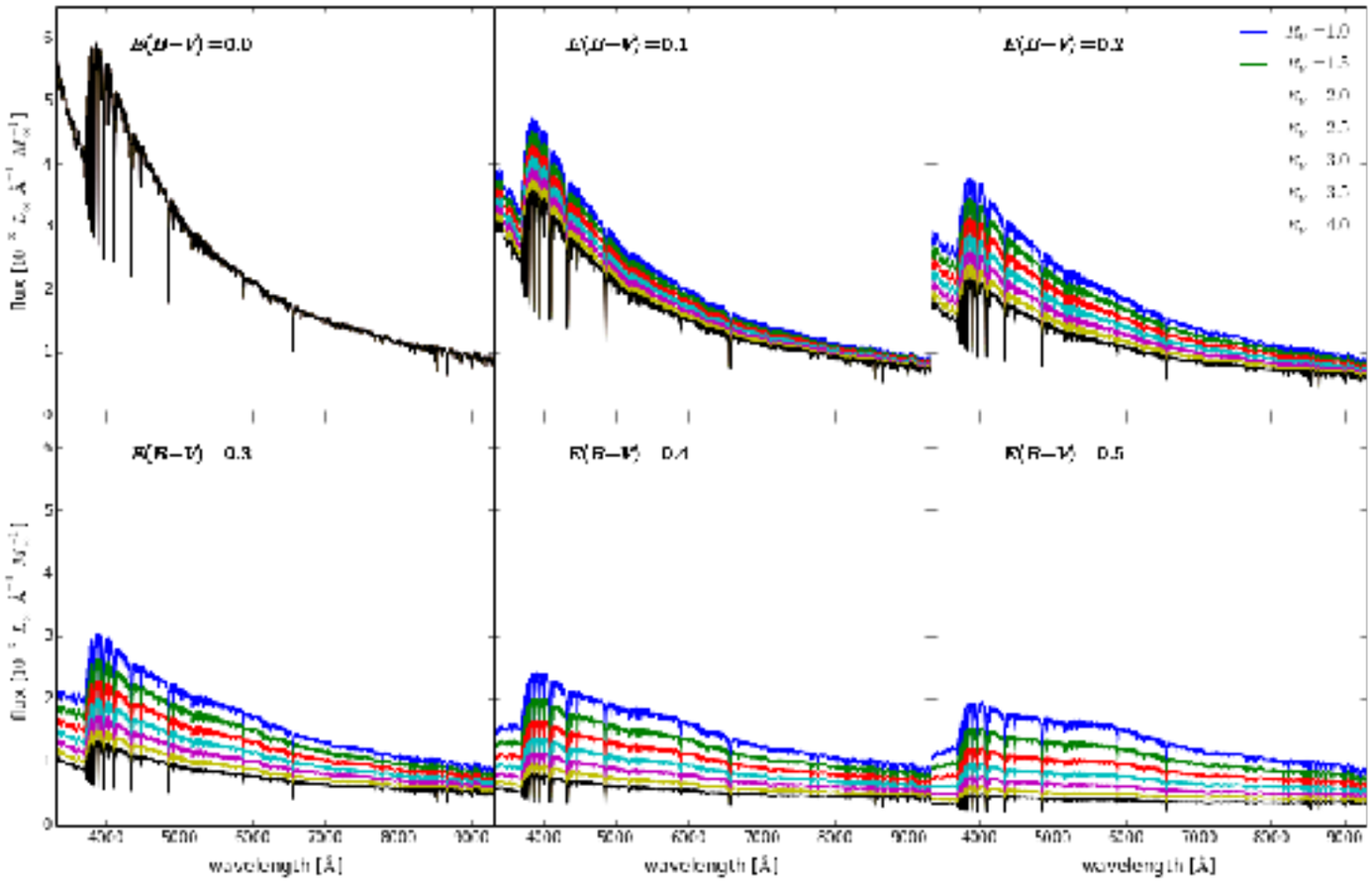
e.g. host galaxy dependencies in SNIa cosmology

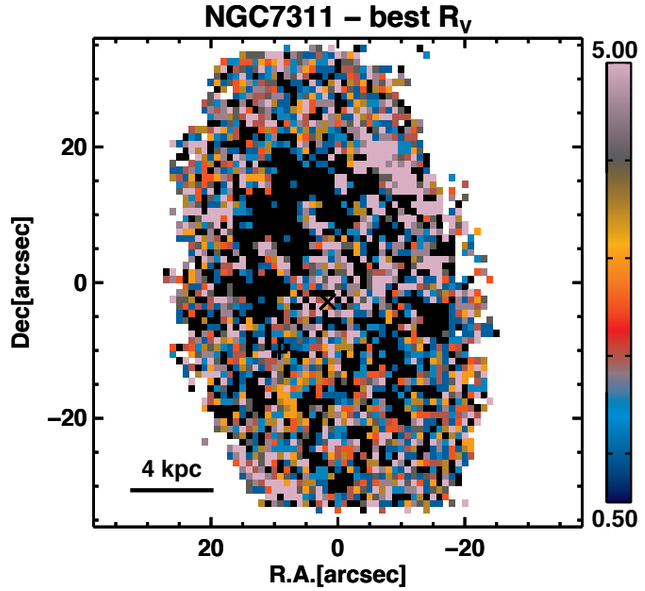


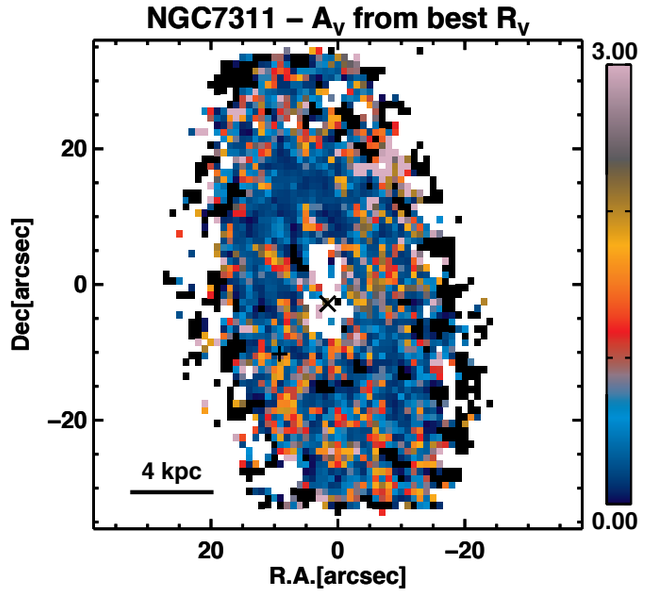
Dust extinction studies

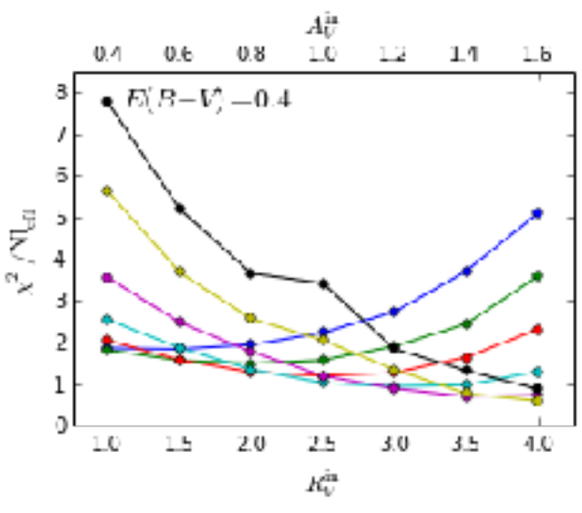
CRISP: Correcting Reddening Intelligently for cosmological Supernova Probes

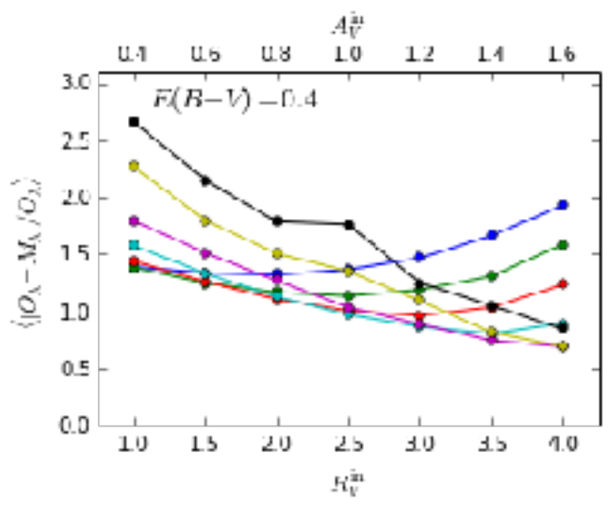
Simulating dust with varying Rv

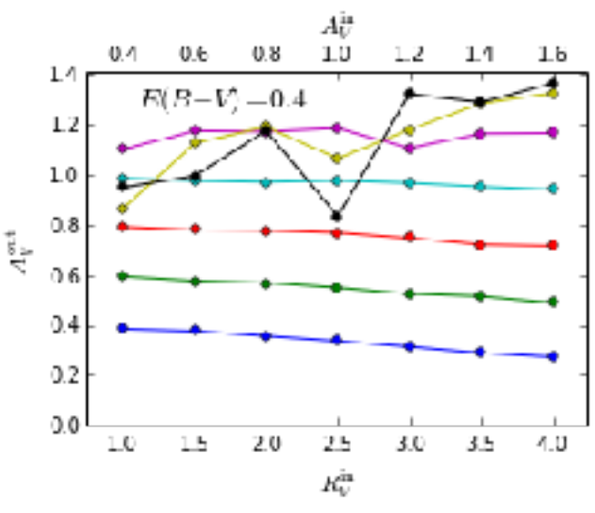








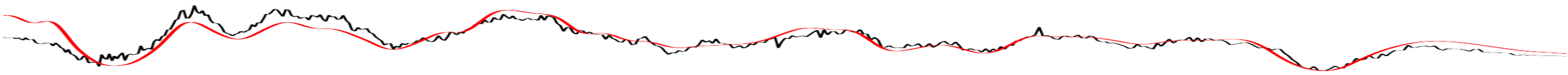




Alessandro Razza (UChile - ESO) In prep.

Preliminary results: 116 objects in PISCO

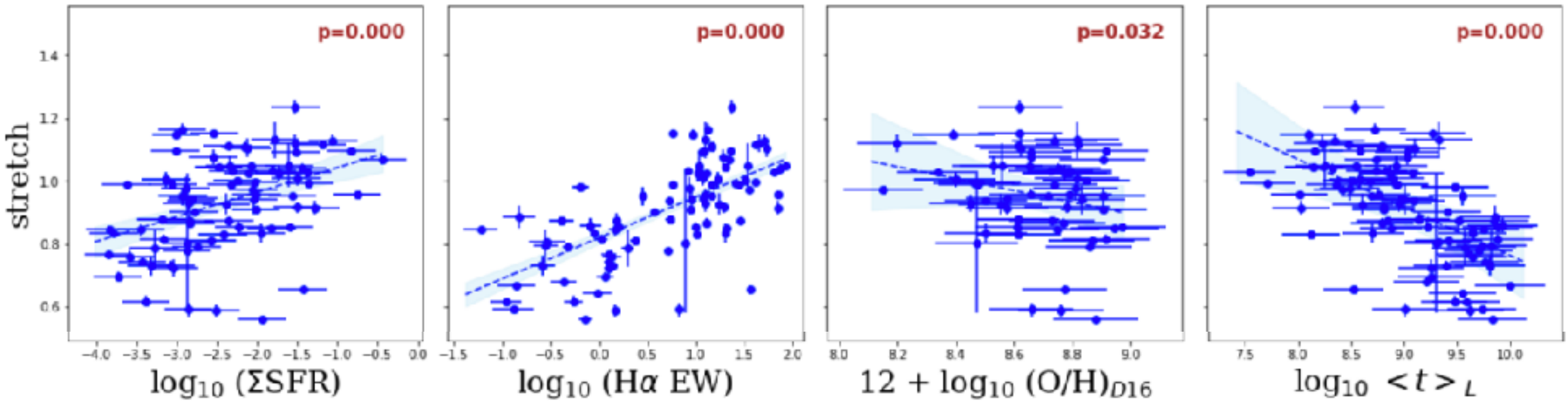
LG et al. in prep.



Carnegie Supernova Project (CSP) I + lit. SNe

Most SNe discovered by targeted searches

→ CSP II (untargeted sample)



Light curve stretch correlates strongly with every single local environment parameter

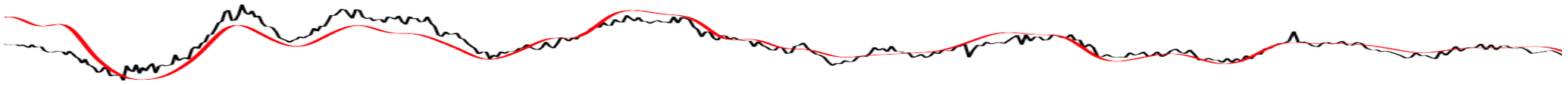
Hubble(-Lamaître) residuals show mild correlations with a few exceptions:

Currently exploring other LC width parameters: S_{BV}. Future: SNEMO

Burns et al. 2014 Saunders et al. 2018

SFH reconstruction and DTD

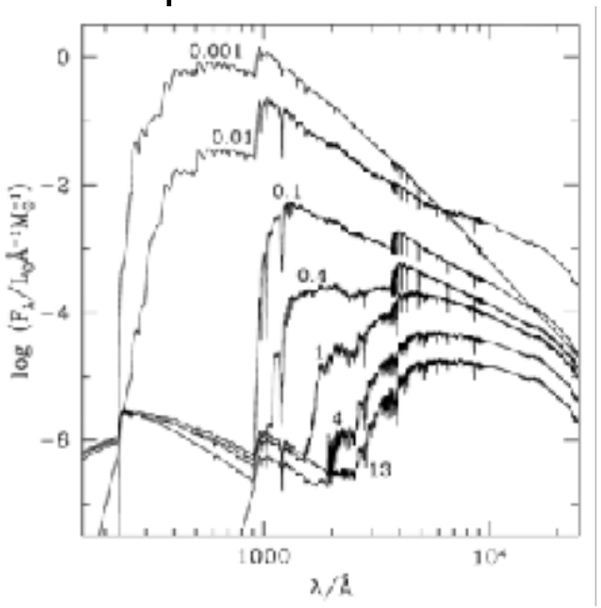
Carles Badenes
(UPitt)



Single Stellar Population (SSP) synthesis

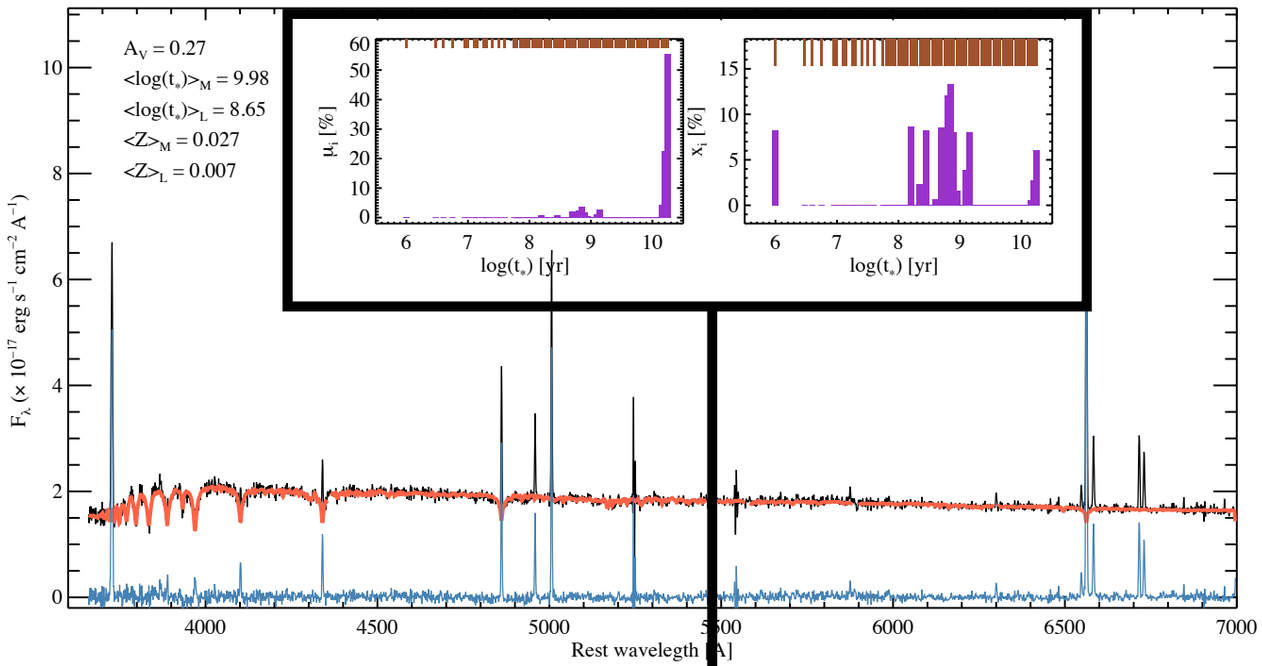
Observed spectrum
Best SSP fit
Residual: gas-phase spectrum

Spectral templates with different t and Z



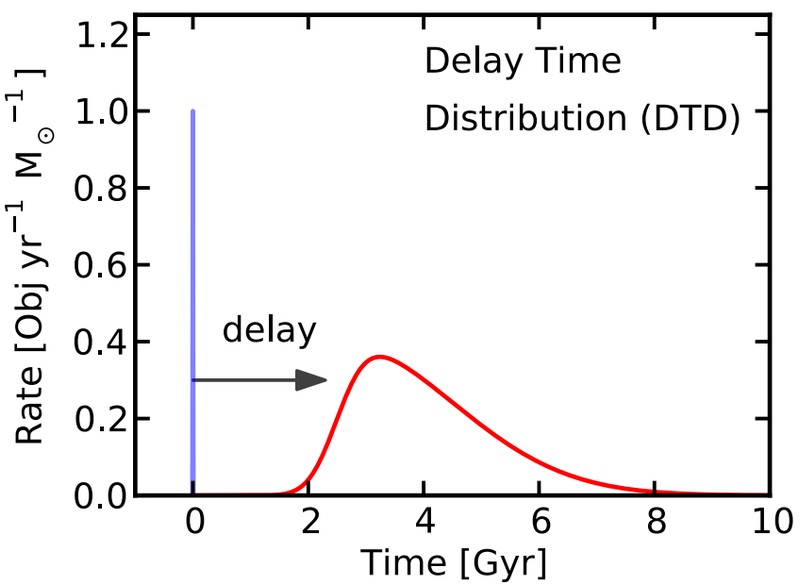
STARLIGHT

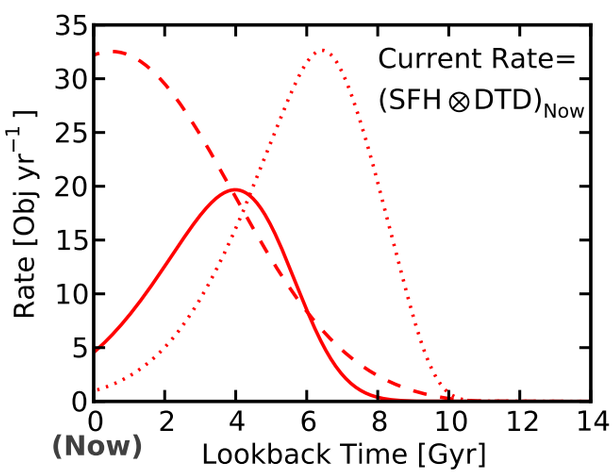
(or other)

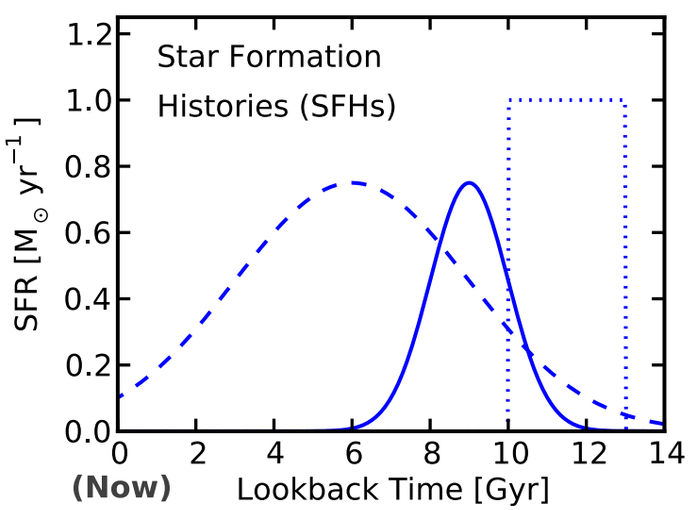


SFH reconstruction

SN rate = (DTD x SFH)

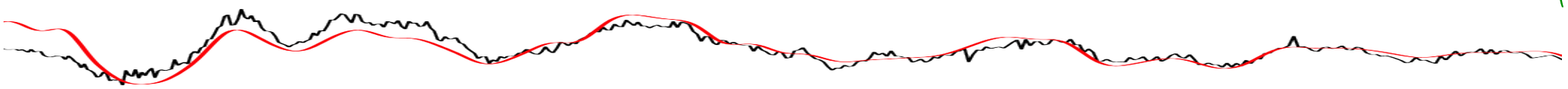


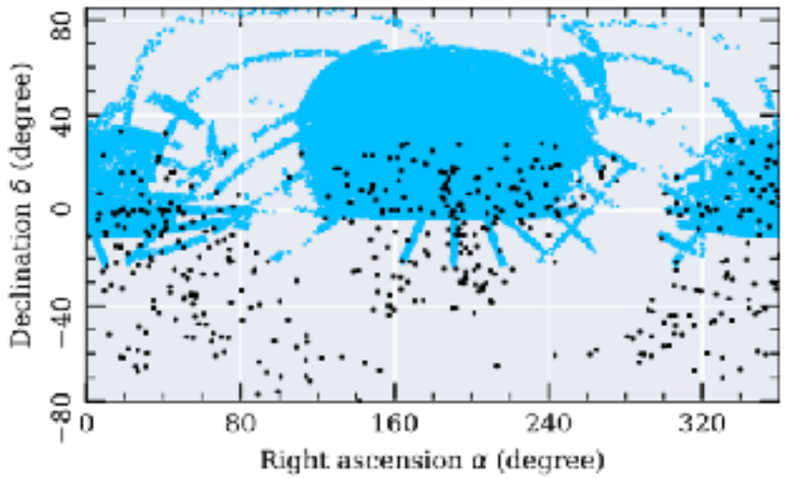


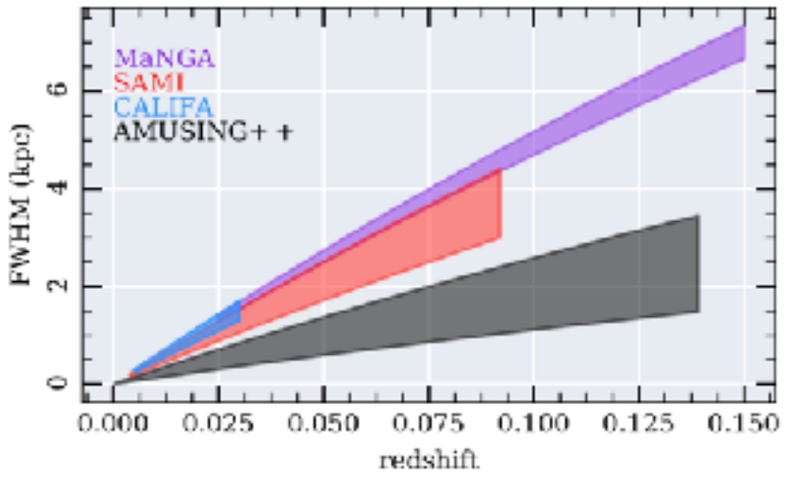


AMUSING++

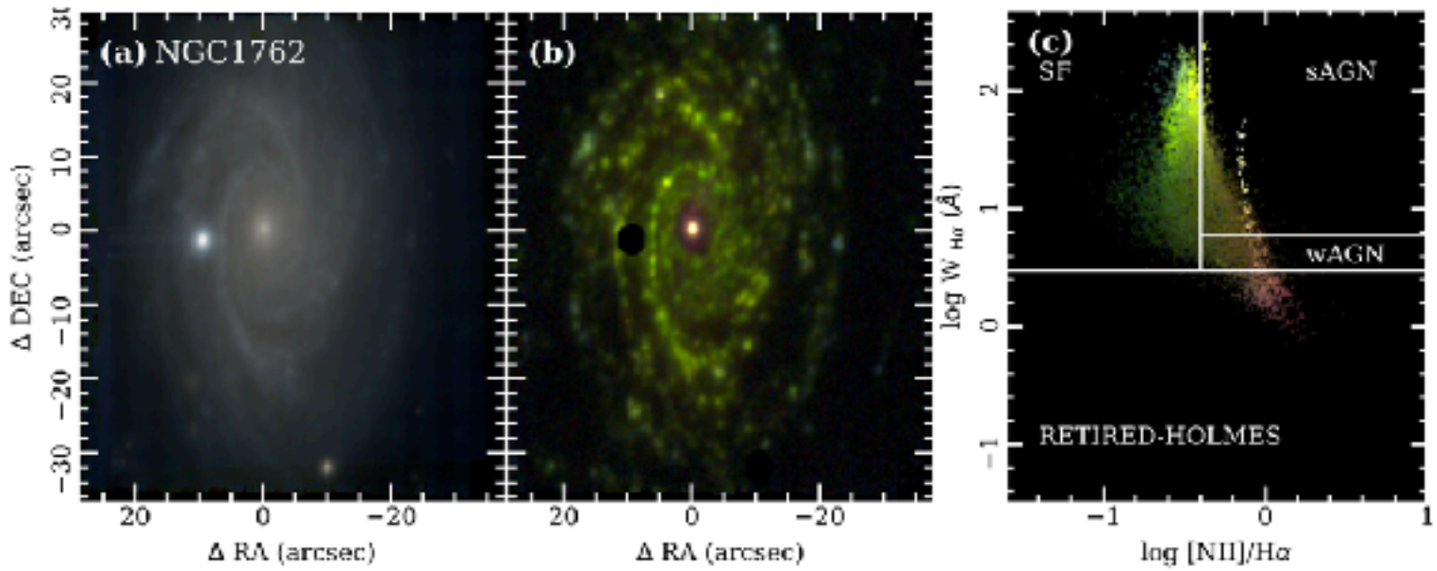
Carlos López-Cobá
(UNAM)

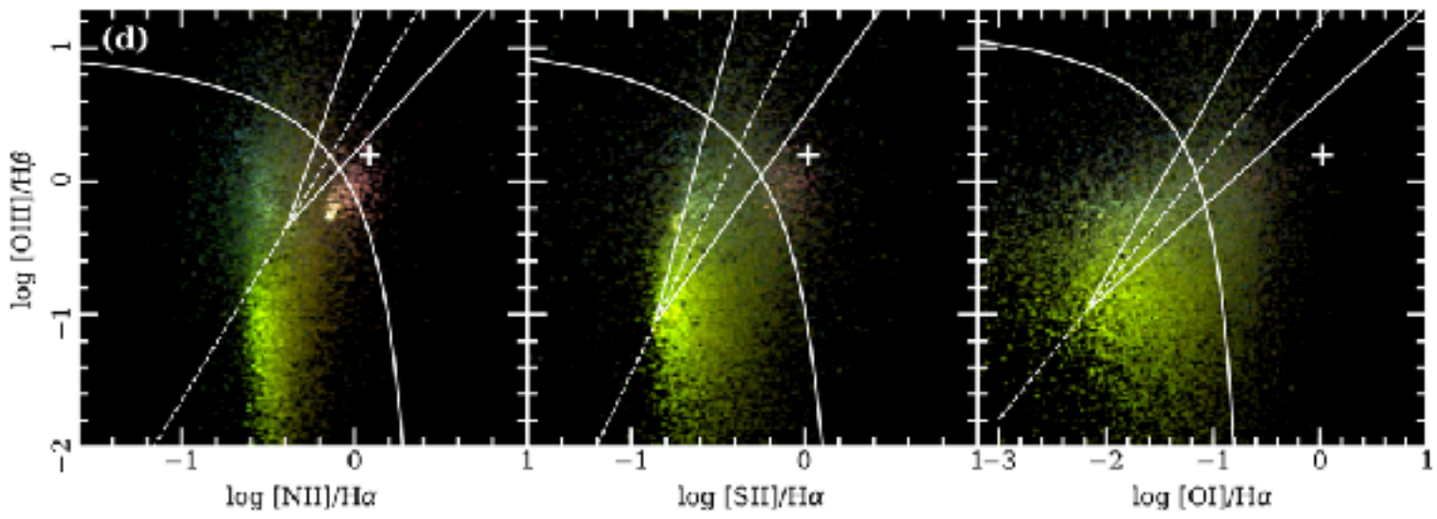






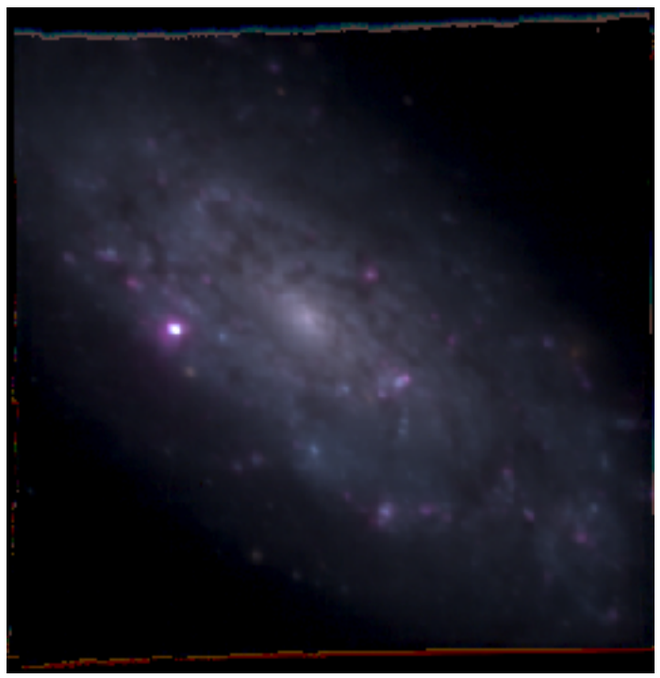
Sebastián Sánchez
(UNAM)

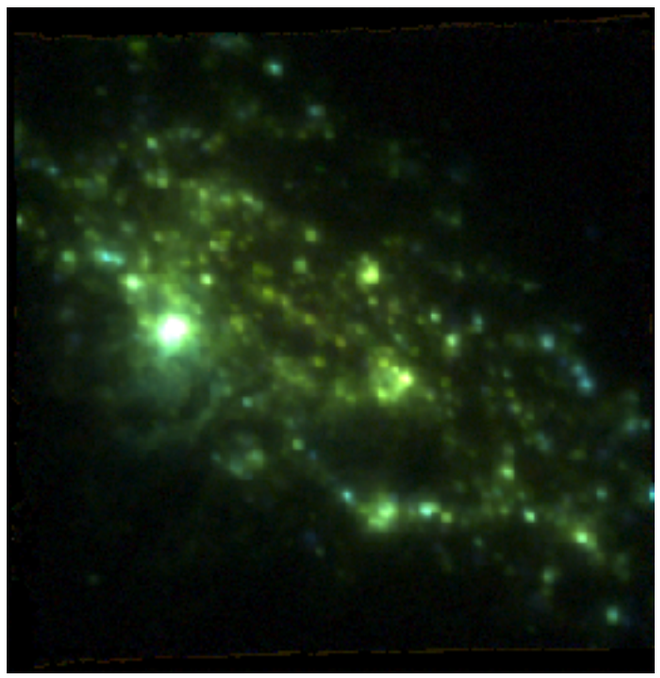


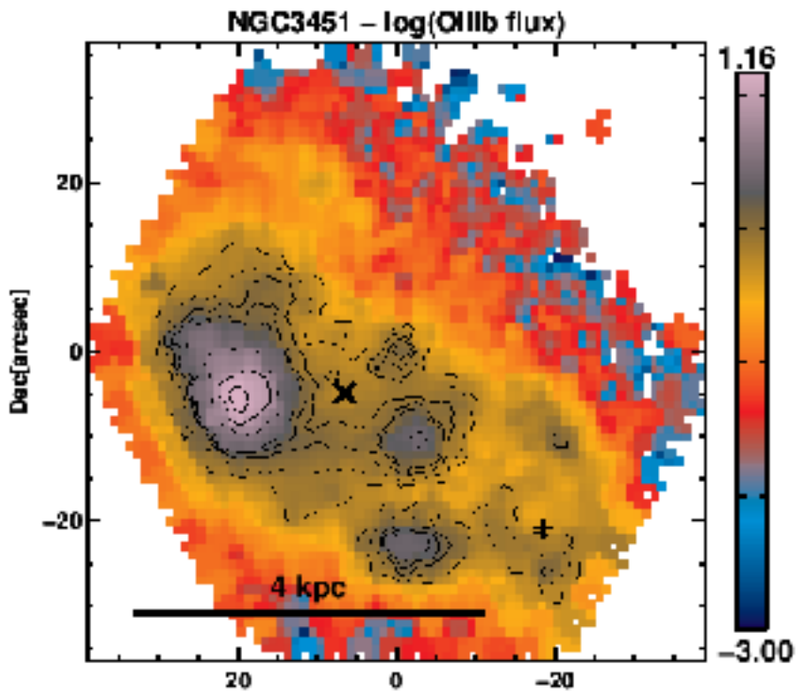


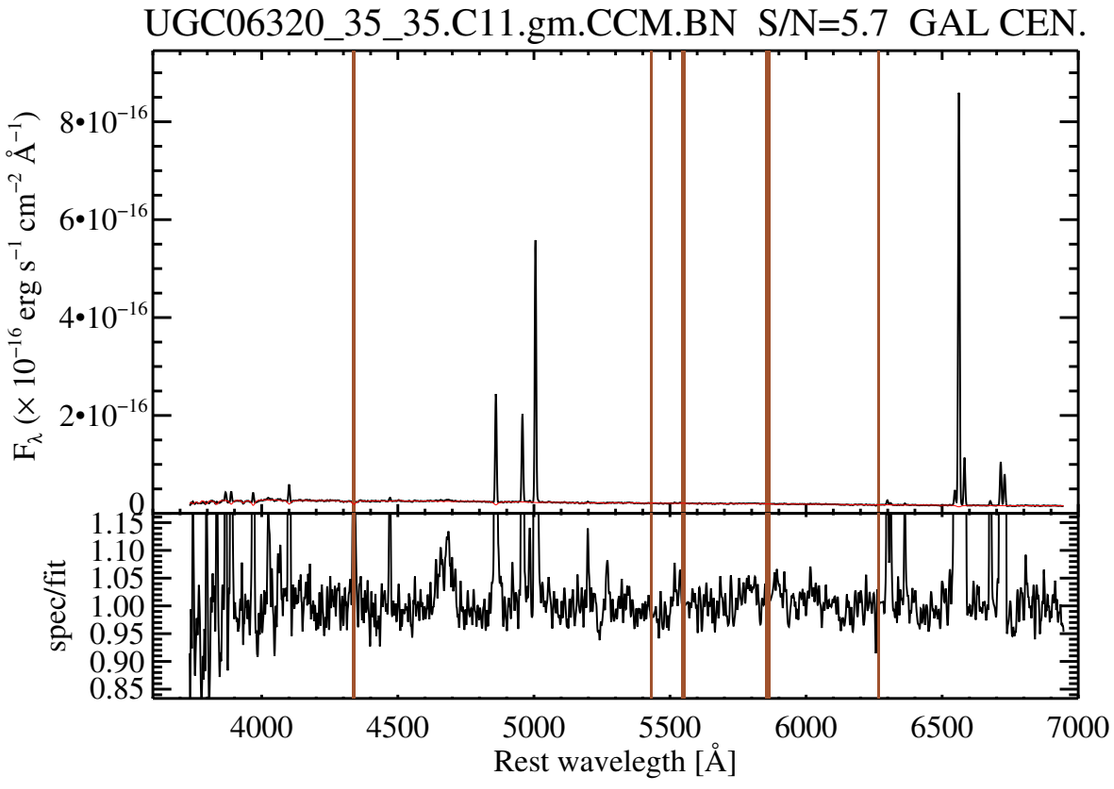
NGC 3451 WR population

Carolina Kehrig, José M. Vílchez (IAA)









$A_V = 0.56$ $\langle\log(t_*)\rangle_M = 8.97$ $\langle Z\rangle_M = 0.022$
$\langle\log(t_*)\rangle_L = 7.91$ $\langle Z\rangle_L = 0.020$

	$t_* < 3\times10^8$	$3\times10^8 \le t_* \le 2.4\times10^9$	$t_* > 2.4\times10^9$
x [%]	45.0	52.8	2.2
μ [%]	1.6	86.5	12.0