Institute of Space Sciences

CSIC
Consejo Superior de Investigaciones Científicas

An Extraordinary Journey into the Transient Sky

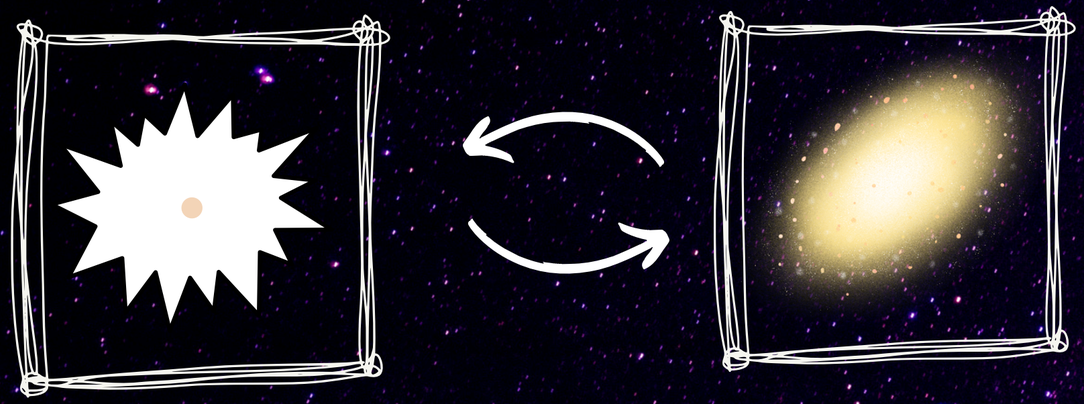
Environments of type Ia supernovae in terms of Si II velocities with IFS

Cristina Jiménez-Palau (PhD Student)
Supervisor: Dr. Lluís Galbany
Collaborators: Prof. Yen-Chen Pan and Shubham Gupta (NCU, Taiwan)

3rd of April 2025, Padova

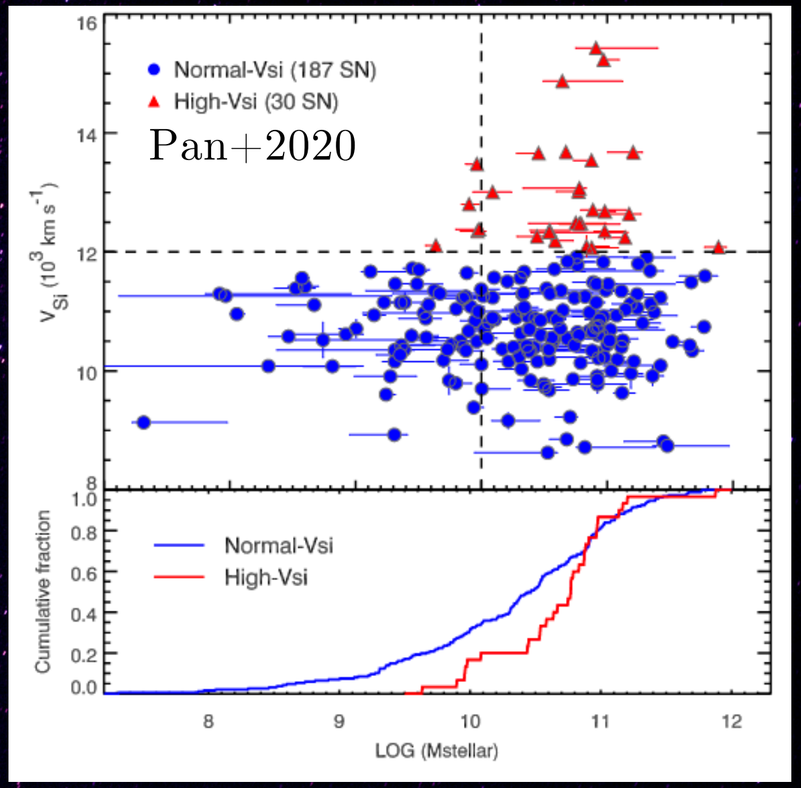
Correlation of spectral properties with SNe Ia hosts

There is evidence that the spectral features of SNe Ia also correlate with the host properties (Foley+2011). The division of SNe Ia into normal and Si II high photospheric velocities suggests the possibility of two different populations of progenitors (Wang+2013, Pan+2015, Pan+2020).



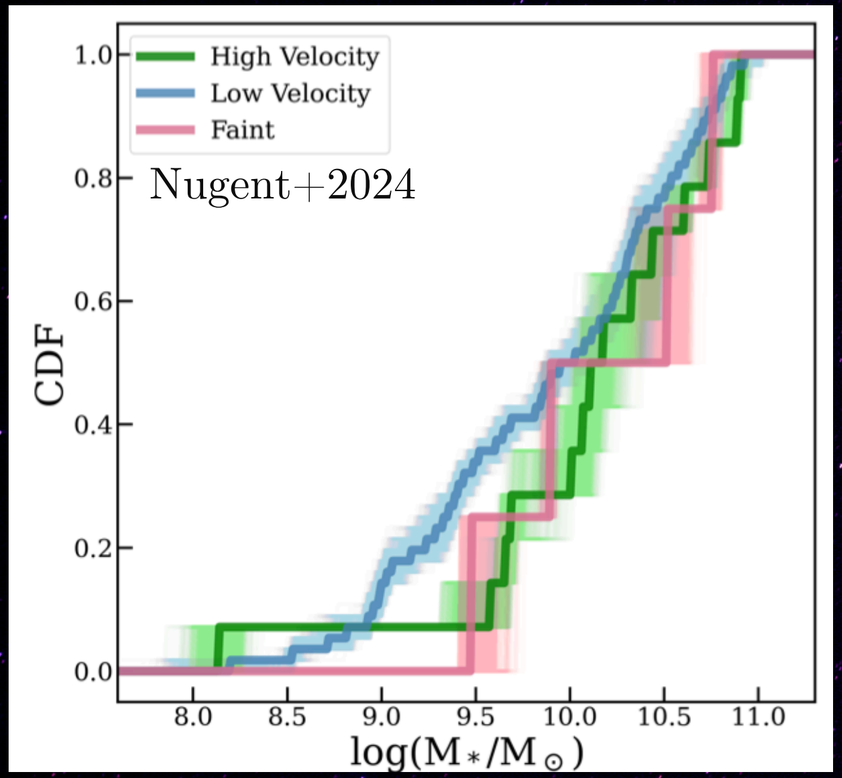
Ejecta velocities of type Ia supernovae can be used to differentiate progenitors and explosion mechanisms.

Pan+2020 suggests that HV (v > 12.000 km/s) Si II supernovae may favor more massive and redder environments.



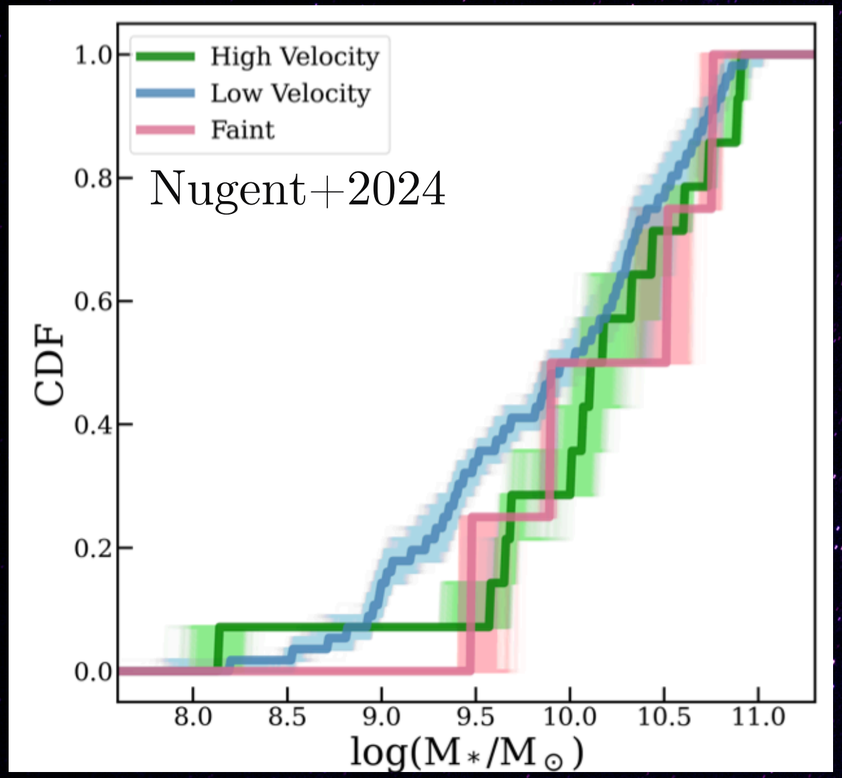
Correlation of spectral properties with SNe Ia hosts (II)

Further recent studies (Nugent+2024, Lin+2024) supported the claims that normal and high velocity Si II phospheric velocities may favor different progenitors by analizing local and global host photometry and bayesian SED fitting.



Correlation of spectral properties with SNe Ia hosts (II)

Further recent studies (Nugent+2024, Lin+2024) supported the claims that normal and high velocity Si II phospheric velocities may favor different progenitors by analizing local and global host photometry and bayesian SED fitting.



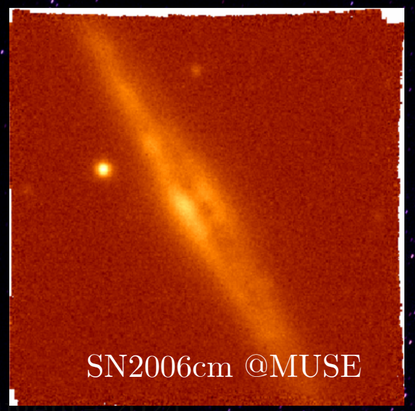
NEXT ➡

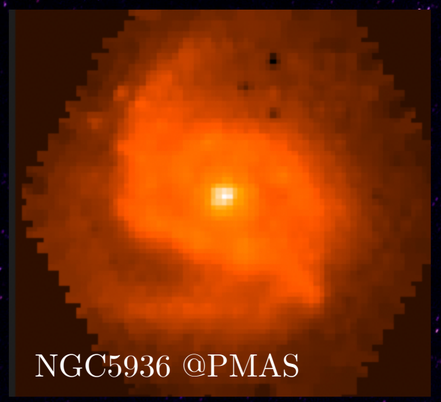
GOALS

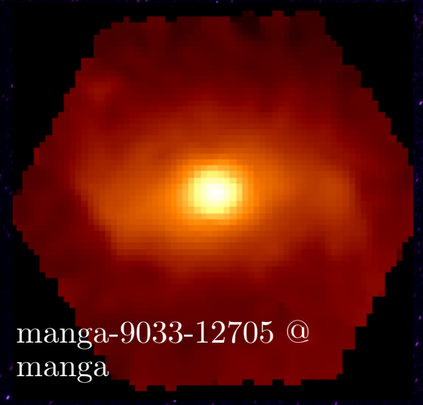
Improve the statistical size of the sample using all available Integral Field Spectroscopy+Photometry data with SNe Ia early spectra in order to perform an extended analysis.

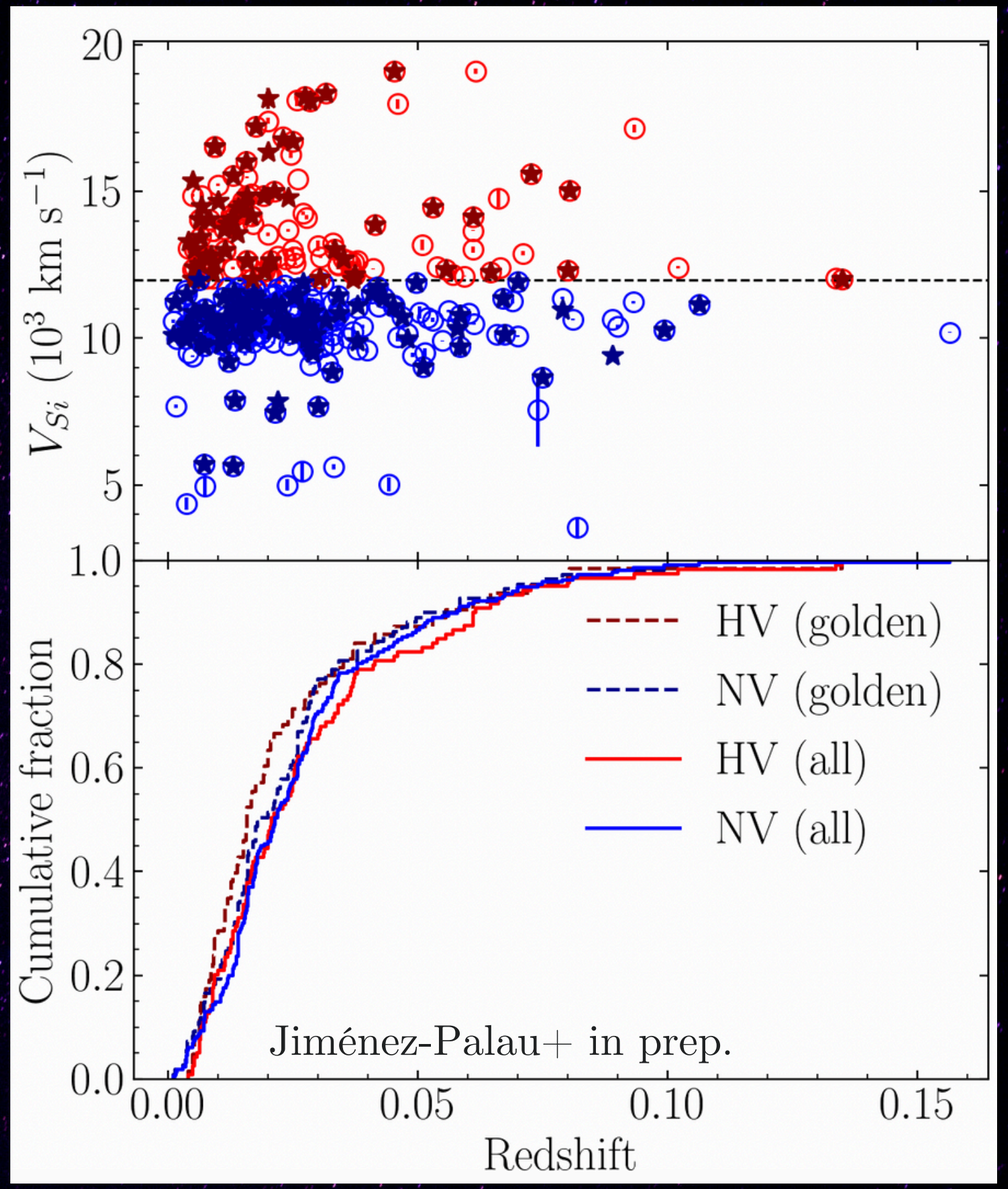
Our IFS + early spectra sample

+300 IFS cubes from PMAS + MUSE + MaNGa surveys with measured Si II velocities from SNe type Ia early spectra.









Definition of the sample

1

Get WISeREP (Yamin+2012) data from spectra from all type Ia supernovae (including peculiar types).

14.335 SN

2

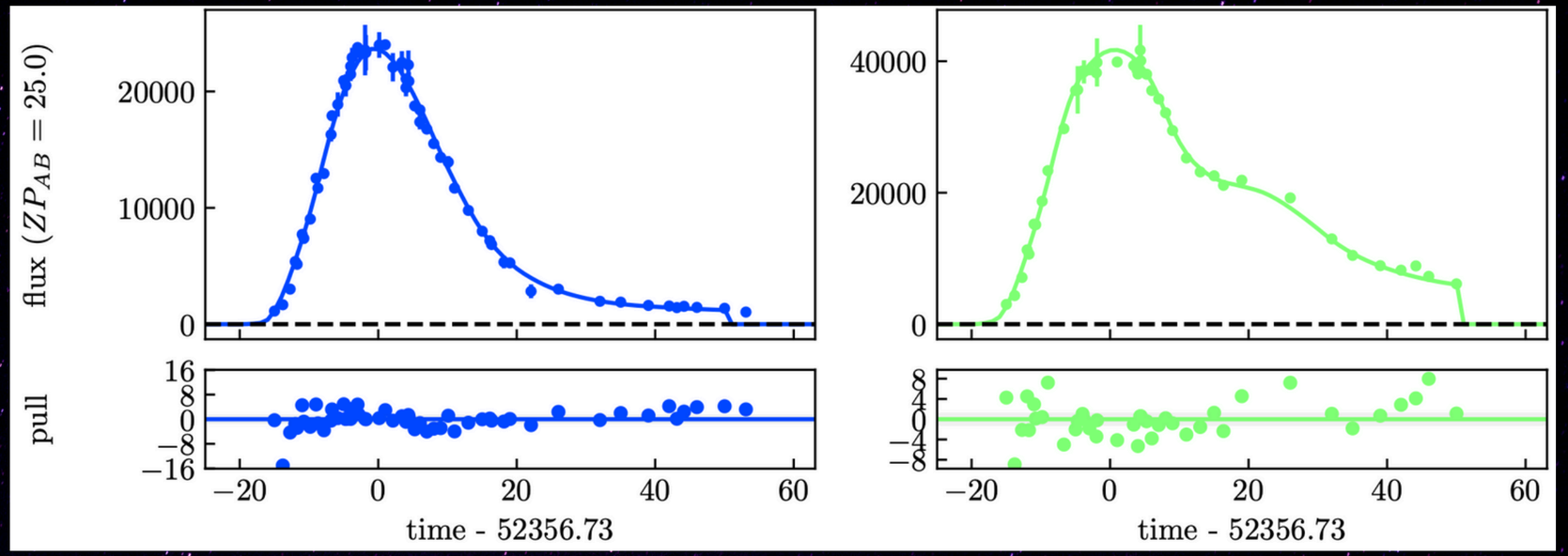
Match the WISeREP data with the available IFS dataset including Galbany+2016 and Galbany+2018 IFS compilations.

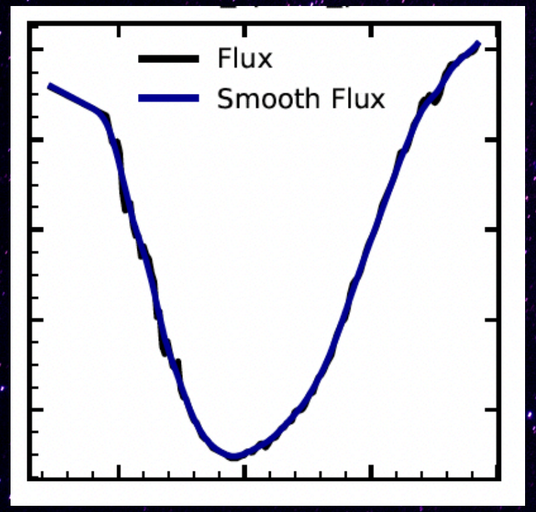
462 IFUs

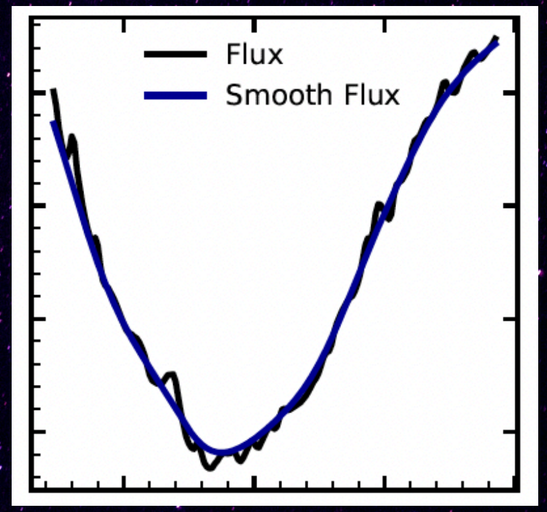
Analysis strategy: Si II velocities

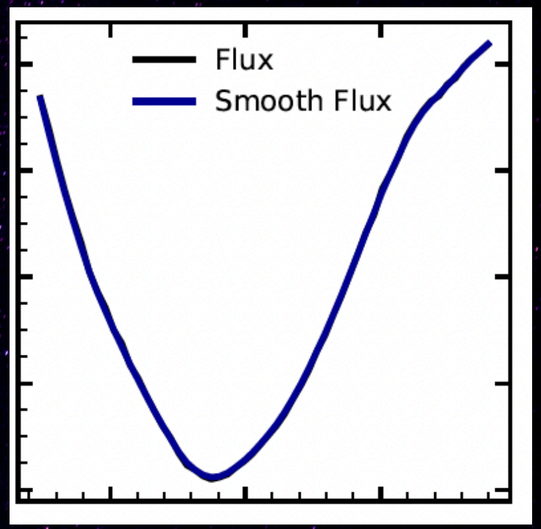
3

Measure velocities using Blondin+2006 and Sibert+2019 methods. Obtain the phases using the B-band maximum estimation using SNCosmo (Barbary+2016)





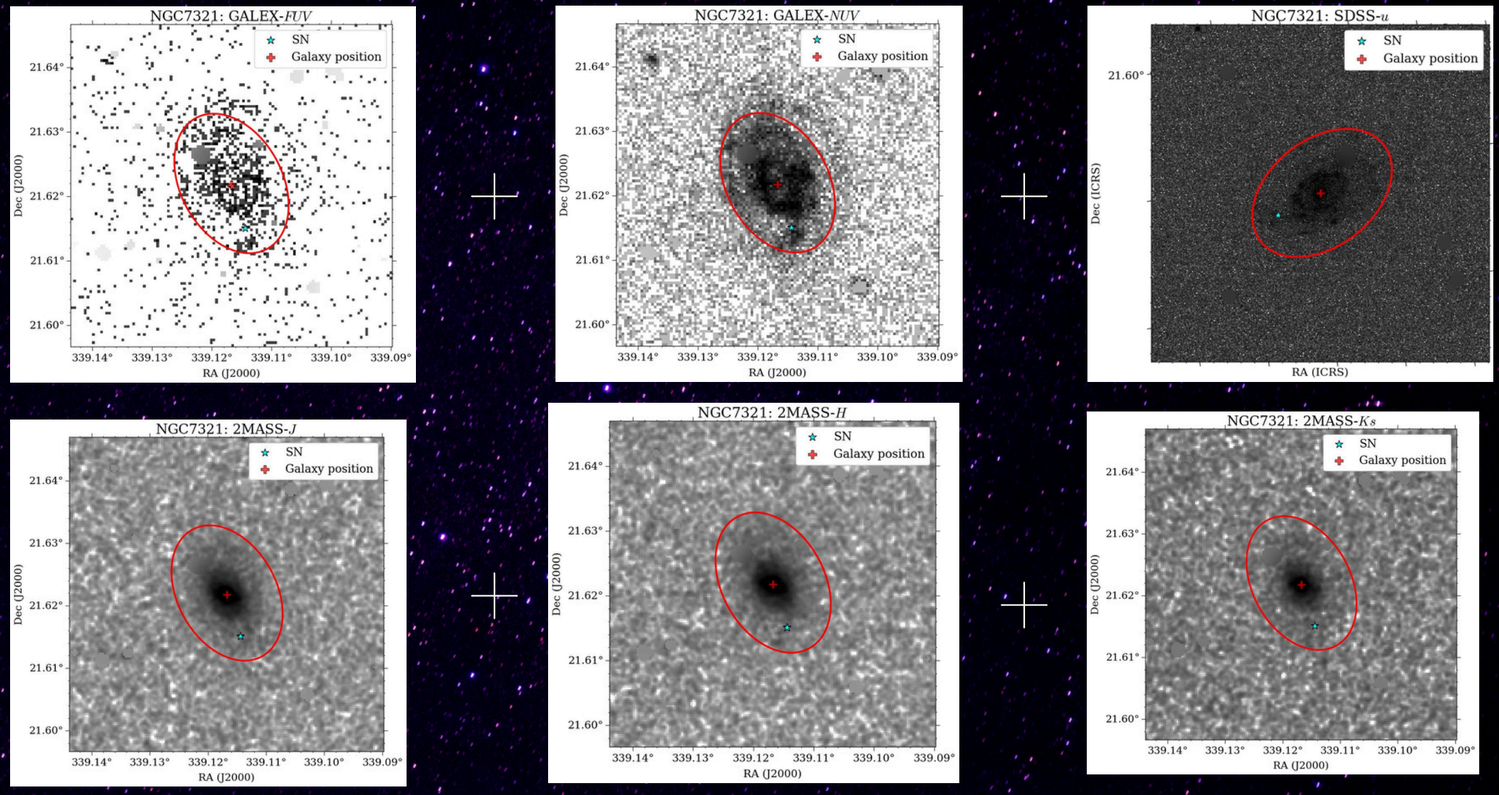




Analysis strategy: host galaxy properties (I)

2

Get the local and global photometry using HostPhot (Müller+2022) for UV (GALEX)+u (SDSS)+NIR (2MASS/UKIDSS) bands when posible



Analysis strategy: host galaxy properties (II)

1

Integrate the flux of the IFS data into local appertures, of r = 1,2,3 kpc and global appertures by the Kron flux parameters obtained using HostPhot (Müller+2022).

Global analysis

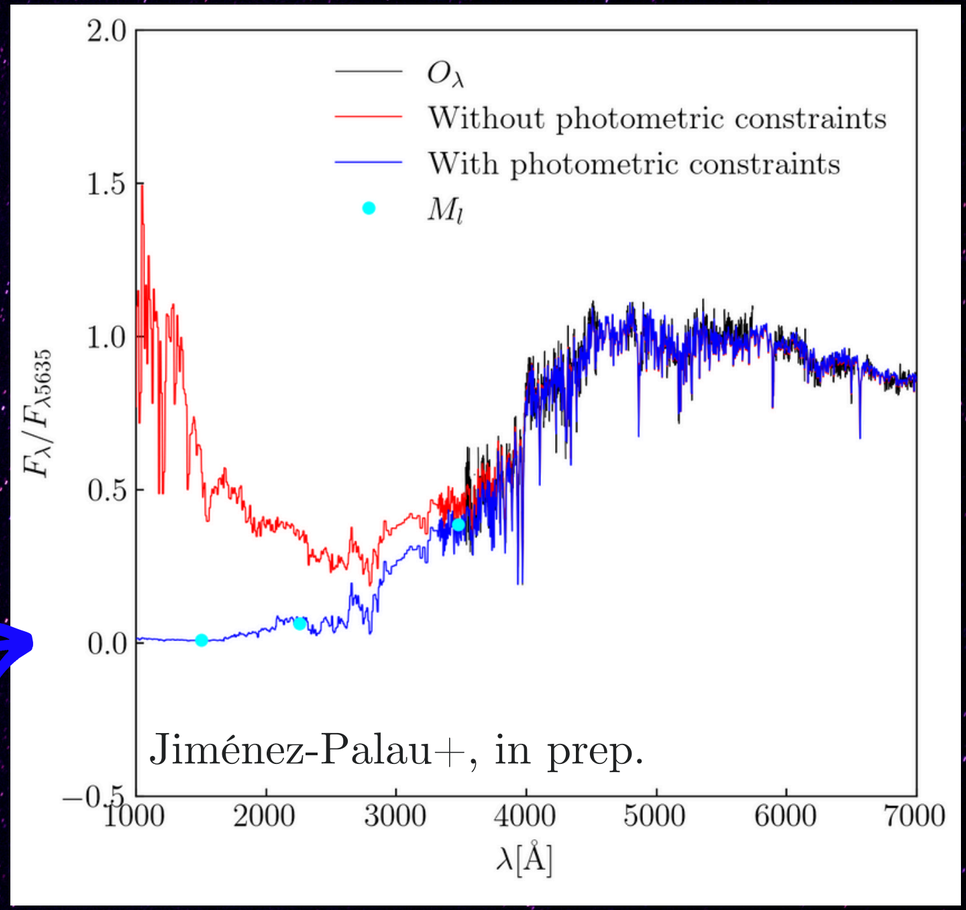
Local analysis

Analysis strategy: host galaxy properties (III)

3

Get the SSP populations from the spectra using Starlight with photometry (López-Fernández+2016) making use of Bruzal+2007 spectral basis.

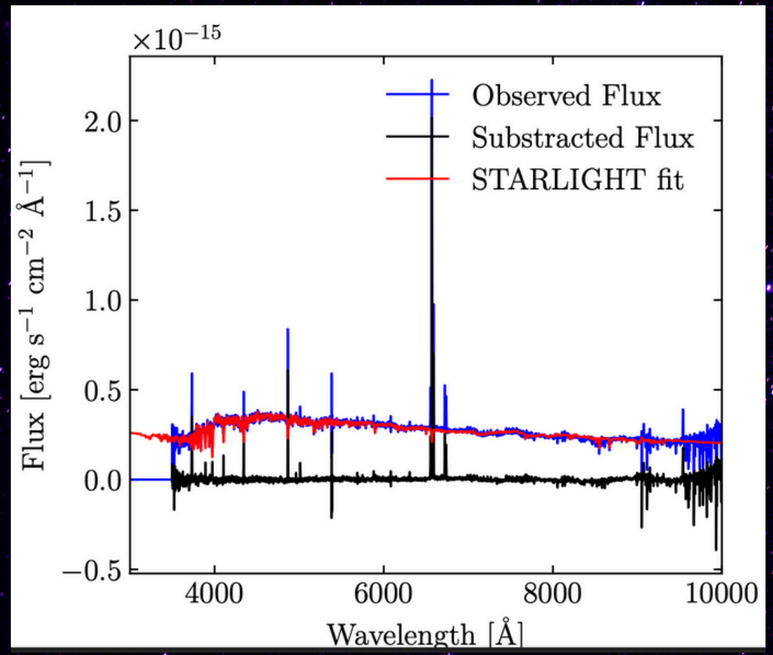
The addition of UV photometric constraints to the spectrum reduces the UV flux without reddening the optical part (Weyle+19).



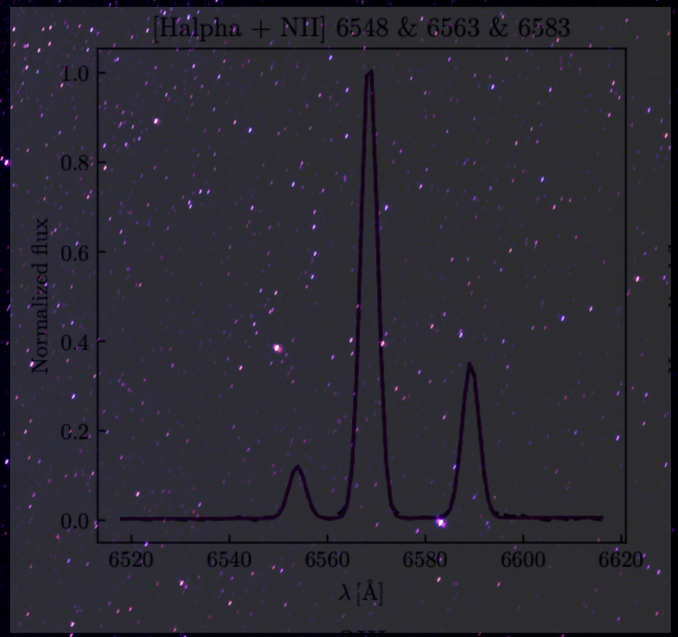
Analysis strategy: host galaxy properties (IV)

4

We measure the emission lines from the nebular spectra to obtain the SFR and metalicity values using Pettini +2004, Marino+2013 and Dopita+16 calibrators.



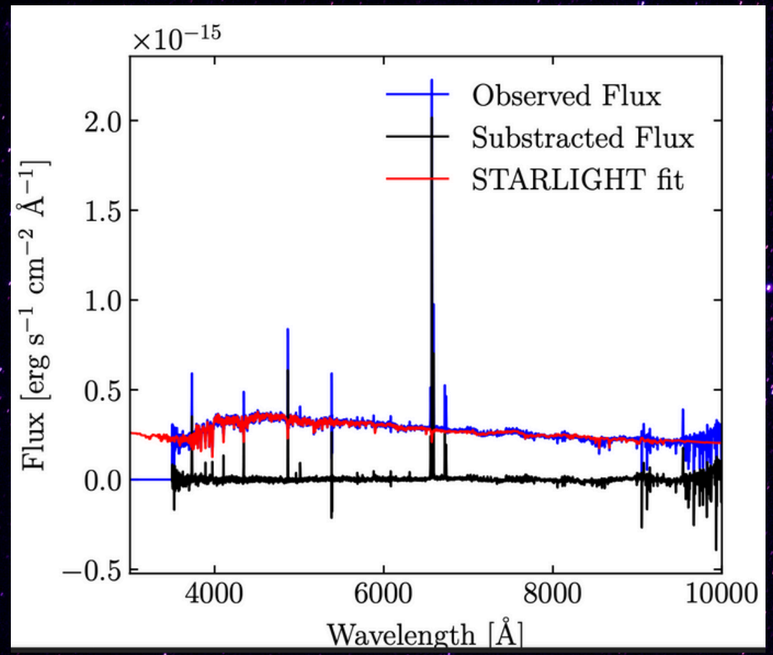
The nebular spectra is obtained by substracting the Starlight fitting results.



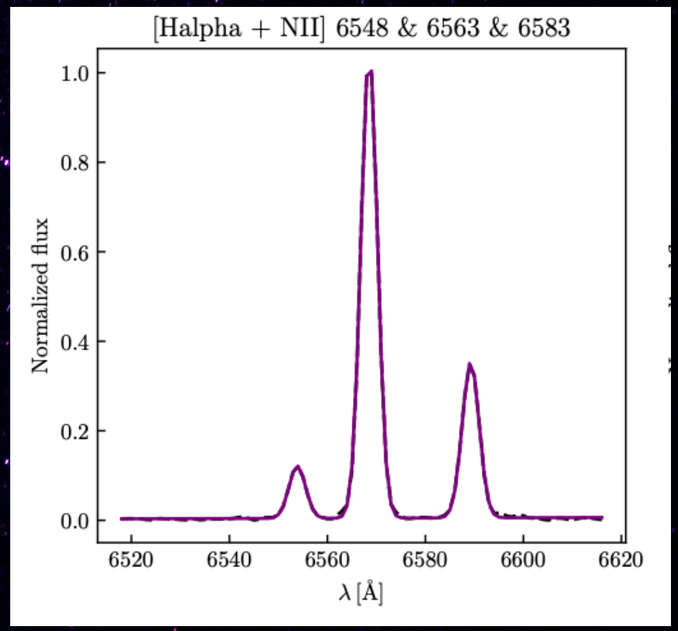
Analysis strategy: host galaxy properties (IV)

4

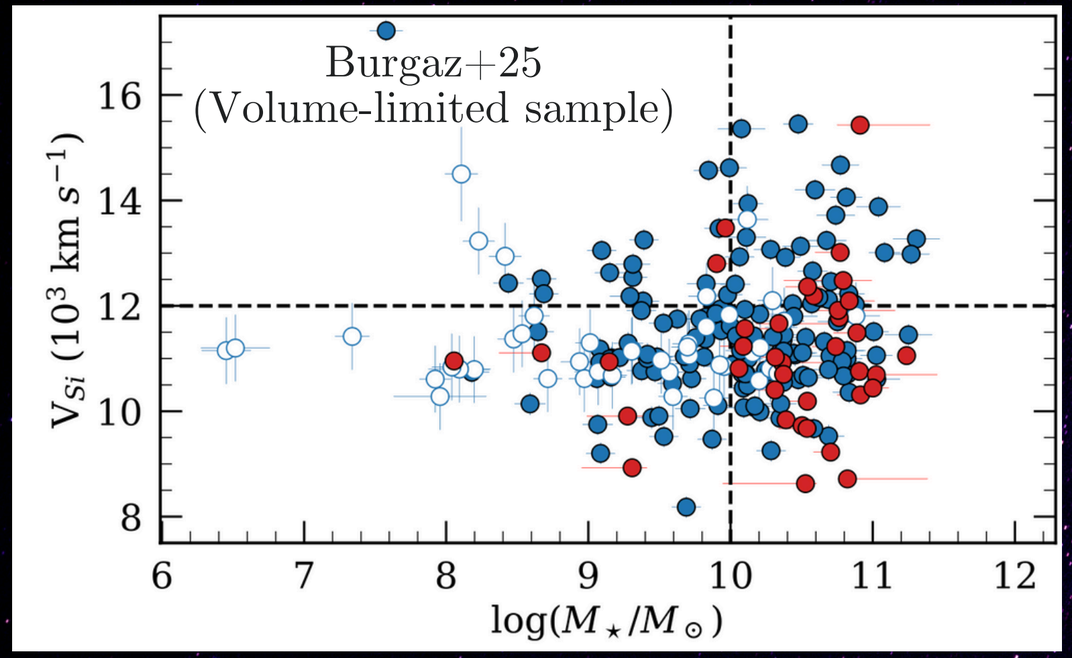
We measure the emission lines from the nebular spectra to obtain the SFR and metalicity values using Pettini +2004, Marino+2013 and Dopita+16 calibrators.

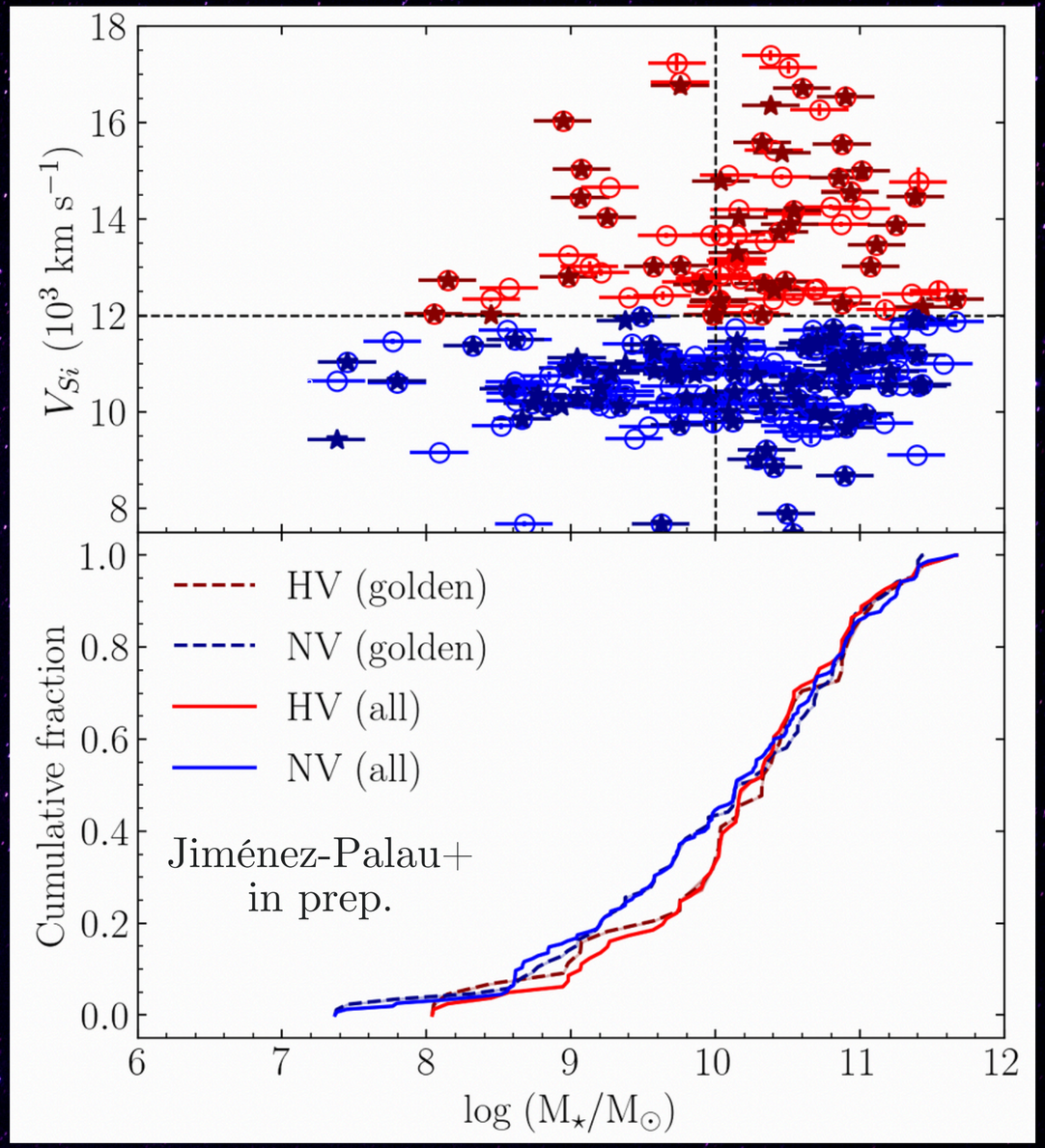


The nebular spectra is obtained by substracting the Starlight fitting results.



Global Stellar Mass in terms of Si II velocities



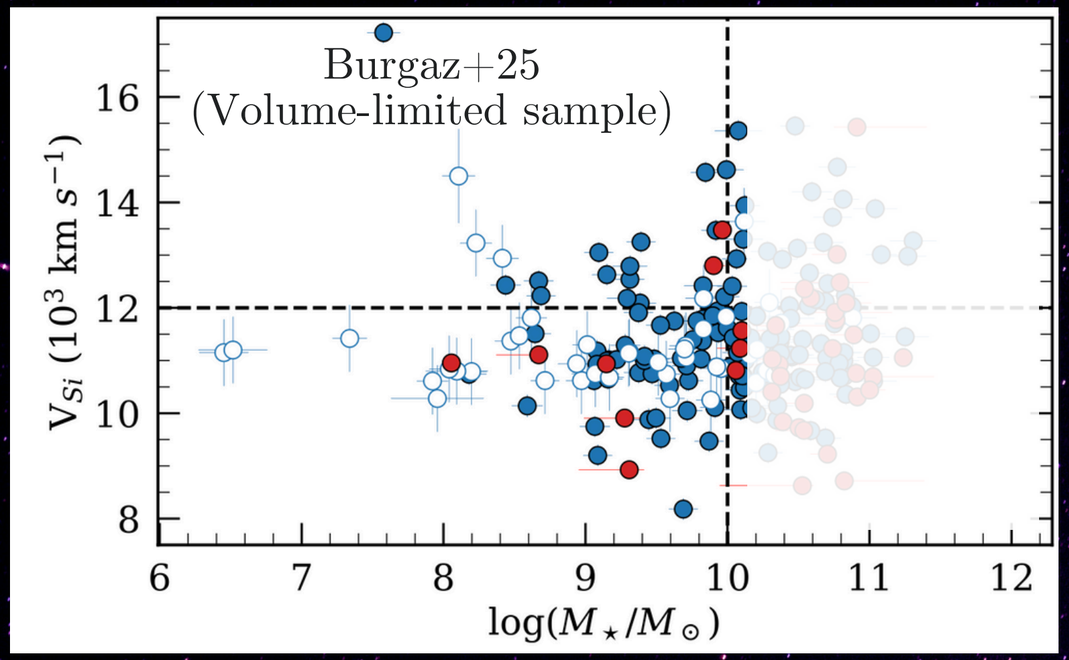


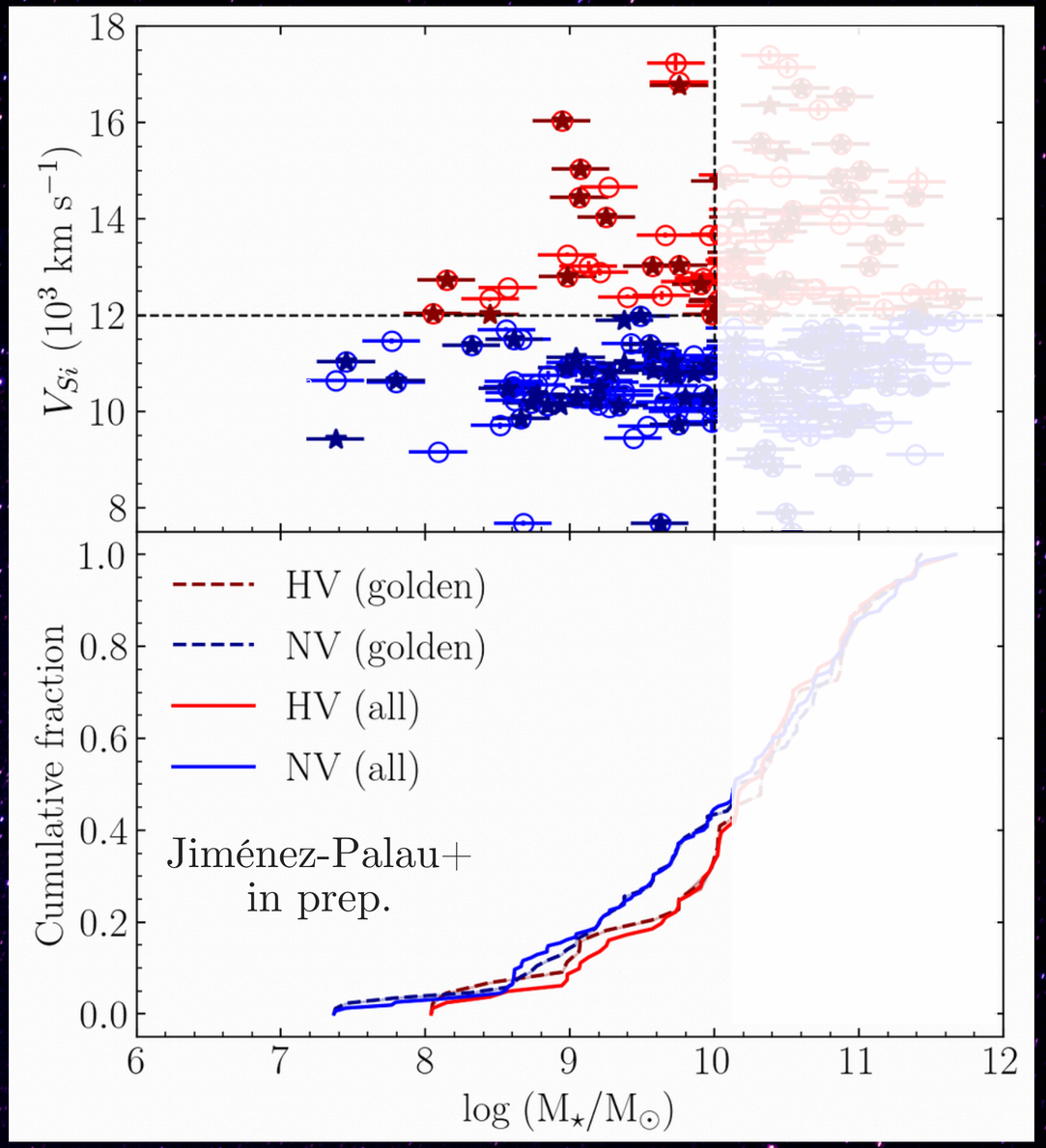
Our sample

Low-mass/High-Mass HV: 39%/61%

Low-mass/High-Mass NV: 43%/57%

Global Stellar Mass in terms of Si II velocities

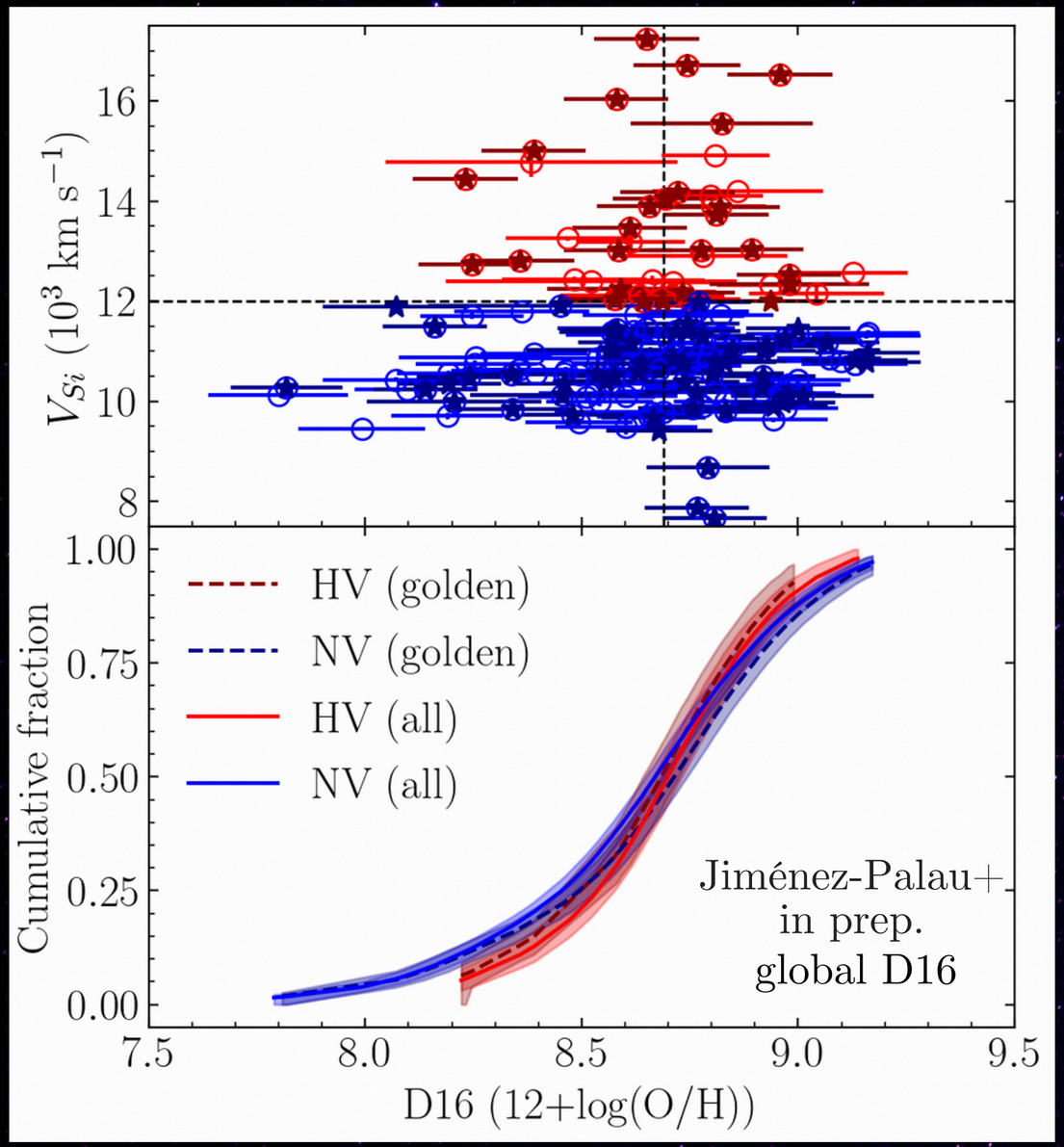




Our sample

Low-Mass NV/ HV: 74 %/26%
High-Mass NV/ HV: 69%/31%

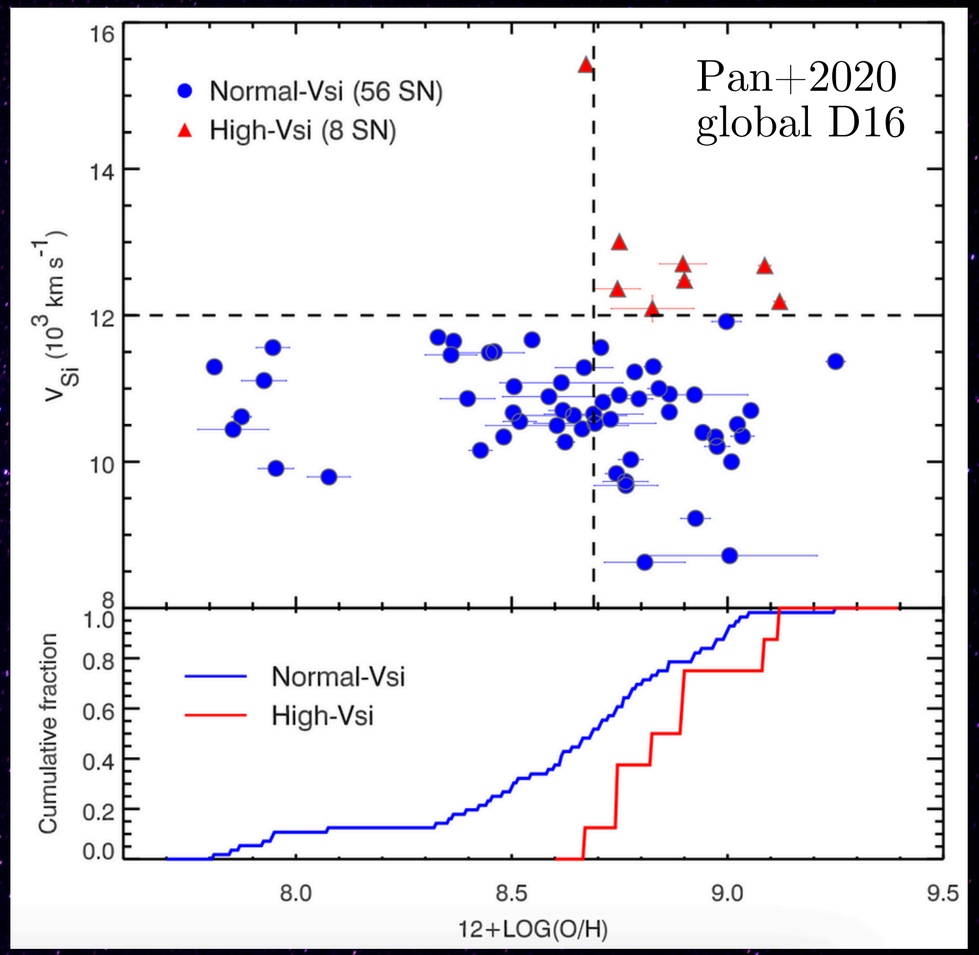
Metallicity calibrators in terms of Si II velocities



$$12 + \log(\mathrm{O/H}) = 8.77 + \mathrm{N2S2} + 0.264 \times \mathrm{N2}.$$

Dopita+16

$$\mathrm{N2S2} \equiv \log\left(\frac{[\mathrm{N\,II}]\,\lambda 6583}{[\mathrm{S\,II}]\,\lambda\lambda 6717,\,6731}\right),$$



Take home messages

The correlations between the spectral properties of the supernovae and the host are key to study the progenitors populations.

The use of IFS+photometry allows us to properly obtain spatially resolved environmental properties.

The stellar mass and metallicity of our hosts may be correlated to the Si II velocities. However this results can be related to sample selection issues or statistical analysis.

Thank you so much!

Reach me!

cjimenez@ice.csic.es