Institute of Space Sciences

CSIC
Consejo Superior de Investigaciones Científicas

ZTF Meeting 2024

Type Ia Si II velocities in terms of mass and metallicity using IFS

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

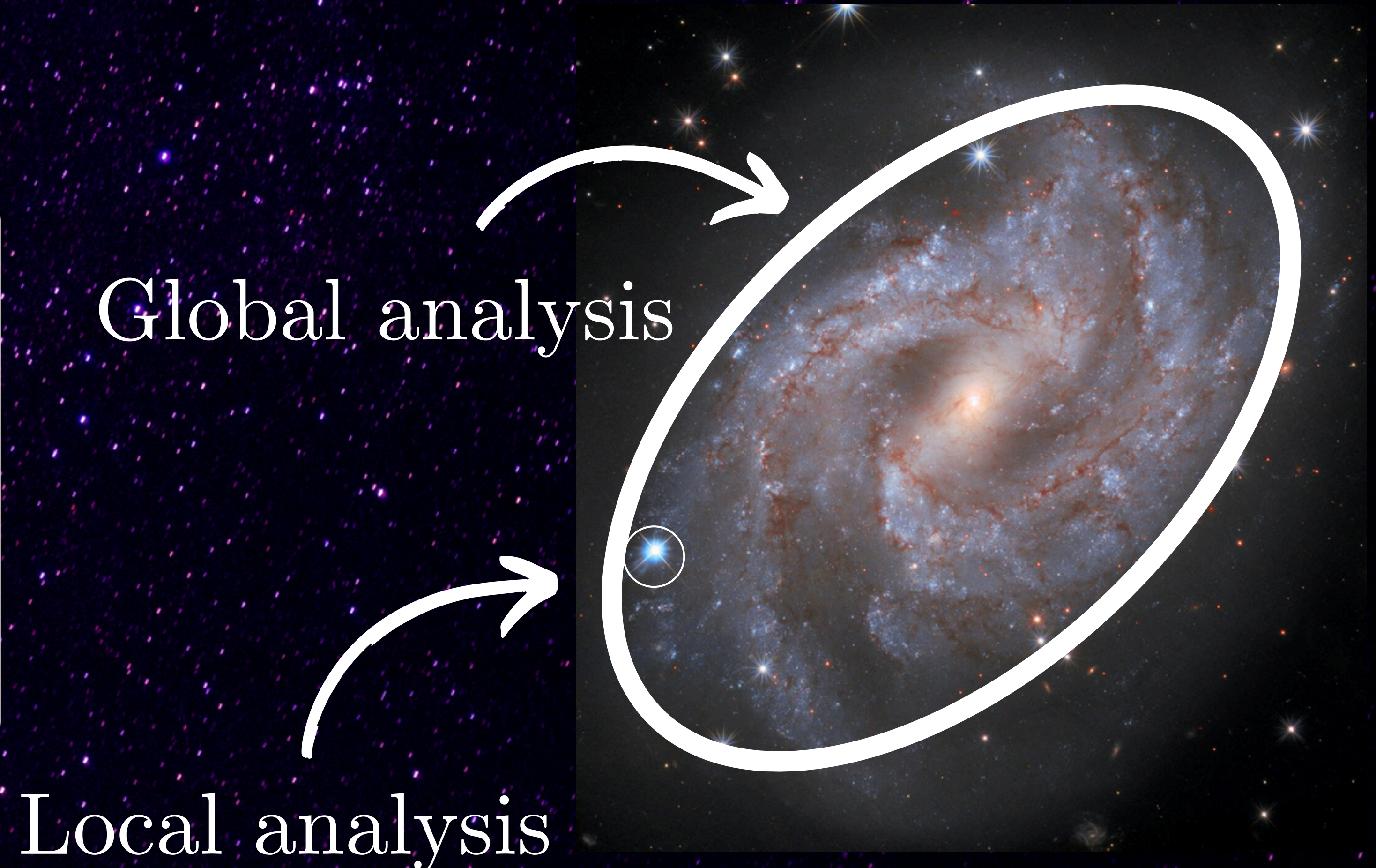
10th of December 2024
Barcelona

The effect of the host galaxy in SNe Ia

Understanding the systematics in SNe Ia standarization is crucial to improve their use as distance indicators.

This leads to the importance to study the known correlations between the standarized luminosities of type Ia supernovae and the host galaxy properties such as stellar mass, SFR, morphology, stellar age and metallicity.

Multiple studies, including Rigault+2013, Galbany+2014, Roman+2018 and Kelsey+2020, suggested that analysing the properties in a small environment around the SN (local analysis) could describe the SN environments better than the whole (global analysis).

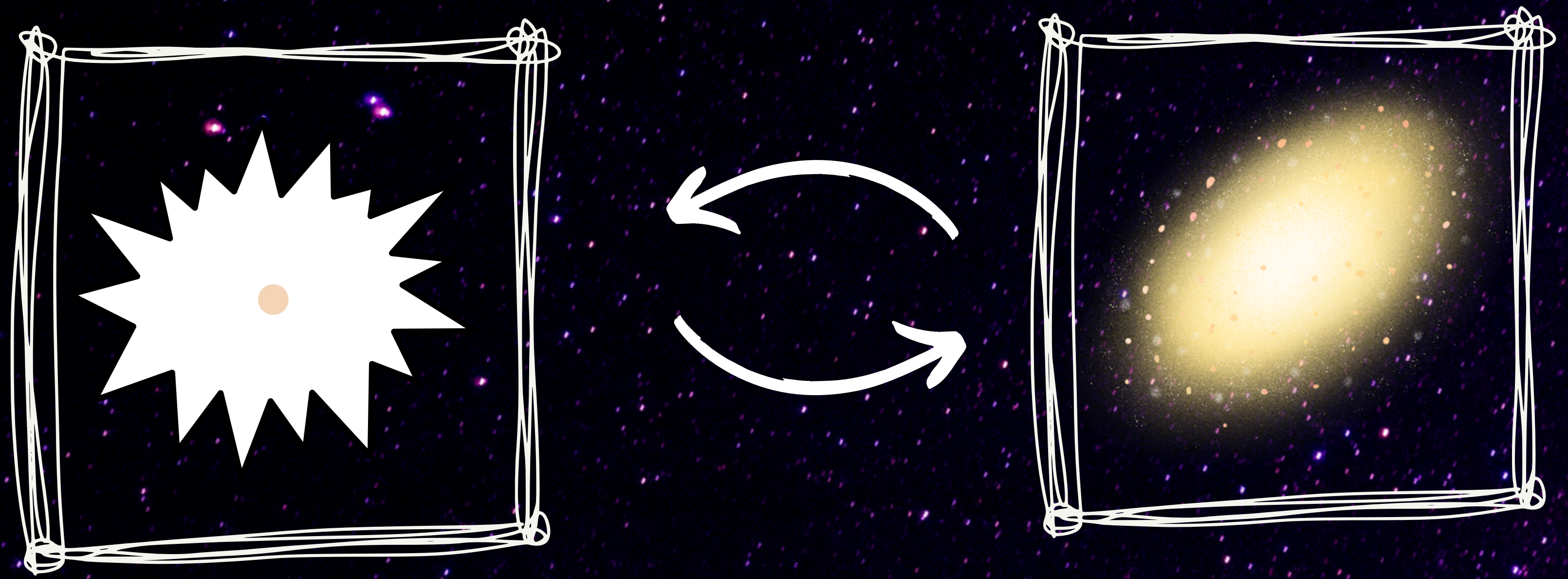


Correlation of spectral properties with SNe Ia hosts

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 high Si II photospheric velocities suggests the possibility of two different populations of progenitors (Wang+2013, Pan+2015, Pan+2020).

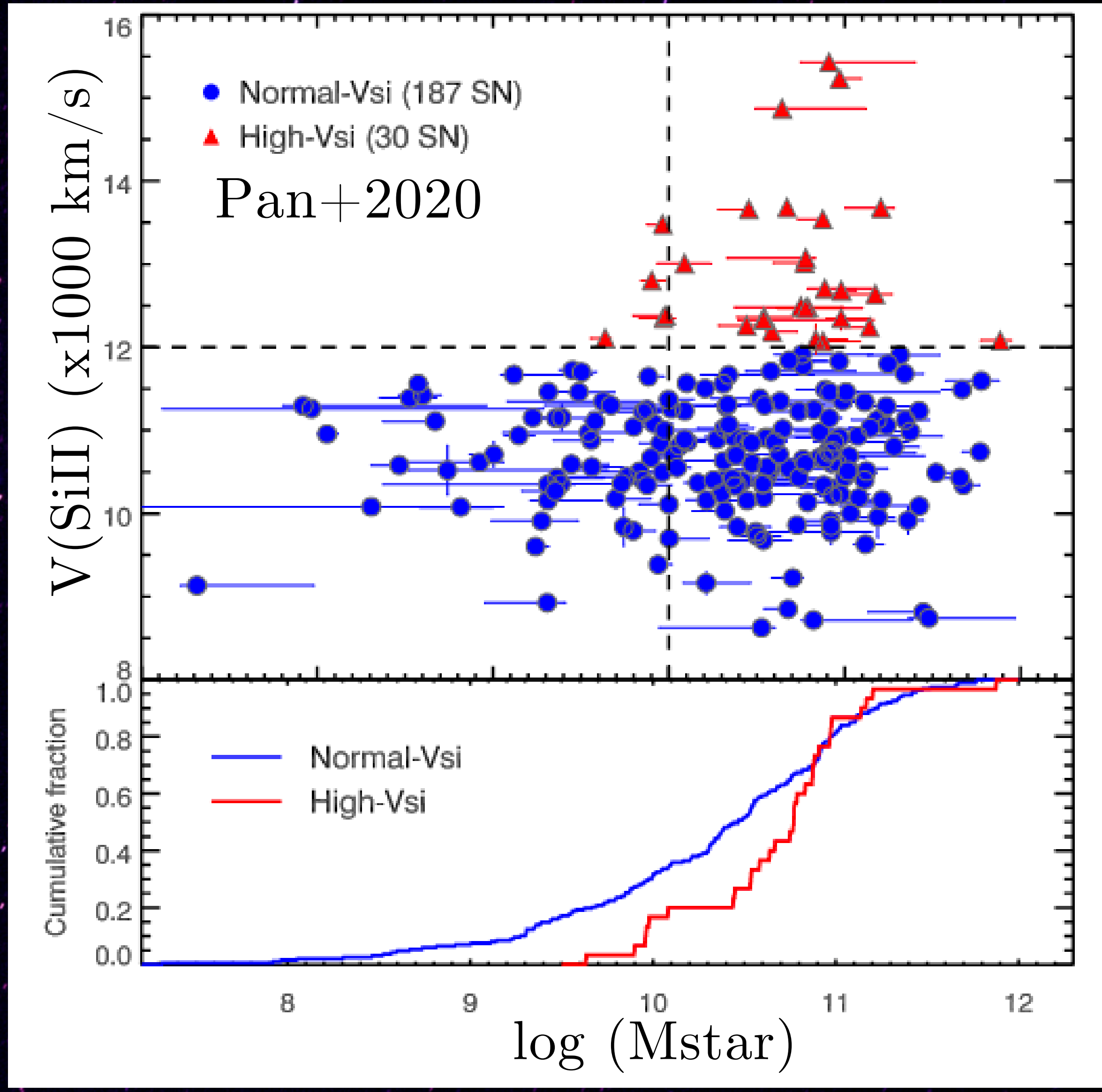
Correlation of spectral properties with SNe Ia hosts

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).



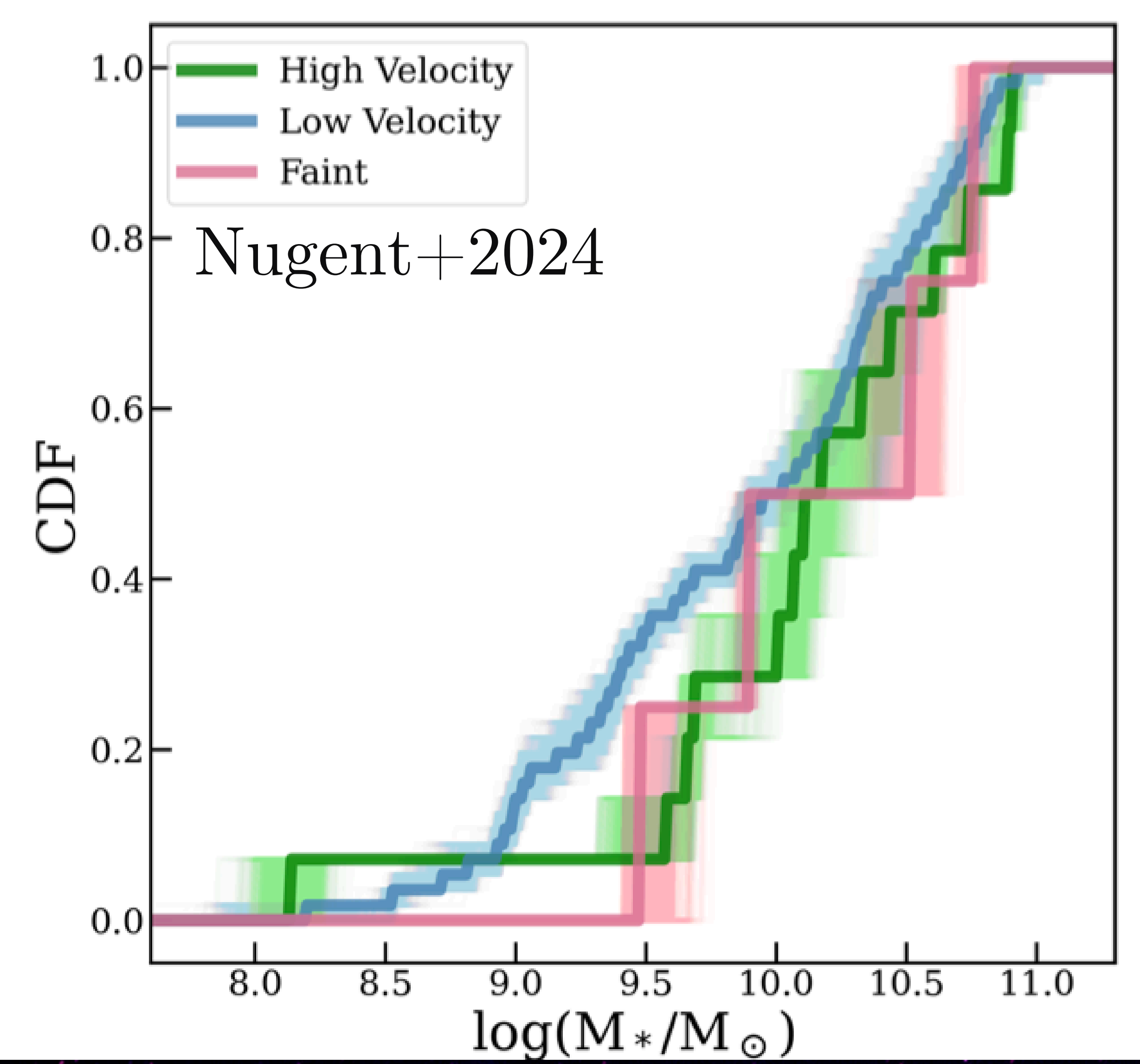
Ejecta velocities of type Ia supernovae can be used to differentiate progenitors and explosion mechanisms.

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



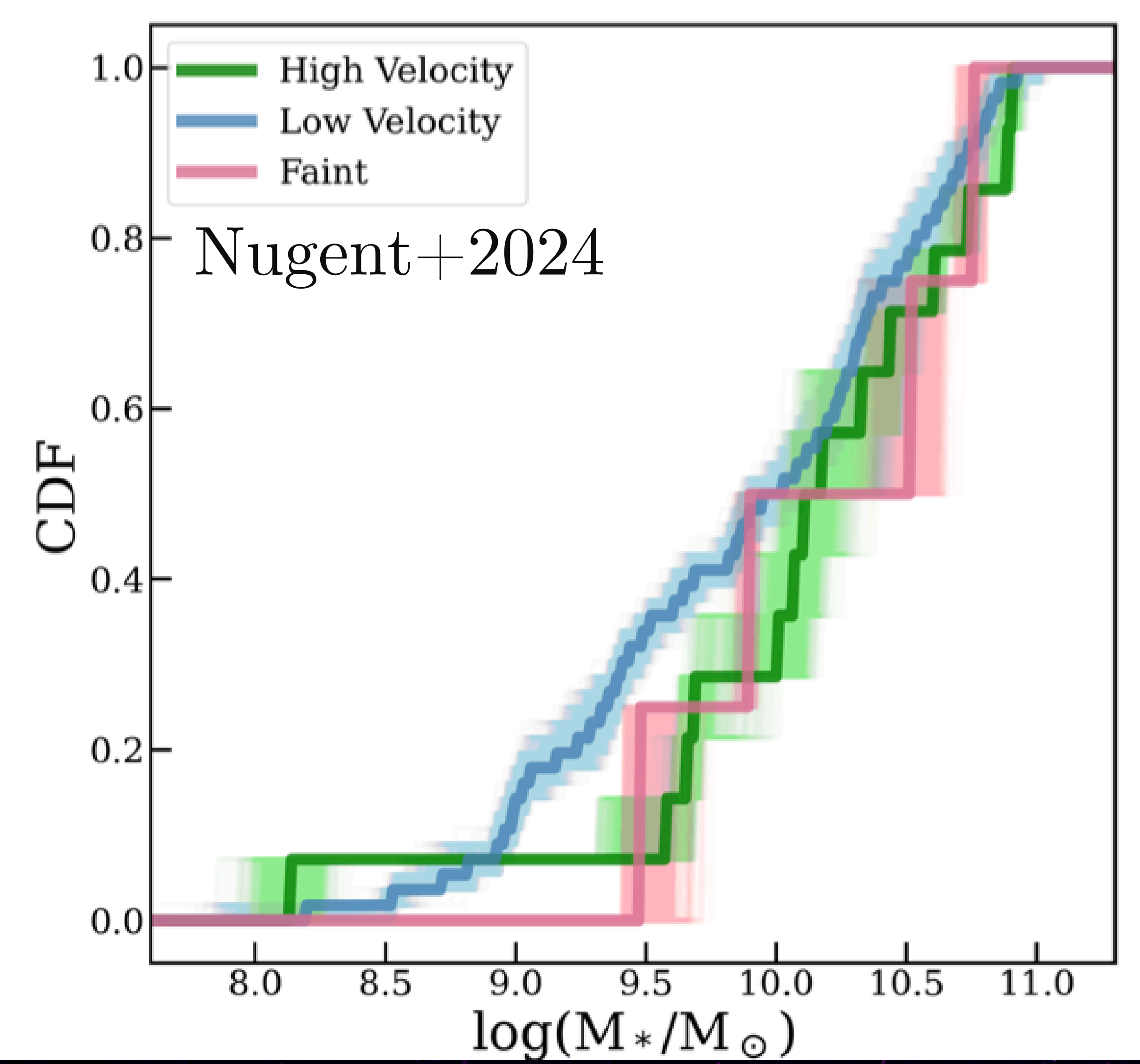
Correlation of spectral properties with SNe Ia hosts (II)

Further recent studies (Nugent+2024, Lin+2024) also suggested that normal and high velocity Si II phospheric velocities may favor different progenitors by analizing host photometry and bayesian SED fitting but they still got inconclusive results.



Correlation of spectral properties with SNe Ia hosts (II)

Further recent studies (Nugent+2024, Lin+2024) also suggested that normal and high velocity Si II phospheric velocities may favor different progenitors by analizing host photometry and bayesian SED fitting but they still got inconclusive results.



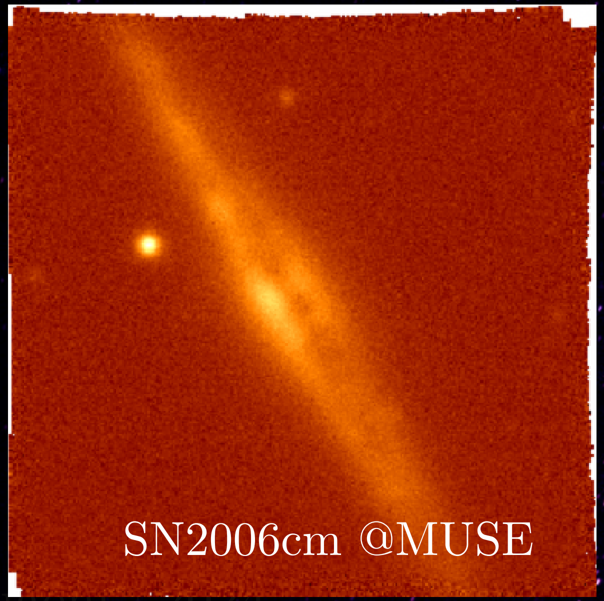
NEXT ➡

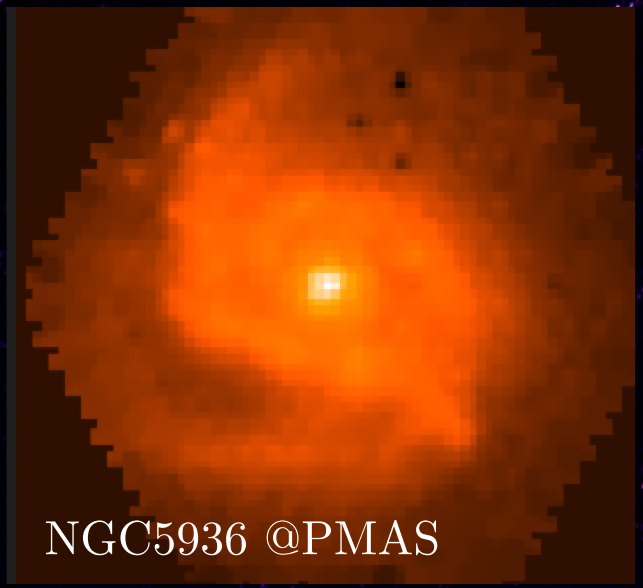
GOALS

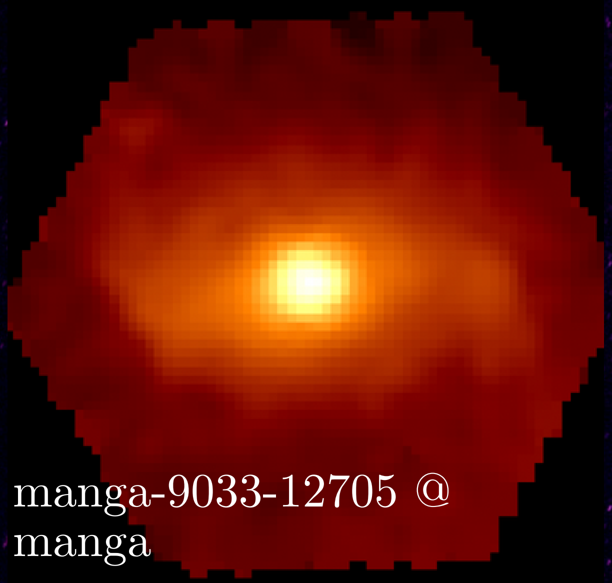
Improve the statistical size of the sample using all available Integral Field Spectroscopy+Photometry data with SNe Ia early spectra in order to perform an extended local and global analysis.

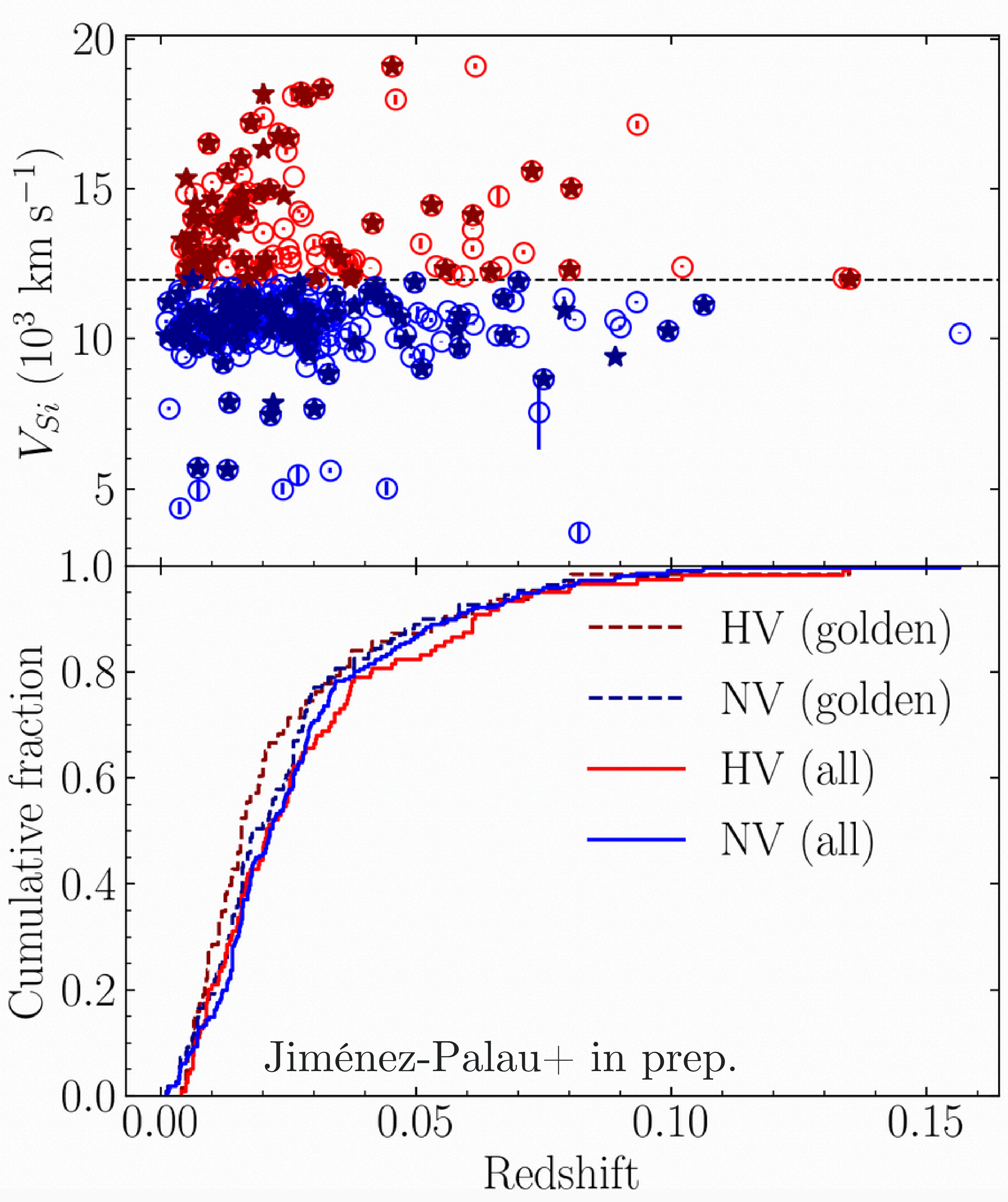
Our IFS + early spectra sample

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









Analysis strategy: Si II velocities

1

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

Analysis strategy: Si II velocities

1

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

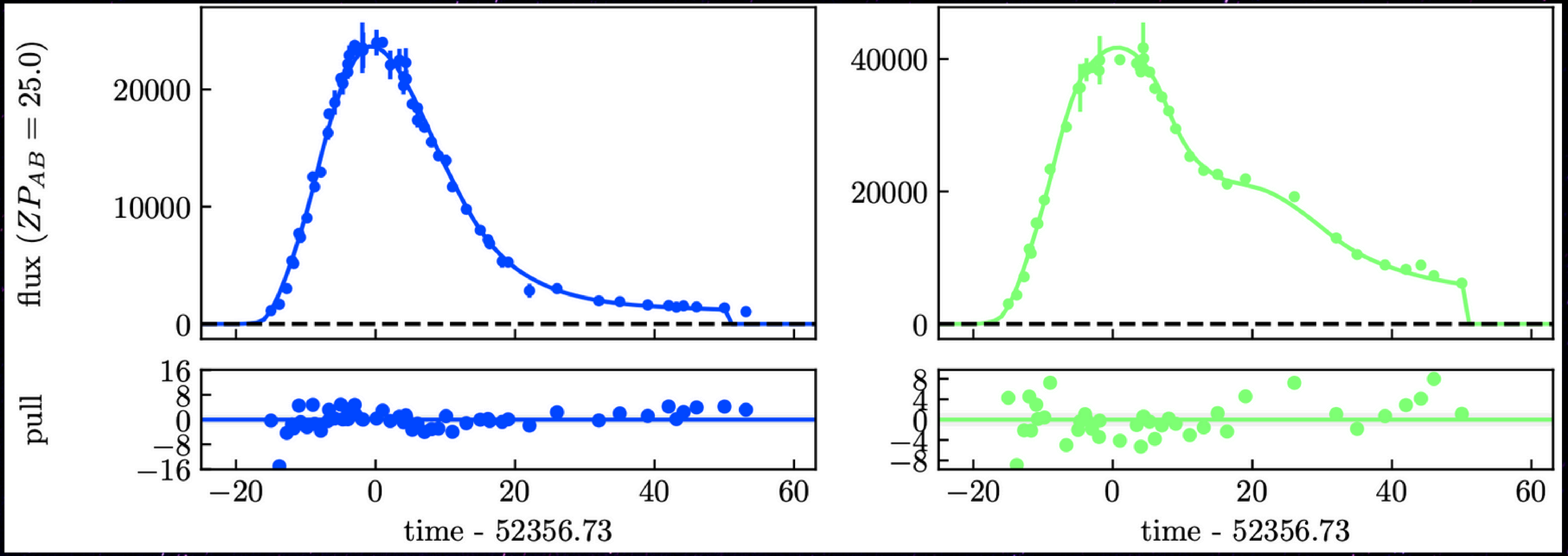
2

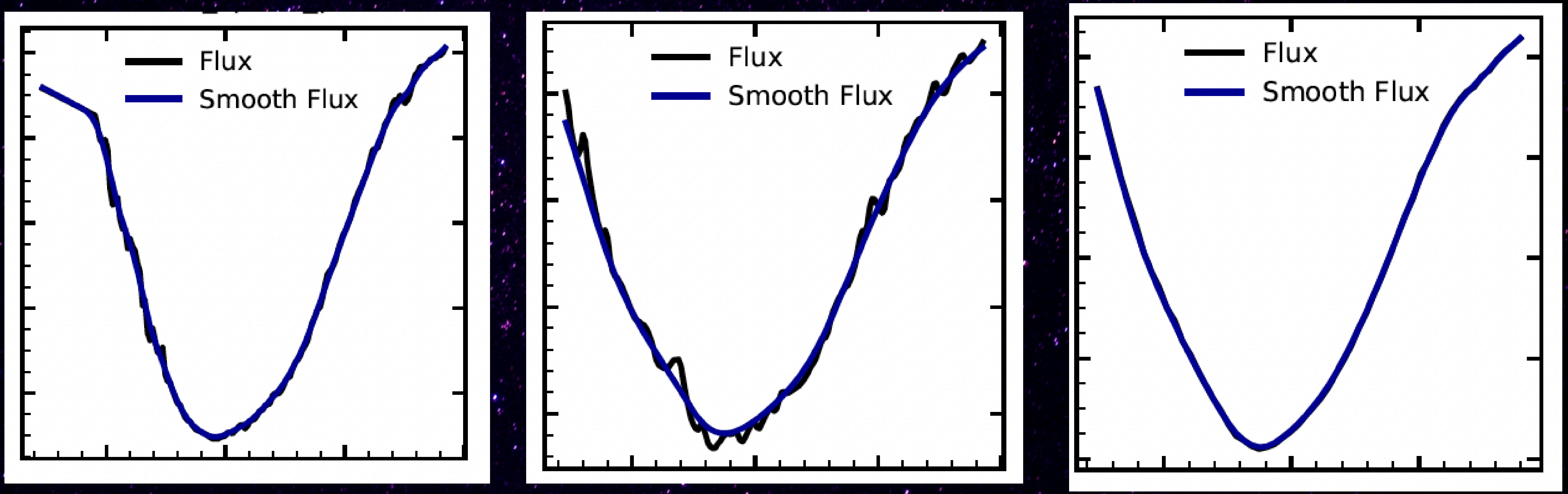
Match the WISeREP data with the available IFS dataset including Galbany+2016 and Galbany+2018 IFS compilations.

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)

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

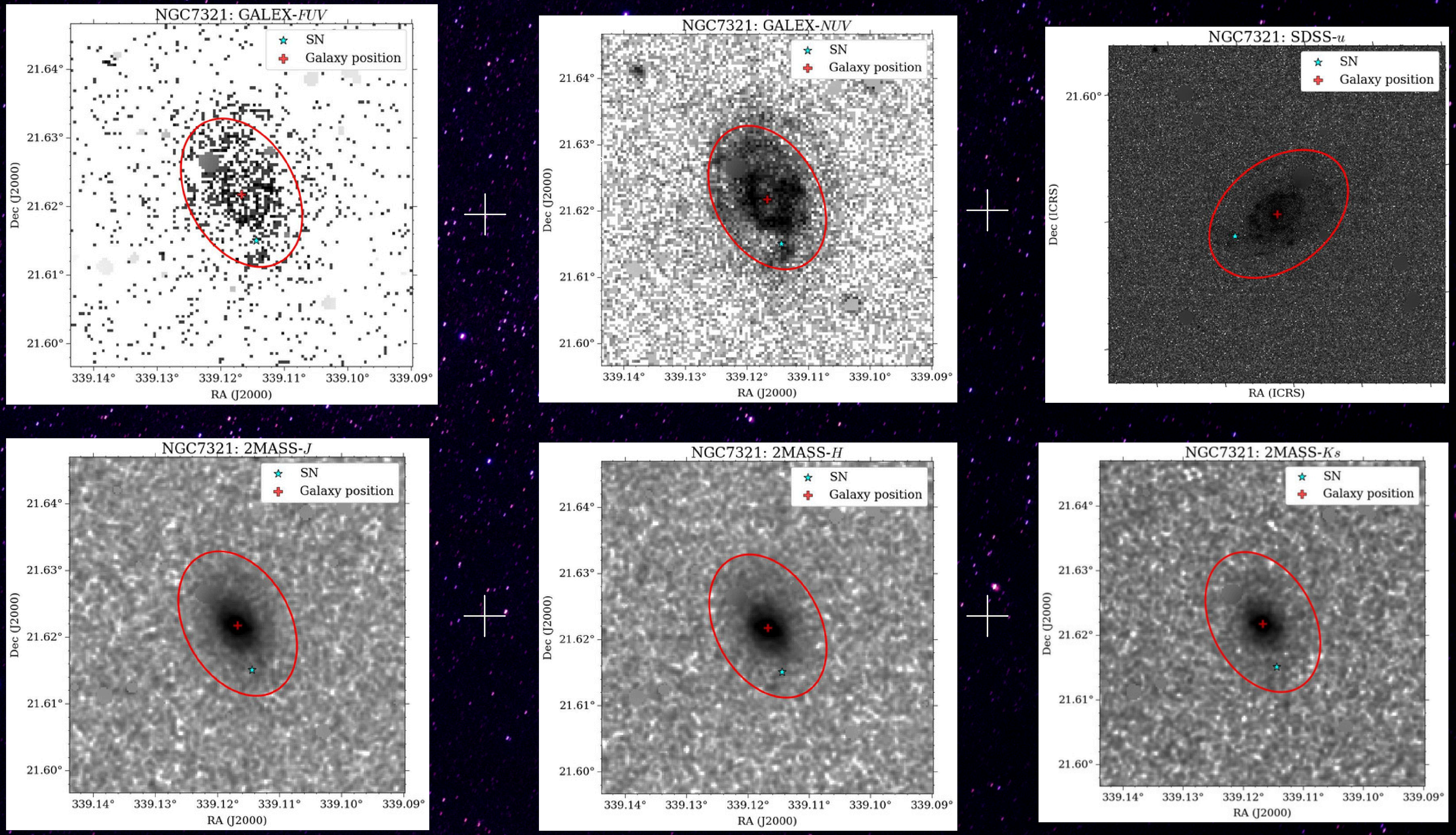
Local analysis

Analysis strategy: host galaxy properties (II)

(See Tomás talk about HostPhot on Thursday)

2

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

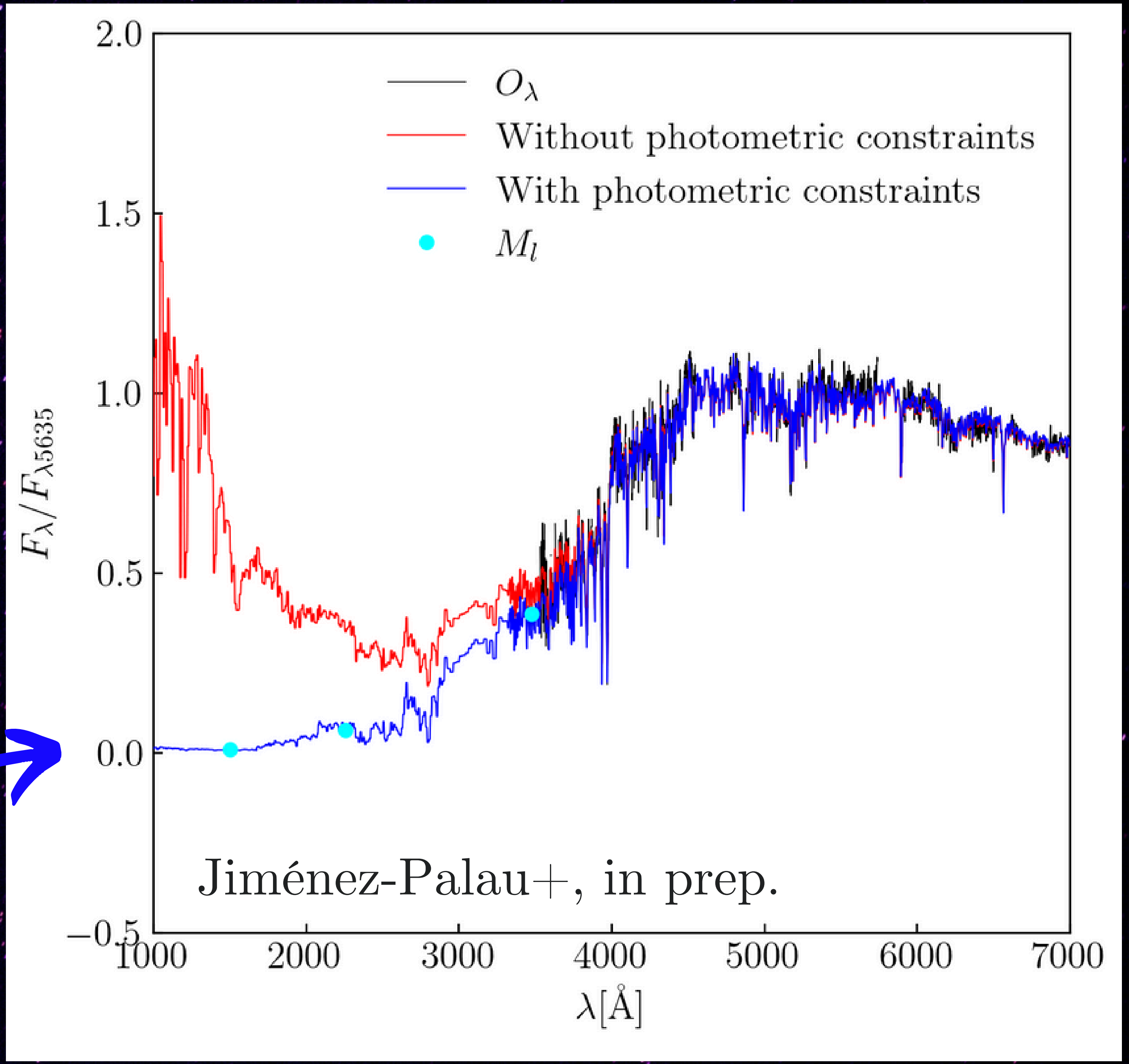


Analysis strategy: host galaxy properties (III)

3

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

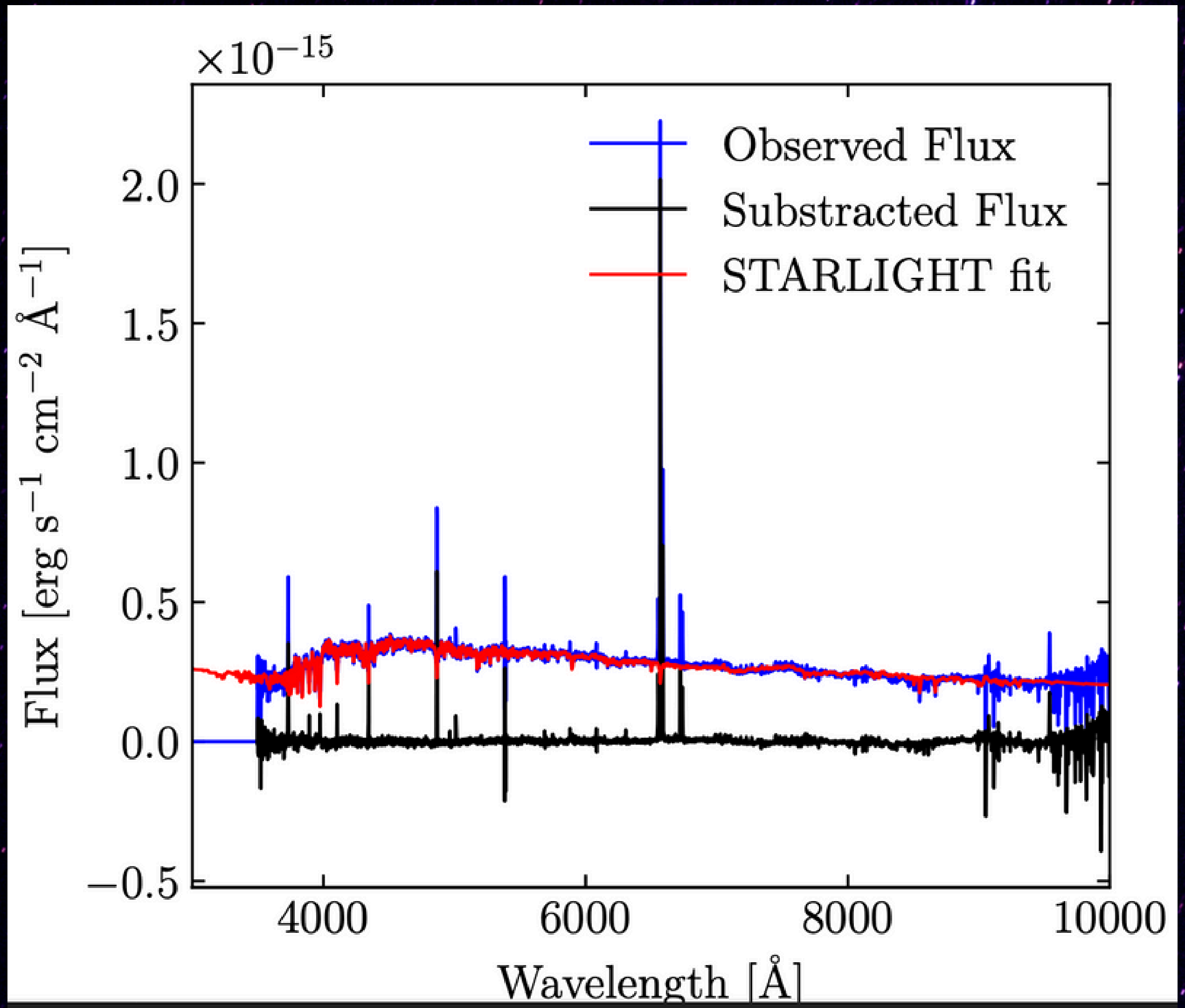
The addition of UV photometric constraints to the spectrum reduces the UV flux without reddening the optical part (Weyle+19).



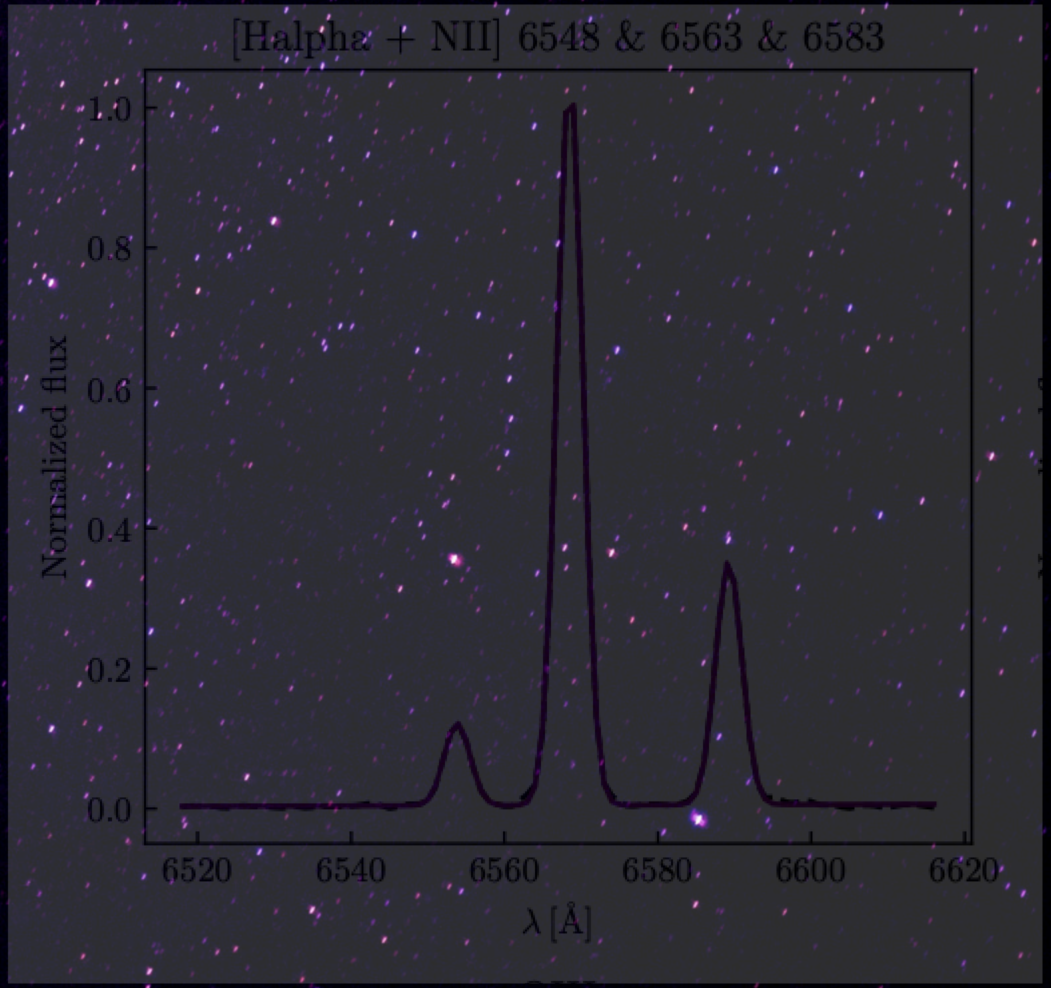
Analysis strategy: host galaxy properties (IV)

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.



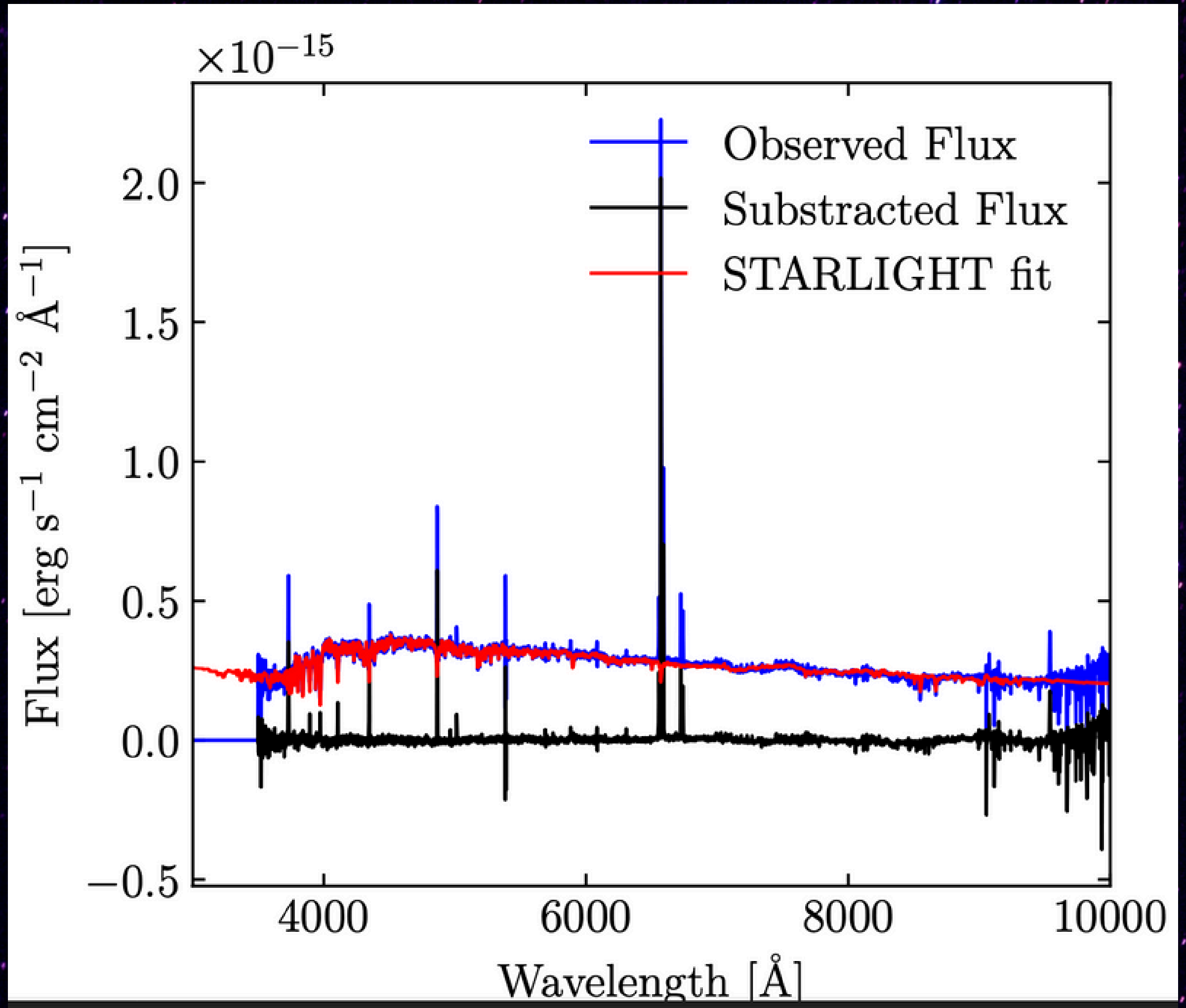
The nebular spectra is obtained by substracting the Starlight fitting results.



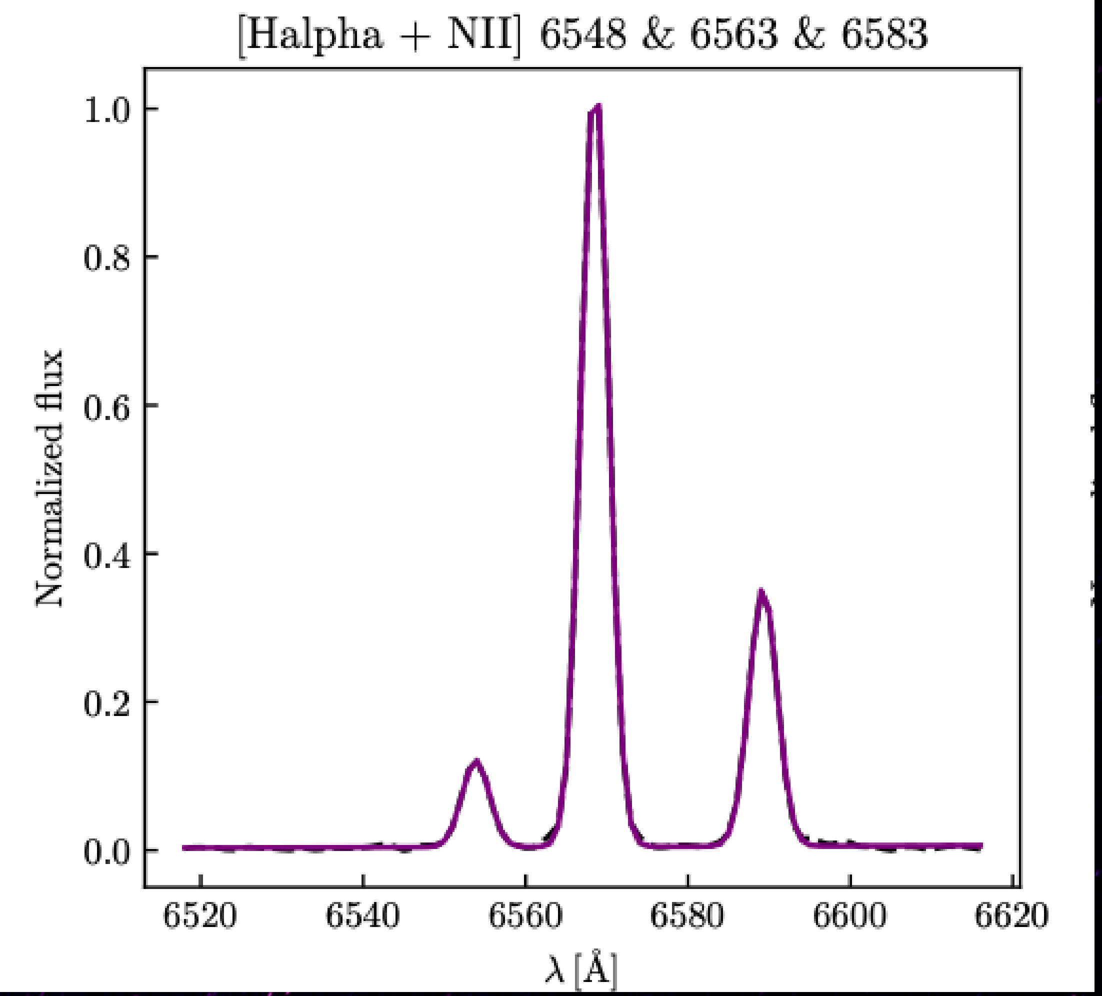
Analysis strategy: host galaxy properties (IV)

4

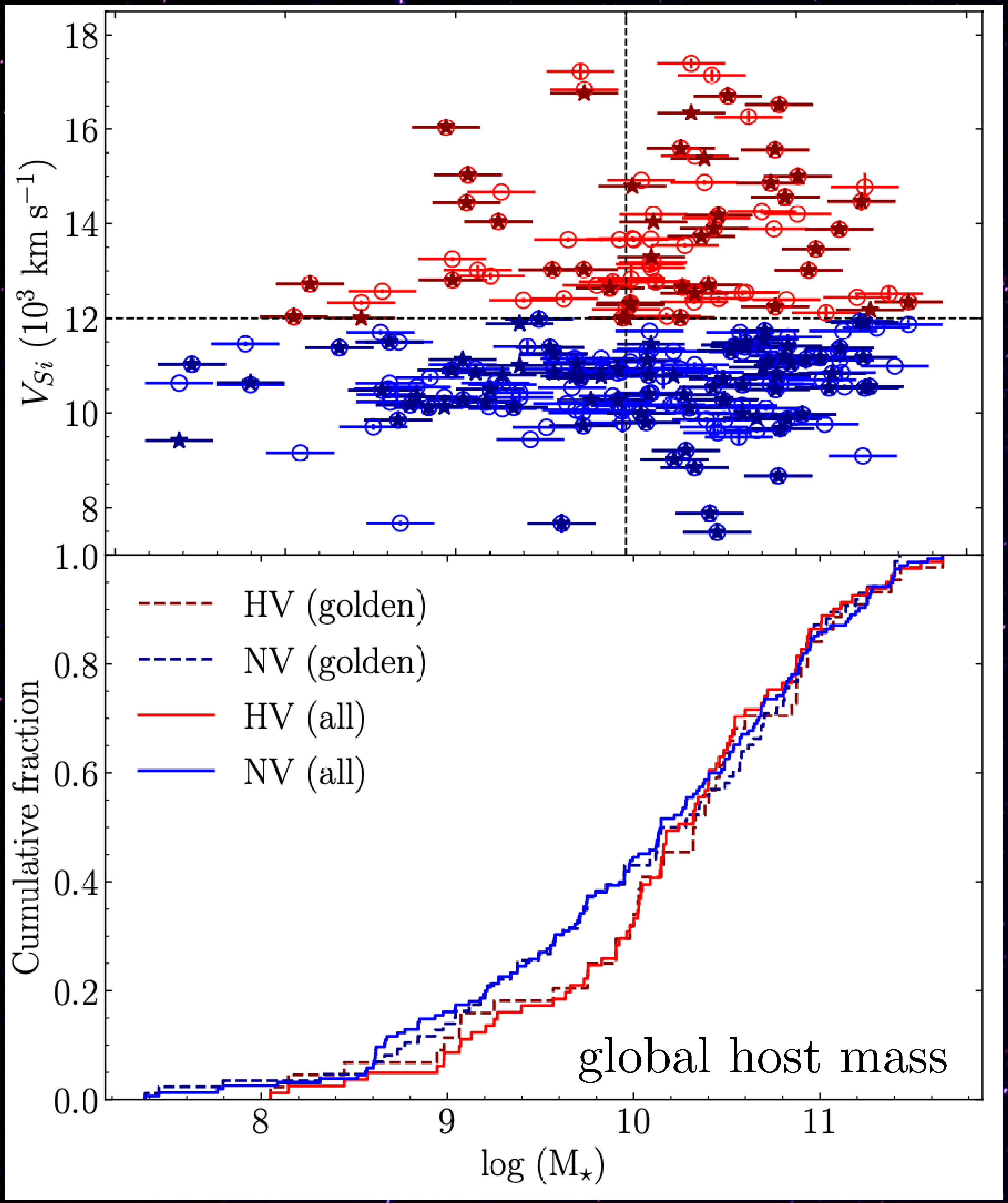
We measure the emission lines from the nebular spectra to obtain the SFR and metalicity values using Pettini +2004, Marino+2013 and Dopita+16 calibrators.

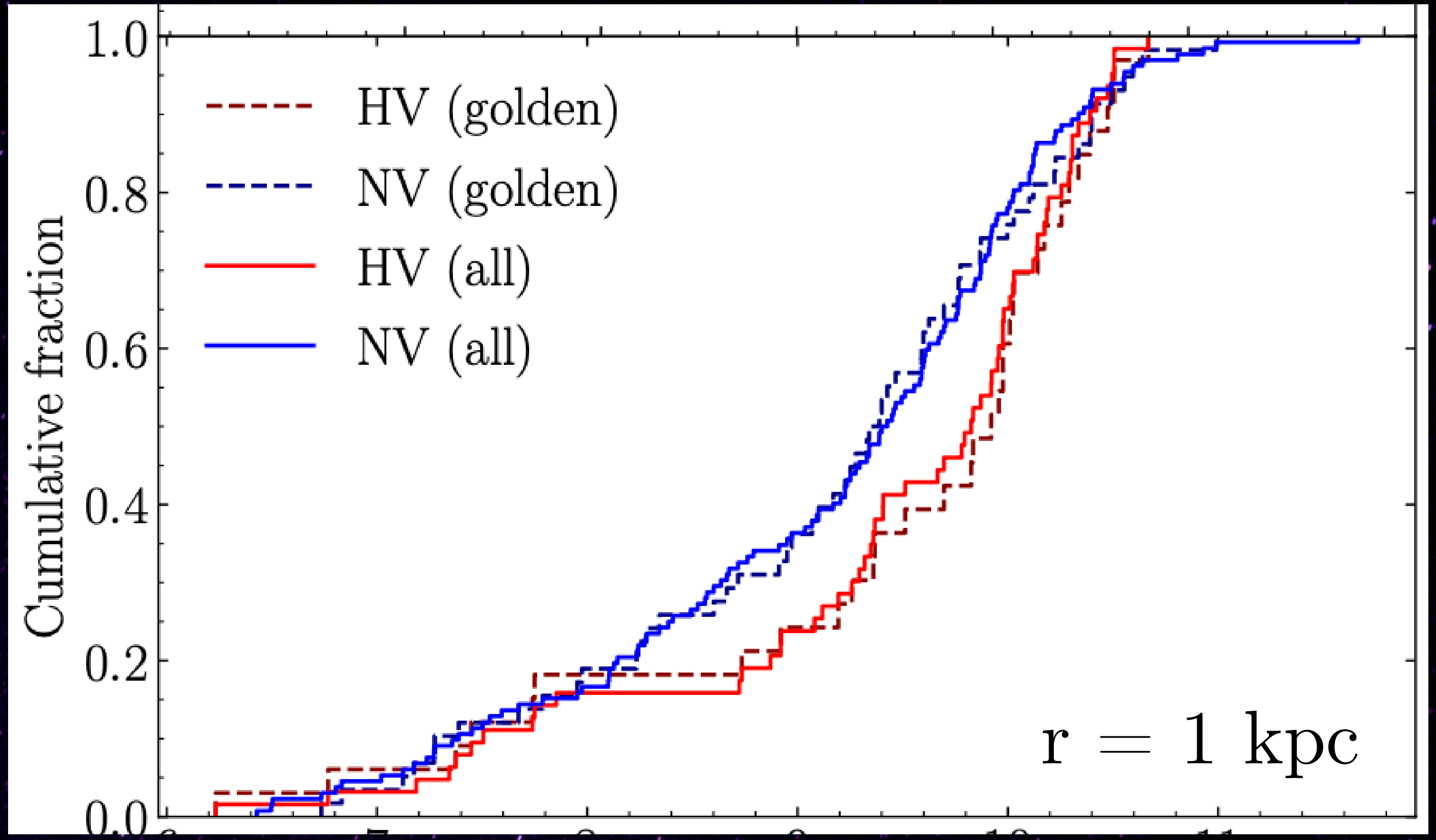


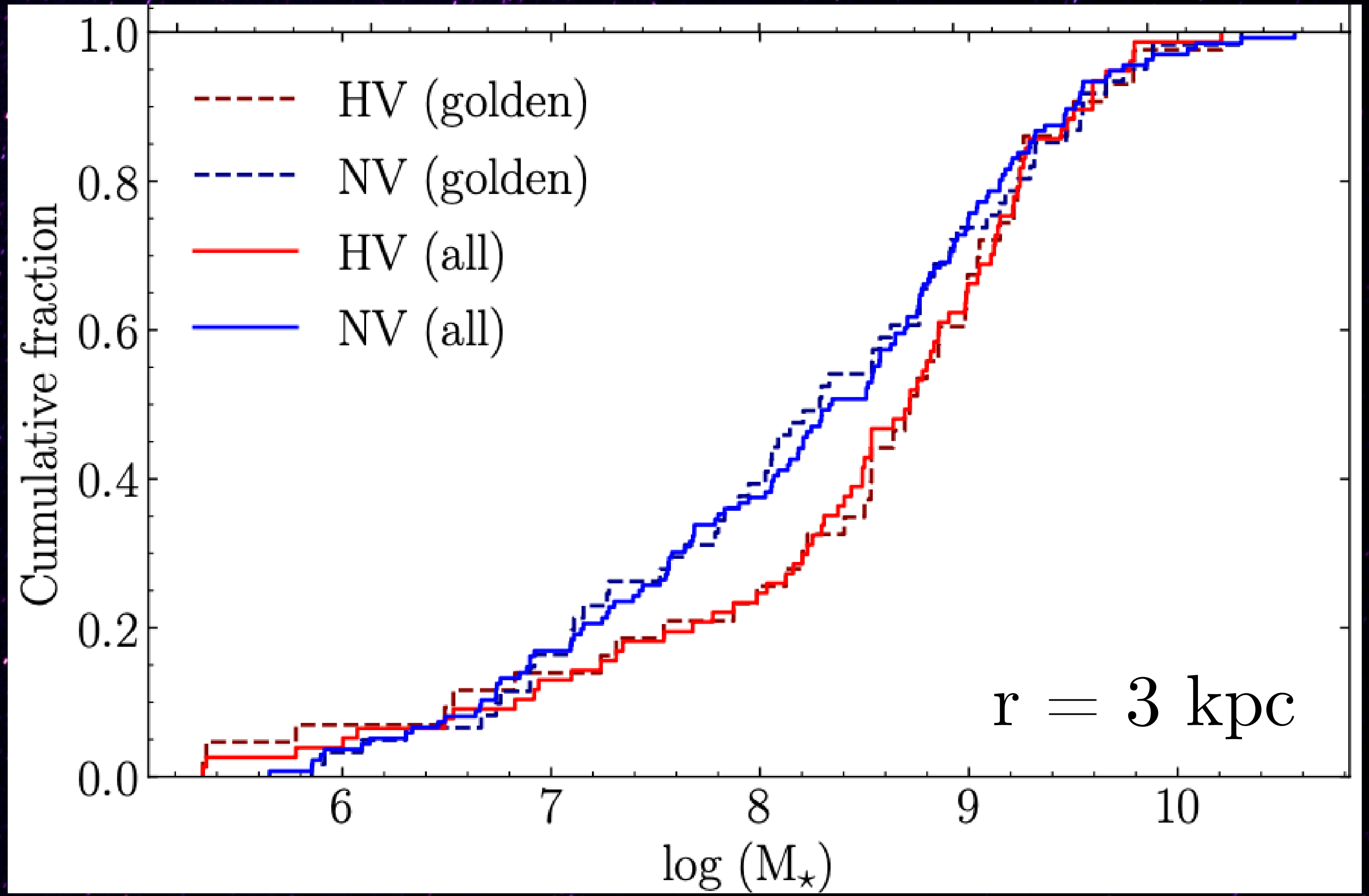
The nebular spectra is obtained by substracting the Starlight fitting results.



Si II velocities in terms of stellar mass





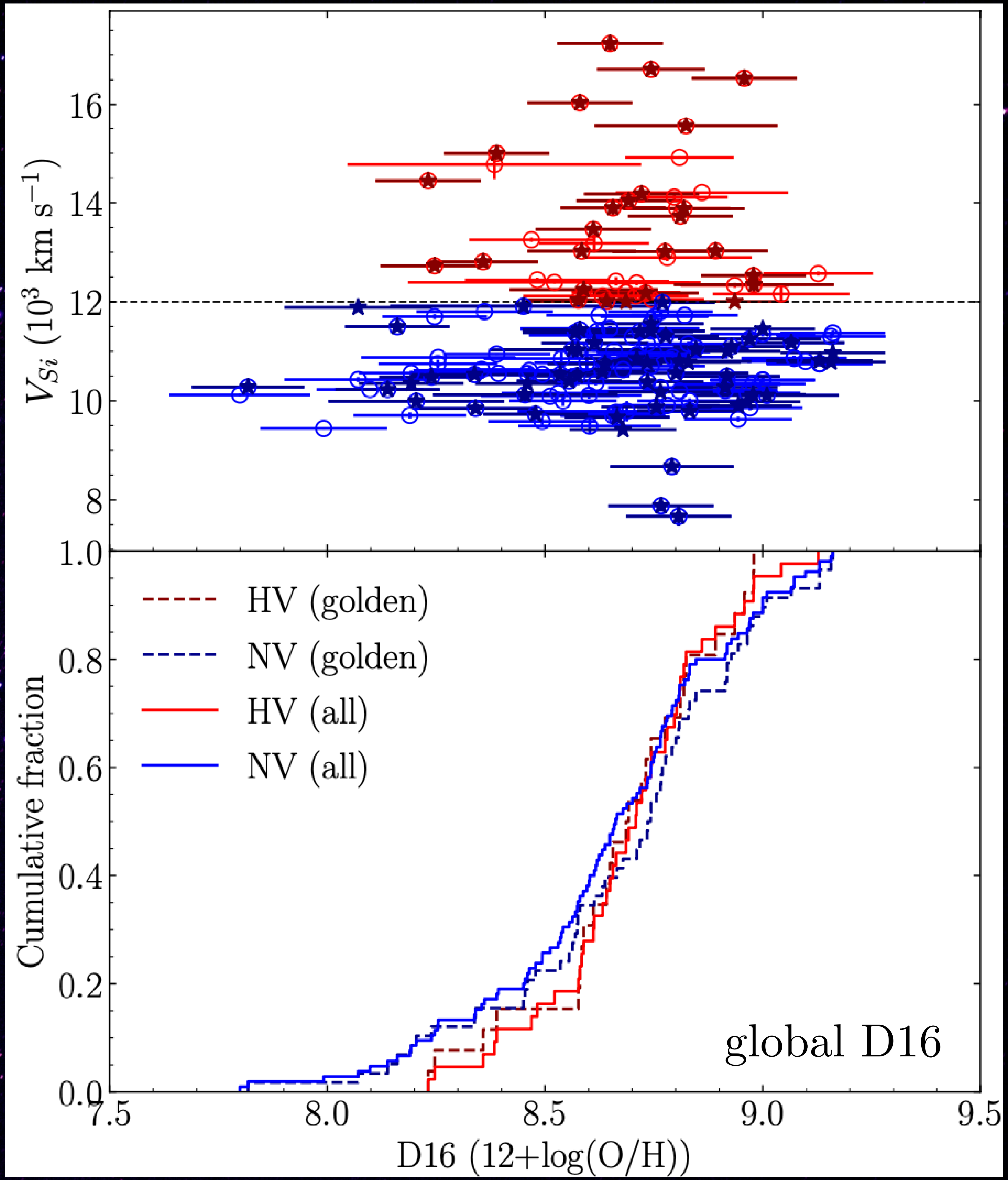


Si II velocities in terms of metallicity calibrators (I)

Dopita+16

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

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

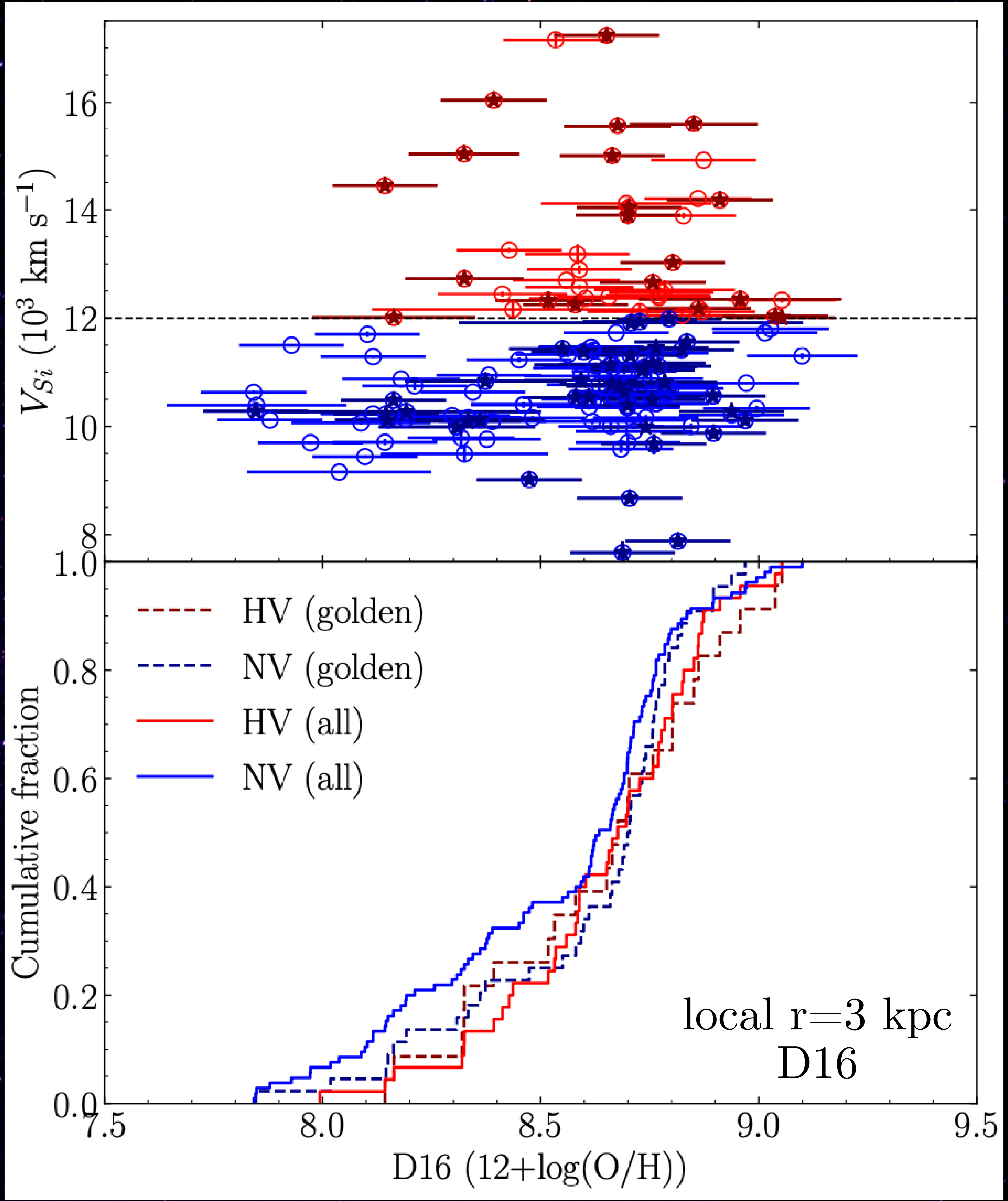


Si II velocities in terms of metallicity calibrators (II)

Dopita+16

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

$$N2S2 \equiv \log\left(\frac{[N\,\textsc{ii}]\,\lambda6583}{[S\,\textsc{ii}]\,\lambda\lambda6717,6731}\right),$$



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.

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!
(and enjoy your time in Barcelona)

Reach me!
cjimenez@ice.csic.es