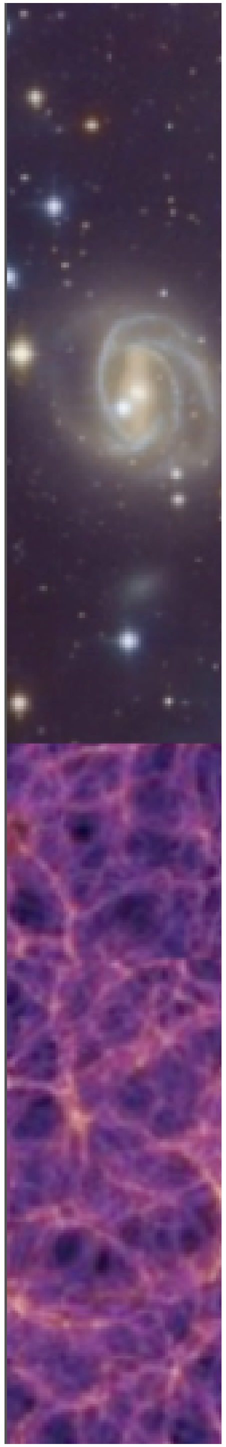


Study of Sn Ia Host for cosmological use

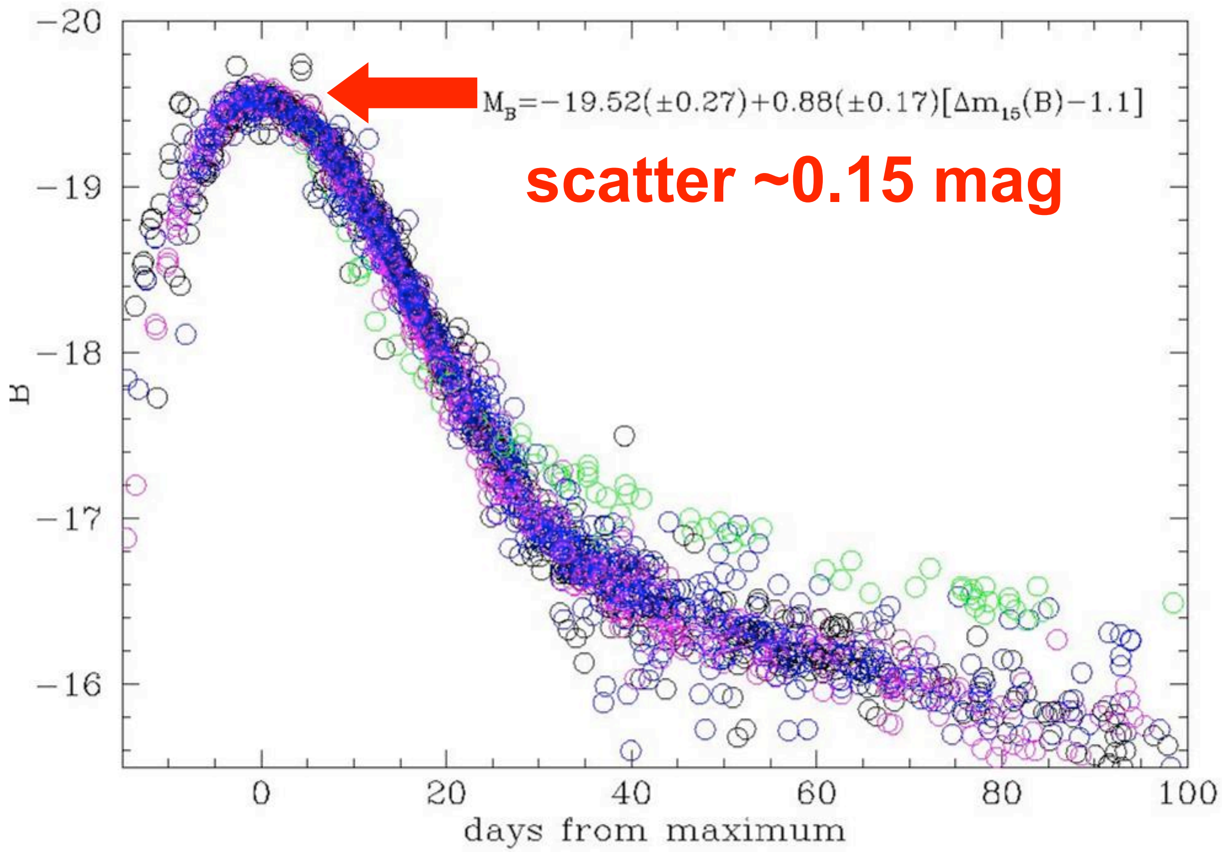
Myriam Rodrigues

Hector Flores, Ana Mourão, Vallery Stanishev

Cosmology with Sne Ia

Type Ia Supernovae have played a central role in modern cosmology.

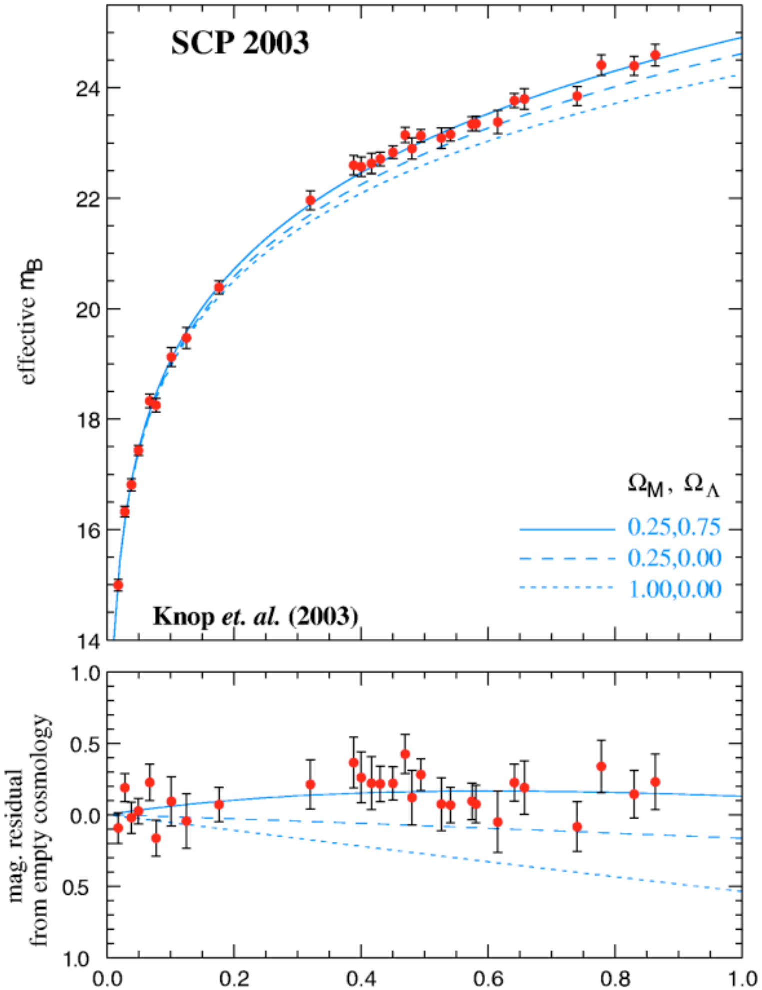
The relation between their light curve shape and their peak absolute magnitude makes them presently the best cosmological standard candles.



Talk of Vladan Arsenijevic

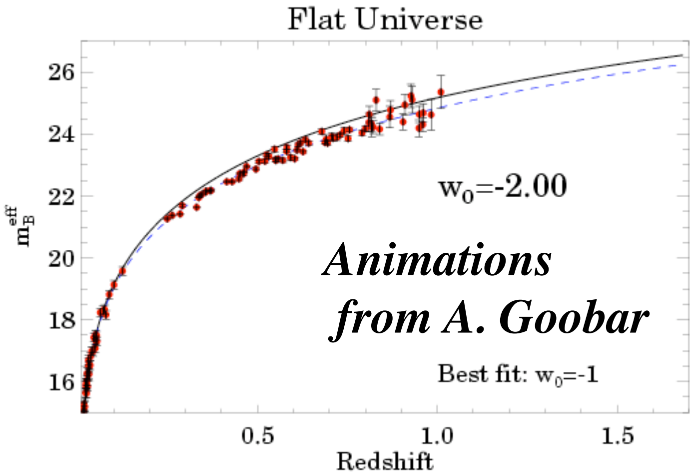
Cosmology with Sne Ia

Led to the discovery of the accelerating expansion of the Universe and the dark energy *[Permulter 1999; Schmidt et al. 1998; Riess 1998]*



Now

What is the nature of the Dark Energy?



Need better SN Ia observations and to reduce the systematic uncertainties

Sources of uncertainties

Challenge for future Survey

- Observational challenge - Photometry of distant Sne Ia

- Insufficient knowledge of the physics of the explosion and progenitor stars of SNe Ia

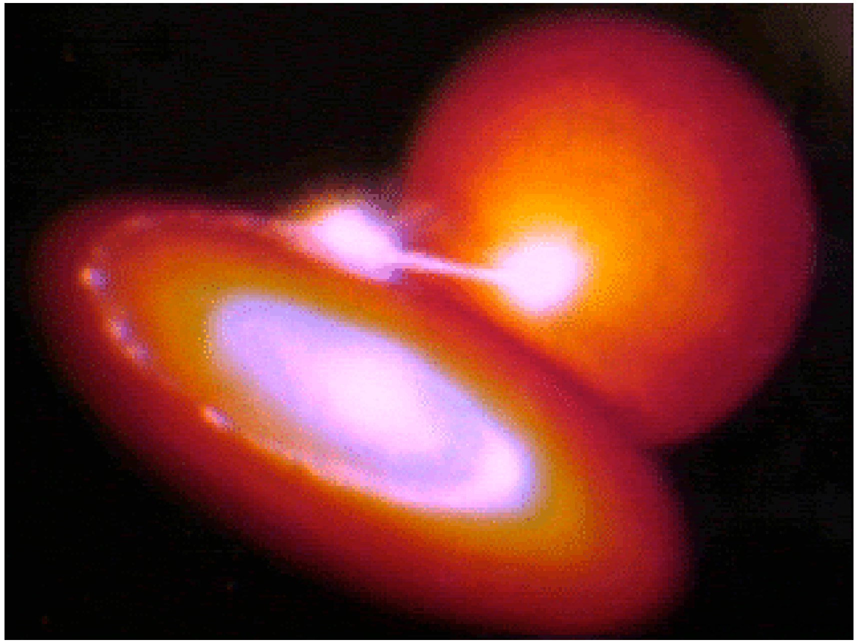
- Possible evolution of the progenitor properties

- Effect of the dust

SNIa progenitors

Nature of the progenitors of SNe Ia is still very incomplete

General agreement
Thermonuclear disruption of carbon/oxygen (C/O) white dwarfs (WD), reach the Chandrasekhar limit $M_{ch} = 1.38\ M_{\mathrm{sun}}$.



But

little observational evidence on the evolutionary scenario that leads to the explosion.

Two possible scenarios

1. Single degenerate channel WD + S or RG

Mass accretion of a C+O WD from a main sequence star or red giant companion

Time delay between the episode of star formation producing the progenitor system ~ 670 Myrs

But

Time delay < 100 Myrs massive main sequence star (6-7Msun) ***[Hachisu, Koto & Nomoto, 2008]*** or helium star ***[Wang et al 2008].***

Very long delay are also possible if the companion is a low-mass red giant ***[Hachisu, Koto & Nomoto, 2008]***

2. Double degenerate channel of merging of two WDs

2 white dwarfs merging ***[Iben & Tutukov, 1984 ; Webbin 1984].***

Time delay depends on :

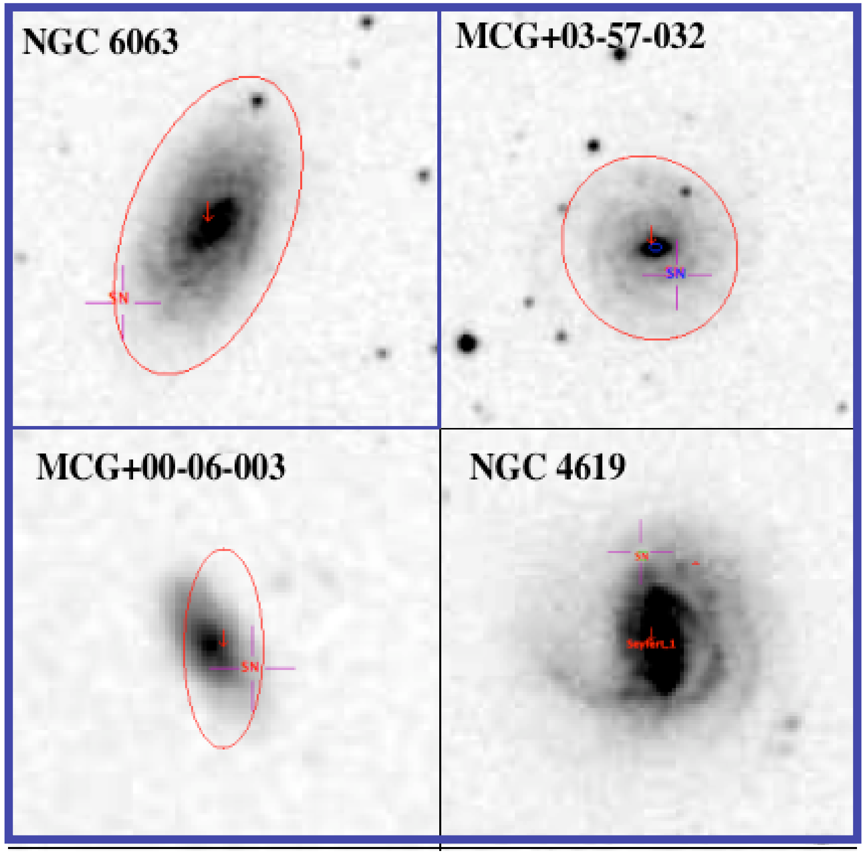
the timescale of formation of the WD binary system **+** orbital decay via gravitational waves

Evolution of the parameter of explosion

WD properties

- progenitor age
- metallicity
- explosion channel

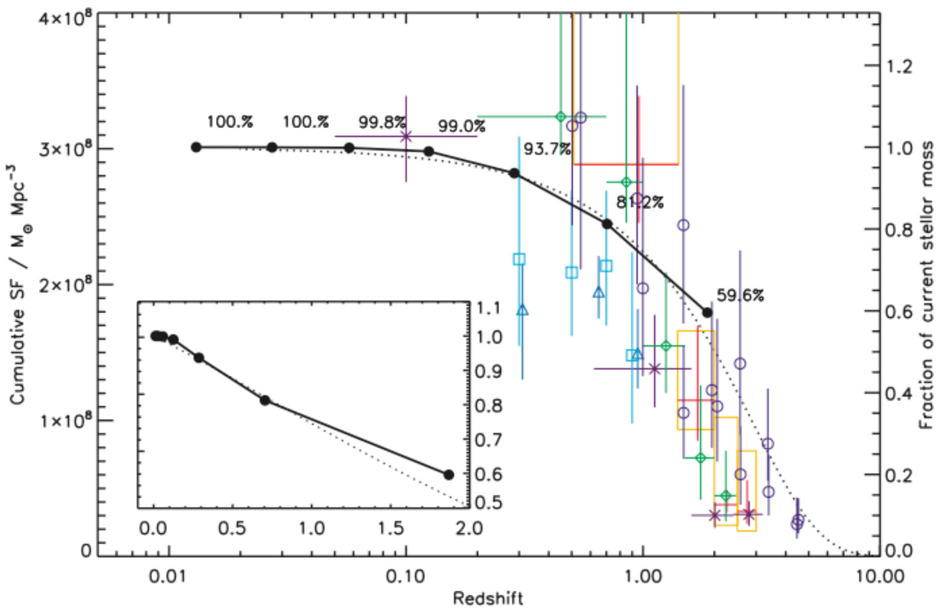
} may significantly influence the SN Ia peak luminosity → large impact on the determination of cosmological parameter



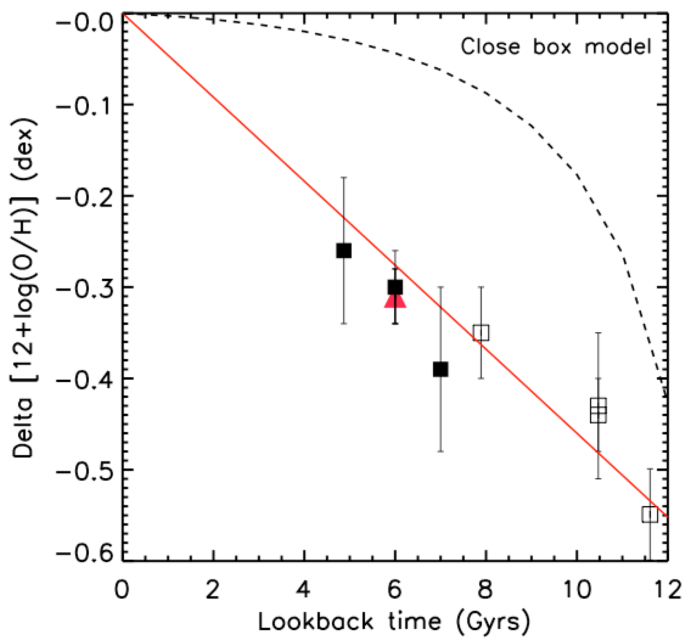
Use host galaxy as a proxy of the properties of SN 1a progenitor

Evolution of the parameter of explosion

Metal content and age of stellar population strongly evolve with cosmic time



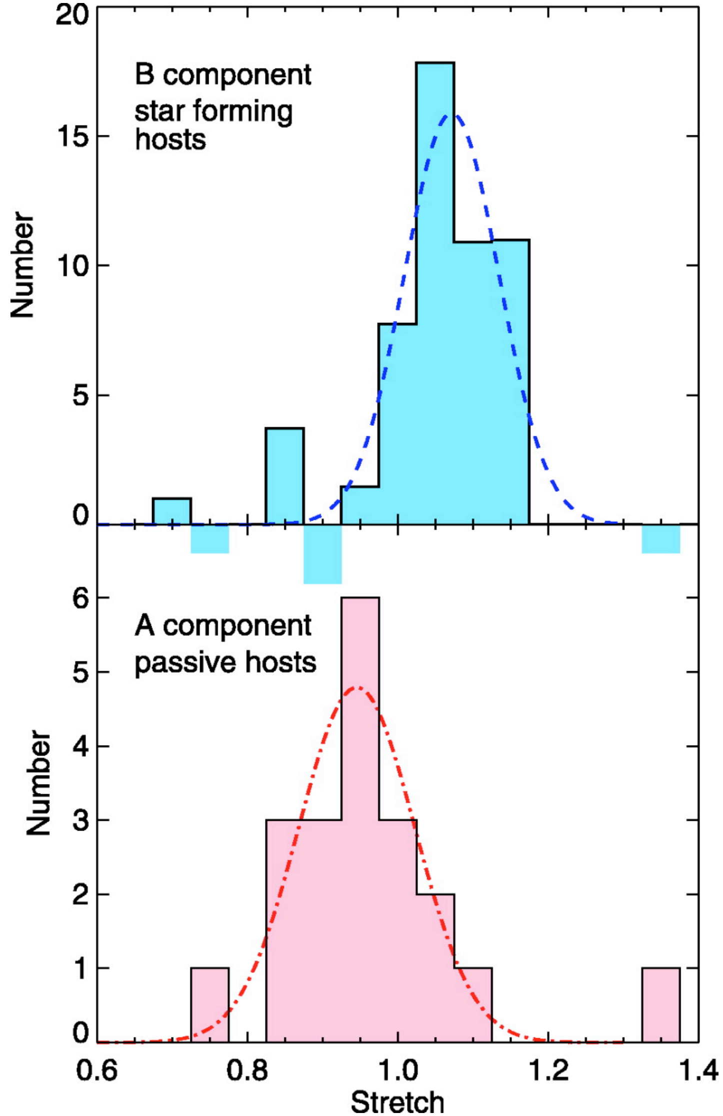
Panter et al. 2007



[Rodrigues et al. (2008)]

Characteristics of SNe Ia explosions may be dependent on the lookback time

SN 1a host



morphology

affects the peak luminosity of the SN1a.

Fainter event -> elliptical and spiral galaxies
bright Sne 1a -> late-type and irregular galaxies
[Hamuy et al. 1996 ; Sullivan 2003]

Stellar population

early type galaxies -> long delay channel
late-type galaxies -> prompt delay channel

SN1a rate - correlate with the host specific SFR.
(Mannucci et al 2005 ; Sullivan 2006)

2 type of Sne Ia :

- Prompt delay (< 0.2Gyrs) related with recent star formation
- Long delay (~2-4Gyrs after star formation) related with old stars ***[Strolger et al. 2004]***

Two channel evidence

Prompt time delay

- active galaxies

- brighter event

- dependent of the SFR

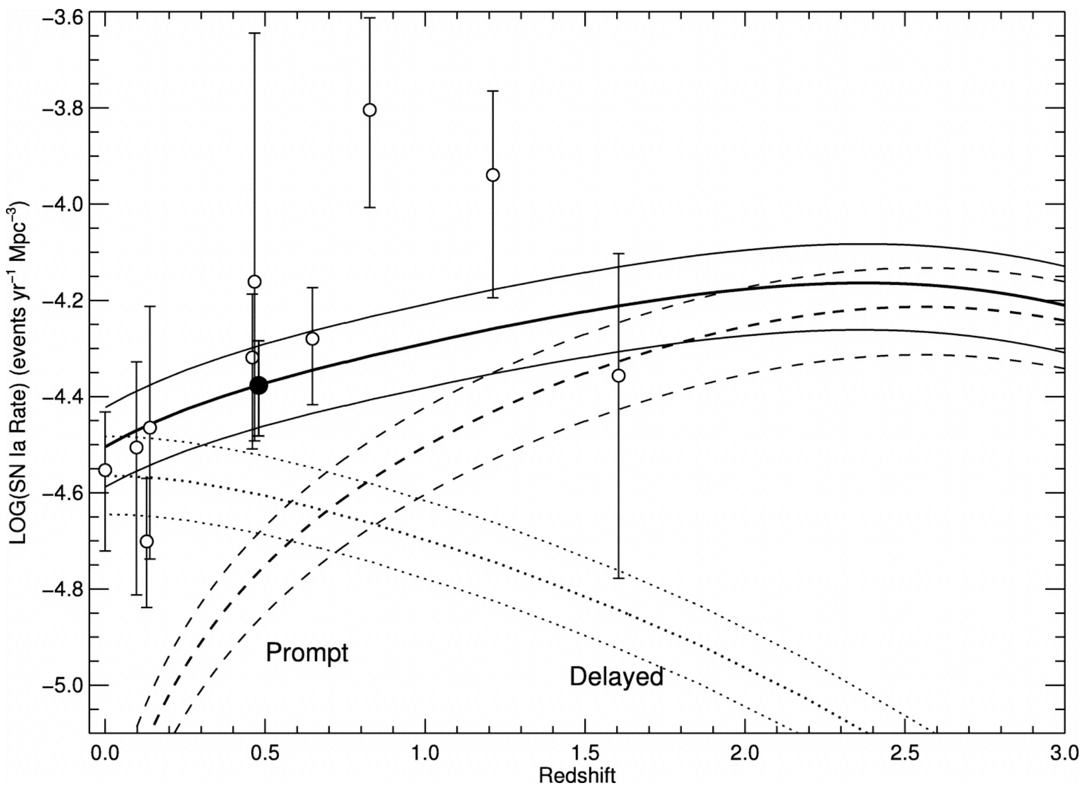
- current number of WD.

Long delay channel

- early type galaxies

- SN1a rate correlate to the stellar mass

- cumulative number of produced WD.



From Sullivan et al. 2006 (SNLS)

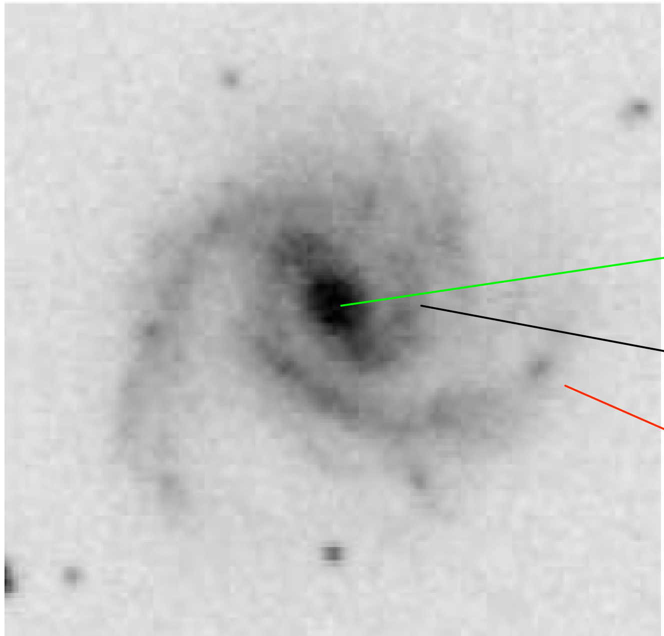
SFR evolve with lookback time → increase number of prompt delay SN 1a at high-z redshift

Global vs local properties in host

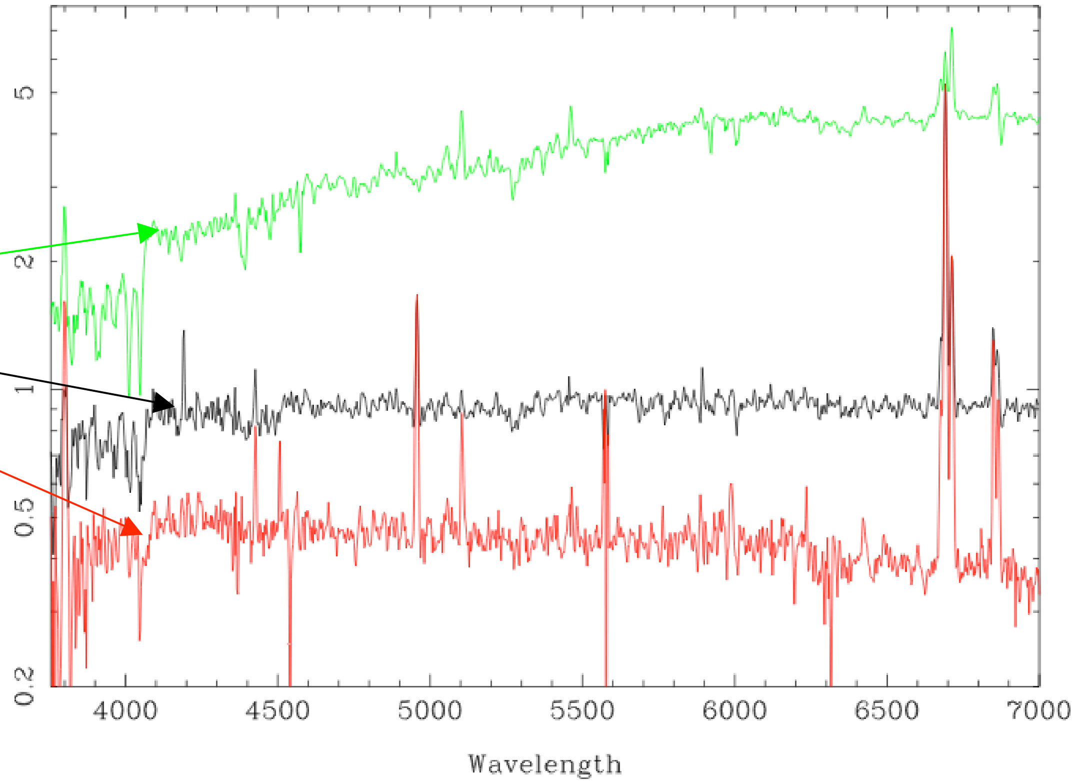
Previous work probe global properties

But

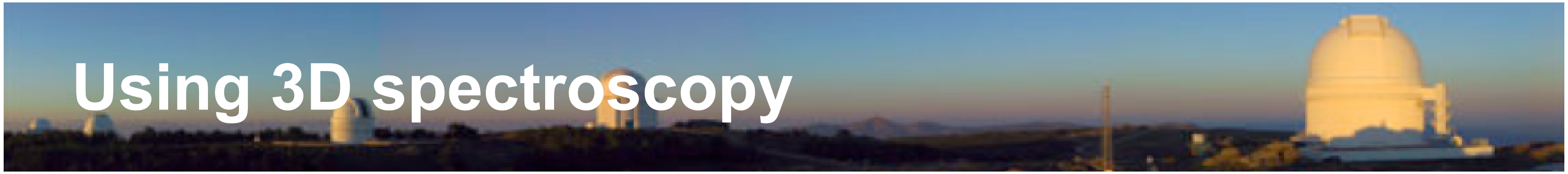
Physical properties do vary in a galaxy



UGC 11813 with PMAS



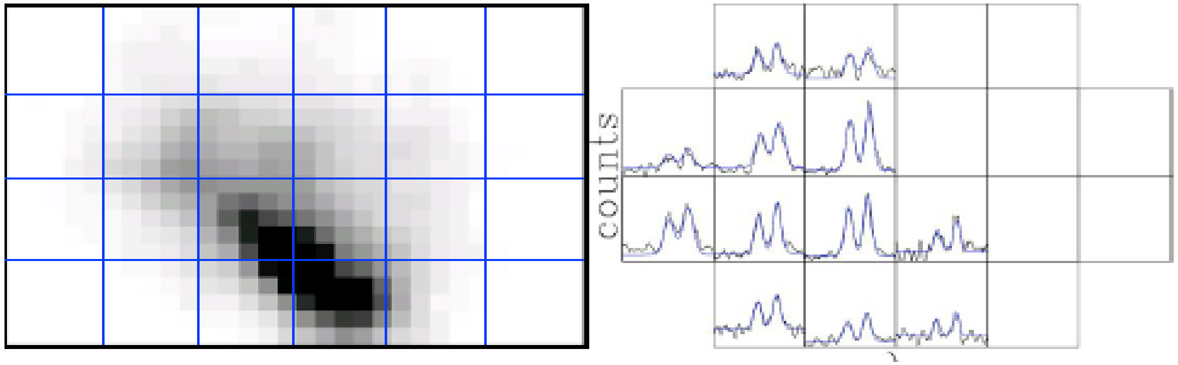
- Need complete description of the close environment of SN Ia
- Influence of the supernova ***local environment*** on properties of the SNe Ia



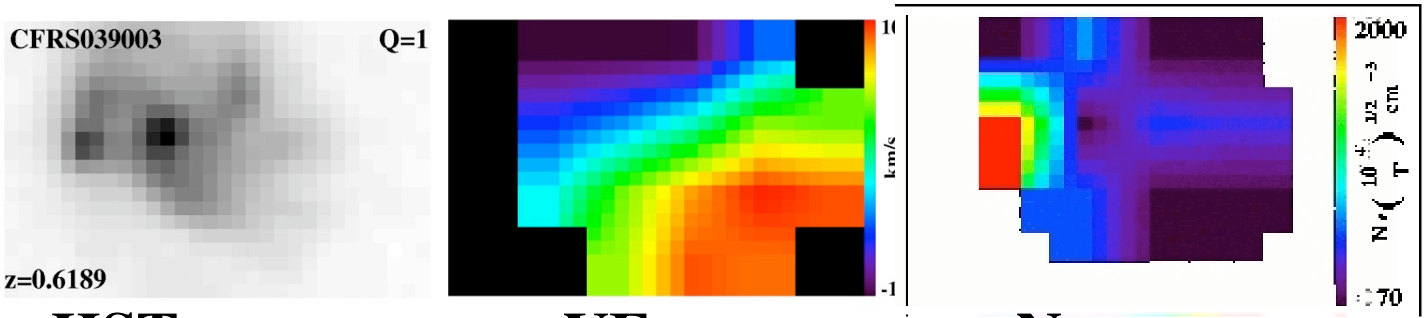
Using 3D spectroscopy

Derive the properties of the gas and the stellar population of the immediate vicinity of the SN

3D spectroscopy (2 spatial dimension + 1 spectral dimension)

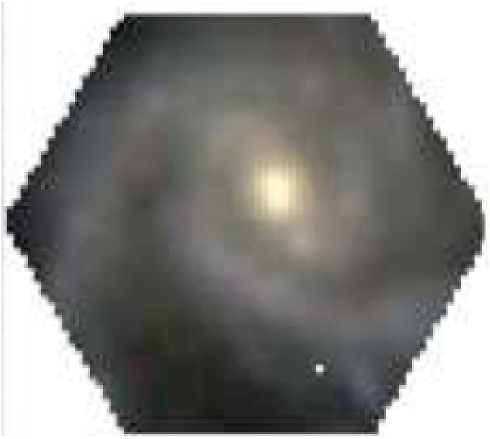


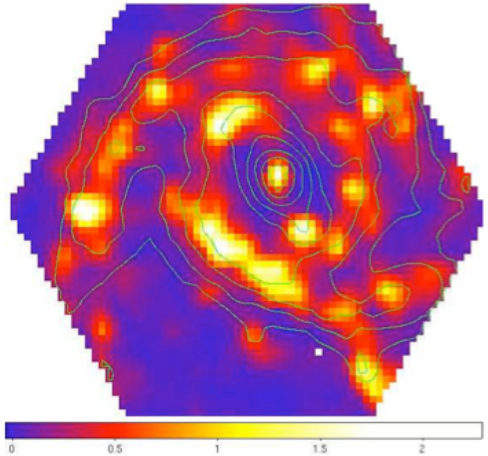
Map the properties of host galaxies



HST VF Ne

Observational strategy





[OII] 3727 flux

The wide-field **IFU PMAS** 16x16 arcsec2

(16x16 kpc^2 at $z < 0.05$)

Covering 3700–7100 Å at a spectral resolution of R=1000

Sample selection:

- Redshifts $z < 0.05$
- Observable close to the zenith to minimize the effect differential atmospheric refraction
- Emission line galaxies

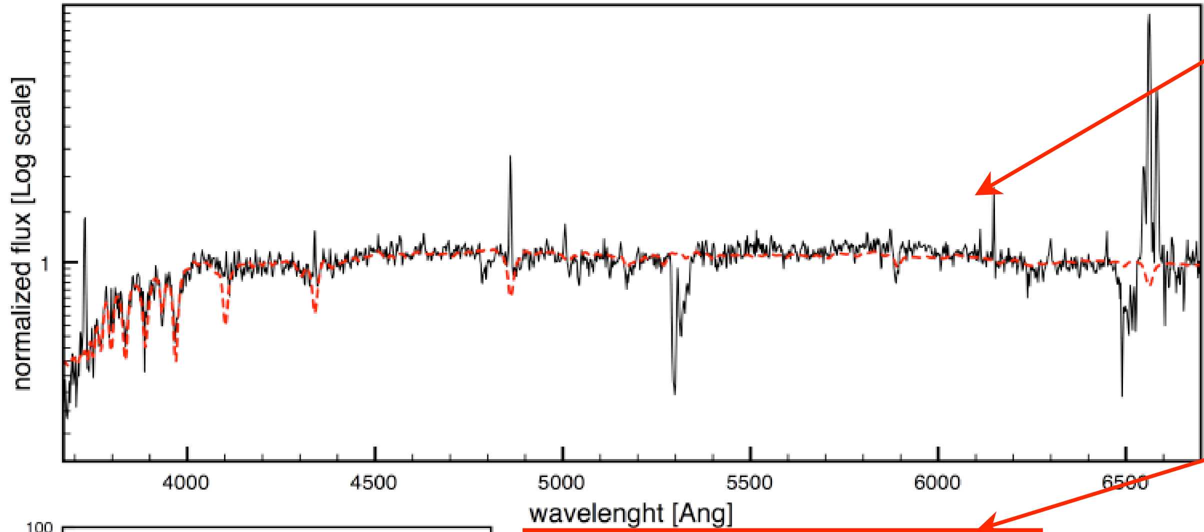
Observation status :

Two nights schedule in November 2009

A science case for CALIFA survey (~1000 galaxies in the local universe)

Data Analysis

For each resolution element we will follow the same methodology of Rodrigues et al 2009:



Fit the absorption line spectrum with synthetic spectra to:

- derive the properties of the stellar population

Stellar population properties

$\langle \log(t) \rangle = 8.70$

$\langle Z_* \rangle = 0.045$ $A_{V*} = 1.07$

- obtain unbiased estimate of the emission line fluxes and hence the gas properties

Gas properties

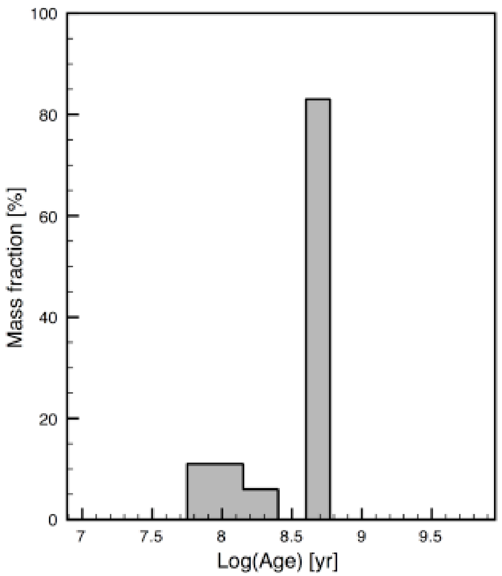
$SFR_{H\alpha}(M_\odot/yr) = 3.15$ WR features = no

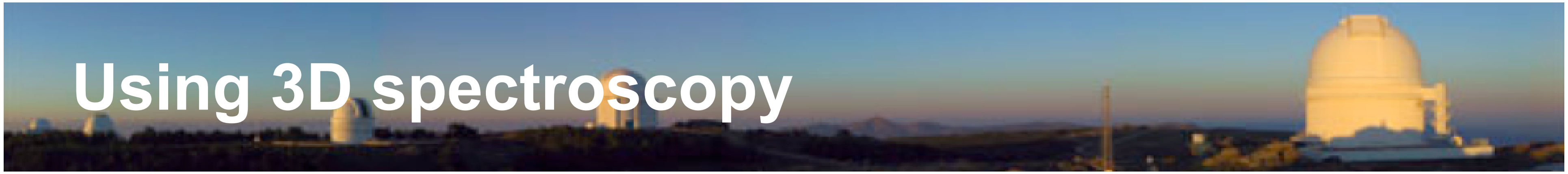
$\log(O/H)+12 = 9.1$ Ne-=na

$A_V = 2.10$

Te =na

Abundance of other elements :





Using 3D spectroscopy

The 3D spectroscopy will allow us to construct maps of physical properties:

- extinction, electronic density and diagnostic diagram;

- star formation rate from H alpha;

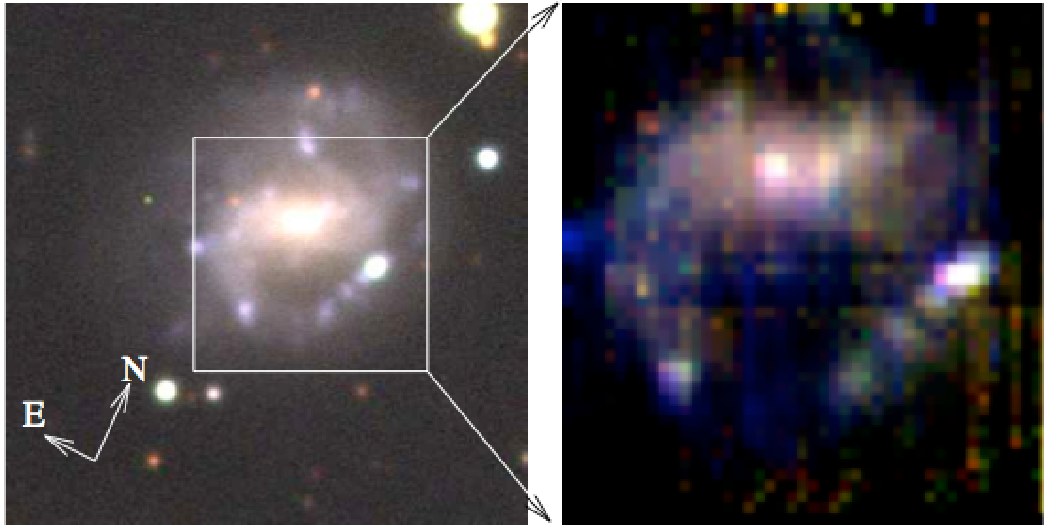
- electronic temperature and abundances of several elements (O, N, Fe) and ratio as [O/H],[Fe/H];

- stellar population from absorption lines: map of age, stellar extinction and stellar metallicity’

- velocity field and velocity dispersion field from emission and absorption lines. Search for possible outflow or gas motions;

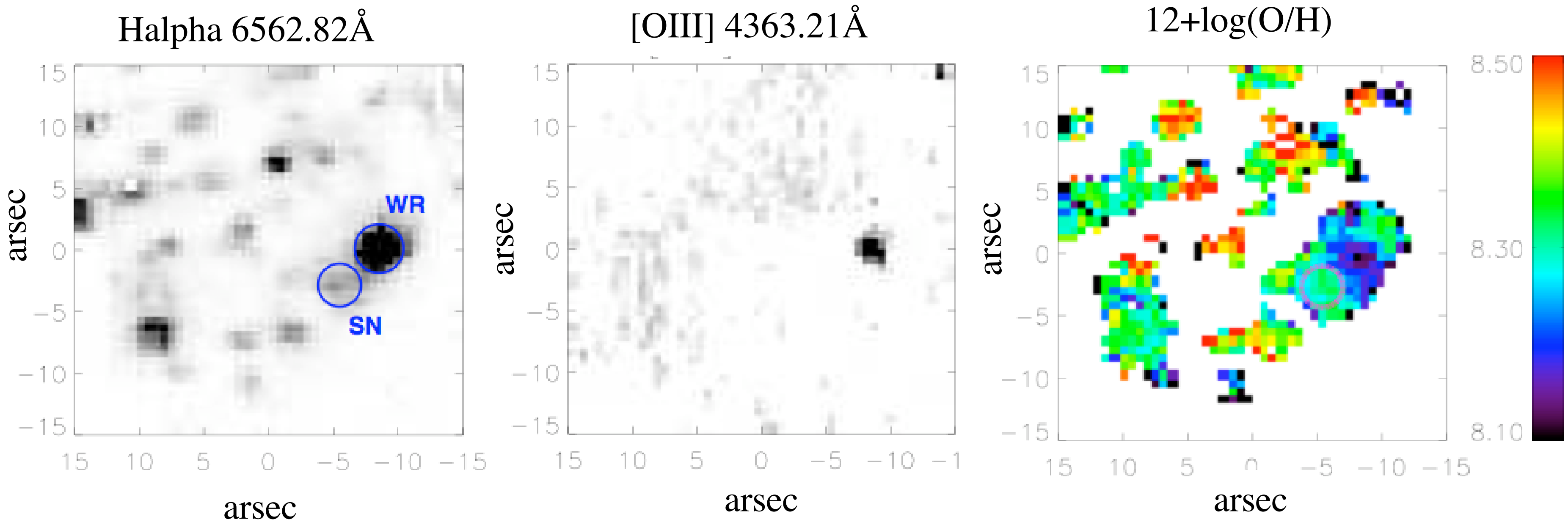
- search for specific stars features in the spectra as Wolf-Rayet stars.

GRB host illustration

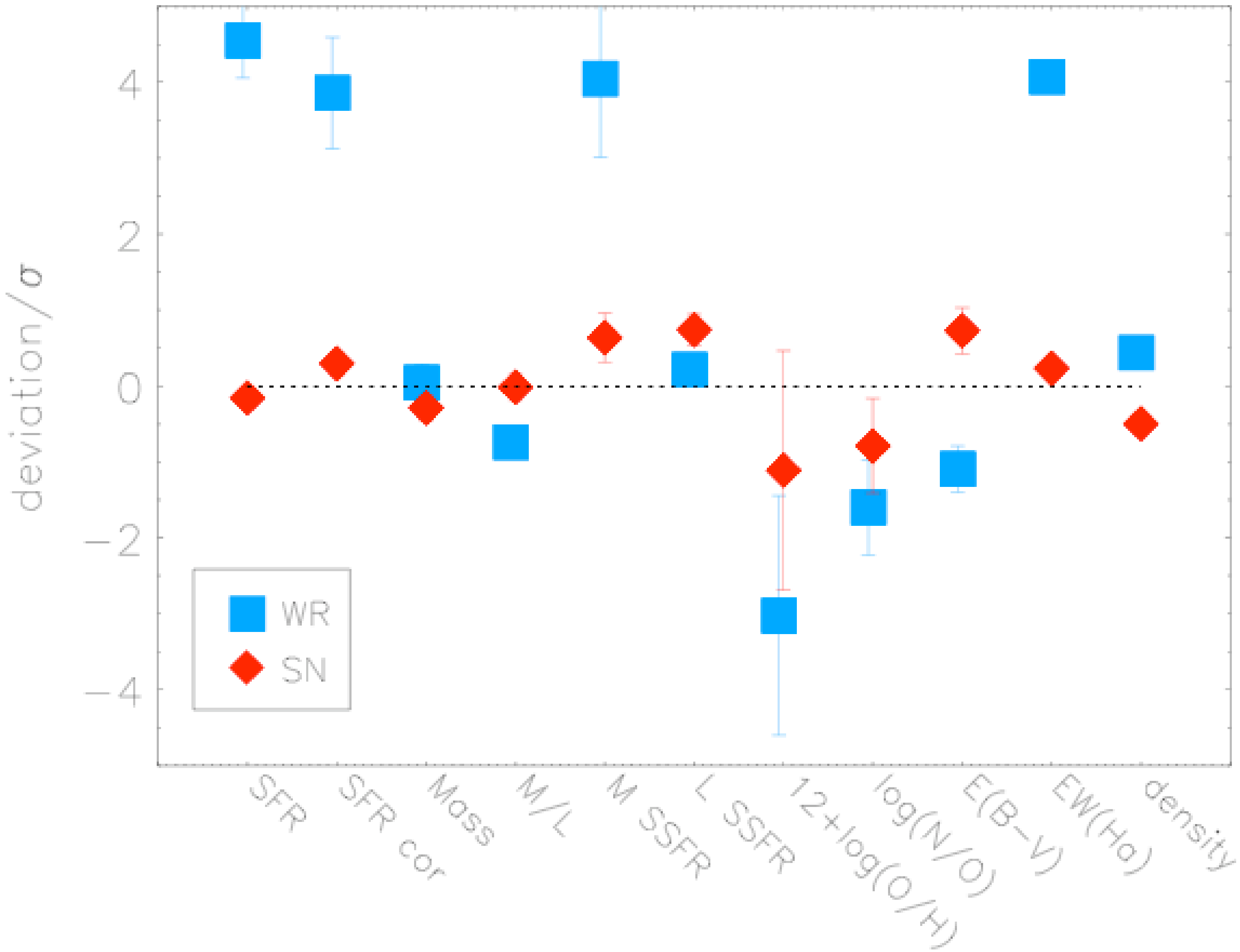


Christensen et al 2008

VIMOS IFU observations of the GRB 980425 and type Ic SN host galaxy

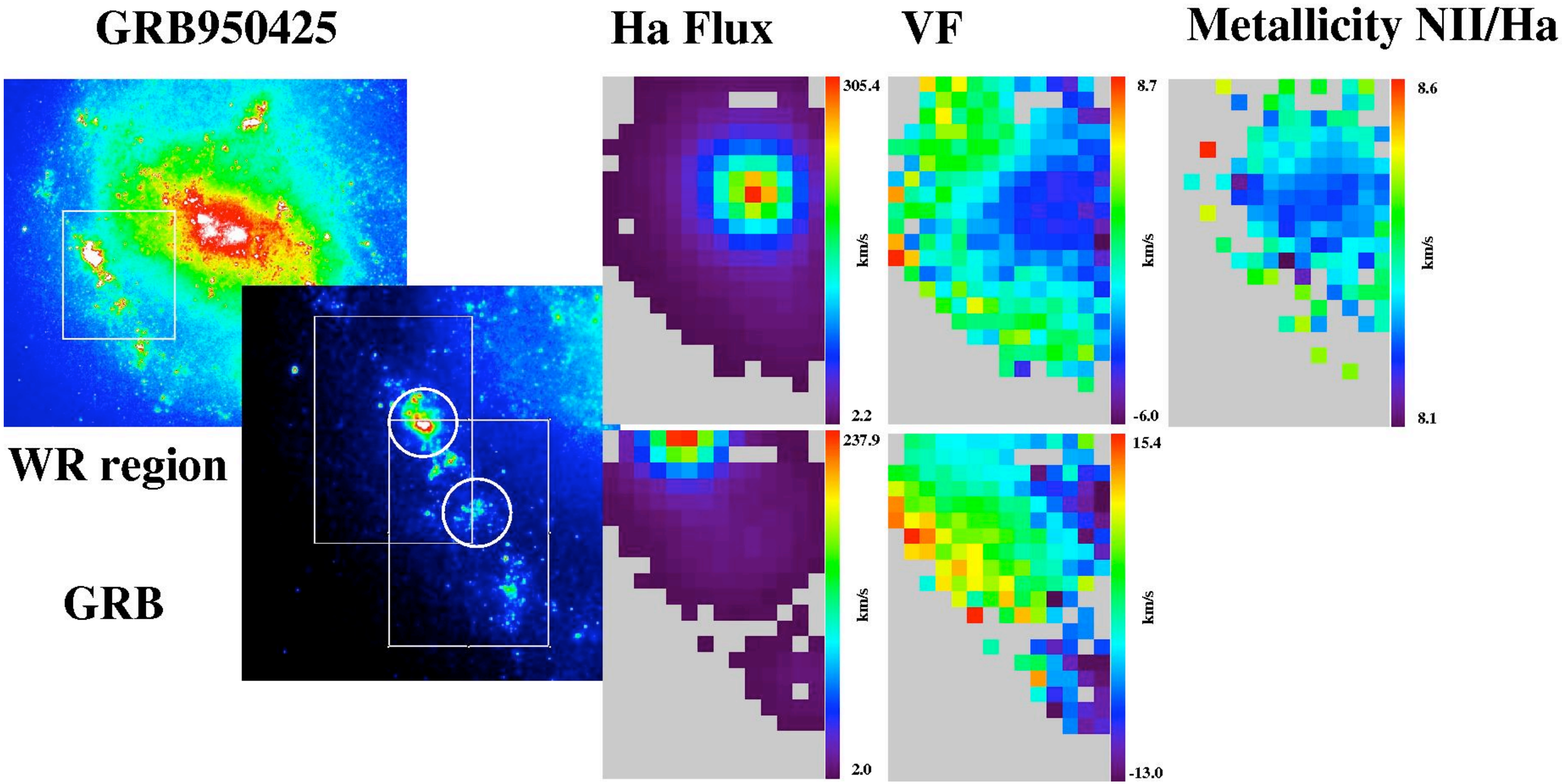


GRB host illustration



GRB host illustration

GIRAFFE Argus Observations R ~ 27000



Conclusion

The results of the survey will allow to address the following key questions for the SNe Ia research and SN Ia Cosmology:

o **Correlation between the properties of the environment with the properties of the SN Ia ?**

Environment : metallicity, ratio of elements, stellar population age

Sn Ia properties : peak luminosity, color indices, stretch, etc

o **Probe the star formation history in the immediate vicinity of the SN**

What are the progenitors of the SN Ia?

Are there different scenarios for SN Ia progenitors?

How they correlate to SN Ia light curve properties?

o **Use the properties of the host galaxies to improve the SN Ia calibration as standard candles?**