# The 1st year of science with X-shooter
# SUMMARY TALK

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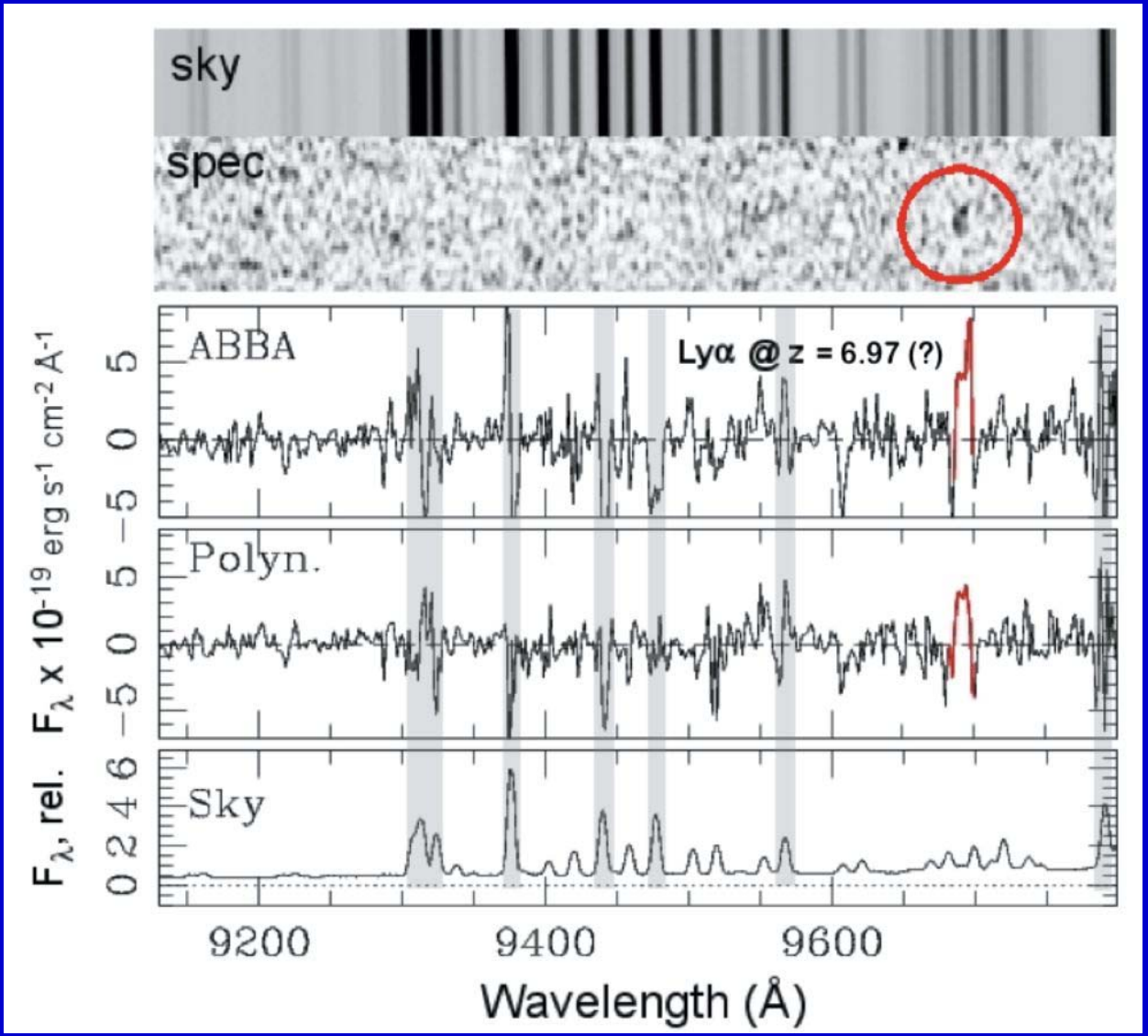
The first year of science with X-shooter (in memory of R. Pallavicini)
Como, October 19-22, 2010

# X-shooter vs. FORS2




63150 s

FORS2

Is this a line?

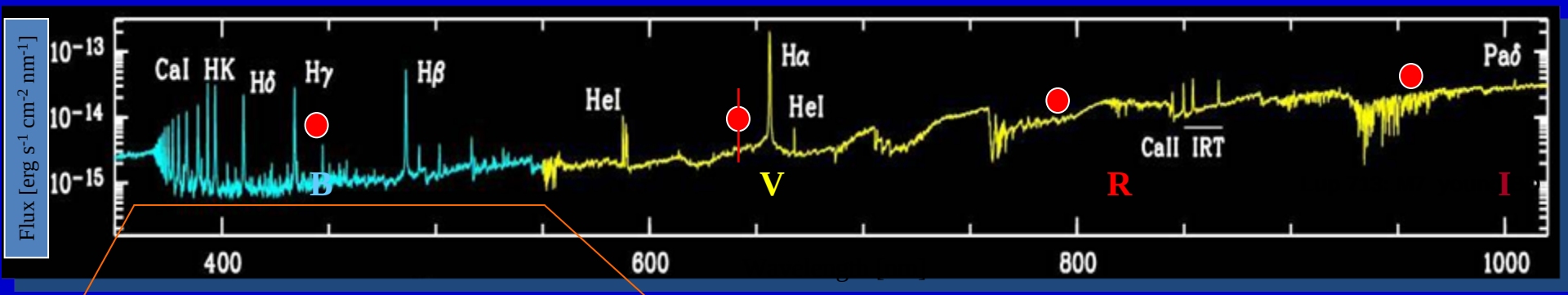
If Ly-α

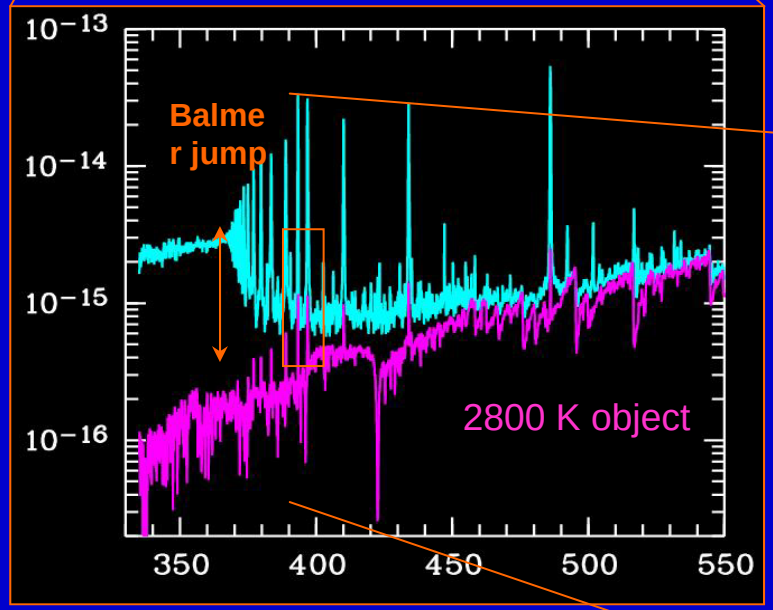
z=6.972

σ ≤ 7

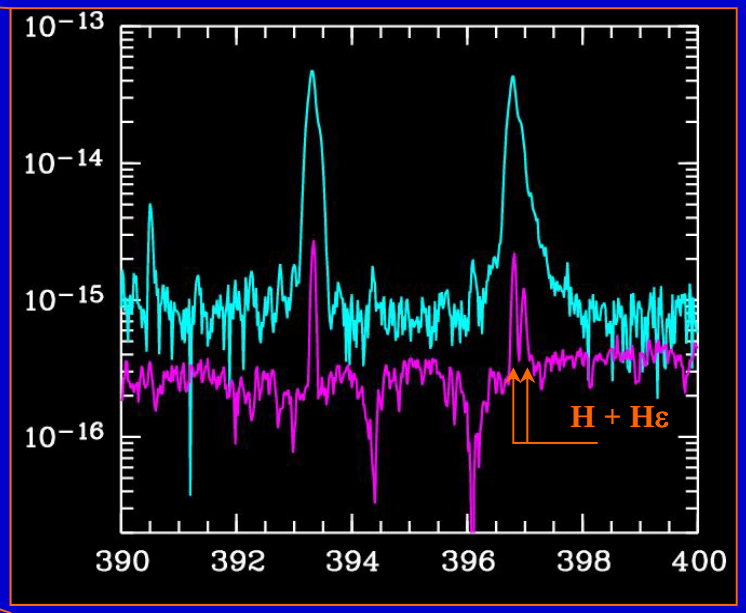
Fontana, Vanzella et al. 2010

# X-shooter is fun… examples of spectra of low- and substellar mass stars (Alcalà's talk)




Ca I H + K




ESO P85: April 2010

# Mind-boggling conclusions

# 1) X-shooter is a great instrument!

## Special thanks to:

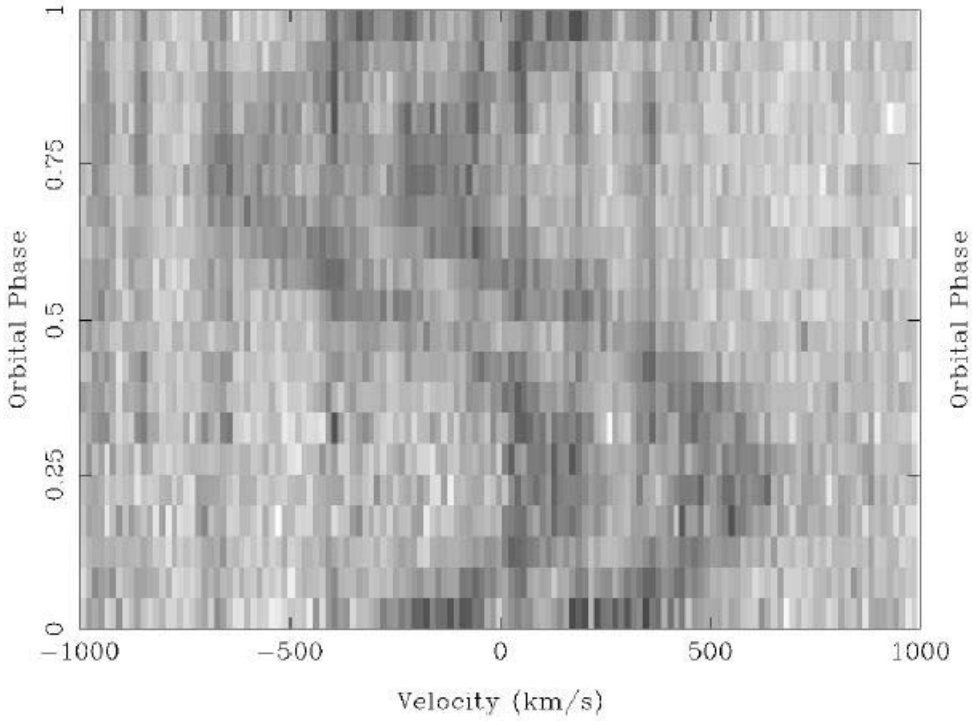
Everybody who has contributed to this accomplishment (from Bristow to Zerbi)

# Memorable quotes

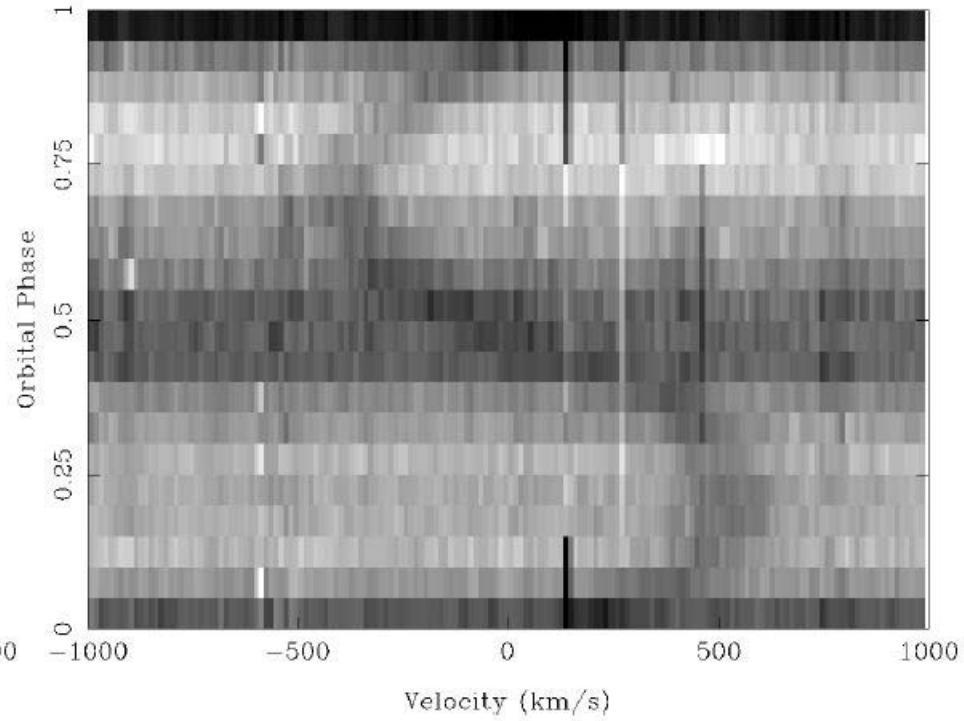
- A unique combination of wavelength coverage, efficiency and resolution (everybody)
- Spectroscopy is the mother of astrophysics (Andersen)
- Opening new windows in the parameter space immediately translates in new discoveries

# Memorable quotes

- The importance of being simultaneous (Alvarez, Parsons, Trager, + Sne, GRBs +)




CTCV 1300-3052, Na I doublet




OY Car, K I 12522Å absorption

# Memorable quotes

An efficient pipeline is an essential part of the instrument (UVES 2001 SPIE paper – Goldoni- Modigliani)

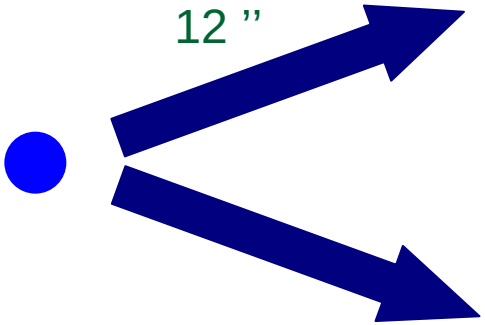
# From Observation to Results


0.6''-1.5''

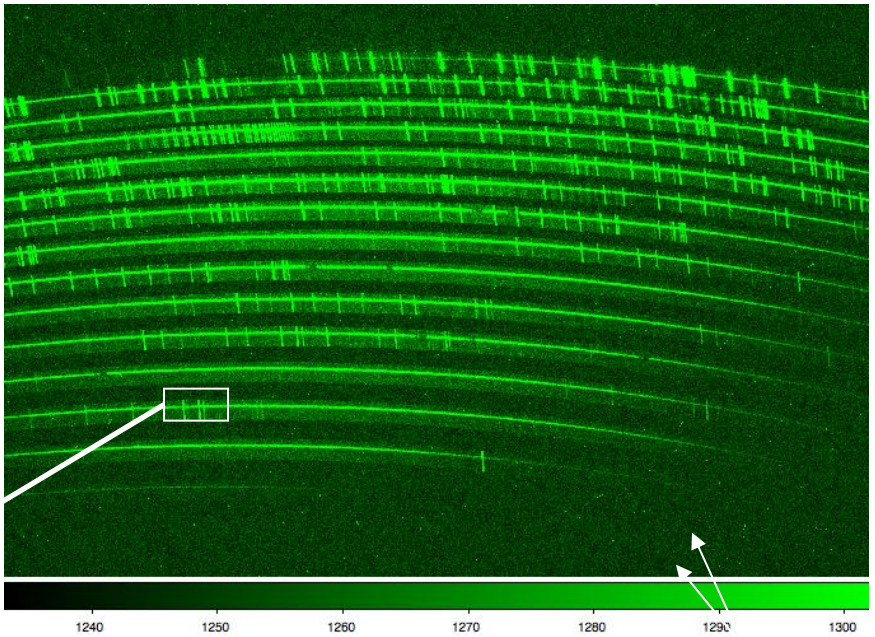
Y=S

12 ''

Y=S

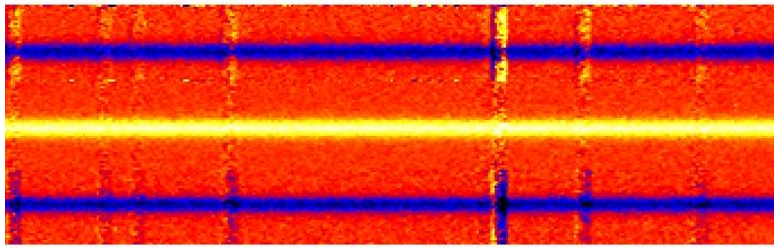


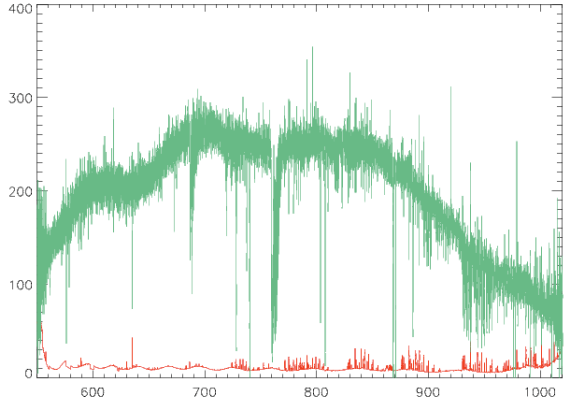
X=λ




X=λ

Orders



# Mind-boggling conclusions

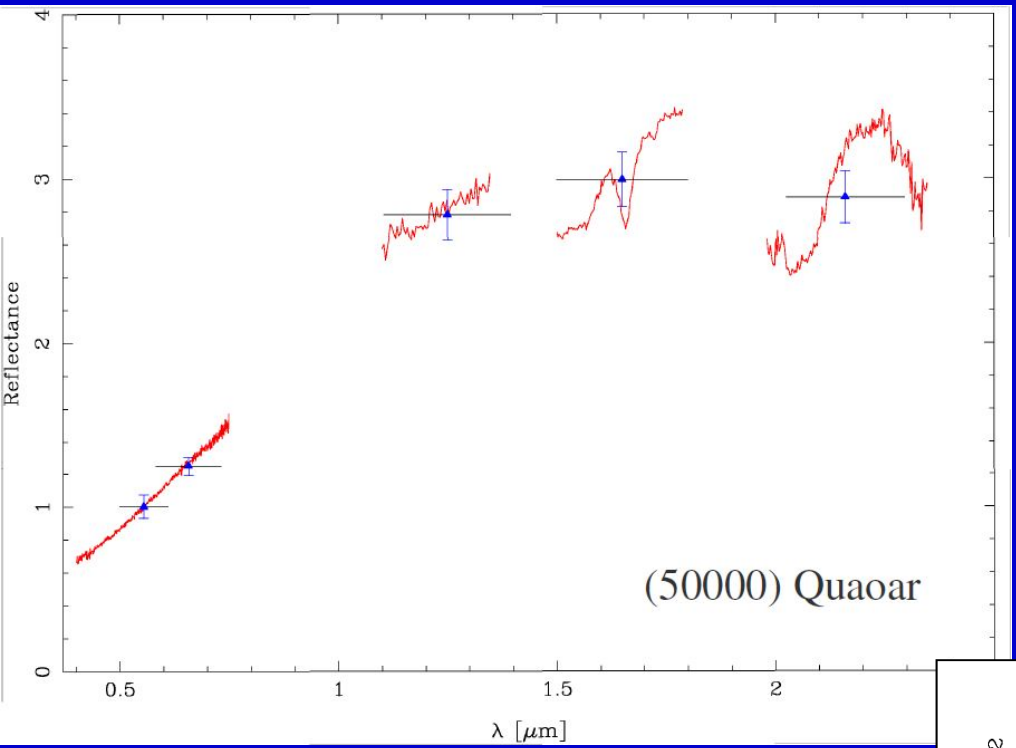
## 2) This was a great meeting!

Experts in instrumentation, data reduction and analysis, science from z=0 to 10

# Xsh Scientific Objectives – is it complying?

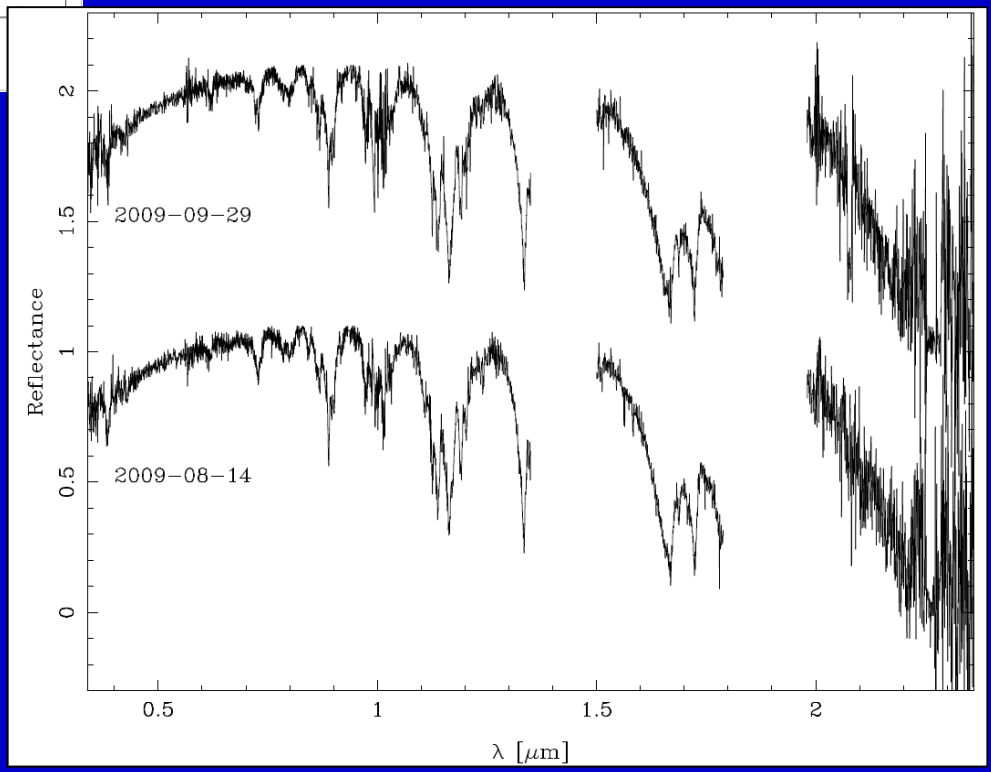
- Spectral properties and gas kinematics of protostars
- Properties of cool white dwarfs
- The nature of neutron stars in close binary systems
- Physical processes in the atmospheres of brown dwarfs
- Properties of core-collapse SNe; Type Ia supernovae to z =1.7
- Gamma-ray bursts as high-energy laboratories and cosmological probes of the intergalactic medium
- The role of faint em-line galaxies in the interval z = 1.6-2.6
- High mass star formation and massive galaxies at high z
- Metal enrichment in the early universe through the study of high z absorption systems
- Tomography of the Intergalactic Medium through the observations of faint background QSOs

Yes: all this and more




# From solar system to…

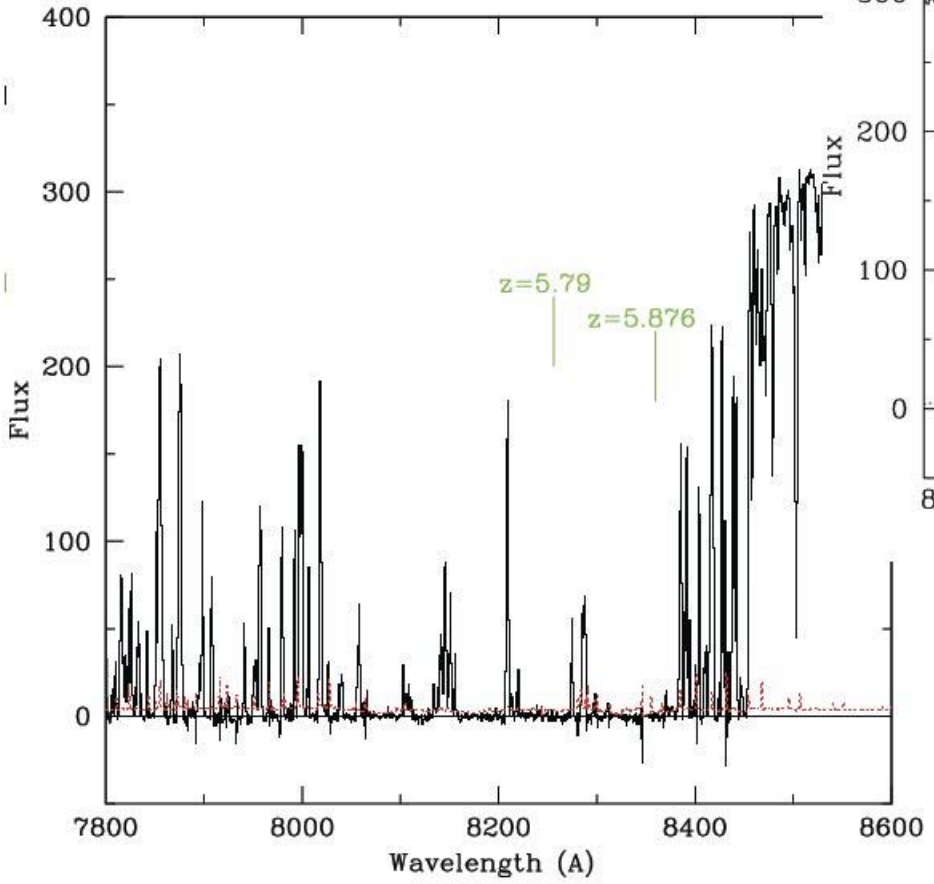
136199 ERIS
(from Alvarez)

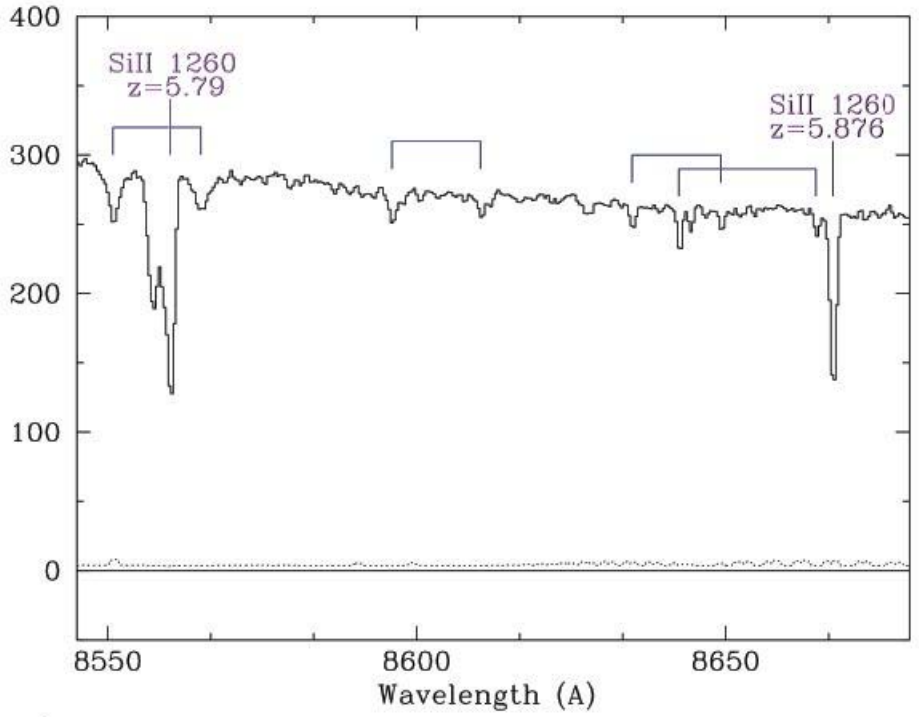


# … the edge of reionization

J0818+1722

V.D'Odorico




Smaller transmission region due to the presence of associated strong overdensities !

# Is X-sh doing well with papers?

- 9 Refereed
- 4 Non – refereed
- 12 Circulars
- 20 technical

NB: from 2009 - incomplete

**Publications using data from VLT/VLTI instruments**

Instrument-level data for the VLT and VLTI are available since the beginning of operation, i.e., from 1999 onwards.

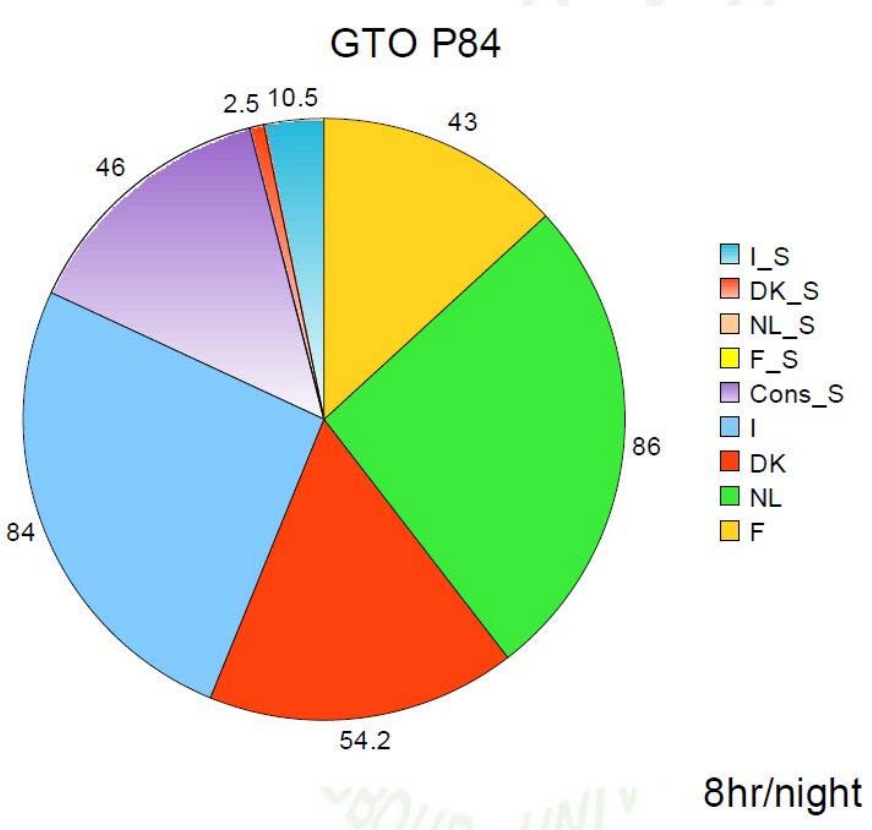
Papers can use data from more than one instrument/telescope.

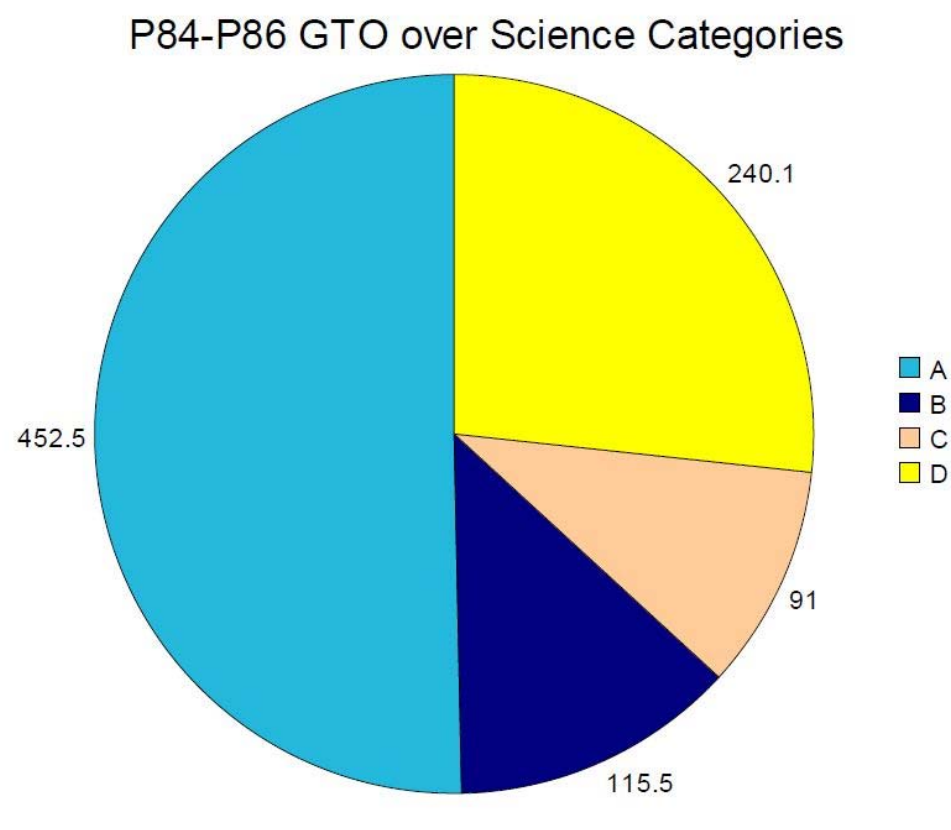
provided by ESO Library

| | | VLT | | | | | | | | | | VLTI | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CRIRES | FLAMES | FORS1 | FORS2 | HAWK-I | ISAAC | NACO | SINFONI | UVES | VIMOS | VISIR | AMBER | MIDI | VINCI |
| 1999 | | | 14 | | | 5 | | | | | | | | |
| 2000 | | | 24 | 2 | | 11 | | | 17 | | | | | |
| 2001 | | | 49 | 11 | | 23 | | | 33 | | | | | |
| 2002 | | | 61 | 30 | | 36 | 1 | | 51 | | | | | 1 |
| 2003 | | 1 | 91 | 41 | | 75 | 10 | 1 | 72 | | | | | 6 |
| 2004 | | 8 | 104 | 89 | | 83 | 24 | 1 | 92 | 2 | | | 3 | 12 |
| 2005 | | 14 | 76 | 84 | | 83 | 31 | 1 | 96 | 20 | 3 | | 5 | 12 |
| 2006 | | 34 | 89 | 78 | | 87 | 40 | 14 | 100 | 20 | 6 | 2 | 11 | 6 |
| 2007 | 3 | 36 | 86 | 83 | | 81 | 50 | 27 | 121 | 56 | 14 | 9 | 19 | 4 |
| 2008 | 7 | 46 | 76 | 99 | 2 | 65 | 52 | 24 | 114 | 45 | 22 | 12 | 11 | 1 |
| 2009 | 10 | 39 | 73 | 102 | 6 | 70 | 41 | 29 | 98 | 64 | 20 | 12 | 18 | 4 |

FLAMES = FLAMES/UVES + FLAMES/GIRAFFE
NACO = NAOS + CONICA
SINFONI = SPIFFI + MACAO

# GTO - Fragmentation?



# GRB Data sets / papers in prep. (Fynbo)

- GRB091018A z=0.971 Wiersema et al. (NL)
- GRB091127A z=0.497 Vergani et al. (F)
- GRB100219A z=**4.699** Thöne et al. (I)
- GRB100316B z=1.180
- GRB100316D z=0.059 Starling et al., Bufano et al. , Flores et al. (NL,I, F)
- GRB100418A z=0.624 Postigo et al. (I/DK)
- GRB100425A z=1.756 Skúladóttir (master thesis, DK)
- GRB100621A z=0.542 Watson et al. (DK)
- GRB100728A z=2.106 none (very faint afterglow, ADC broken)
- GRB100814A z=1.440 Piranomonte (I)
- GRB100816A z=0.806 Tanvir/Antonelli (NL/I ?)
- GRB100901A z=1.408 Hartoog (NL)
- GRB100925A z=0.000 NL/I ? (not a cosmological GRB!)

$z < z_{median}$

$z > z_{median}$

$z_{mean} = 1.3$

$z_{median} = 1.2$

**X-Shooter!! – GRB Host Galaxies French-Italian GTO Proposal**
**(PI: Piranomonte, Flores)**

Our first selections were based on galaxies with one or more emission lines already detected in the optical

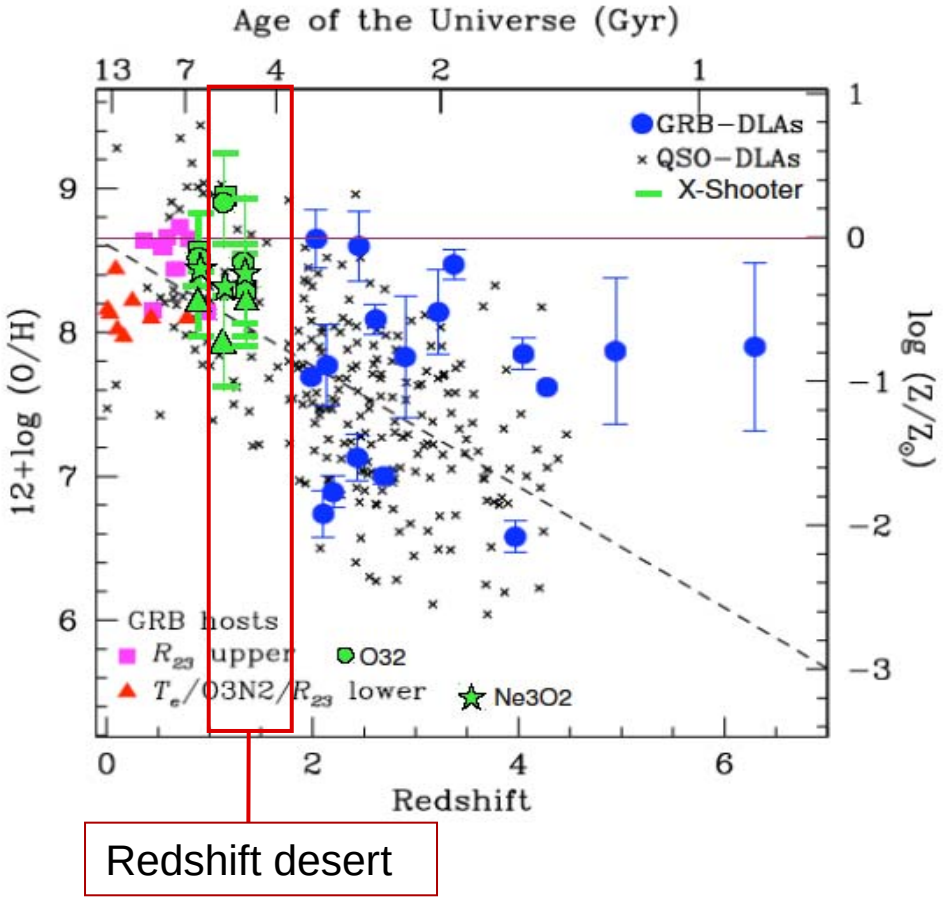
GRB 021004 z~2.3 **(Vergani's talk)**
GRB 000210 z~0.8 dark
GRB 000911 z~1.1
} November 2009

GRB 990506 z~1.3 dark
GRB 011211 z~2.1
} March 2010

GRB 000418 z~1.1
GRB 060801 z~1.1 short
} April 2010

Exptime: 1 - 2 hours

## ✓Metallicity

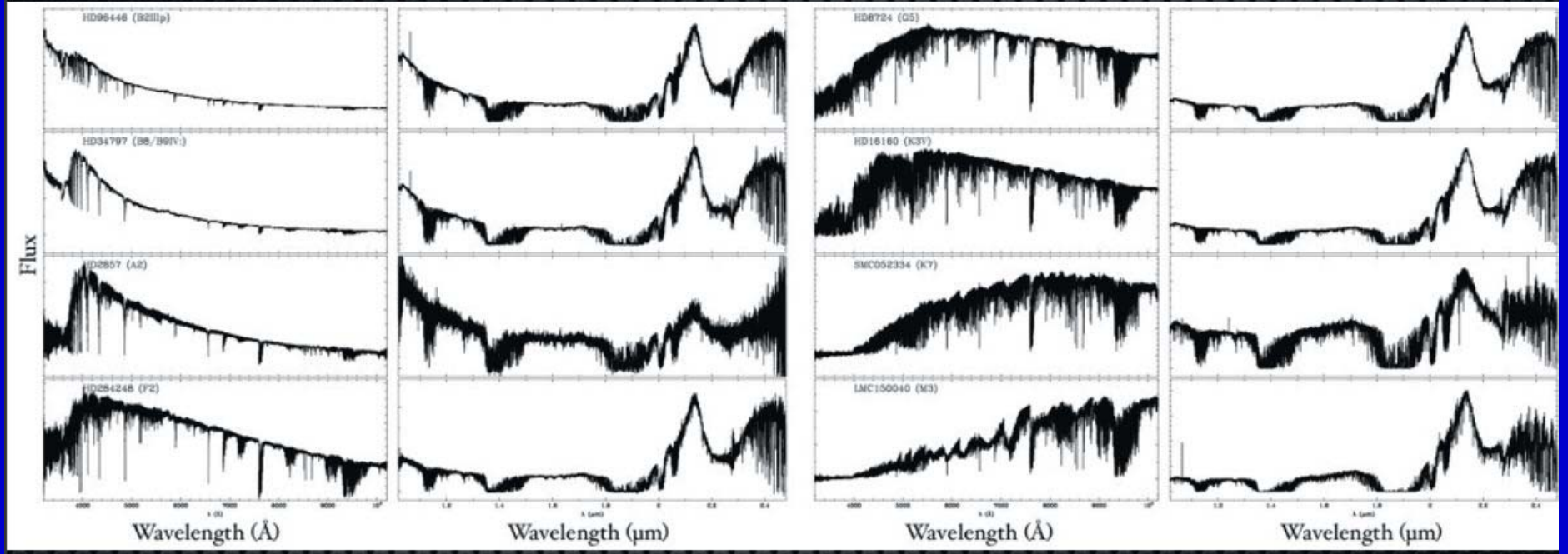



SFR

(Piranomonte et al, in prep)

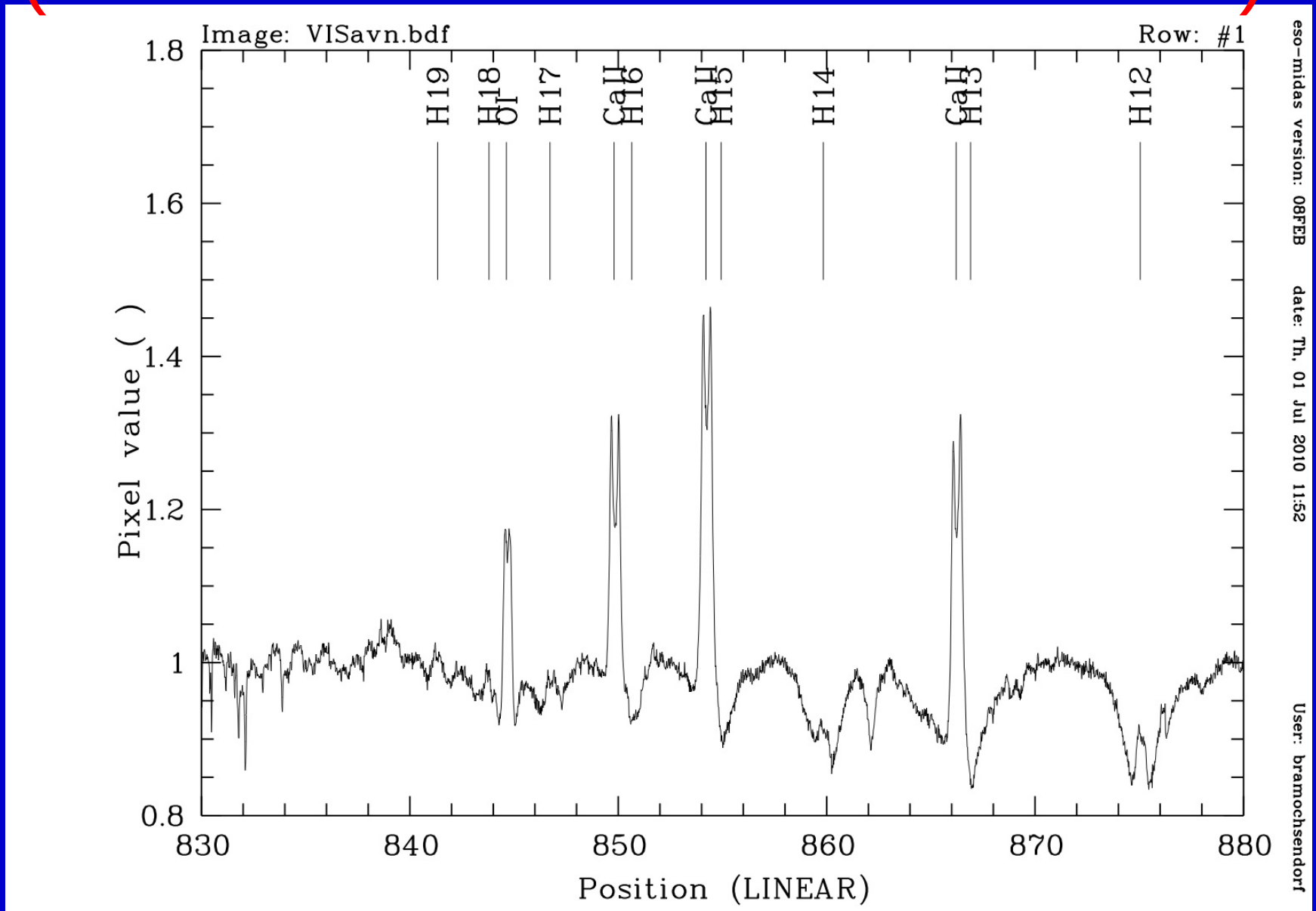
Trager

# XSL: Current status

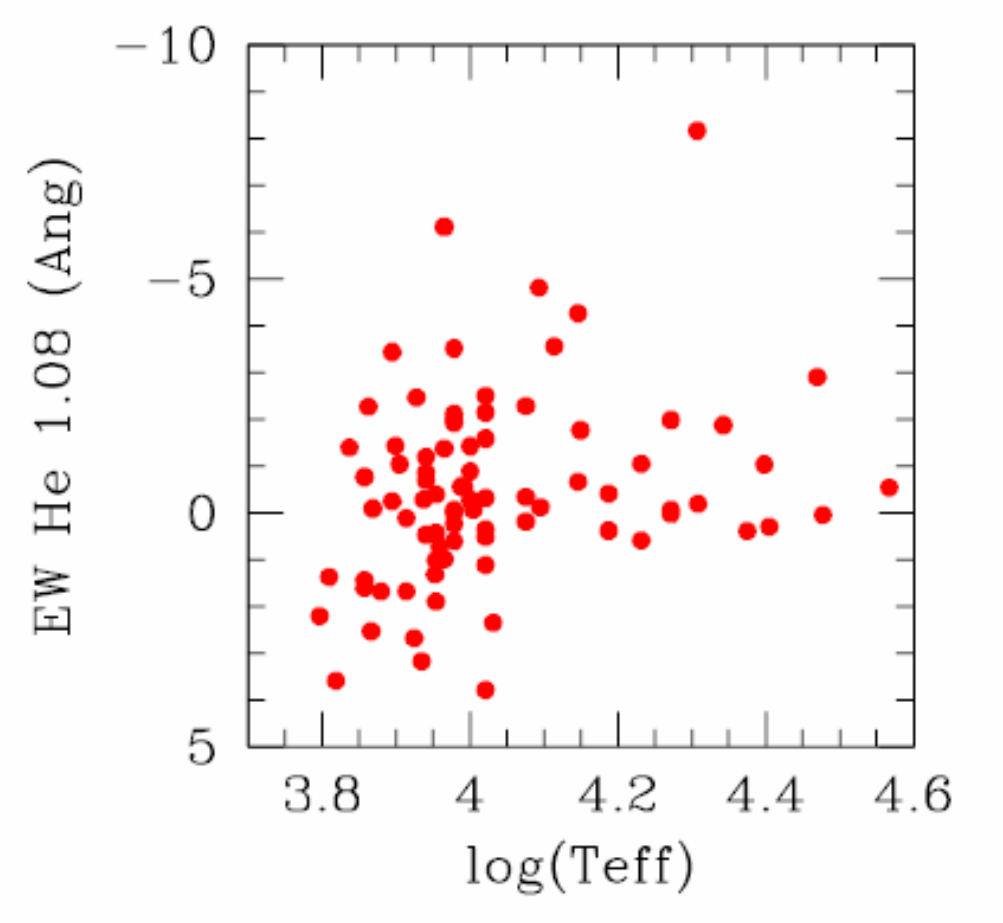



- The P84/85 data quality has been excellent!
  - For the most part: variable pattern noise in VIS plus UVB ADC problem have caused some problems

# Kaper- High mass stars (Active accretion or remnant disc?)



# Intermediate mass - Oudmaijer

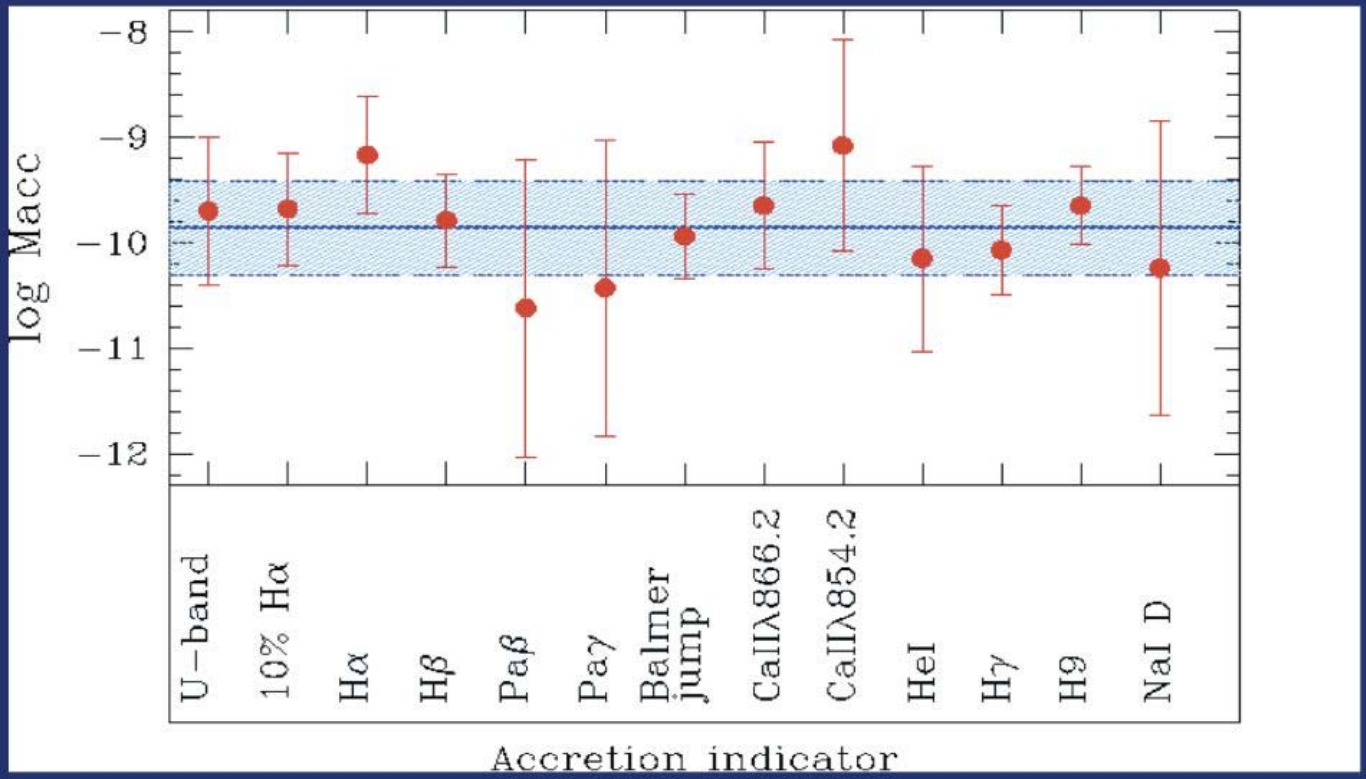



Helium shows break

From magnetically controlled to direct disk accretion?

# Low-mass (Alcalà, Rigliaco, Goldman)

## Comparison between all accretion indicators:



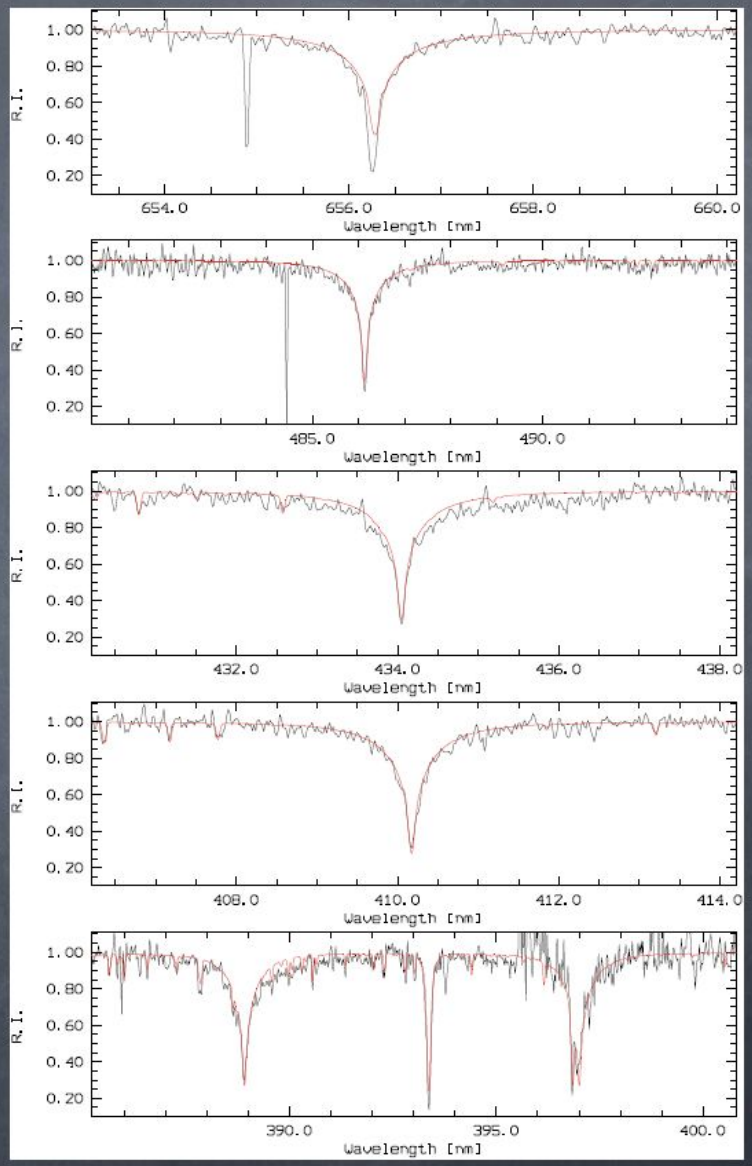

The X-Shooter spectrum proves that the large discrepancies between Macc values found by different techniques by various authors do not depend on variability, but rather on the uncertainties of the relations between the observed properties, such as line luminosities and Lacc.

# Low-metallicity (Bonifacio)

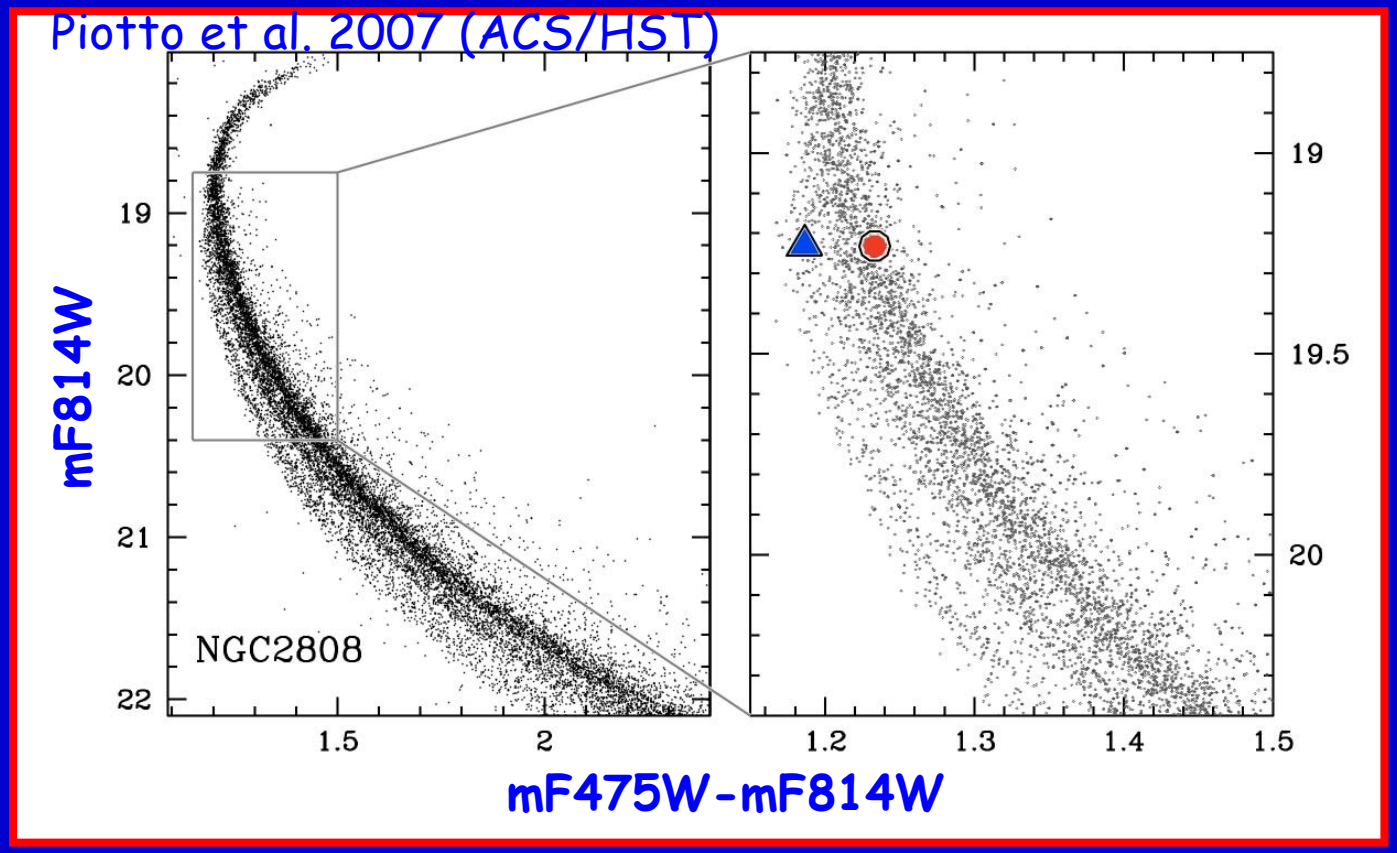
SDSSJ135046.74+134651.1

g=18.29

Teff from g-z colour = 6284K



# Multiple MS (Bragaglia)




- ESO GTO 084.D-0070 1.25 nights
- slit mode
- stare
- 0.8"-1" slit
- seeing <1"
- R~10000

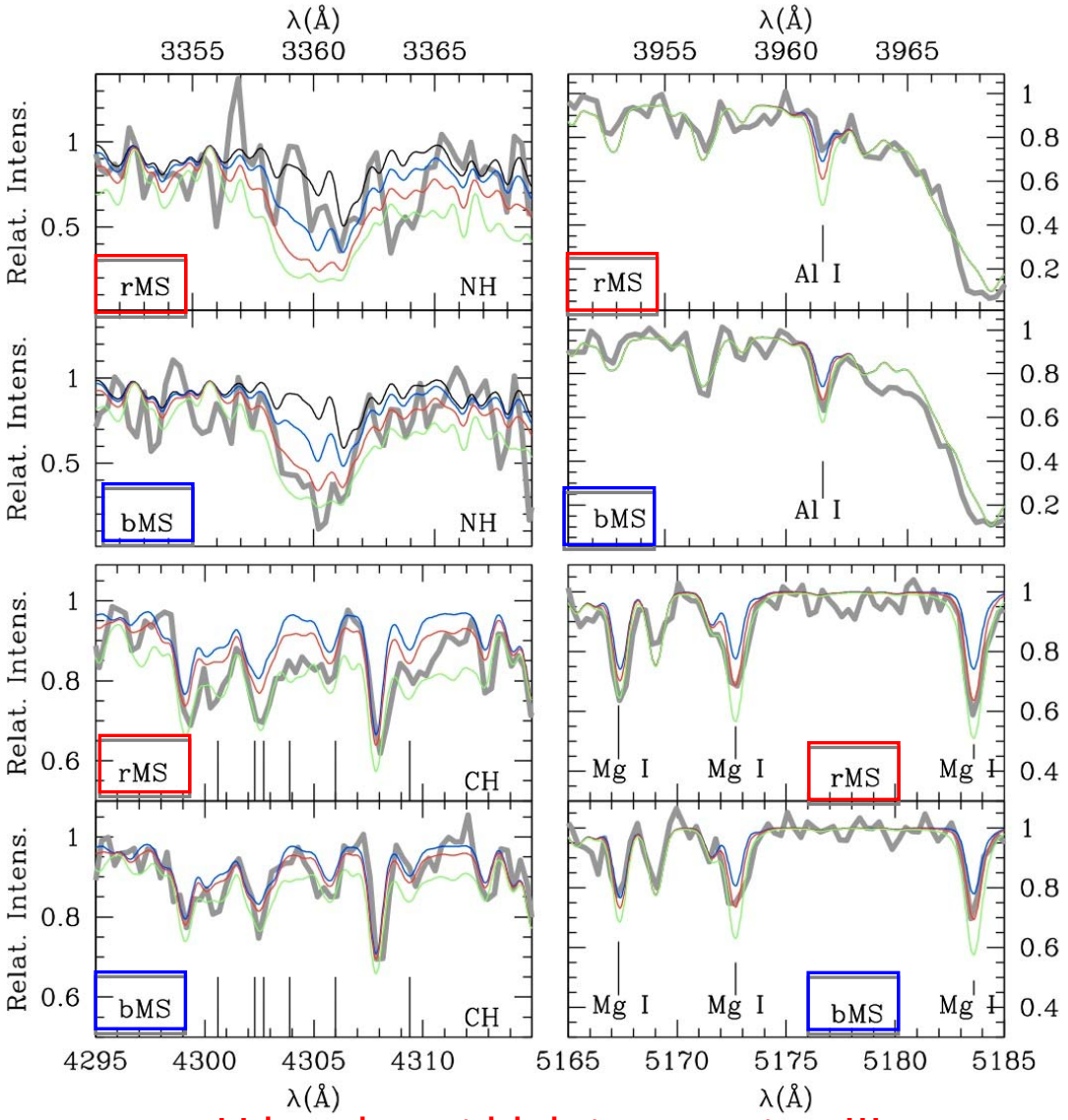
- stars without neighbors (<1.5")
- with p.m.

bMS : mF475W=20.42 mF814W=19.23 5x1hr exps
rMS : mF475W=20.47 mF814W=19.23 4x1hr exps

# Results : N, C, Al, Mg, Na

[N/Fe]=
0,1,1.5,2

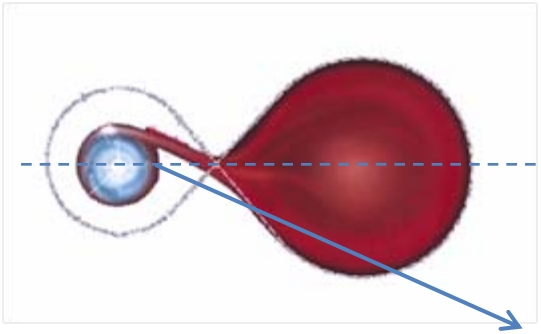
[C/Fe]=
-1,-0.5,0



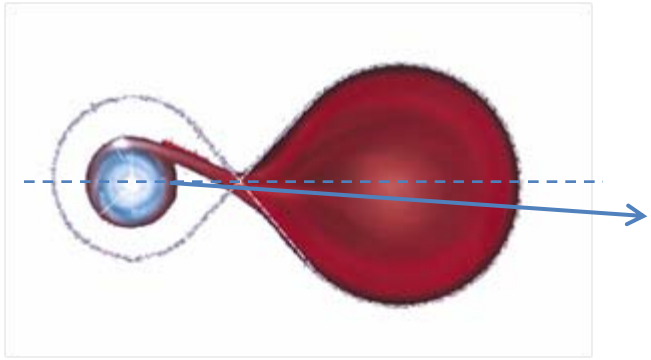

H burning at high temperature!!!

[Al/Fe]=
-0.7,-0.2,
0.3,0.8

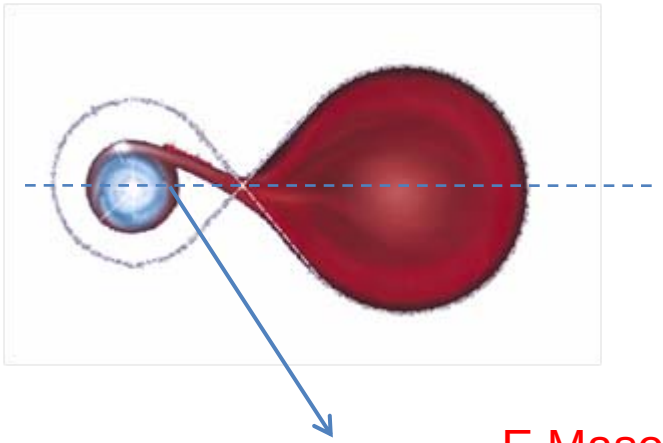
[Mg/Fe]=
-0.5,0,0.5



phase 0.07
+46 dd



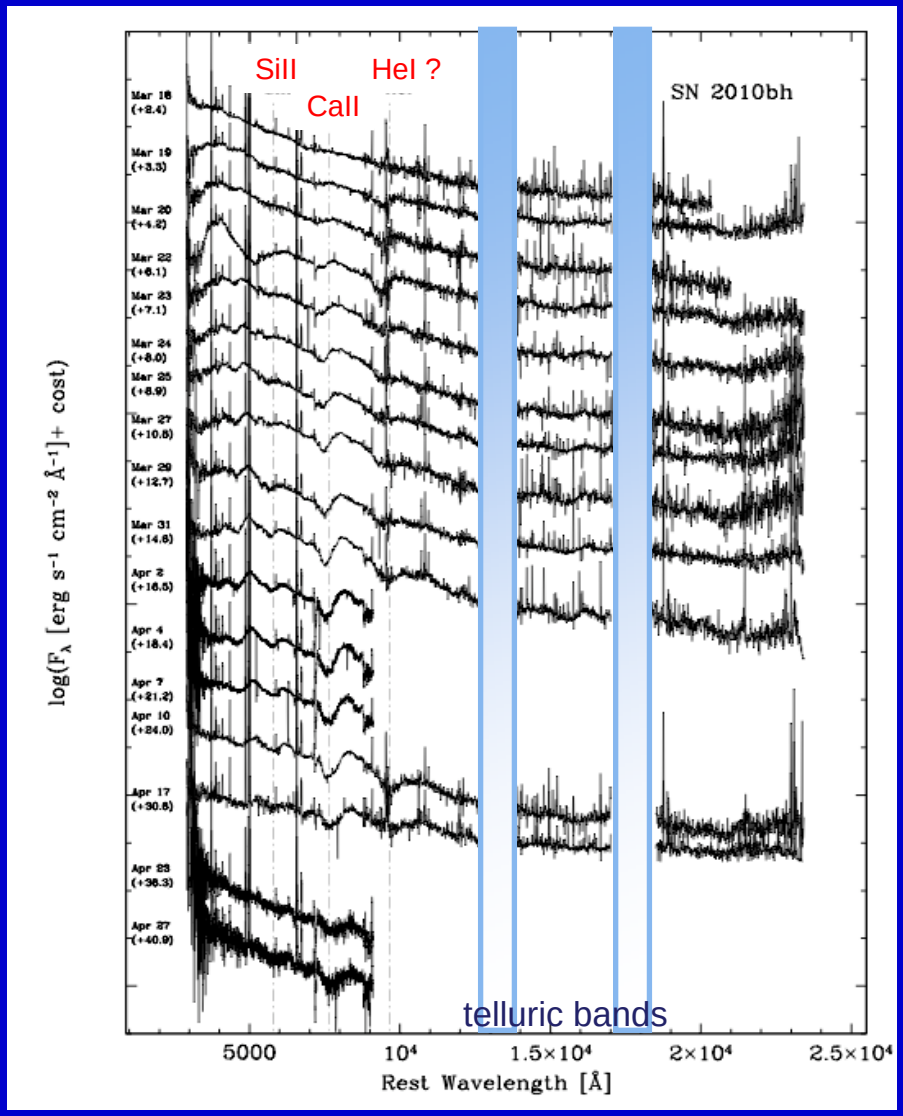
phase 0.01
+73 dd



phase 0.17
+104 dd

E.Mason

# SNe (Strizinger, Bufano, Pastorello)




## Unique Spectral Coverage!

✓Extended Wav. Range:
SED and temperature time evolution

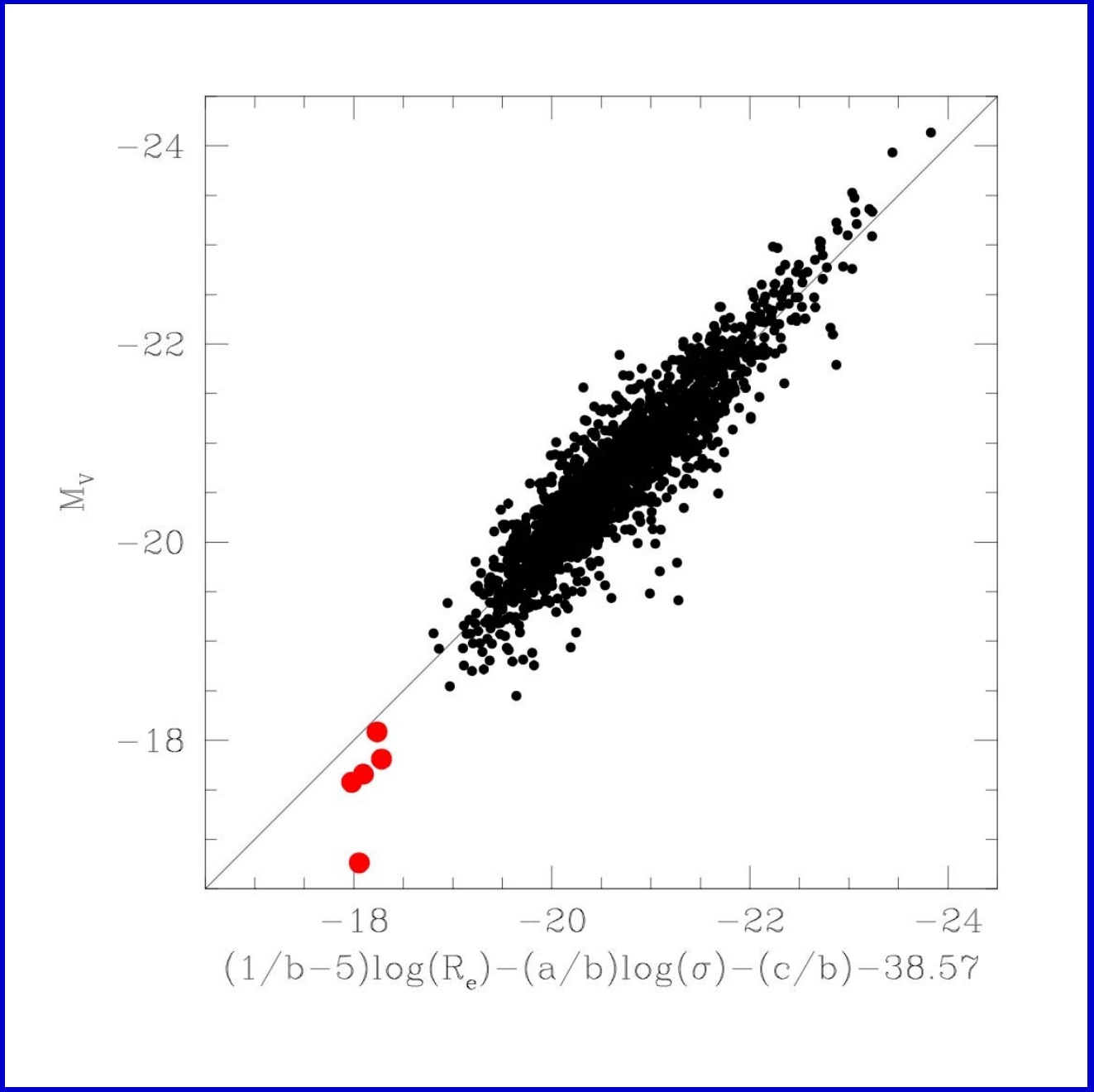
✓Detailed Time Coverage:
Starting from +2.5day from the burst!

✓High Resolution:
redshift measured with high precision ($z=0.05899 \pm 2\times10^{-5}$)

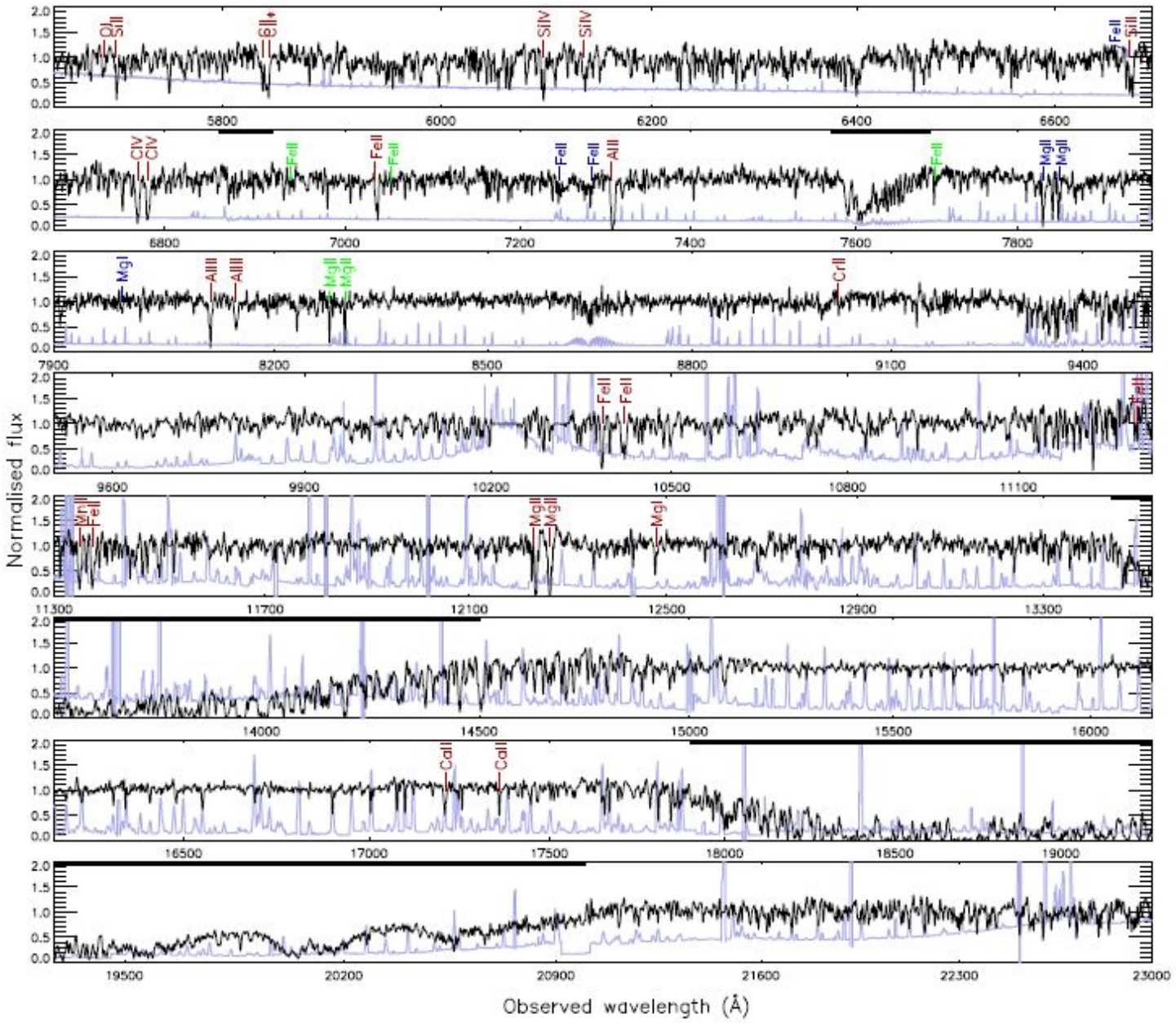
HeI @10830 Å

no clear detection HeI @20580 Å
NIR arm less sensitive
Find compromise between S/N and exposure time

# FP Bettoni



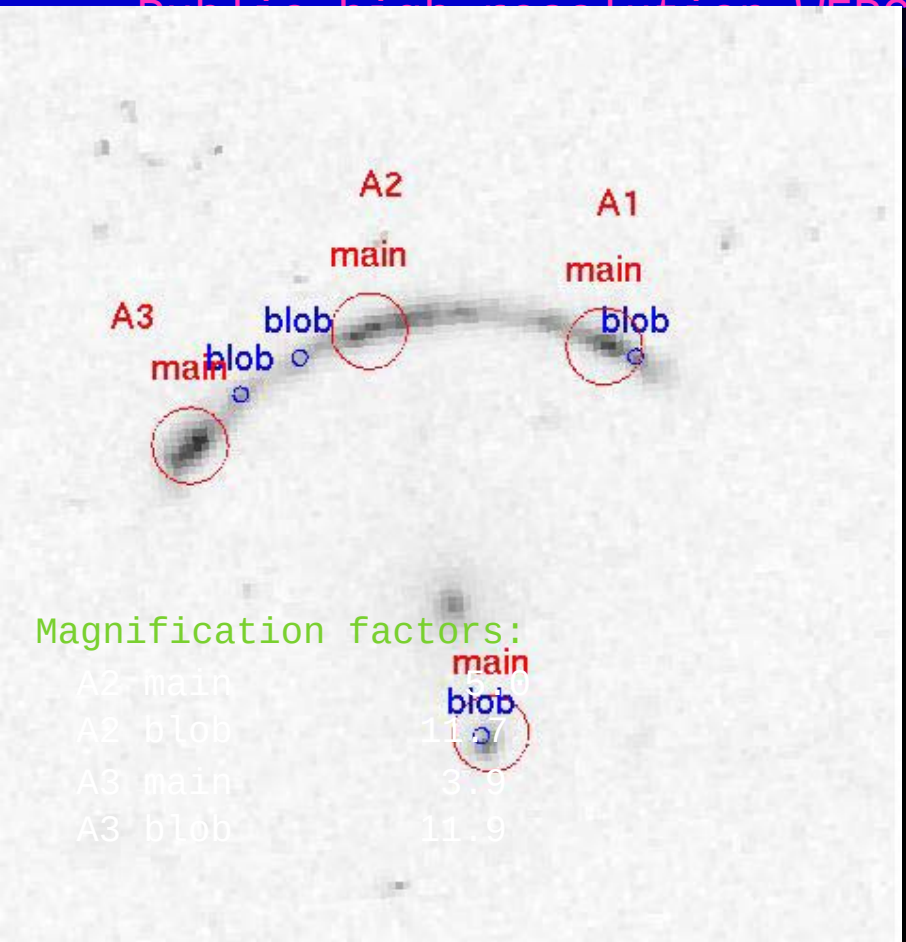
A. de Ugarte Postigo et al.: GRB 090313: X-shooter's first shot at a GRB



# Gravitational Lens Modeling

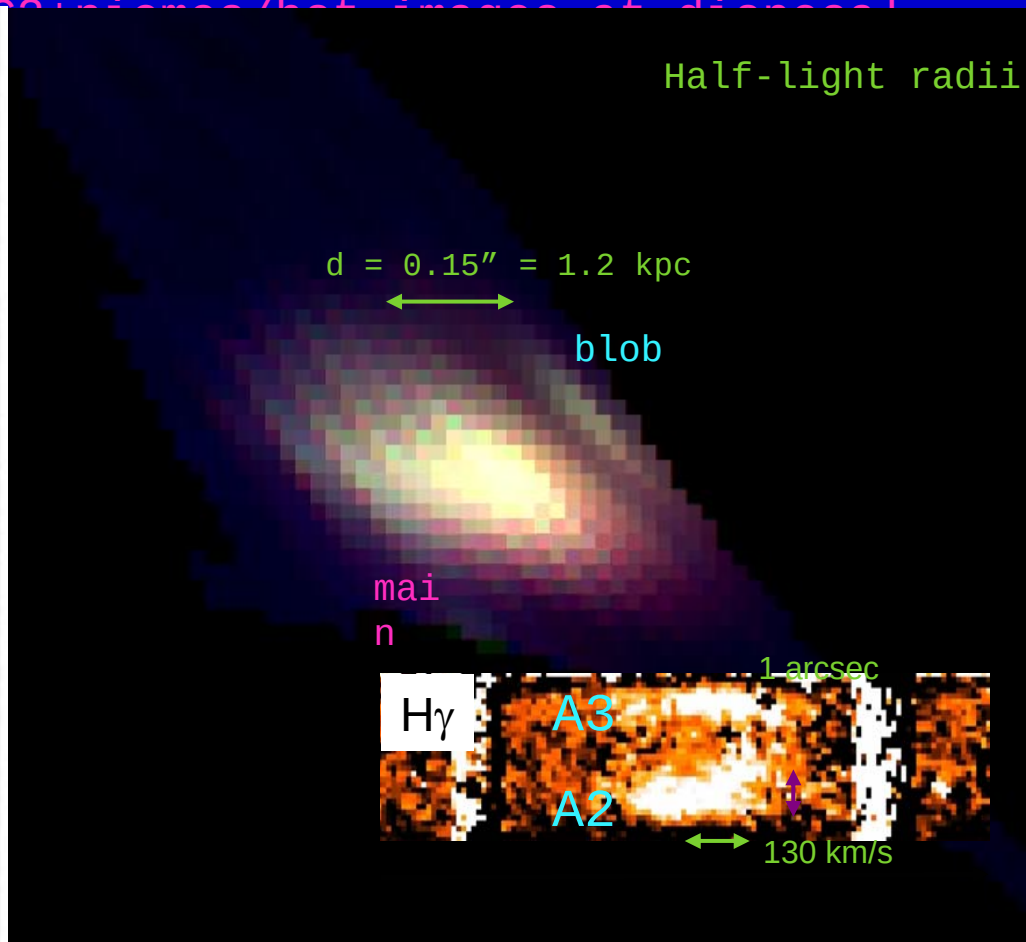
Use of the public software “Lenstool” *(Jullo et al. 08)*:

- to reconstruct the morphology of the 8 o’clock arc in the source plane
- to derive accurate magnification factors




Magnification factors:

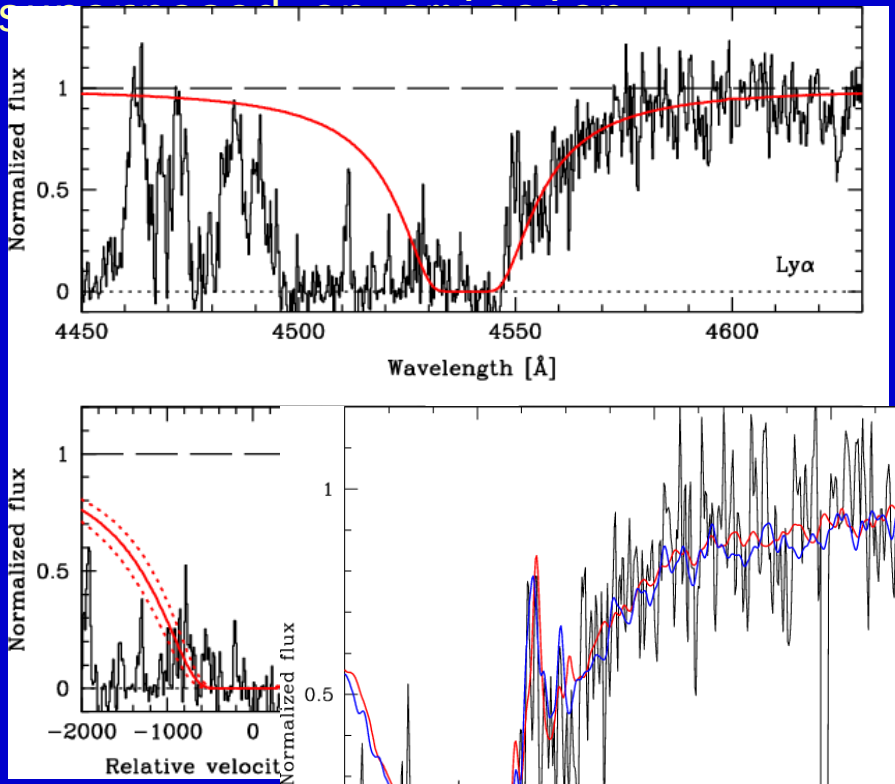
| | |
|---|---|
| A2 main | 5.0 |
| A2 blob | 11.7 |
| A3 main | 3.9 |
| A3 blob | 11.9 |

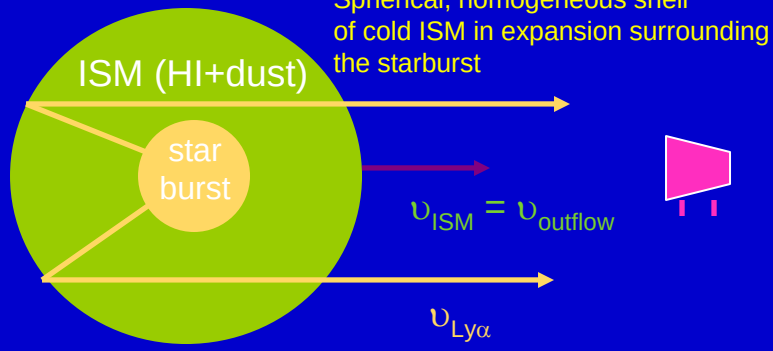


# Dessauges

## Lyα Line Profile:

dominated by a damped absorption profile on top of which is




Voigt profi ISM):

N(HI) = (3

$\upsilon_{Ly\alpha}$ = +570 e to 2 kpc

⇨ backscattering

3D Radiation transfer modeling

*(Verhamme et al. 06,08; Hayes et al. 10)*

⇨ N(HI) = $6.3 \times 10^{20}$ $cm^{-2}$ (ok with Voigt profile fitting)

E(B-V) ≈ 0.3 (ok with the Balmer decrement)

intrinsic $W_0$(Lyα) = -50 Å (SF exceeding >$10^7$ yrs)

$\upsilon_{outflow}$ = 100-150 km/s (ok with $\upsilon_{ISM}$)

large N(HI) + dust optical depth

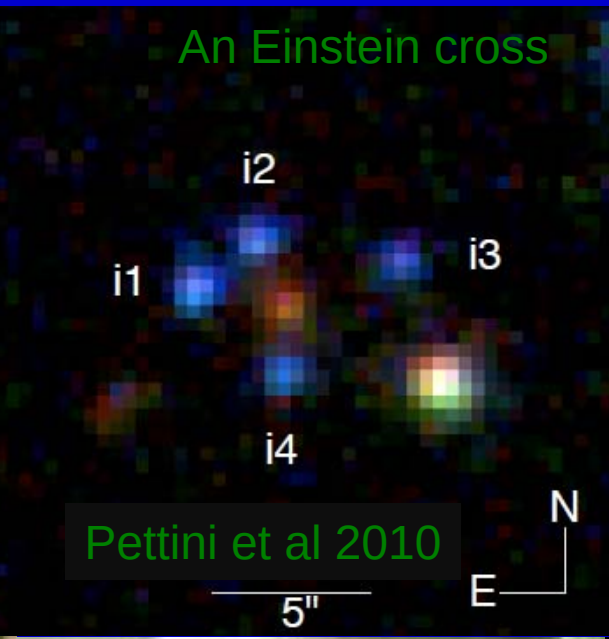
# Lenses : a real cosmological zoo

Cosmic Horseshoe

Belokurov et al. 2007

Cosmic Eye

Smail et al. 2007




An Einstein cross

Pettini et al 2010

8 o'clock arc

Allam et al 2007

Dessauges-Zavadsky et al 2010

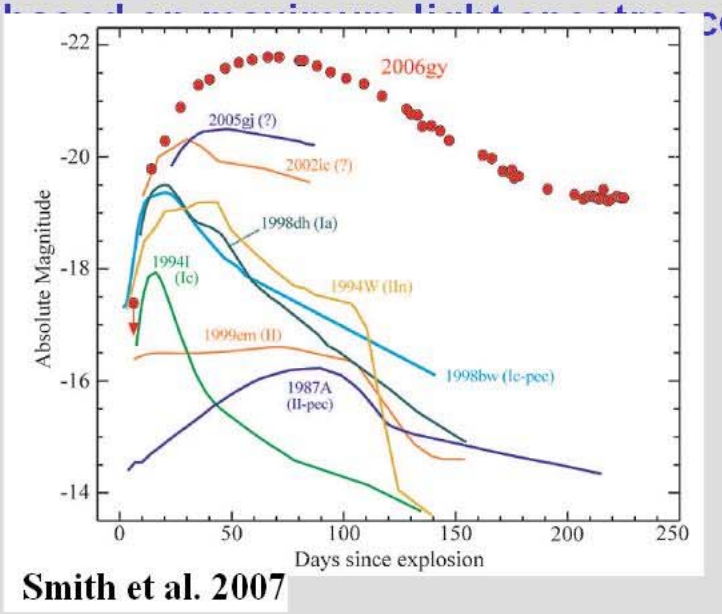
Cheshire cat

Belokurov et al 2008

Christensen et al 2010

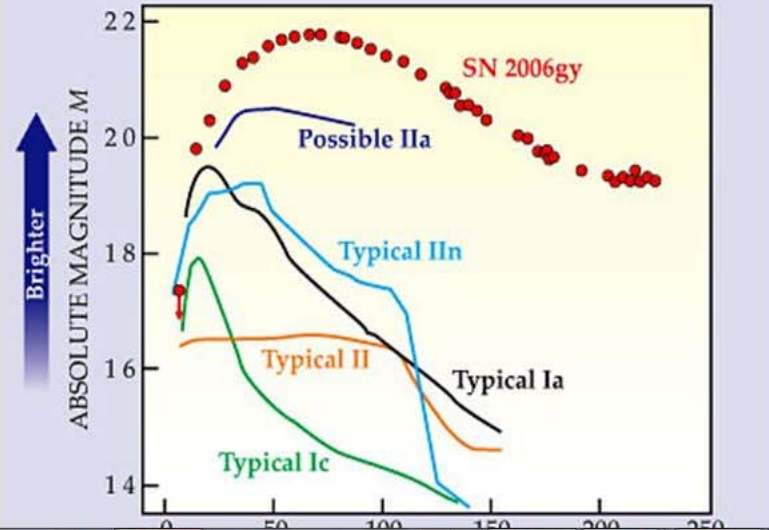
# Supernova Taxanomy

Stritzinger




Smith et al. 2007

Smith et al. 2007




## Thermonuclear supernovae

## Core-collapse supernovae

hydrogen

no

yes

silicon

yes

no

**Ia**

SN 2006gz
---
Tycho's SN
SN 1991T
SN 1992A
SN 1998bu
SN 2001el
SN 2002bo
---
SN 1991bg
---
SN 2002cx
SN 2008ha

**Ib/c**

**IIb**
SN 1993J

helium

no

yes

**Ic**
SN 1994I
SN 1996N
SN 2004aw

**Ib**
SN 1983N
SN 1999ex
SN 2007Y

**II**
SN 1979C
SN 1980K
SN 1987A
SN 1999em
SN 2004dt

**GRBs**

SN 1998bw
SN 2003dh

# X-shooter is a great instrument!

But improvements are possible/recommendable

# Simple/immediate improvements

1. Reducing the background in the IR – cold filter?
2. Improving the acquisition CCDs – B V R z photometry – great added value, also for flux calibration
3. Moving X-shooter to UT3 – increase of available observing time
4. IR-only  nodding

# More complex improvement

- An IR sensitive acquisition camera – important for high-redshift work and IR flux calibration

  (should the Consortium come back?)

# Roberto Pallavicini