



# **GRB100316D/SN2010bh and the environments of GRB-SNe**

based on Starling et al. 2010 (arXiv:1004.2919)

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for a larger collaboration  
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# Gamma-ray bursts with SNe: why do we care?

- \* **signal the deaths of massive stars**  
*probes of star formation*
- \* **signal the births of black holes and relativistic jets**  
*probes of physics in extreme conditions*
- \* **are so bright they can be seen out to  $z = 8$**   
*probes of distant galaxies and cosmic evolution*
- \* **Long GRBs should be accompanied by SNe**  
*clues to progenitor stars and circumstances which lead to a GRB*

**First established in 1998:**

# **CCSN features on a GRB non-thermal power law spectrum**

**GRB980425/SN1998bw  $z=0.0085$**

(Galama+98; Patat+01)

**GRB030329/SN2003dh  $z=0.168$**

(Hjorth+03; Stanek+03; Matheson+03)

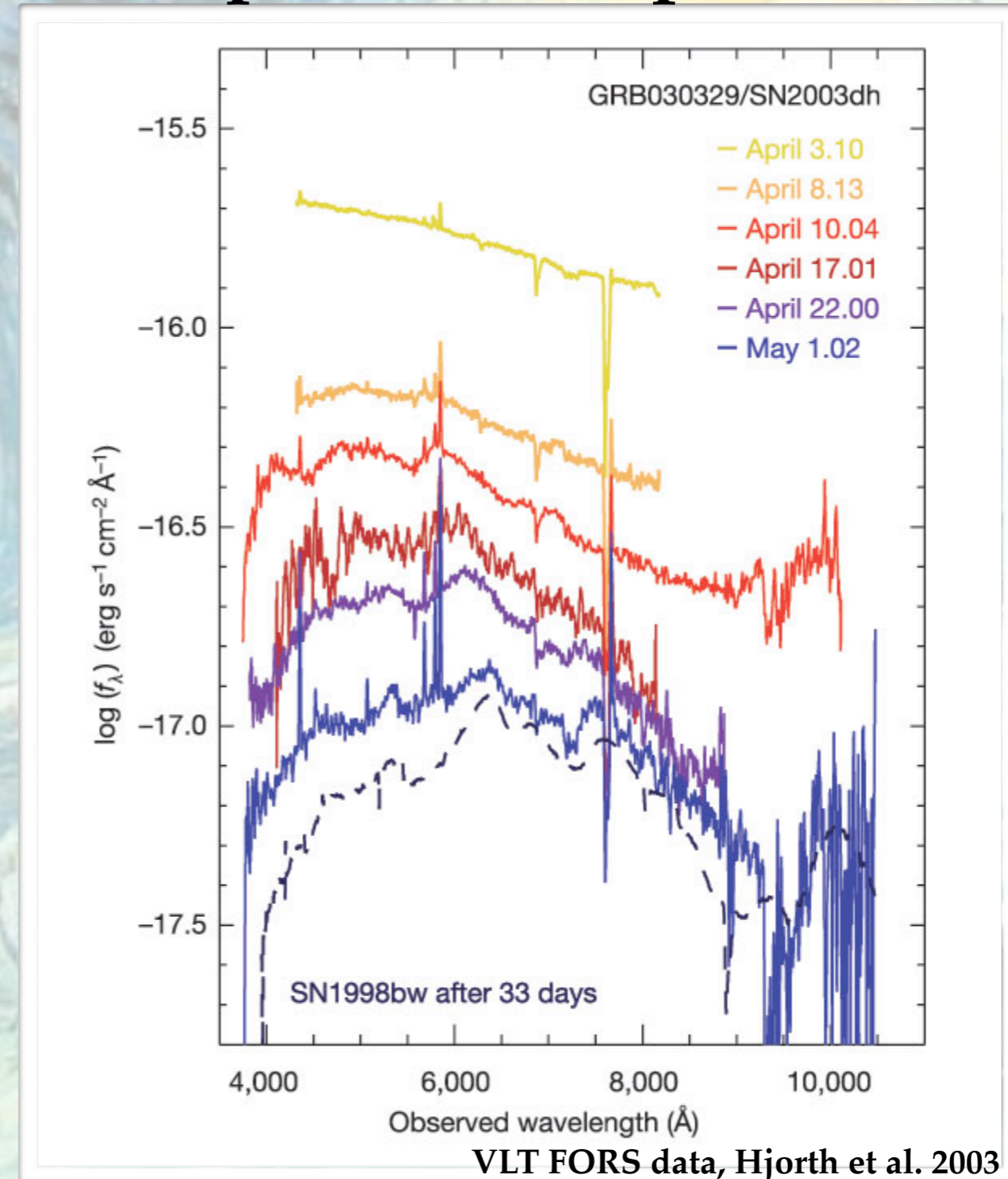
**GRB031203/SN2003lw  $z=0.105$**

(Malesani+04; Gal-Yam+04)

**GRB060218/SN2006aj  $z=0.0331$**

(Modjaz+06; Mirabal+06; Pian+06)

+ 2-3 debated cases

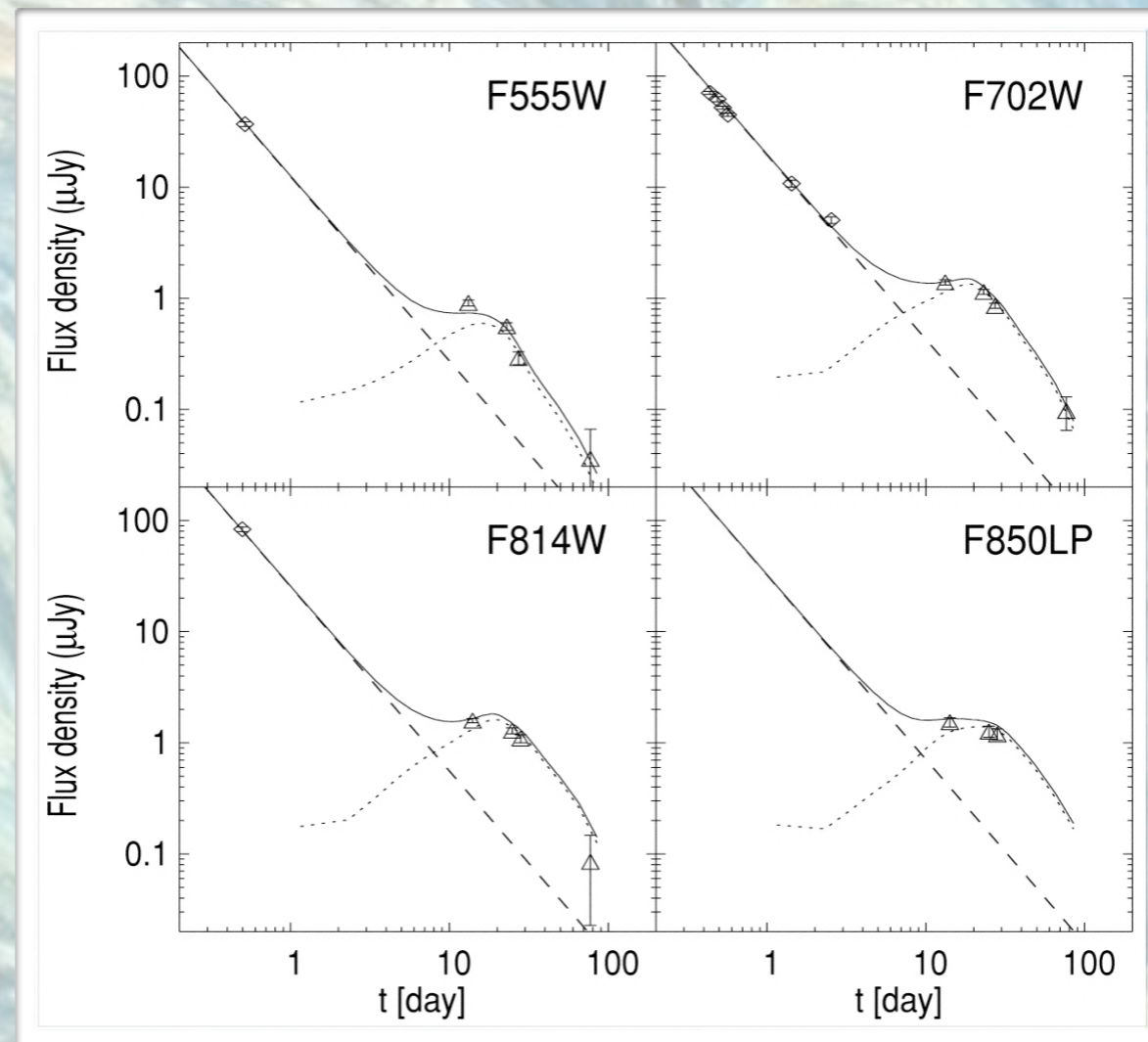


**broad-lined Ic SNe**

**fast ejecta velocities (>90% ordinary SNe Ic)**

All long GRBs should have SNe (see however GRB060505 and GRB060614)

$\langle z_{\text{GRB}} \rangle \sim 2.2 \rightarrow$  Photometric signatures:  
SN 'bump' seen over GRB afterglow decay



GRB 011121, HST data, Bloom et al. 2002

1% SNe Ibc with GRB (Soderberg+10)

# More kinds of progenitors for long GRBs?

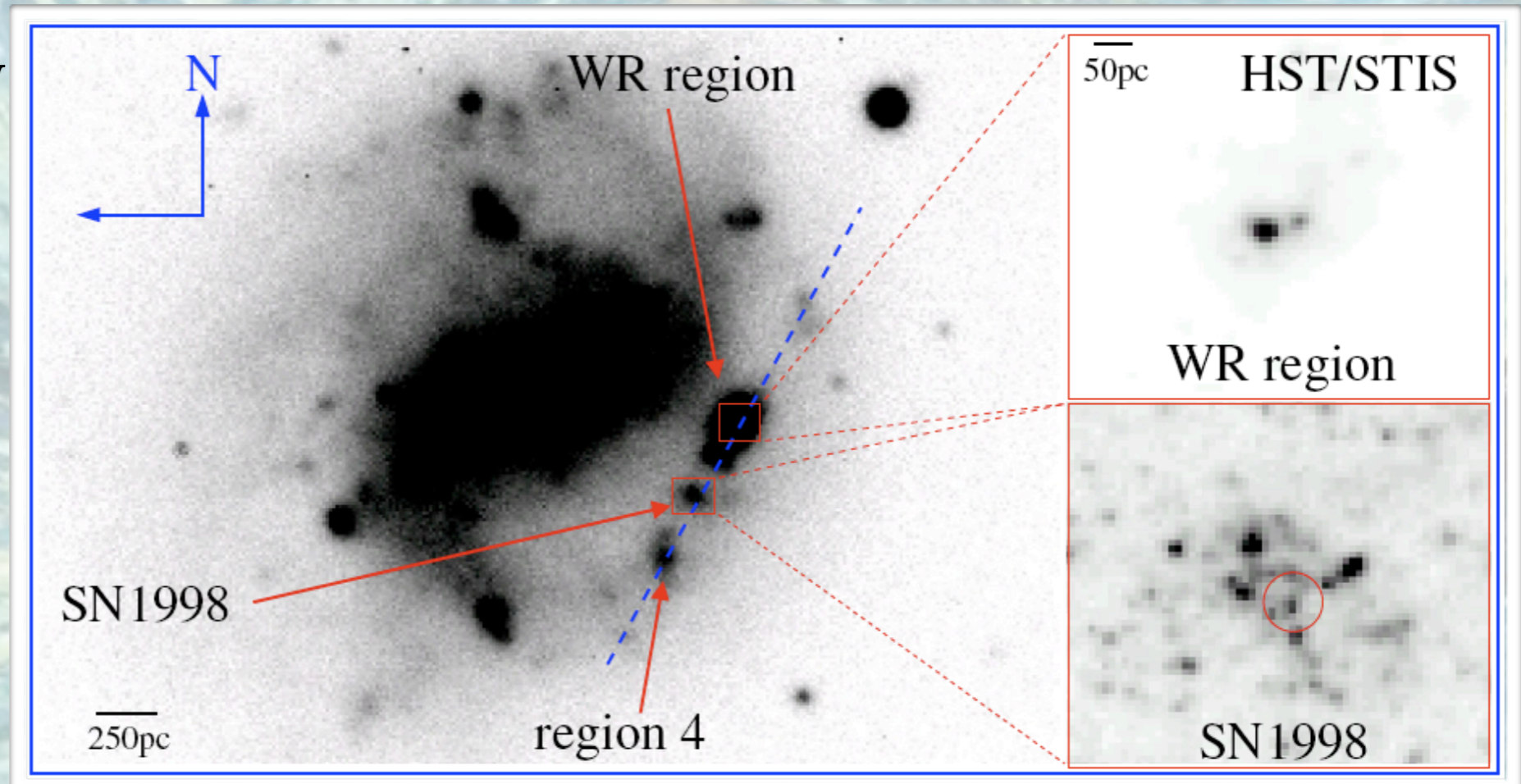
## Why only a few CCSN produce GRBs?

- \* Environment
- \* Identification of the progenitors

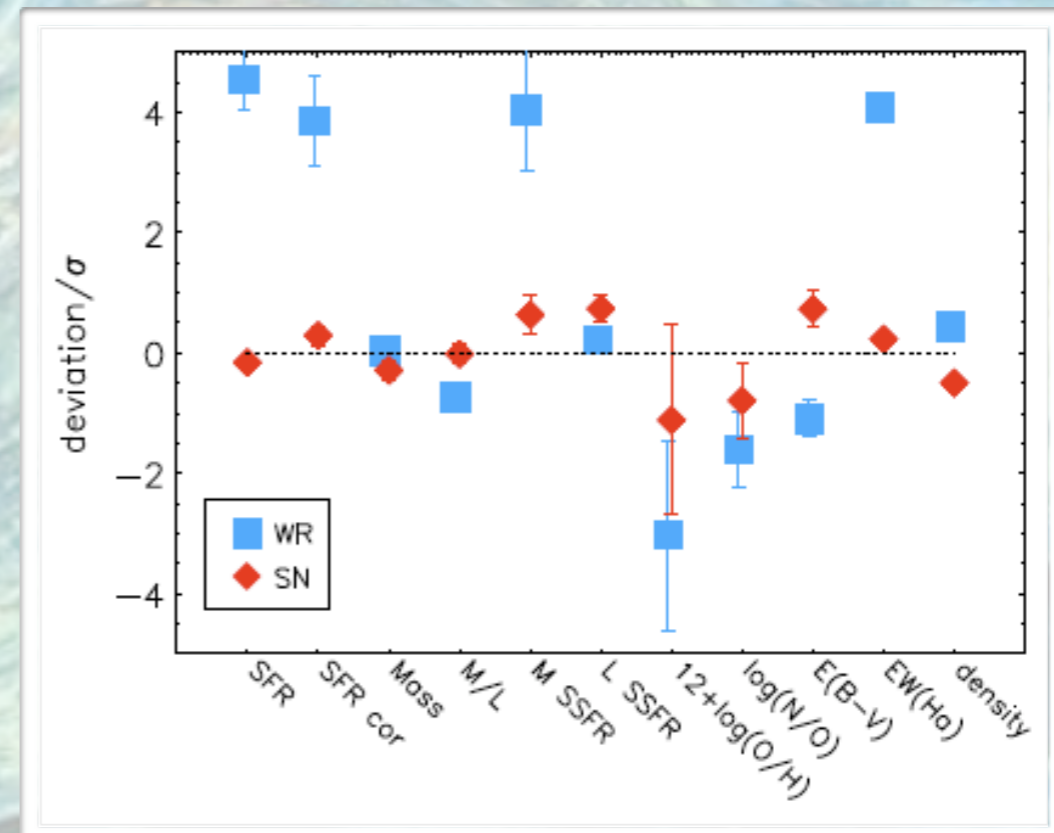
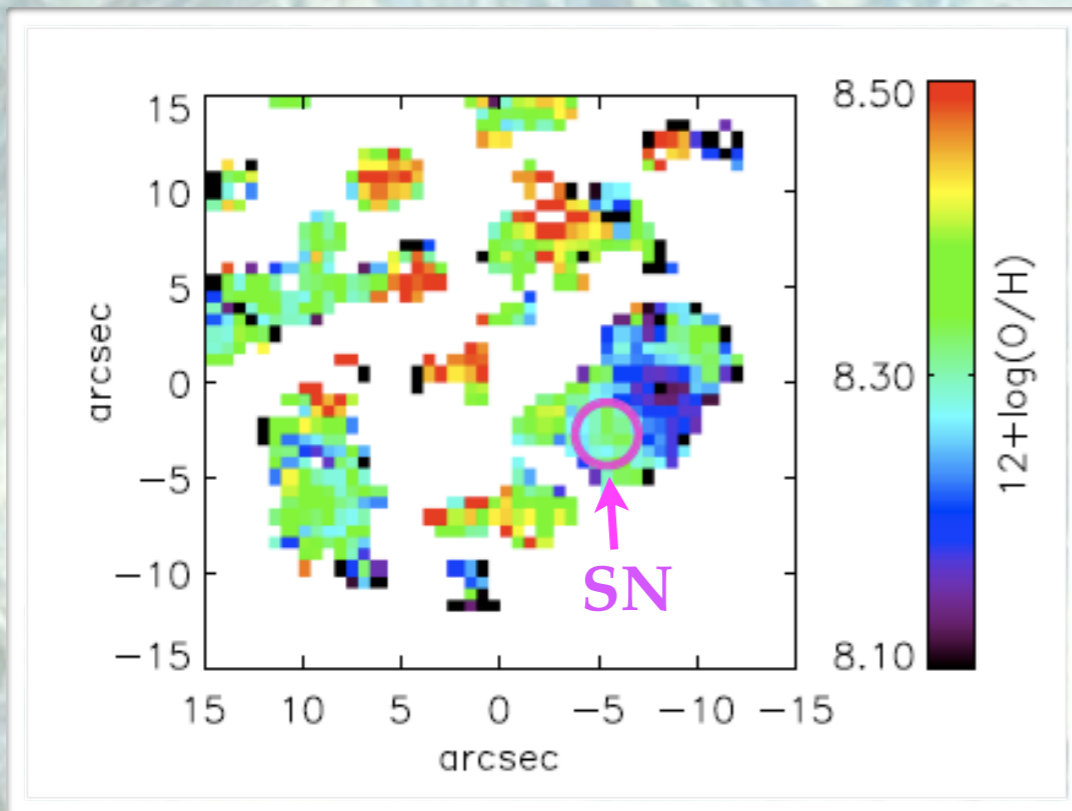
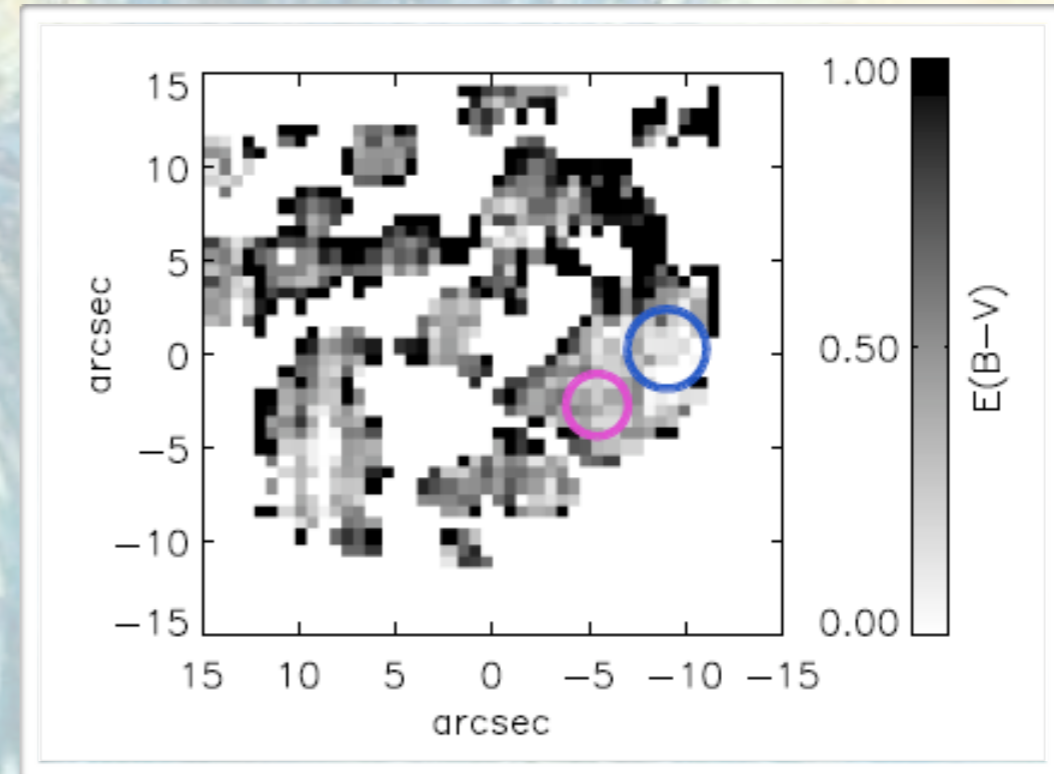
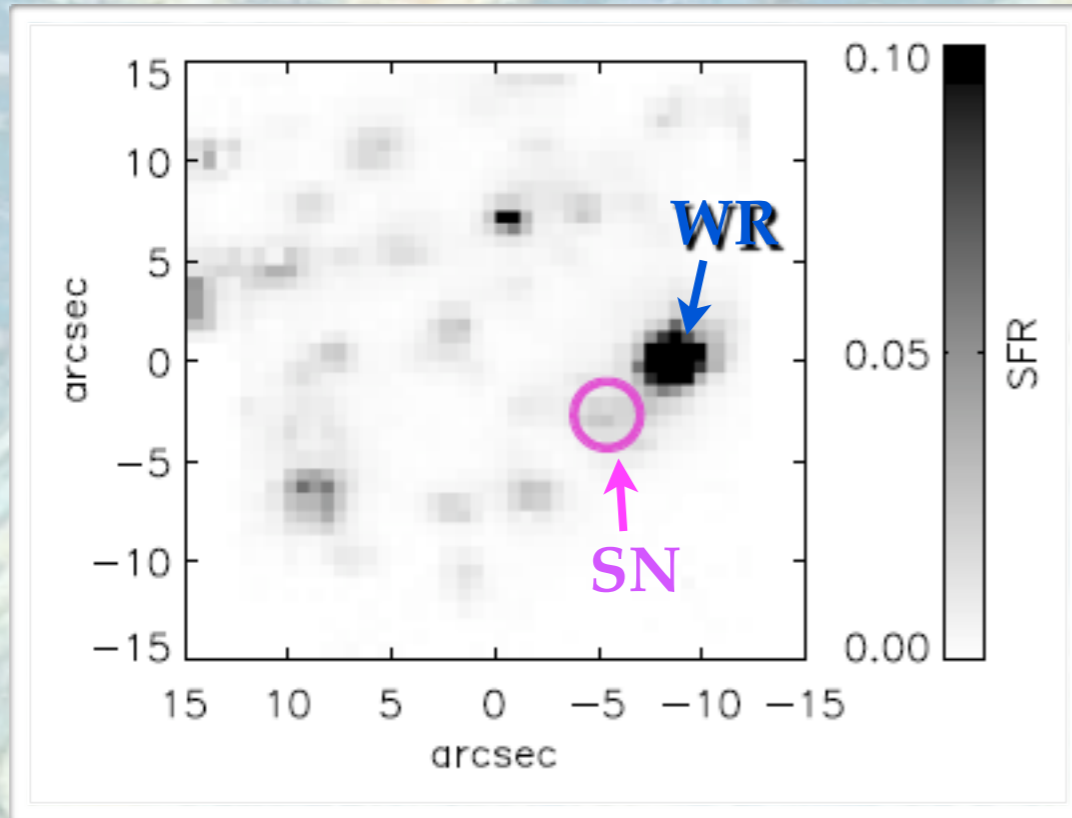
Wolf-Rayet spectral features in 5 GRBs host galaxy spectra.  
Among which 980425, 031213 and 060218 (Hammer+07; Han+10)

GRB980425/1998bw

Runaway???



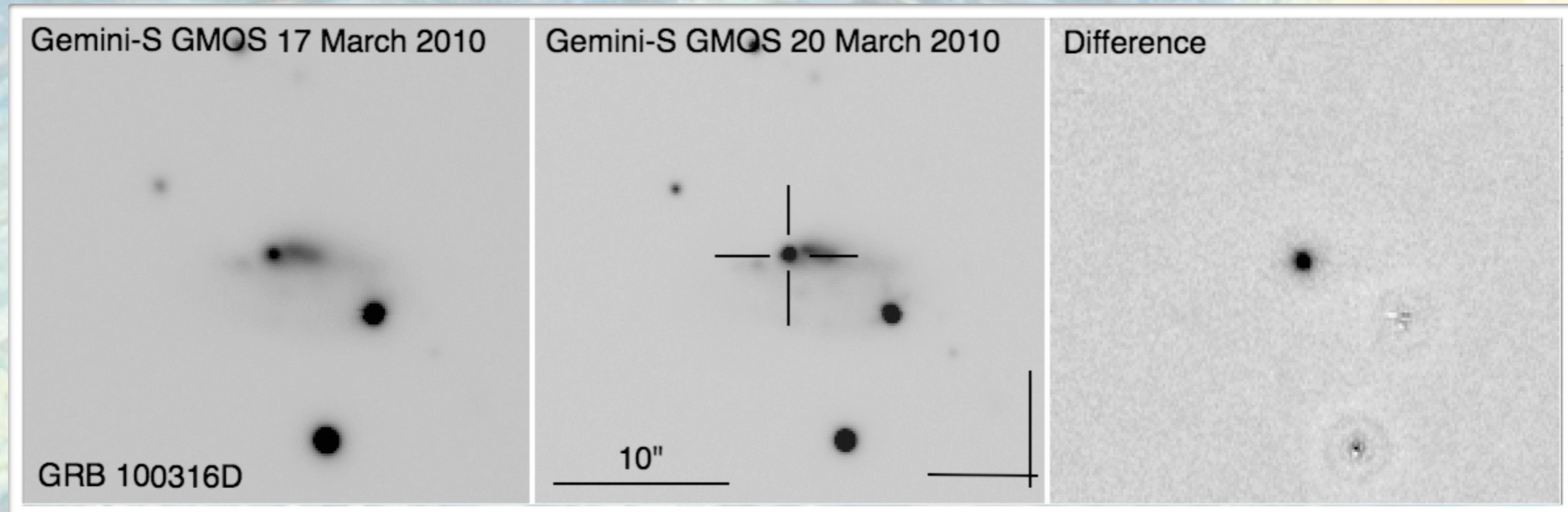
# GRB980425/1998bw IFU (Christensen+08)



See also Modjaz talk

# GRB100316D/SN2006bh

Starling+10



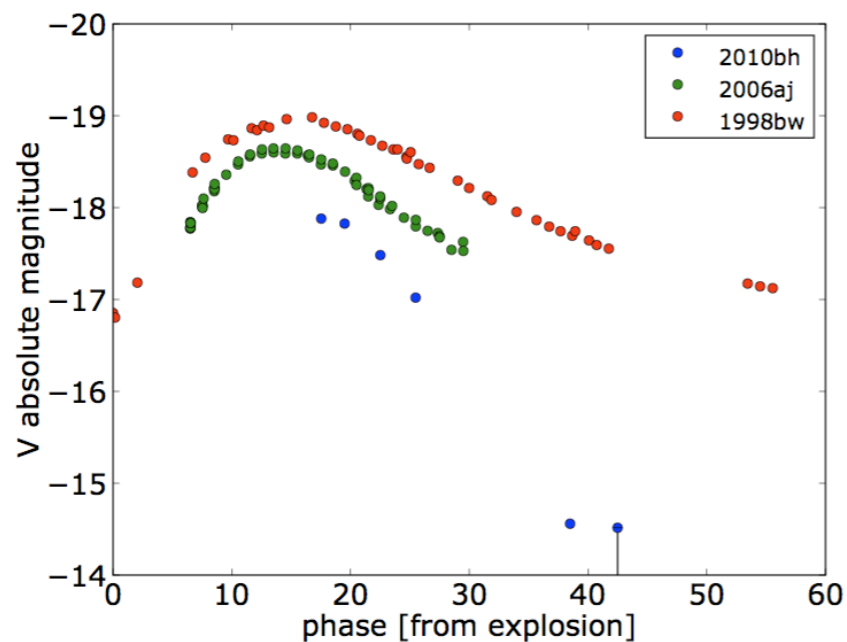
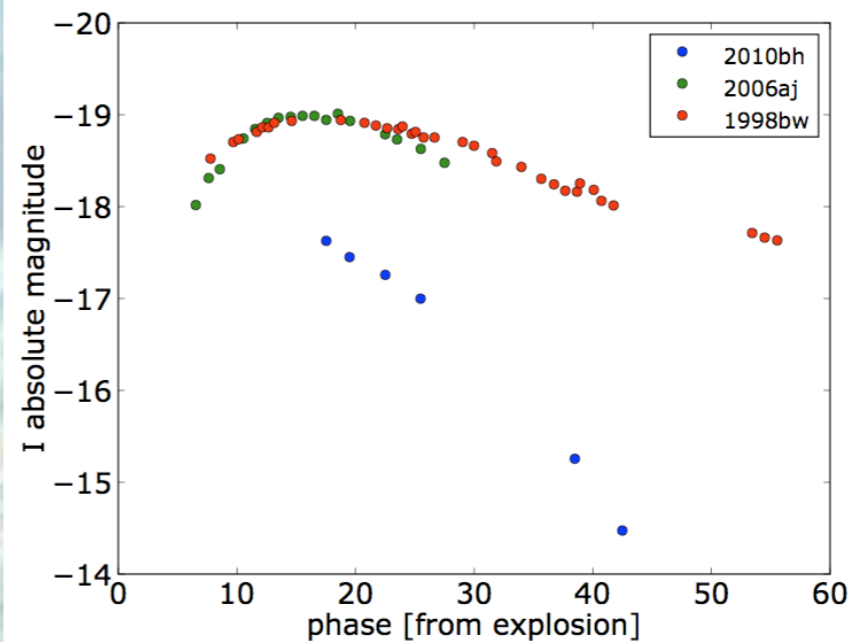
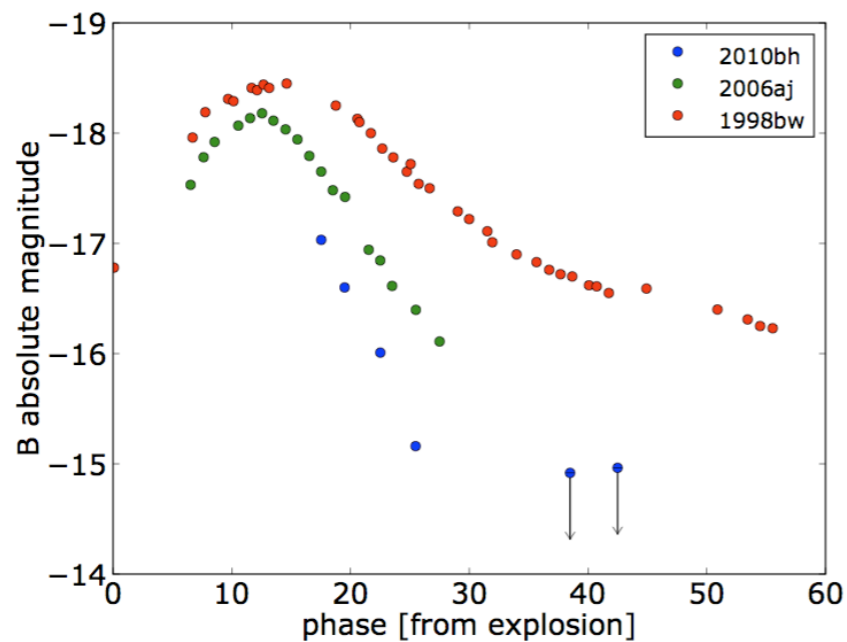
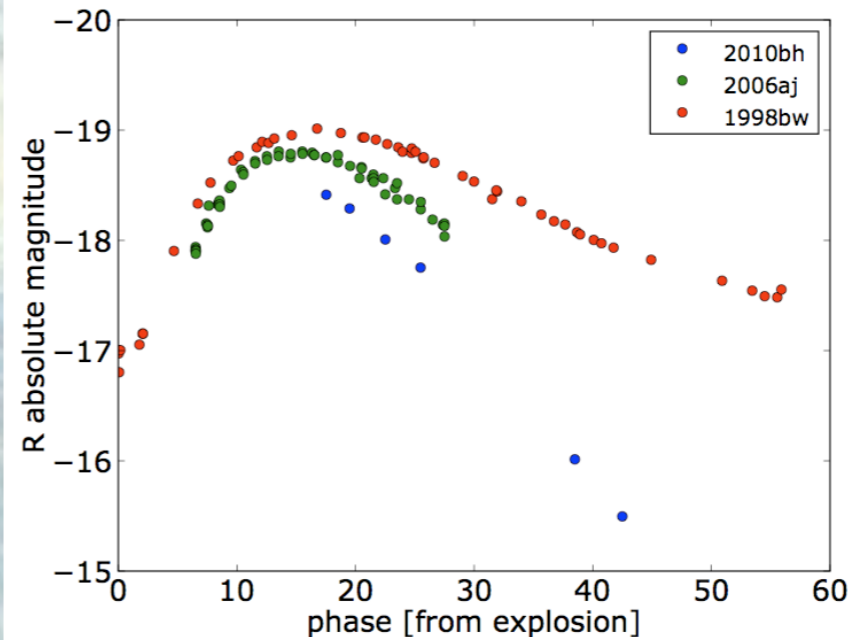
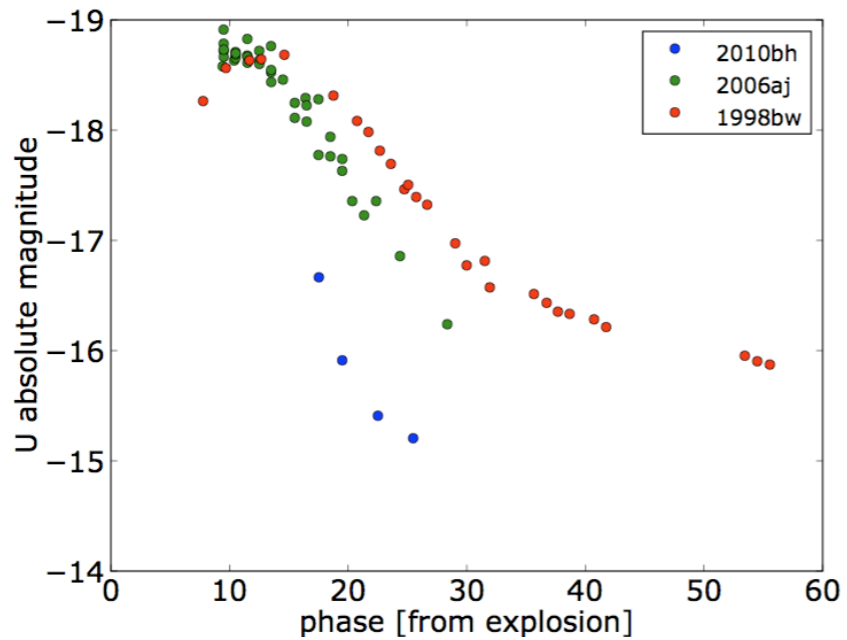
**Brightening broad-lined Ic supernova at *Swift*-XRT position,  
superposed on a bright, nearby host galaxy at  $z = 0.0591 \pm 0.0001$**

**SN peaked at 8-13 days**

**Spectra and images:**

**VLT(*XSHOOTER*, *FORS*), GEMINI, HST.....**

**See also Chornock+10**



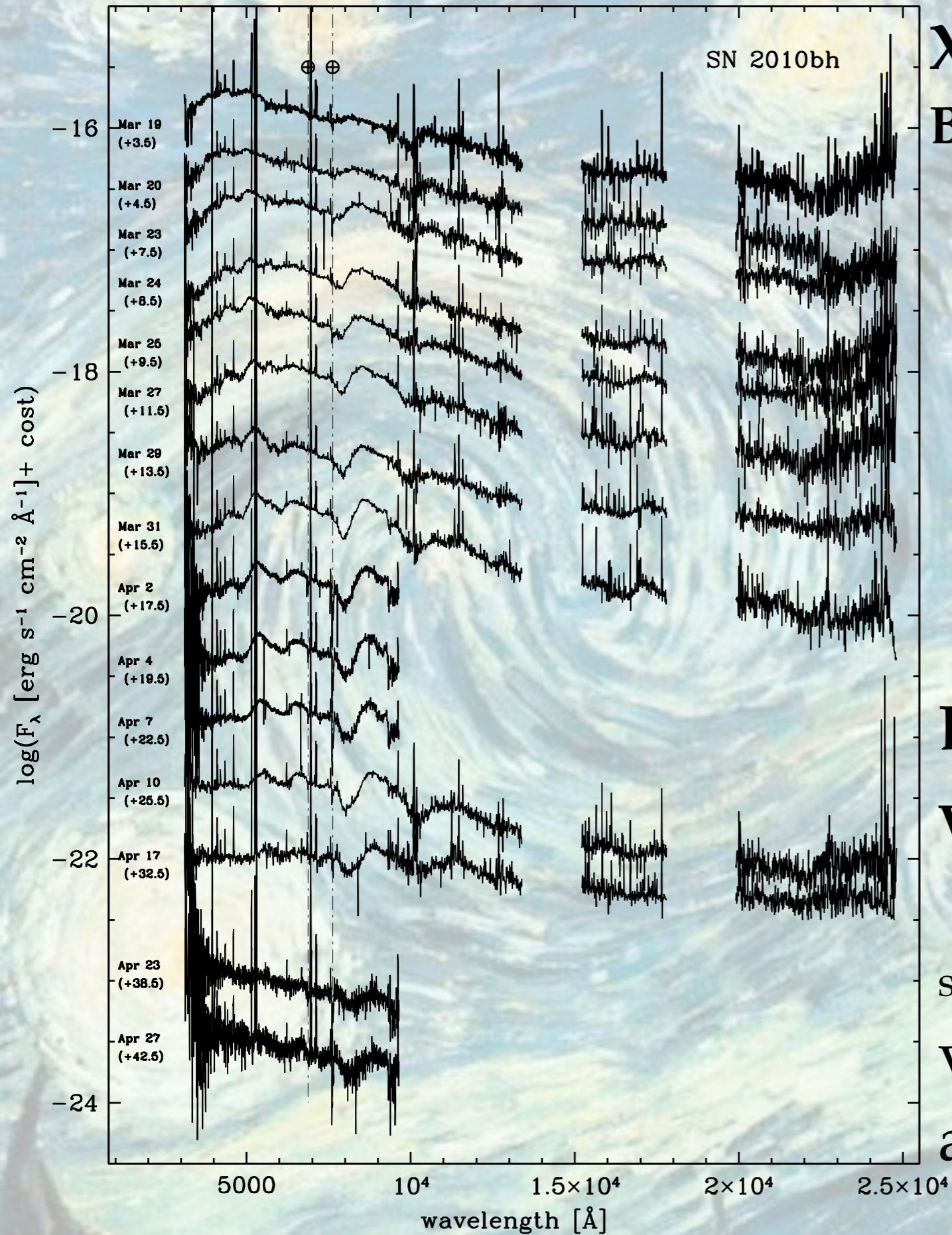
**To be added:  
Prompt + GROND data  
from day 0**

**Bufano et al. in preparation**



# XSHOOTER + FORS spectra

Bufano et al. in preparation



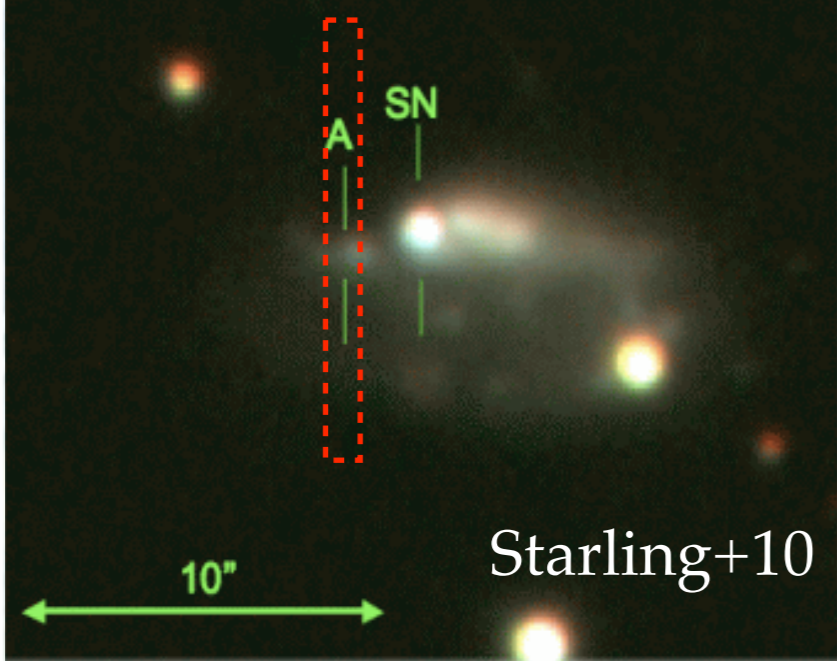
**Lower mass?**

**very high velocity ejecta**

see also Chornock+10 :

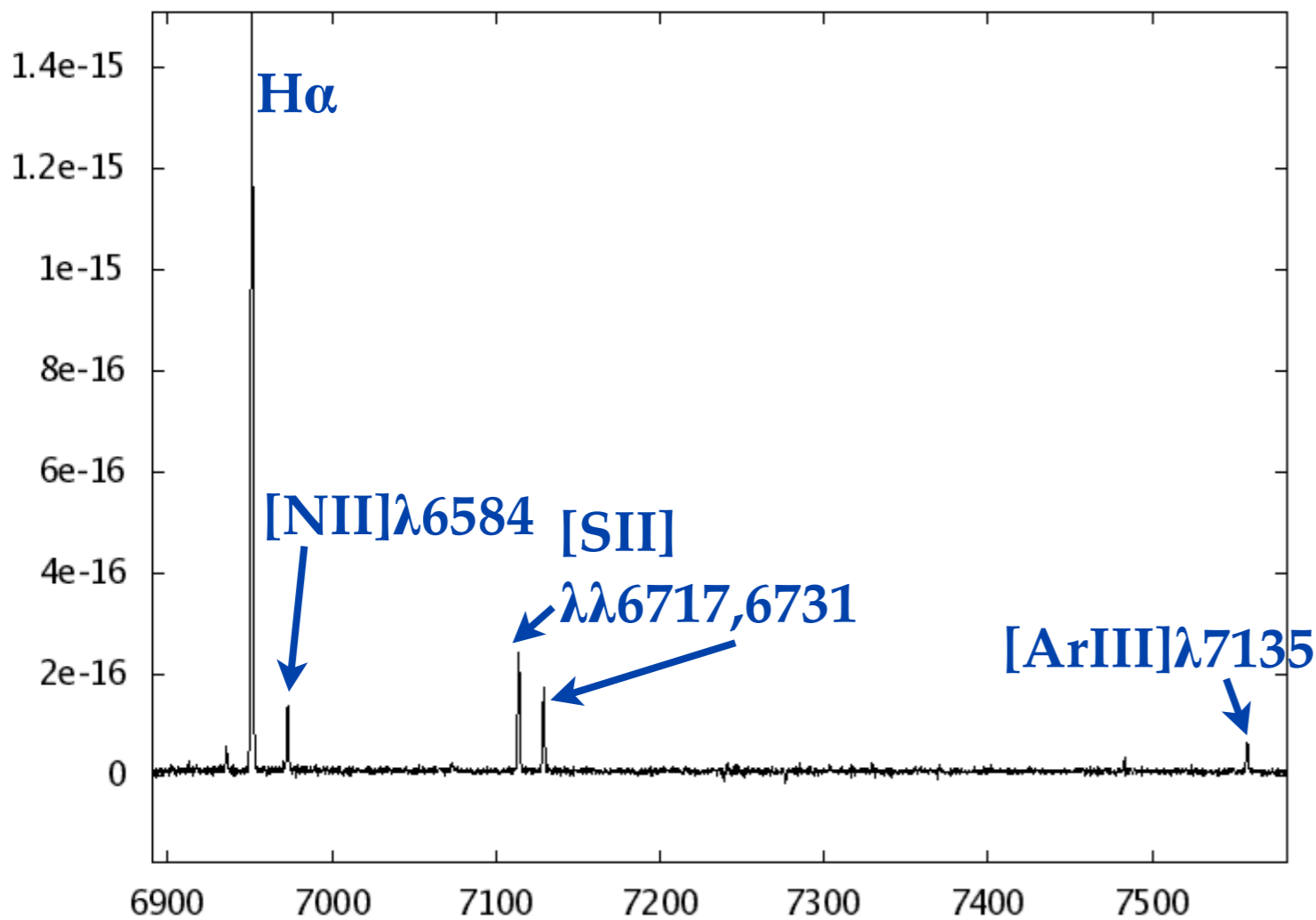
velocity about 30000km/s  
at day 4.3

Bright star-forming host,  
disturbed morphology

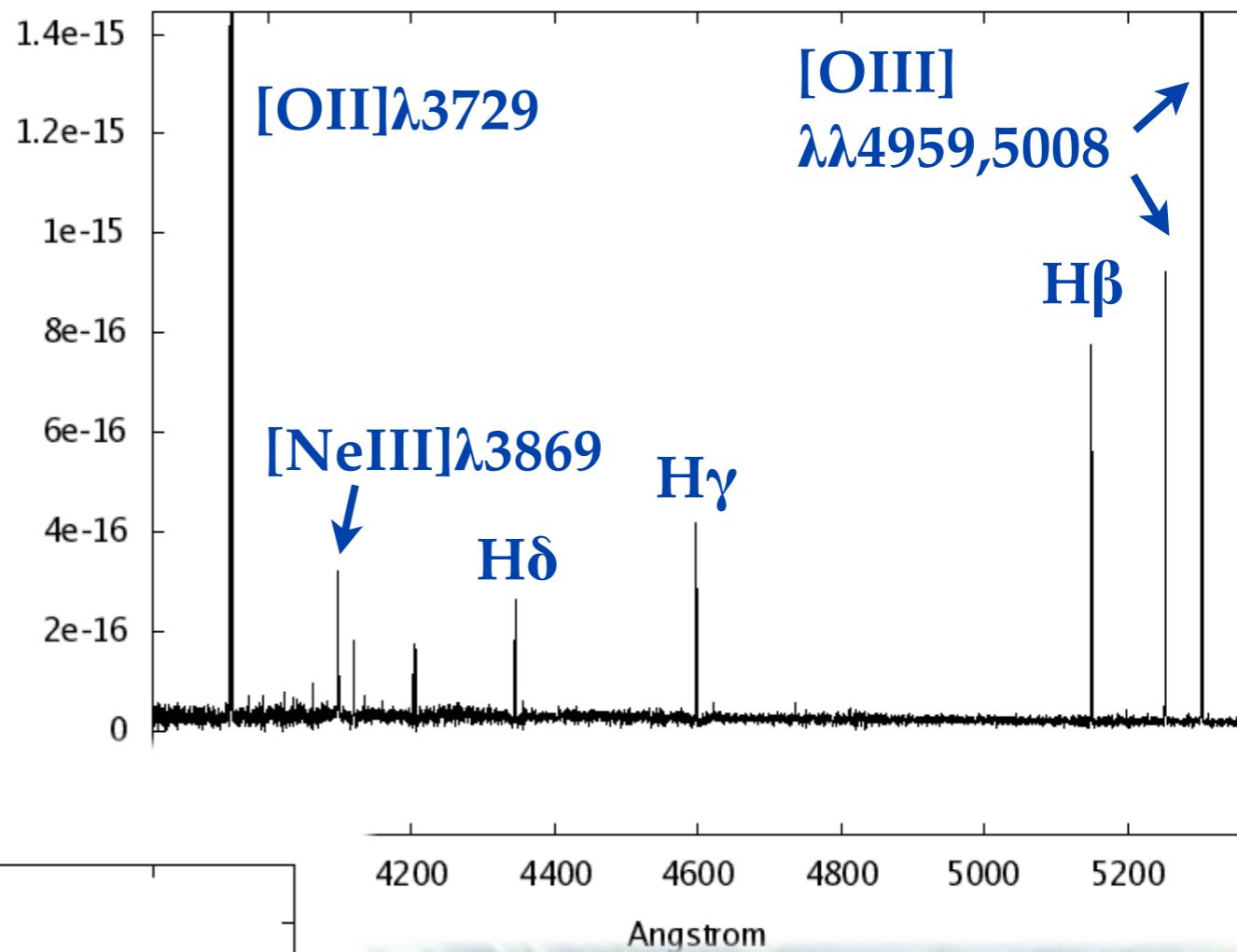


Starling+10

region 'A' VIS

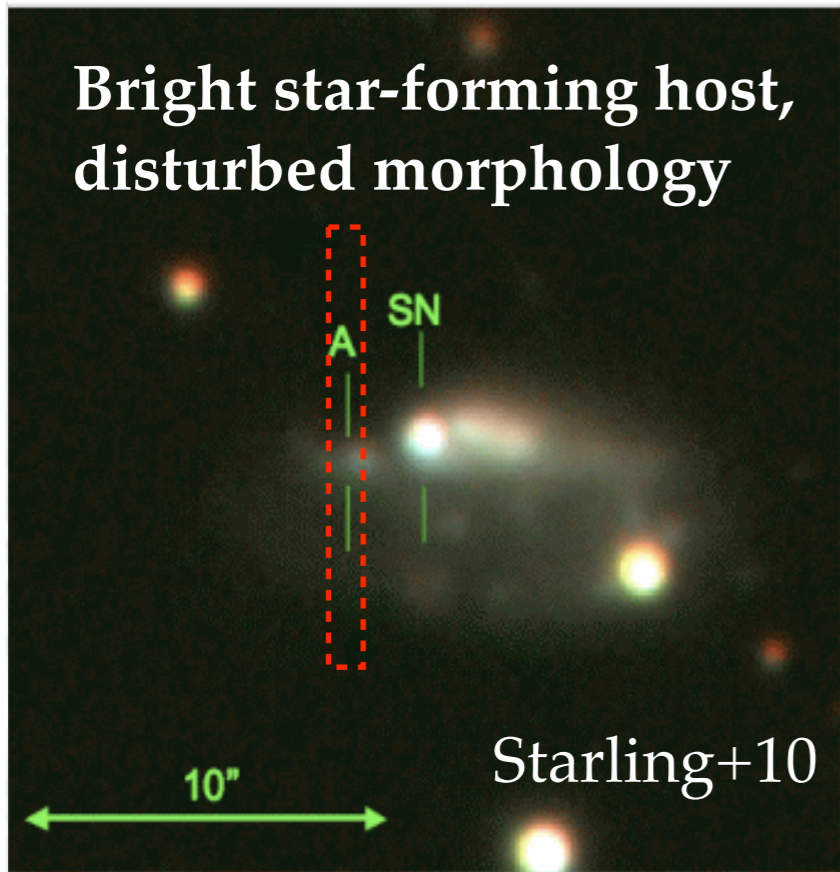


region 'A' UVB



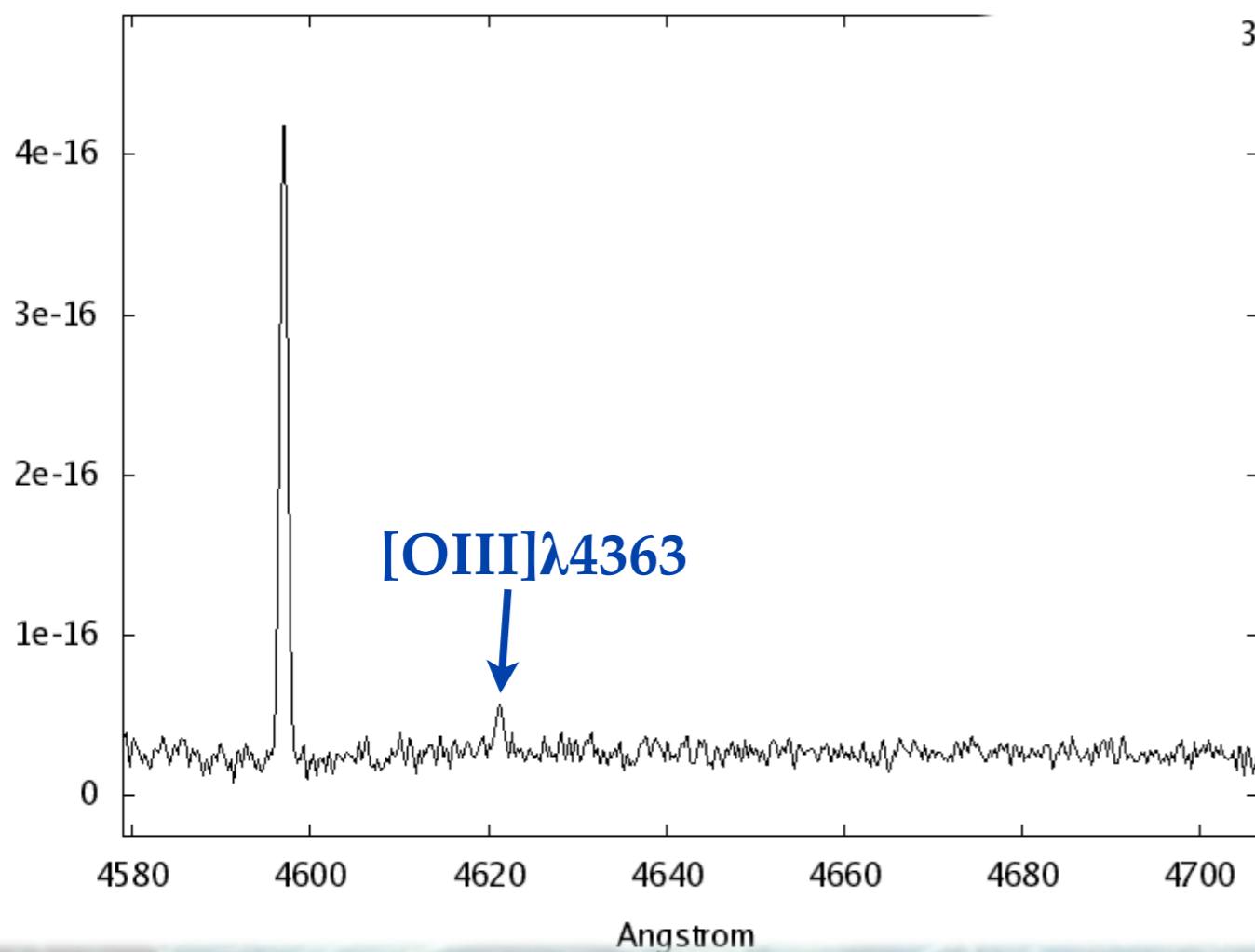
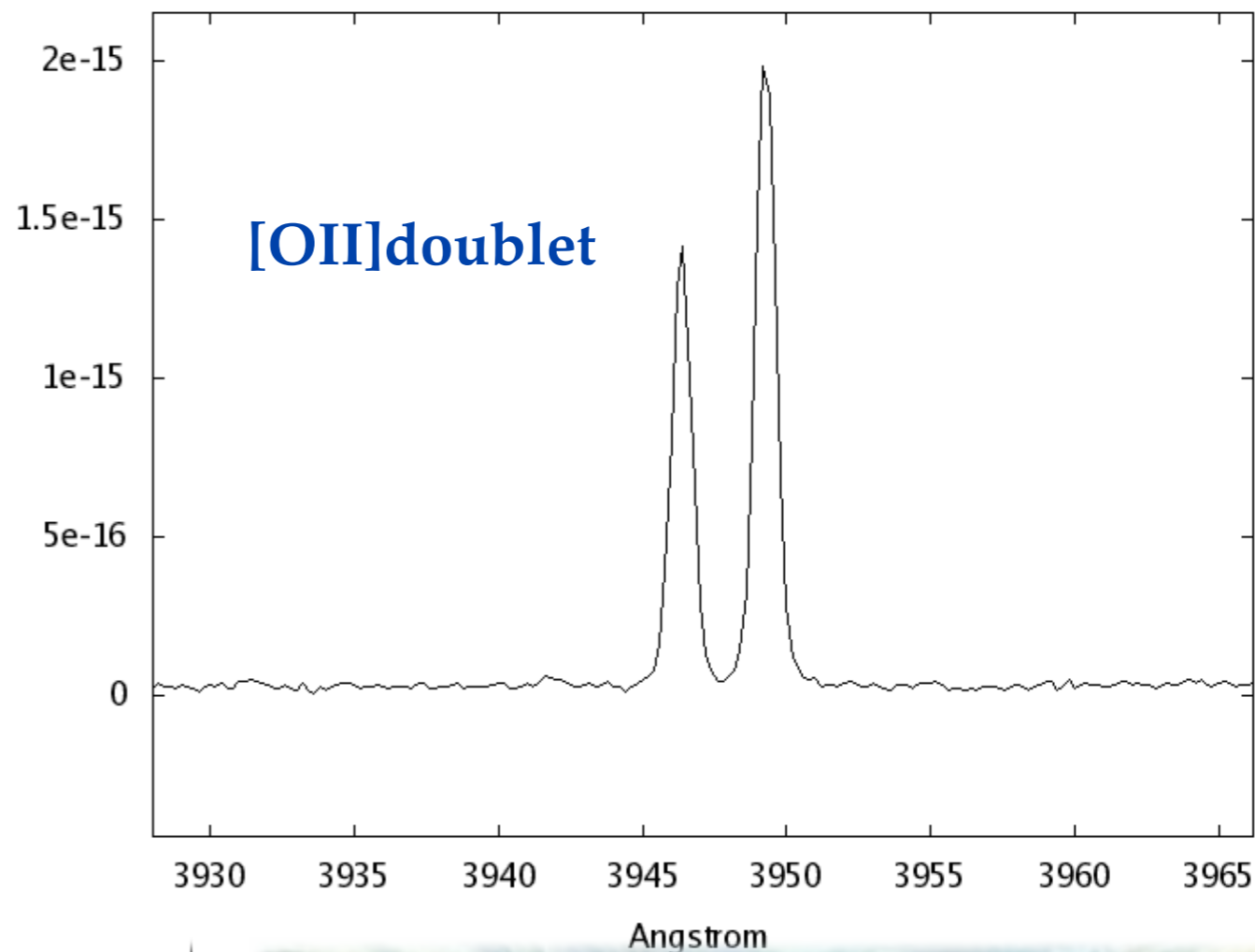
Source 'A' : HII region  
2kpc away from the GRB/SN region

Bright star-forming host,  
disturbed morphology



region 'A' [OIII]4363

region 'A' [OII]3727 doublet



**Region 'A' :**

$n_e = 100 \text{ cm}^{-3}$

Metallicity =  $0.39 Z_{\text{Sun}}$

$12 + \log(\text{O}/\text{H}) = 8.23$

SFR =  $0.17 M_{\text{Sun}}/\text{yr.}$

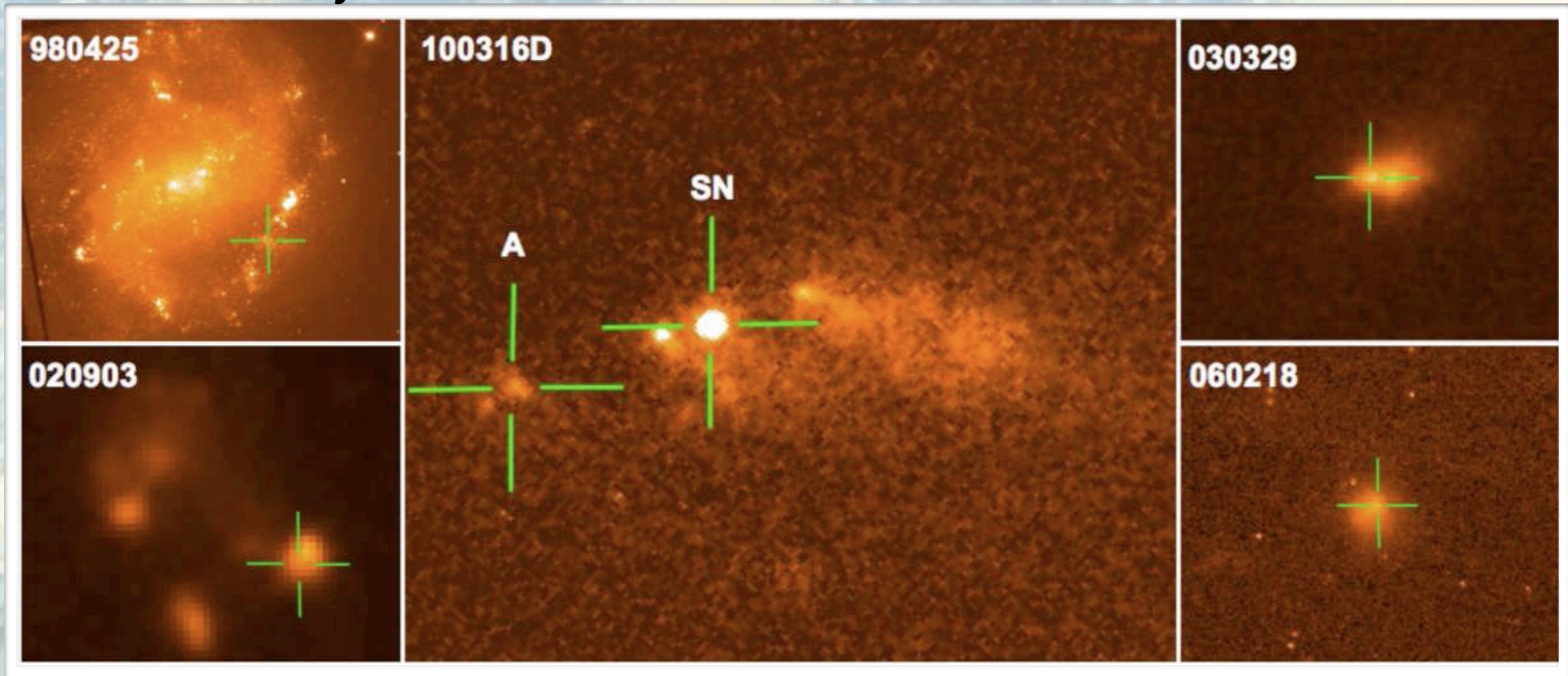
No WR features

See also:

Chornock+10; Bufano+ in prep.;  
Flores+ in prep.

# HST images of host galaxies of GRB-SNe: wide variety of GRB-SN environments

Starling+10



GRB	$T_e$ oxygen abundance ( $12 + \log(\text{O}/\text{H})$ )	Host type	Absolute magnitude $M_B$
980425	8.25 (GRB site) 8.39 (nearby WR region)	Dwarf spiral	-17.6
020903	7.97	Irr	-18.8
030329	7.72	Irr	-16.5
031203	$8.02 \pm 0.15$ (integrated)	Irr	-21.0
060218	$7.54^{+0.16}_{-0.1}$ (integrated)	Irr	-15.9
100316D	$8.23 \pm 0.15$ (source A)	Spiral? Irr?	$\sim -19$

**X- and  $\gamma$ -ray properties of 100316D/SN2010bh similar to 060218/SN2006aj,  
but NOT its host properties**

## Summary and future work

We have found a new GRB-SN!

- important addition to the current sparse sample
- nearby with Type Ic (spectroscopic) SN

Host bright, blue, disturbed spiral(?), irr(?), metallicity 0.4 Solar  
Possibly undergone recent merger?

Analysis of the SN spectra and the SN-HII region properties on going.  
IFU observations of the host planned

GRB early emission well sampled at high energies: subenergetic event  
with unusually long duration and soft spectrum incl. thermal component  
→ high energy properties akin to GRB 060218 (SN2006aj).

May share a common different progenitor type?

GRB 100316D and GRB 060218 stand out among GRB-SN events in their X-ray properties

Like GRB 060218:  
long duration,  
low energy spectral peak,  
thermal component,  
nearby

