Supernovae and GRB

Explosions with ELT

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SNe and GRB

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SNe are fundamental elements:

1. Dominate the chemical evolution of the universe
2. Dynamics of ISM
3. Feedback during galaxy formation
4. Dust production at high redshift
5. Both CC and Ia are important cosmological probes

GRB: most luminous objects in the universe for a few hours/days

Observationally

- Very bright
- Very common

E-ELT role:

- Collecting area
- Spatial resolution: point sources

SNe and GRB

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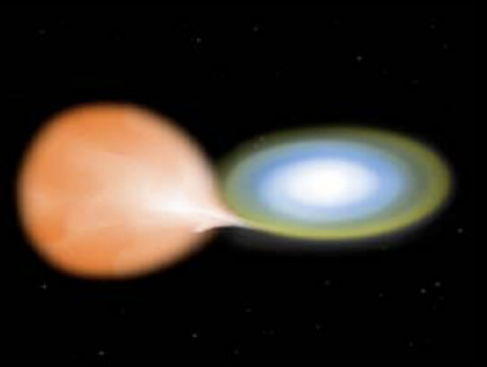
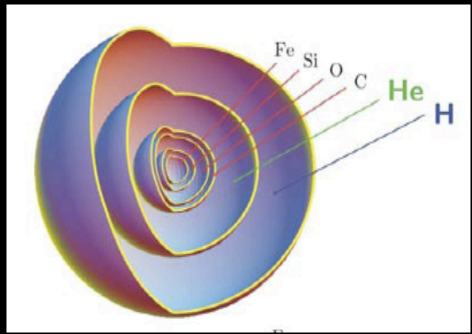
SN Ia



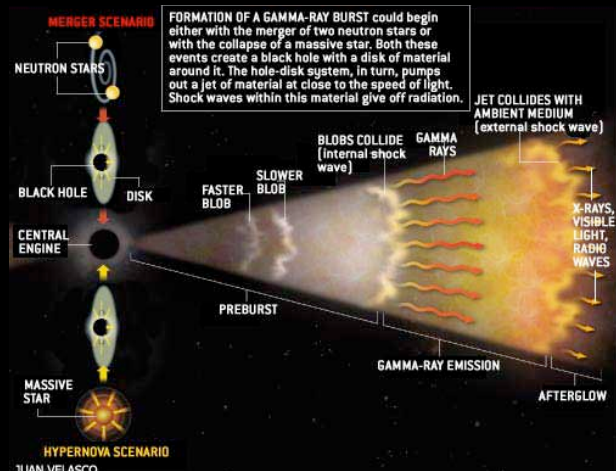
- thermonuclear explosion of a WD in a binary system
- both young and old progenitors
- good “standard candles”: cosmology

SN CC



- massive stars (M>8M☉)
- prop. to SFR
- recent “standard candle”: cosmology

GRB



- relativistic jet
- very bright for a few hours
- very high redshif

Scientific topics

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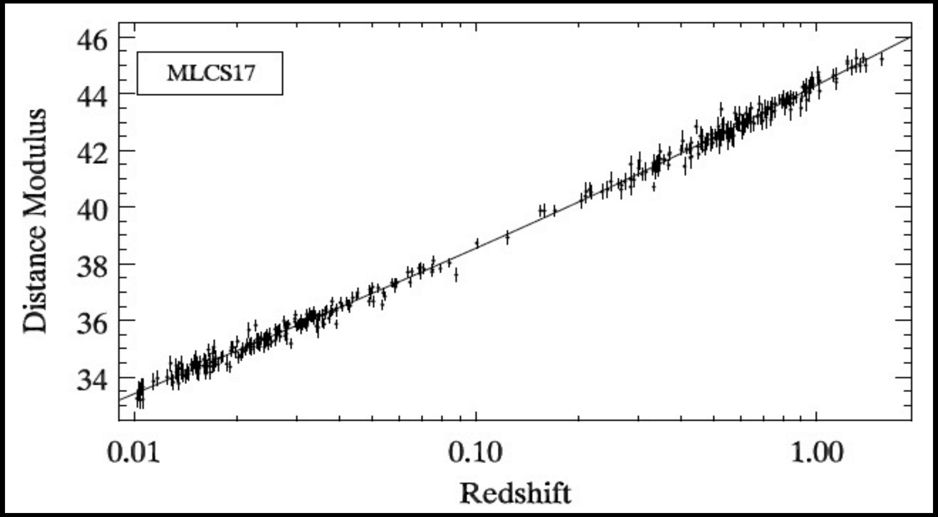
What I'll present::

1. Ia as cosmological probes
2. CC as cosmological probes
3. SFH from the rate of CC
4. Progenitors of Ia
5. High-z GRBs

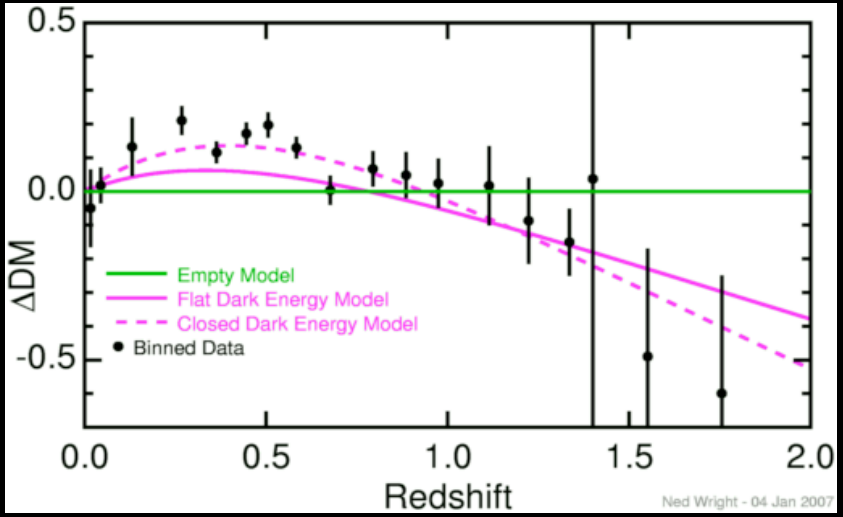
What I won't present

1. Dust enshrouded SNe in starburst galaxies
2. PP SNe from Pop III stars
3. Shock-breakouts
4. All the possible studies about physics and properties of SNe and GRB

Cosmology with ELT



Hicken et al 2009



Wright 2009

- Ia Sne: direct probes of cosmological parameters
- very good data up to z~1
- well known probes

Cosmology with ELT and JWST

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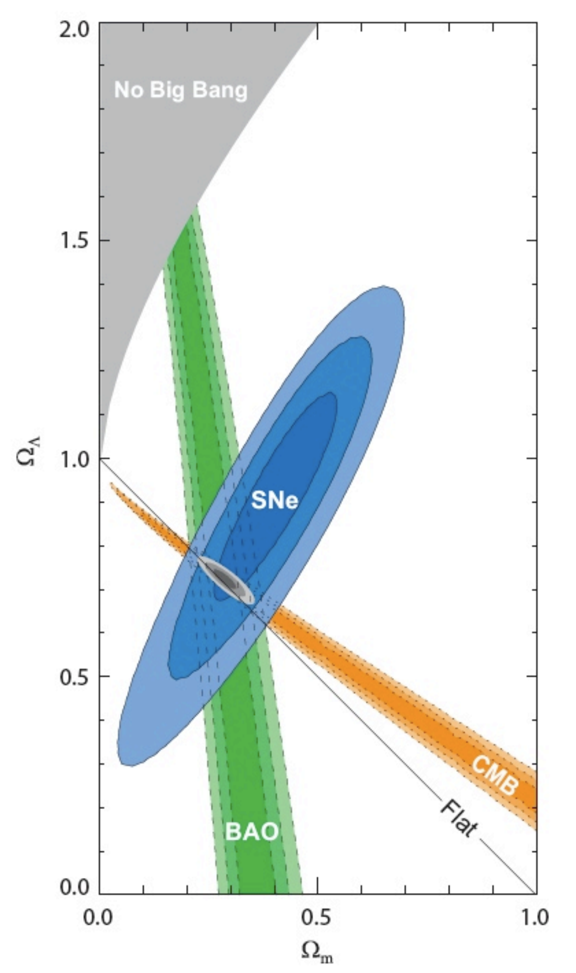
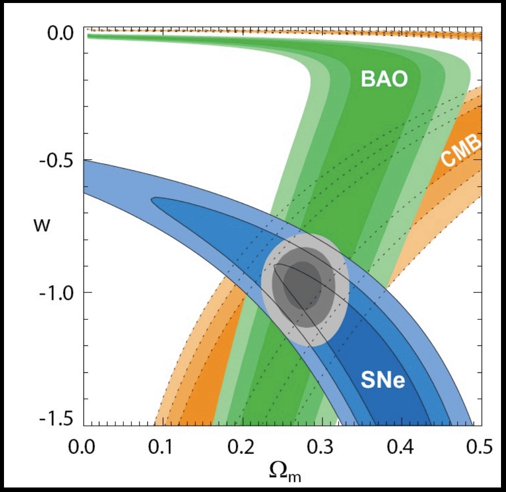


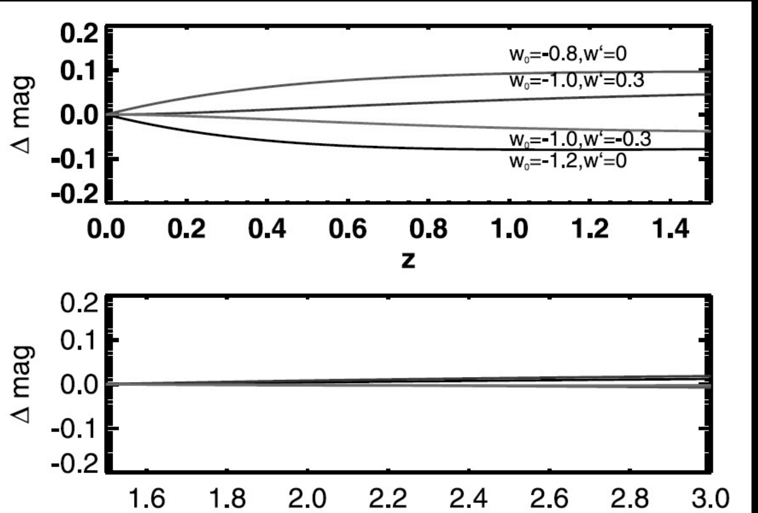
Kowalski et al 2008



Better and at higher redshifts:

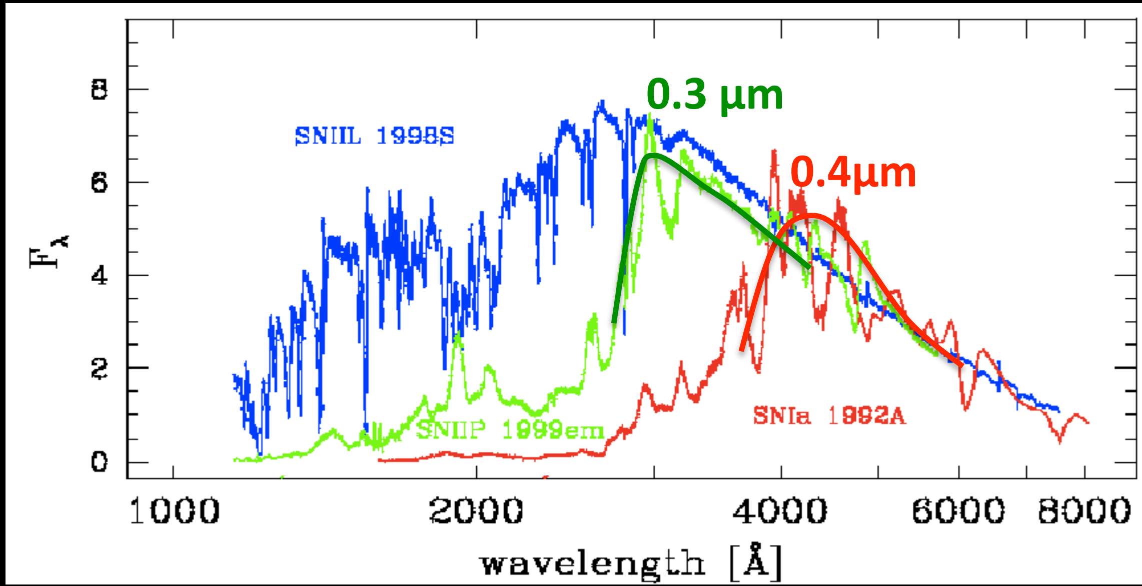
- $w \sim P/\rho$ dw/dt ? Nature of dark energy
- Why $\Omega_\Lambda \cong \Omega_m$?

- evolution



Riess & Livio 06

SNe



Filter	Ia	
	z	ABmag
J	1.7	25.2
H	2.8	26.1
K	4.0	26.7

The role of E-ELT

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Instrument	FoV	AB Limit 10σ, 10^4 sec	z max (Δm=+1)	Vol (z>1) $kMpc^3$/fld	Ia/field/year (η=1)
MICADO + MCAO 3 mas	1'x1'	J= 29.2	z<2.7	5	0.5
		K=29.2	z<4.6	12	1.1
JWST/NIRCAM	2'x4'	K=29.0	z=4.6	95	8.5
VLT + GLAO		K=24.7			
Extremely Wide Field Imager?					
EUEWFI + GLAO 70 mas 1 det	5'x5'	J=27.0	z<2.1	85	7.8
		K=26.5	z<2.0	76	6.9
EUEWFI + sMCAO 30 mas 4 det	5'x5'	J=28.0	z<2.5	120	11.0
		K=28.0	z<4.0	250	22.5

Limits: MICADO: 5mas pix, 3x3 GLAO: 50mas pix, 5x5 EU: 10 mas/pix, 5x5

Finding SNe requires large fields and good PSFs -> Better from space...
... but possible from the ground too

GENERAL QUESTION: JWST: 2014+5 yr E-ELT=2018 .....
Who will provide new targets at the ELT spectroscopic limit after 2020?

The role of E-ELT

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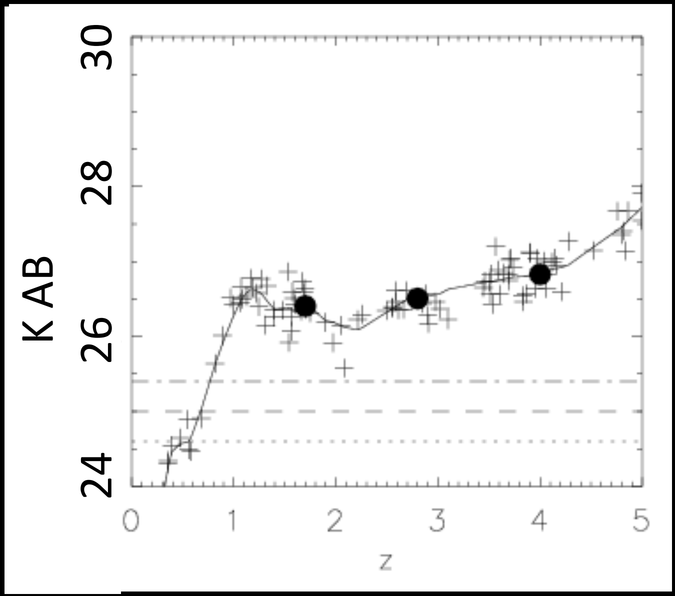
Instrument	band	R	AB Limit 10σ 10^4 sec	z max (Δm=0)
JWST/NIRSPEC	J	1000	24.1	z<0.9
	K	1000	24.2	z<0.6
HARMONI	J	1000	26.6	z<2.6
	K	1000	26.2	z<2.8

Limits: aper=15mas LTAO



Cosmology with E-ELT

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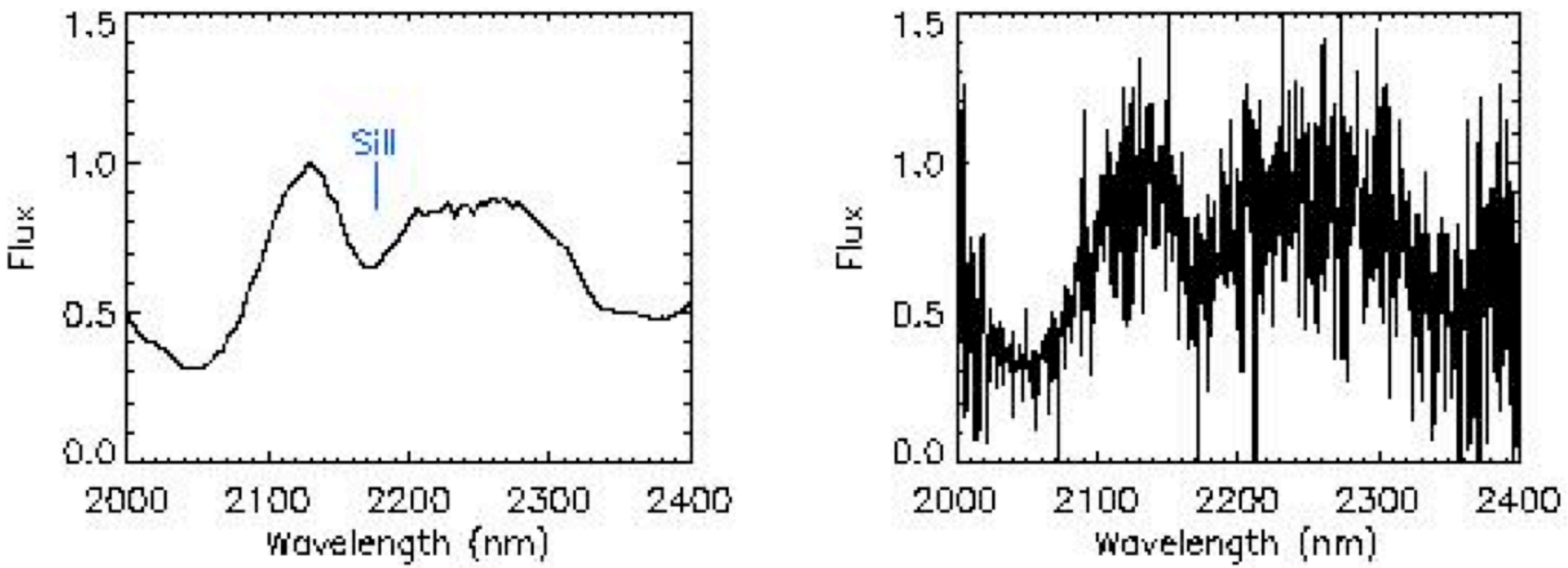

I. Hook: HARMONY science cases 8h, z=4.4 K=24.7

Instrument requirement:
- LTAO
- R~5000 for OH software masking or R~500 with OH suppressor

Strategy

1. JWST to monitor ~10 fields every ~30d for 2 yr -> 50 SNe (considering det. eff.)
2. HARMONI or EAGLE to obtain spectroscopy

Cosmology with ELT and JWST

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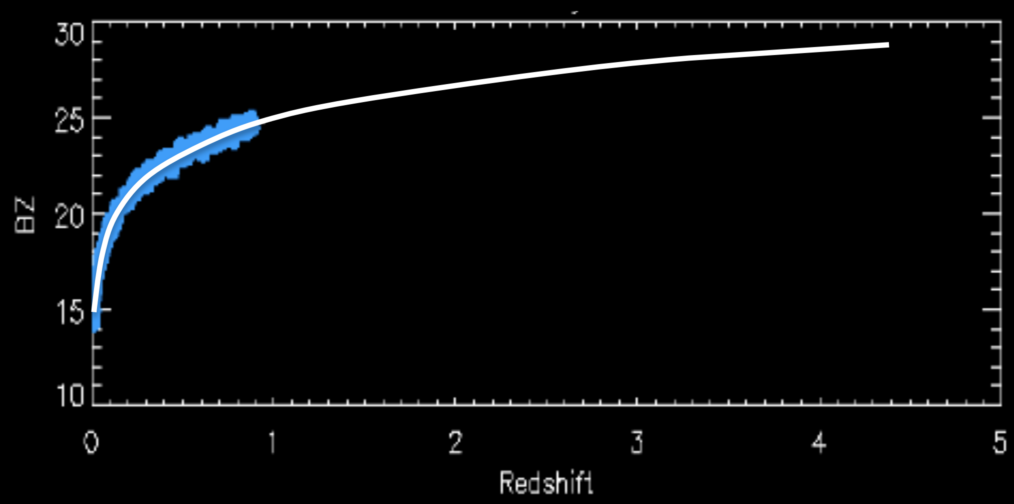
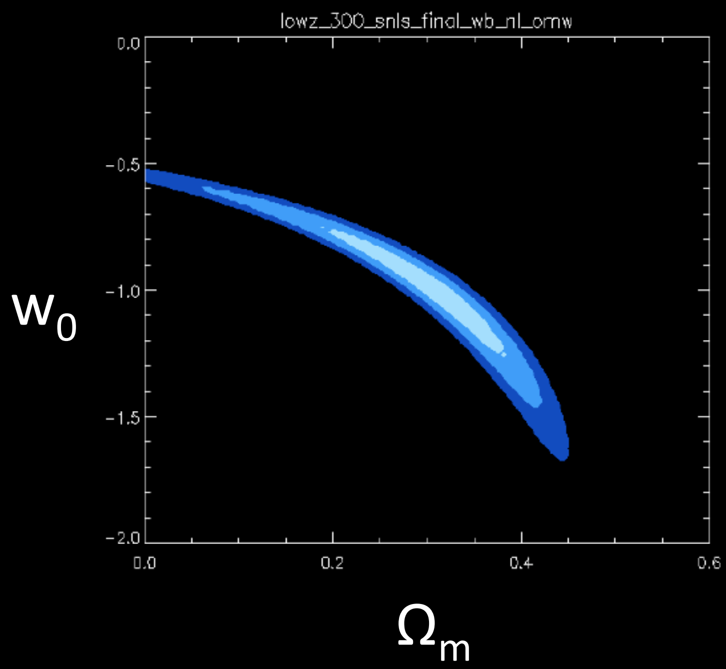
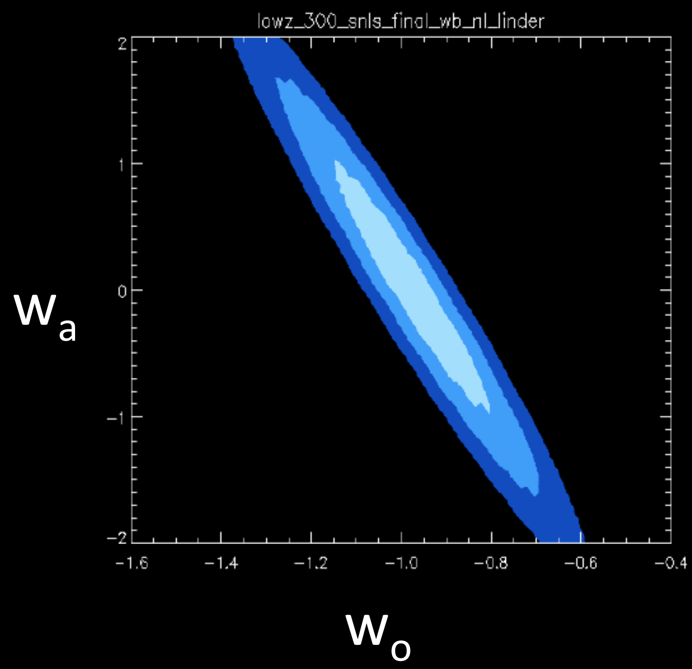


300 low-z +
500 SNLS +
50 ELT

Systematic errors
and evolution





Cosmology with ELT and JWST

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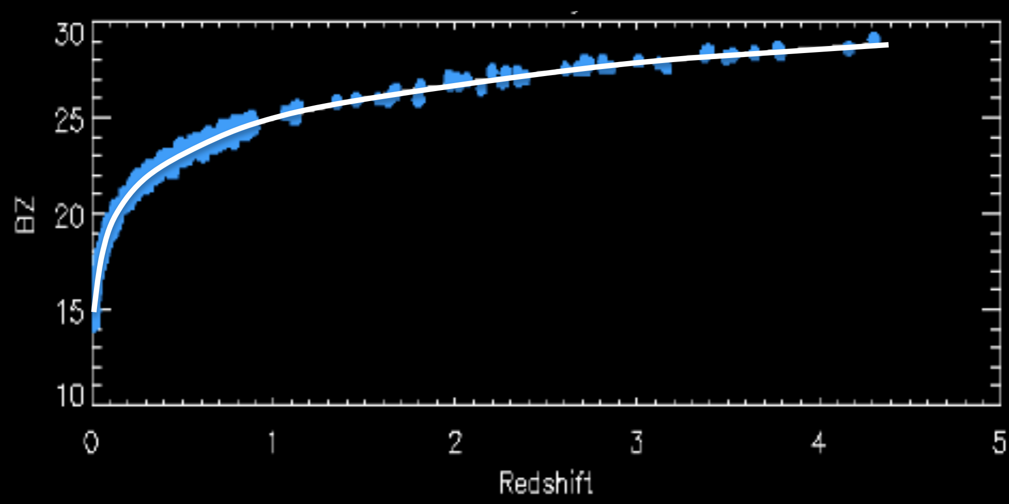
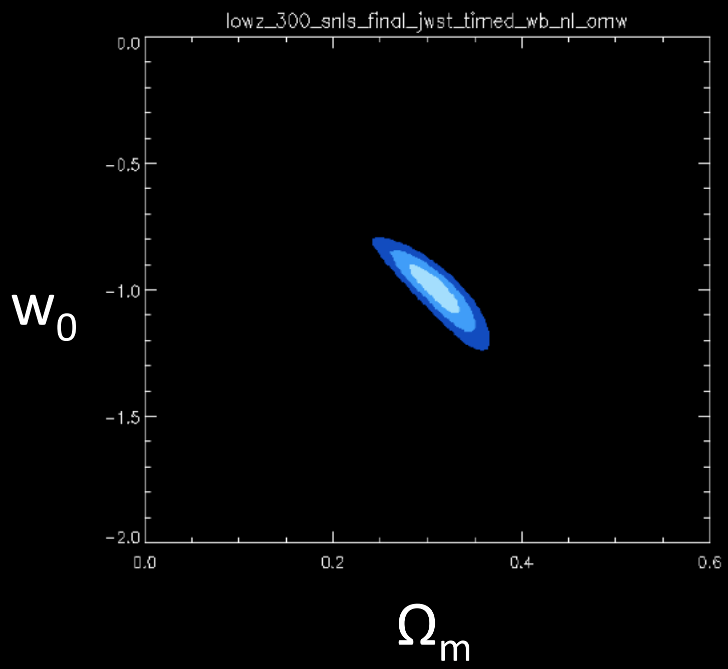
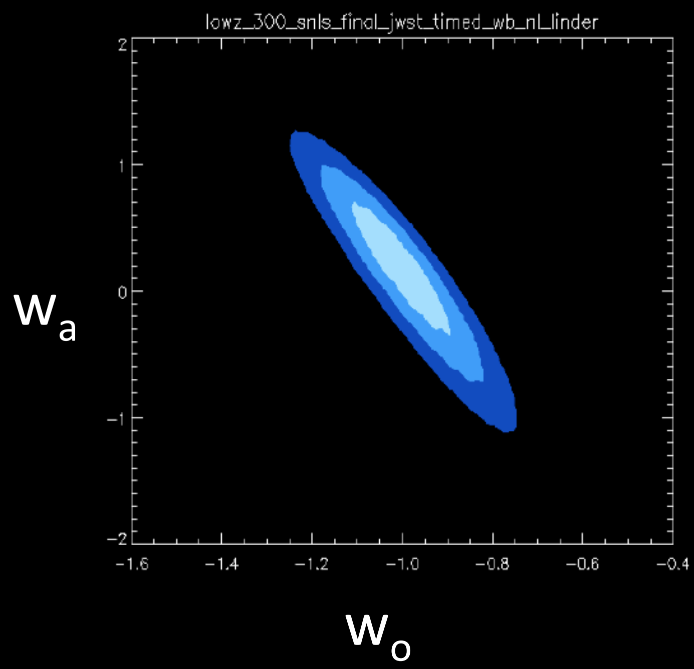


300 low-z +
500 SNLS +
50 ELT

Systematic errors
and evolution





Systematics on Ia SNe

- Many incoming projects at low and intermediate redshifts
- 1000s of low-z SNe per year
- Multi-dimensional data cubes: expansion velocity, luminosity, host type, host metallicity, environment, color, redshift, asphericity…

Substantial improvement is expected before E-ELT

Cosmology with CC

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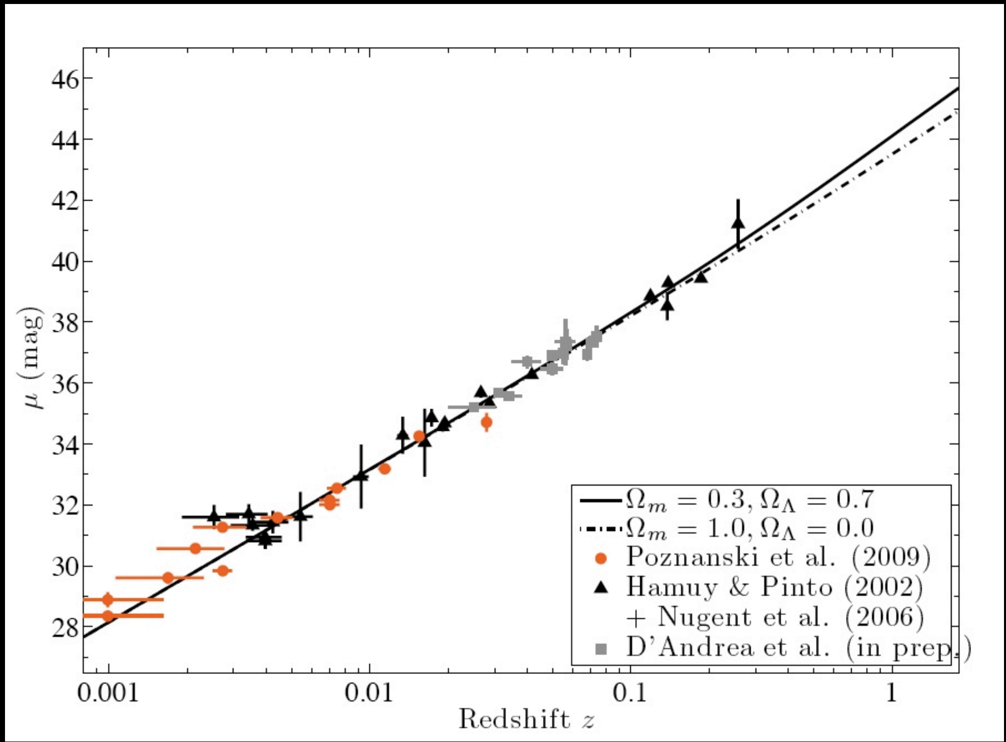

Poznanski et al 2009

Type II-P
- Red supergiants
- fainter than Ia
- much more common

- H-rich, optically thick expanding envelope

Cosmology
- estimate intrinsic size and luminosity

- Completely different systematics w.r.t type Ia: independent probe

ELT: spectroscopy of type IIP at plateau up to z~2

SFH from CC
- Short CC lifetimes < 50 Myr -> instantaneous SFR
- CC SNe: 8<M⊙<12, while Ionizing photons: M>30M⊙ -> less dependent of the high-mass end of the IMF

Properties of type Ia progenitors

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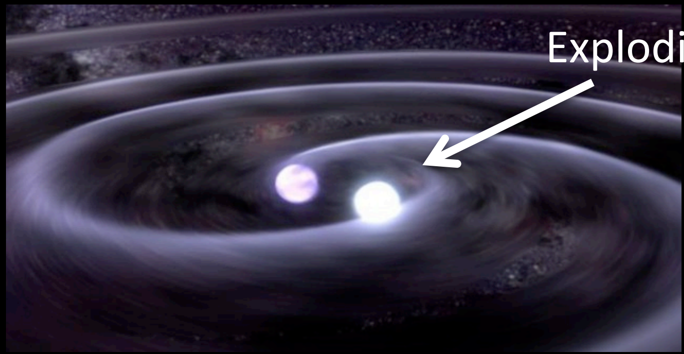
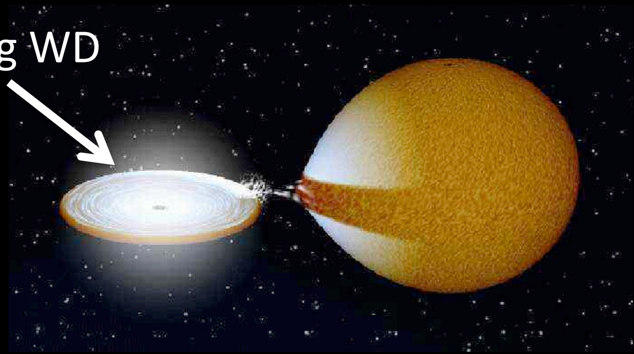
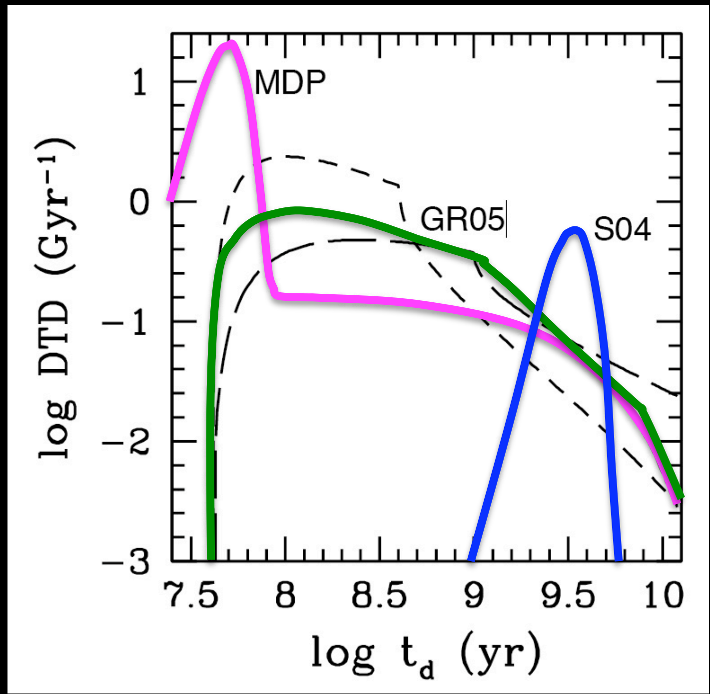


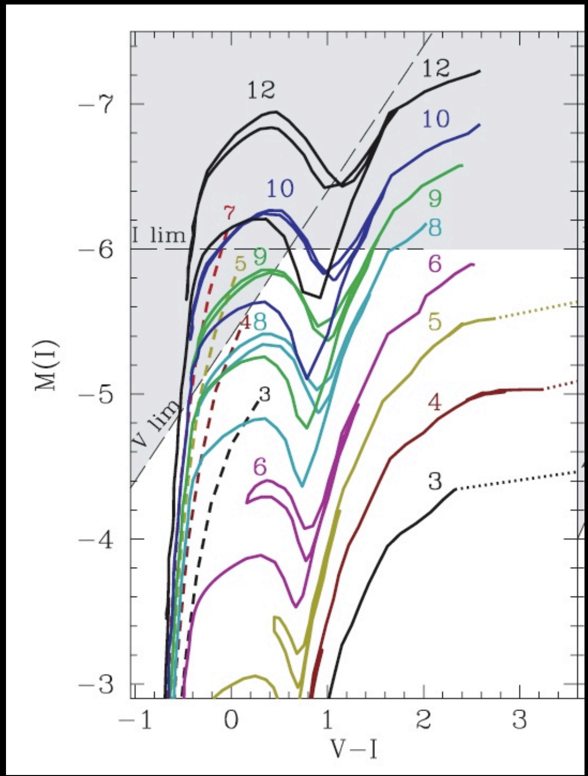


Different progenitors -> Different delay time distributions (DTD)

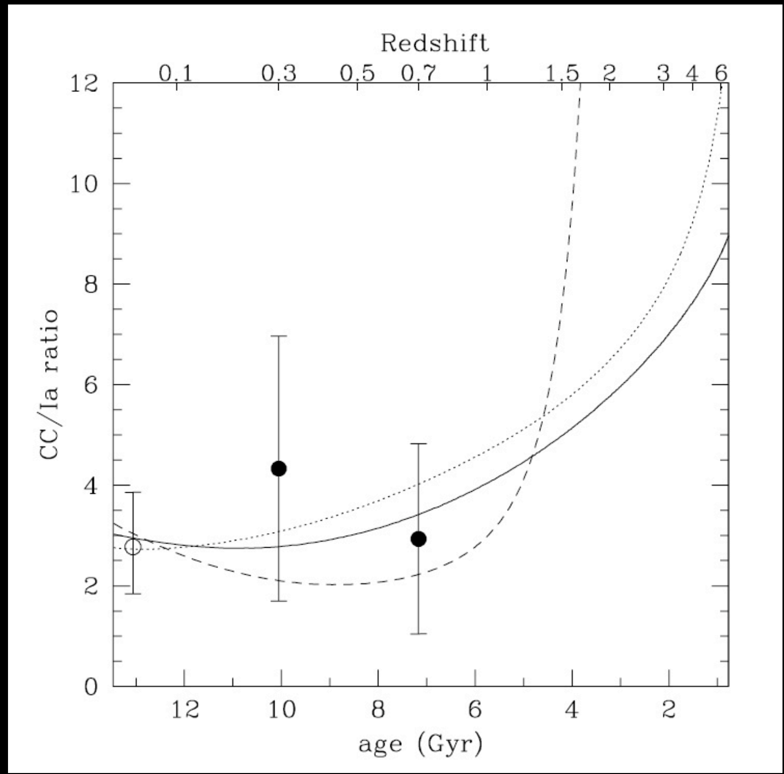
1. Single gaussians
2. Bymodal
3. smooth



Properties of type Ia progenitors



Maoz & Mannucci 2008



Mannucci et al 2006

- RGB companions up to ~ 10Mpc
- SG, UMS?
- Spectroscopy, imagining?
- pre-post images?

(Simulations needed)

Varying CC/Ia rate ratio

GRBs before reionization

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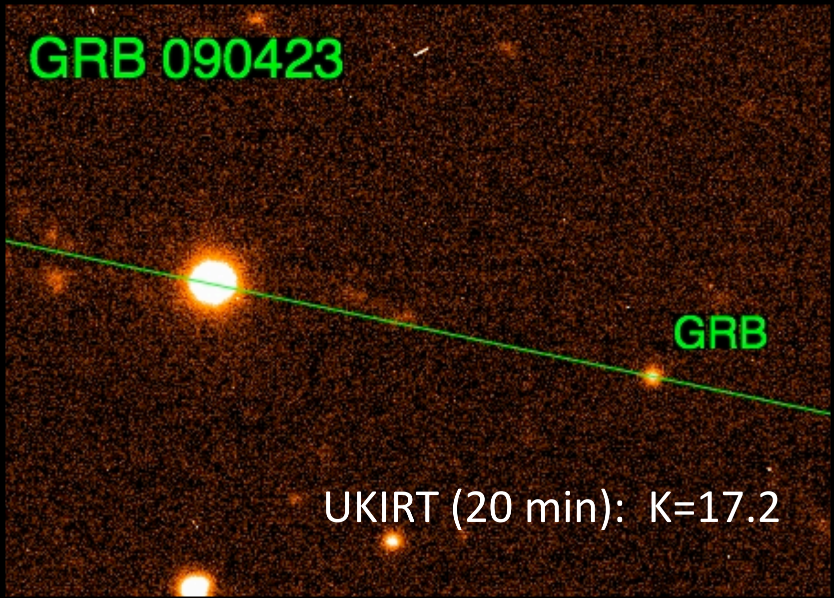
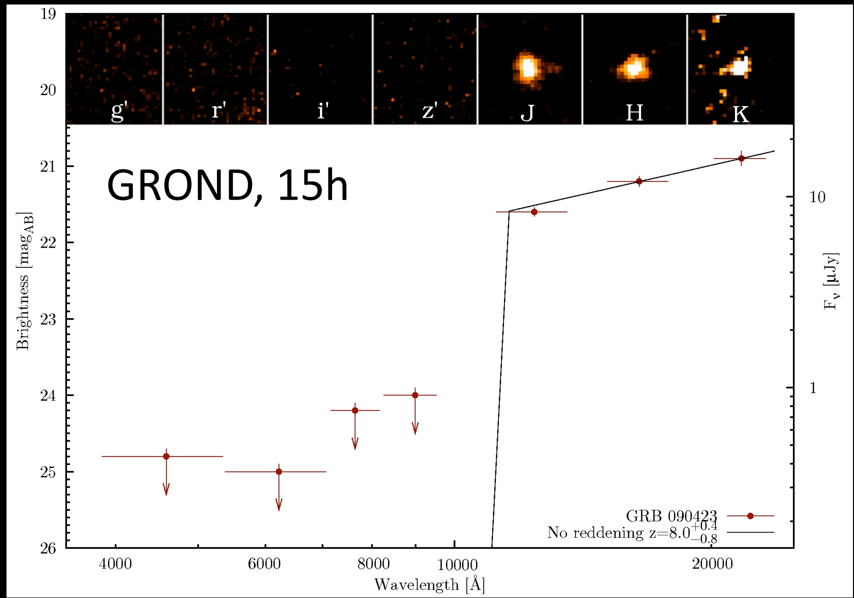
- GRB09423 z=8.1 !





GRBs before reionization

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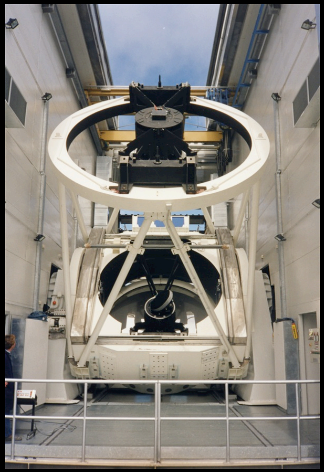

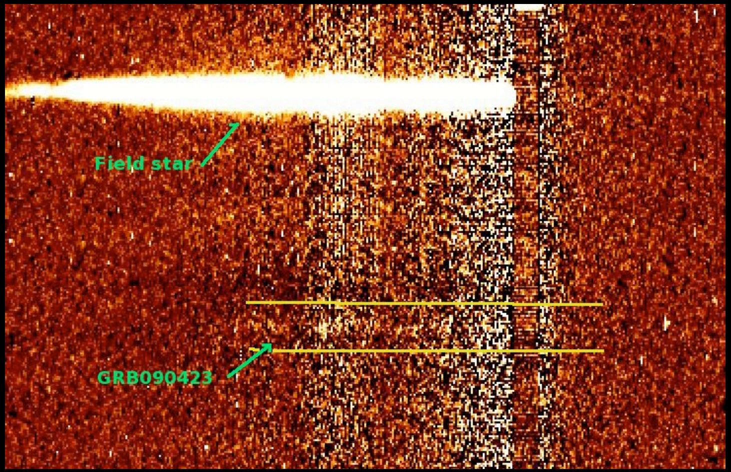

GRBs before reionization

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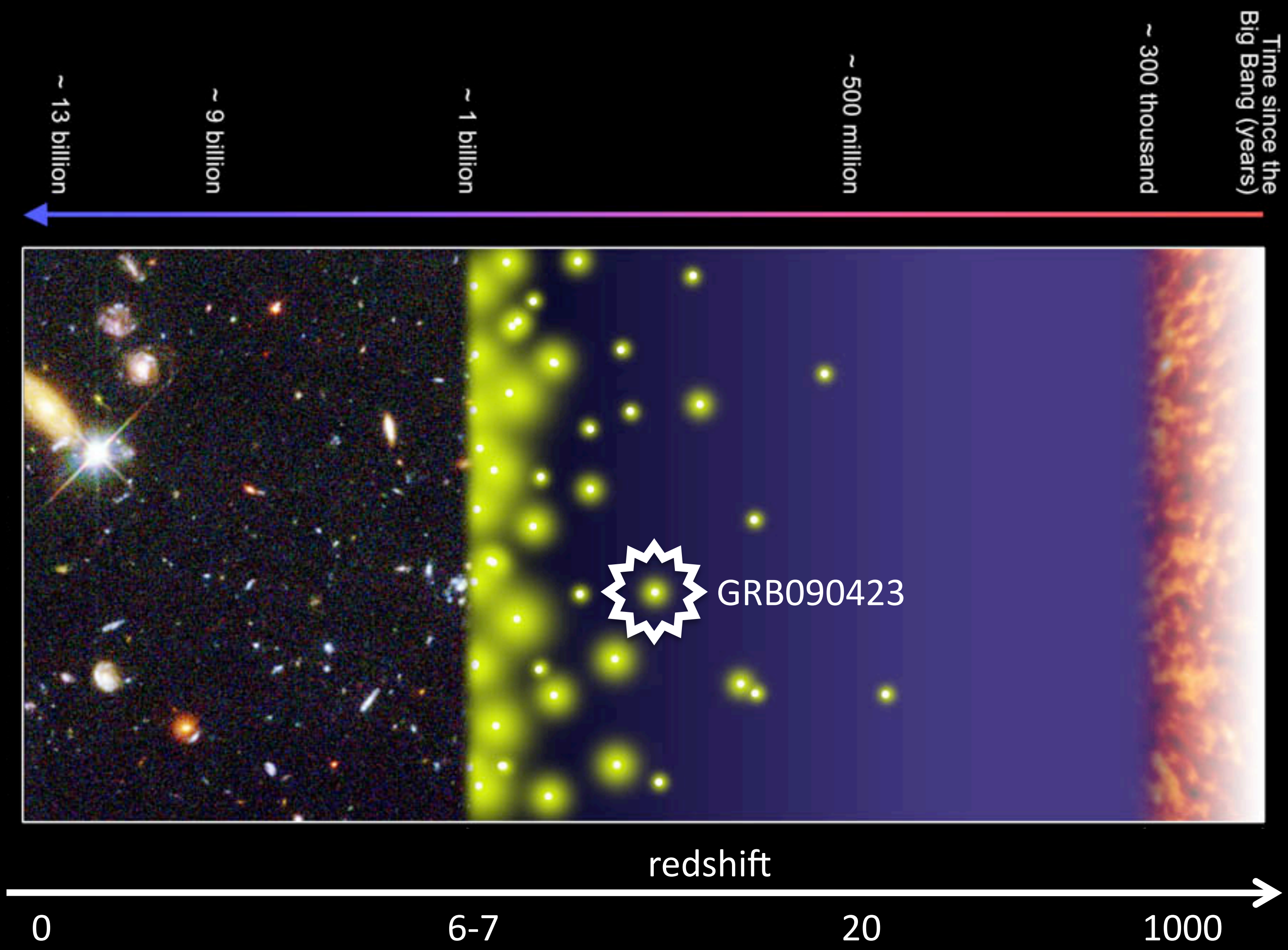
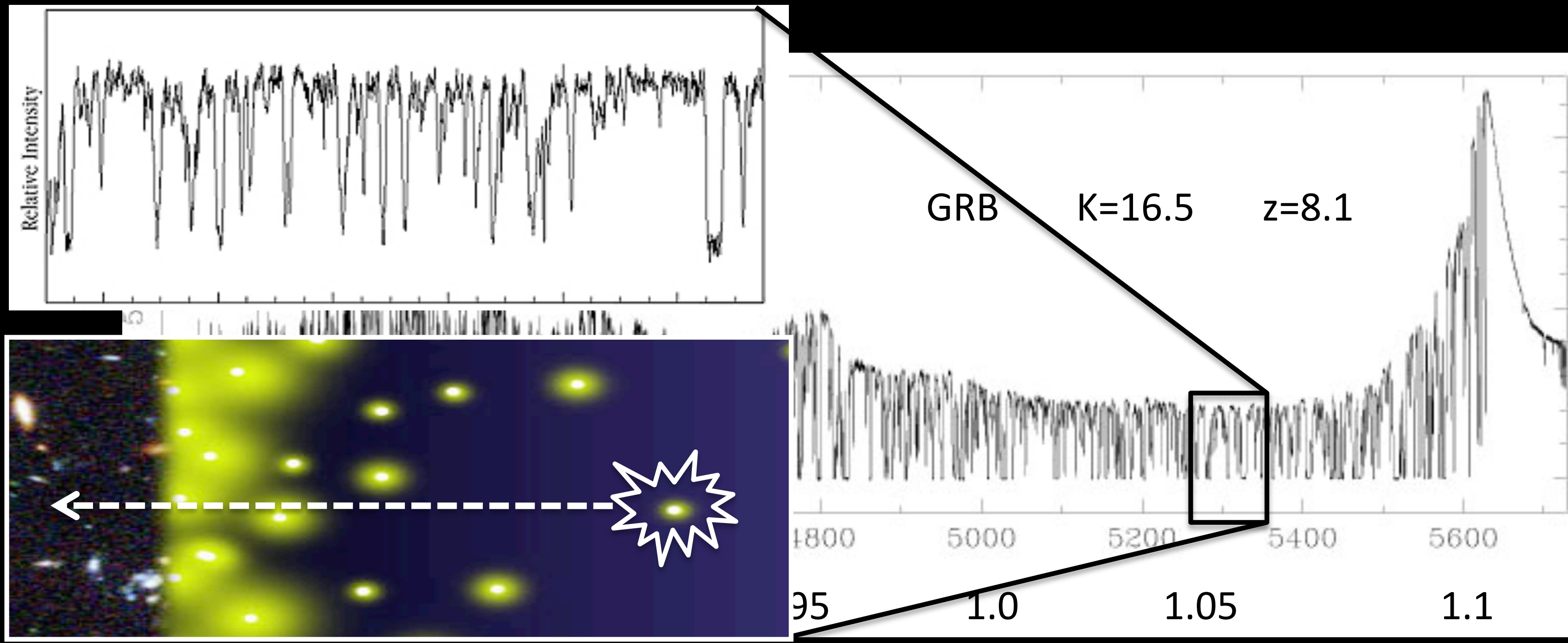


GRB before reionization



SIMPLE spectrum:

R=100.000
K=17.2
T=2h
} SNR=100/element

GRBs

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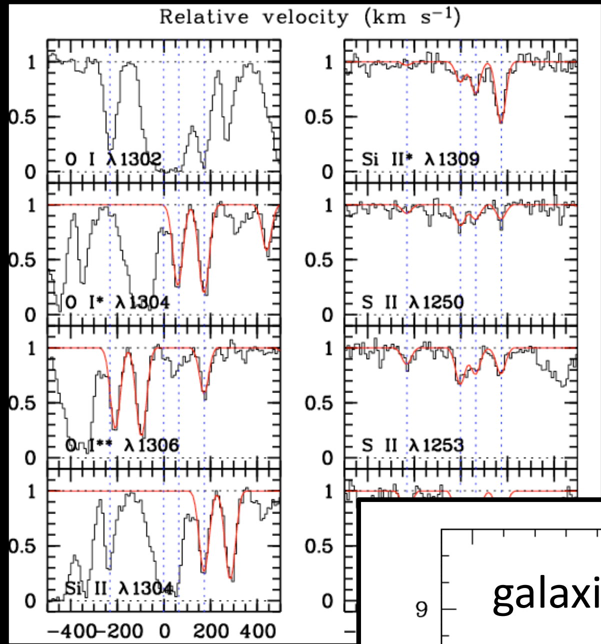
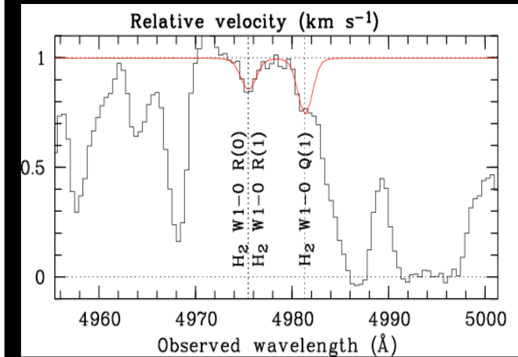
Metallicity evolution, abundance ratios

- metal-rich GRB environment
- metal-poor intervening systems
- signature of Pop III stars
- dust content (Zn/Fe)

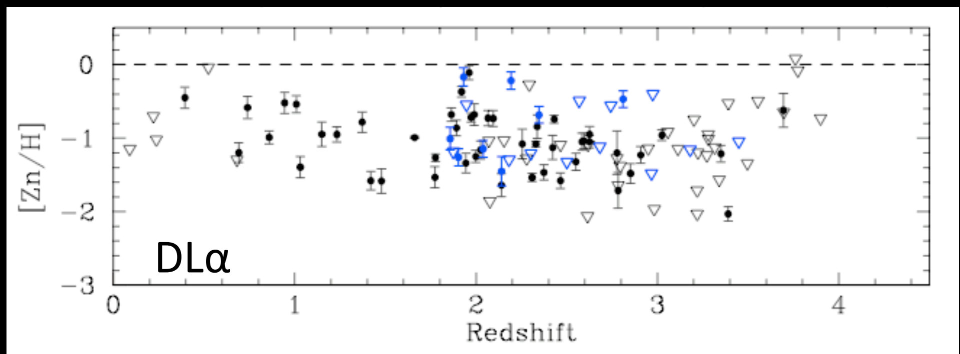
Requires:

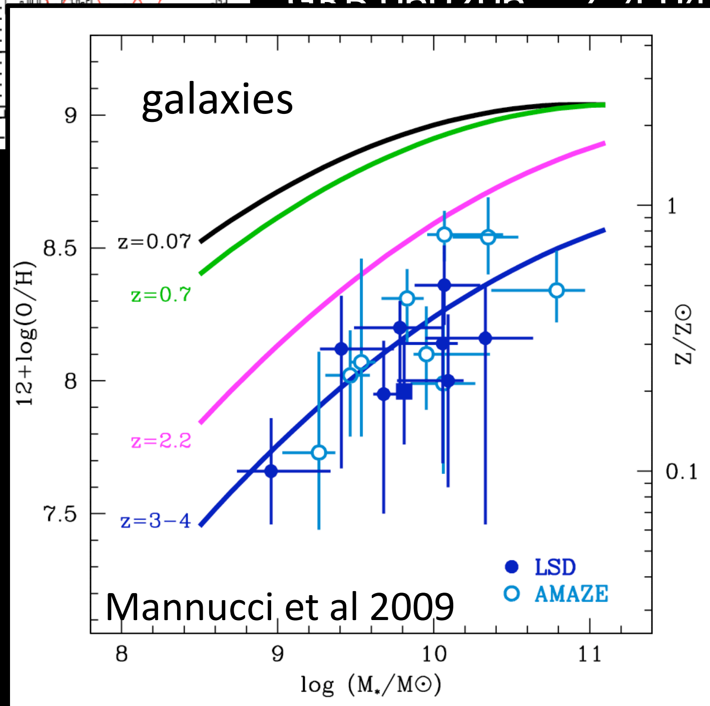
- large collecting area
- near-IR observations





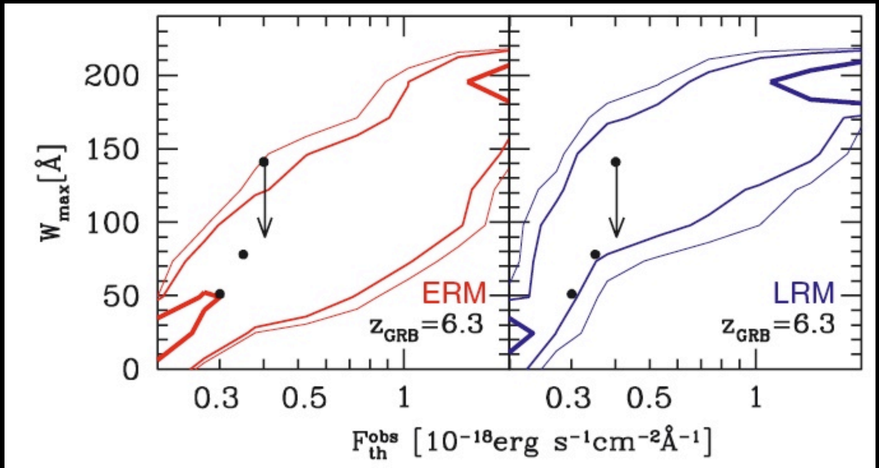
GRB 060206 z=4.04





GRBs

Statistics of gaps
(Gallerani et al 2009)



GRBs

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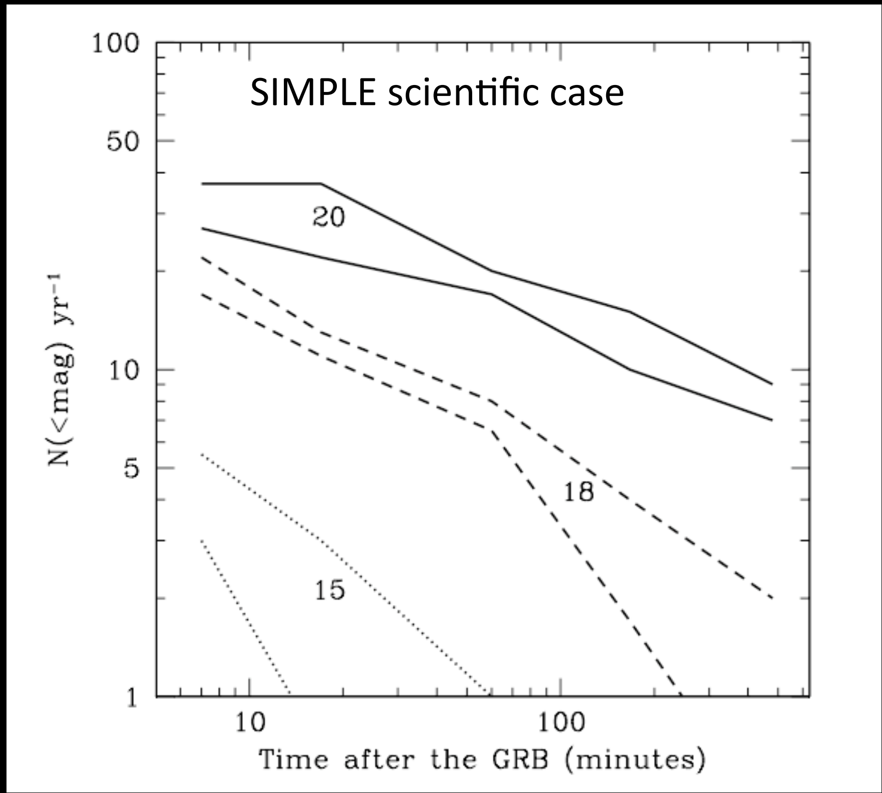

How many GRB?

Reaction time = 1h:

- ~1 GRB/year at J_{AB}<18 and z>5
- ~4 GRB/year at J_{AB}<20 and z>5

Projects

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Requirements:

1. On time (or same delay…)! JWST is aging….
2. EUEWFI (5'x5') with GLAO/MOAO useful
3. Rapid (~0.5h) response ?
4. SIMPLE: IGM at z>7
5. EAGLE or HARMONI: SN at z=4
6. EAGLE or HARMONI and MICADO: progenitors