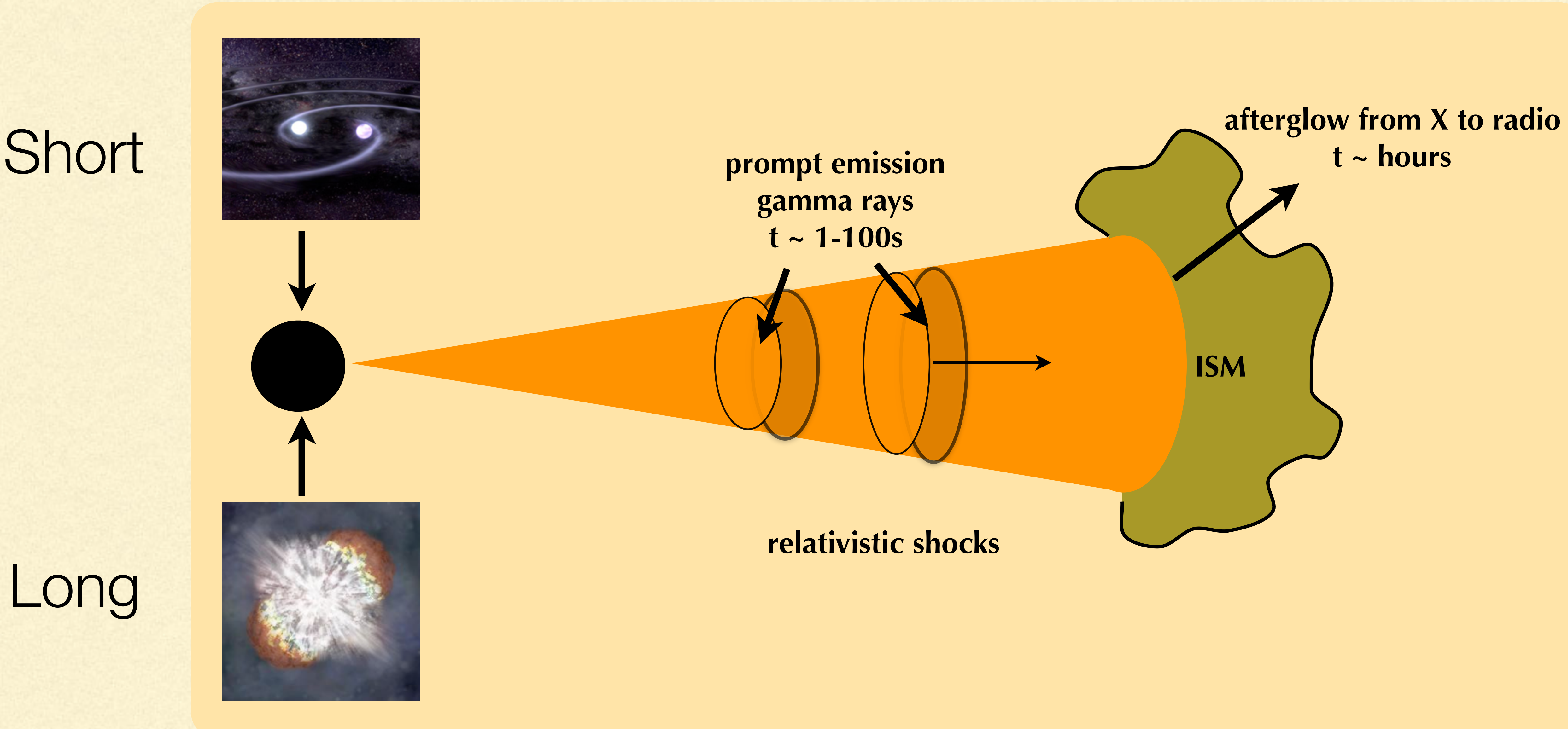
CATCHING GRB ORPHAN AFTERGLOWS FROM GAIA TRIGGERS

S.D.Vergani & collaborators

Special thank to: J. Japelj & G. Ghirlanda



GAMMA-RAY BURSTS

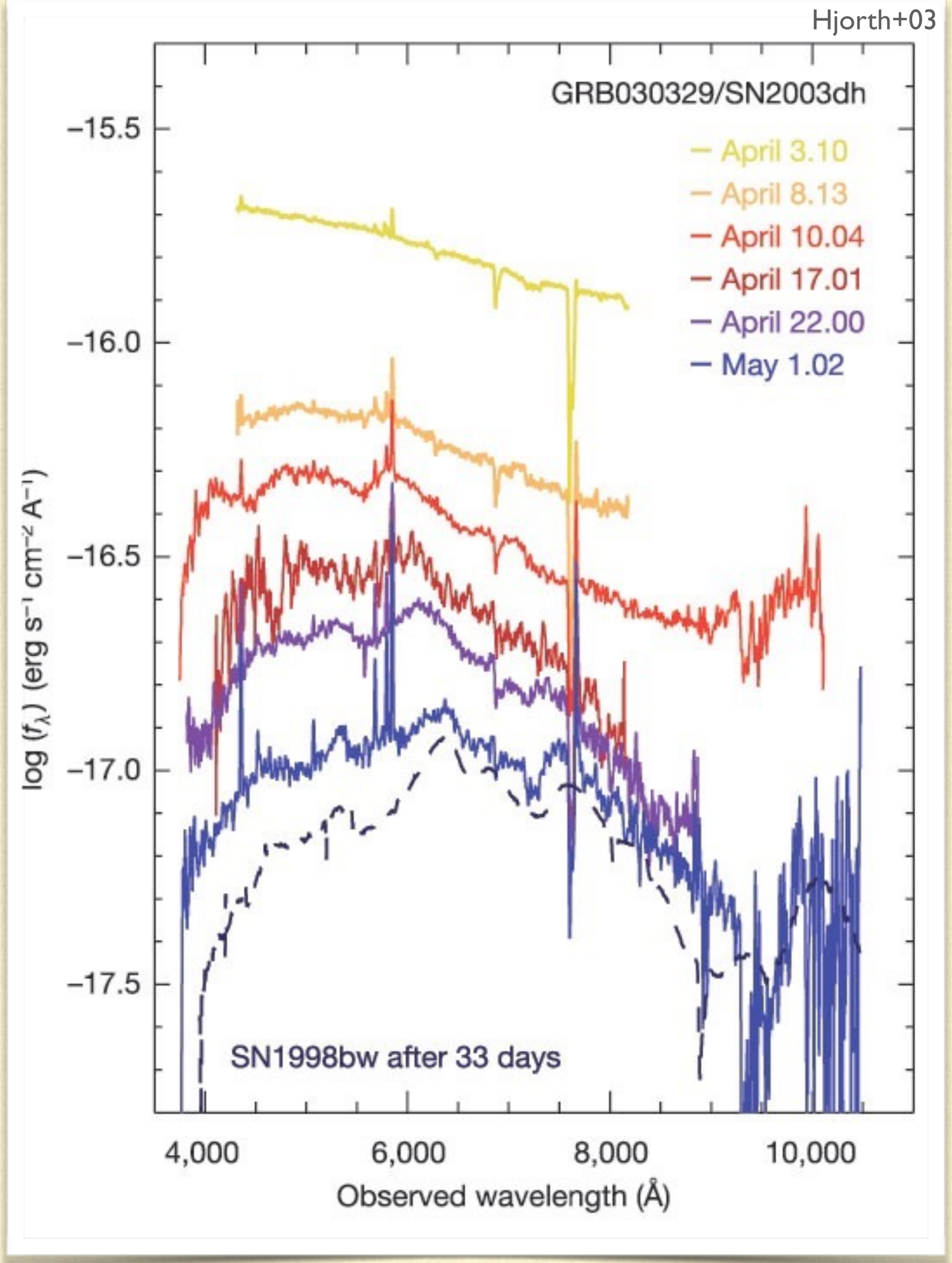
Ultra-relativistic jets associated with black holes formation

merging of compact objects   massive star explosion

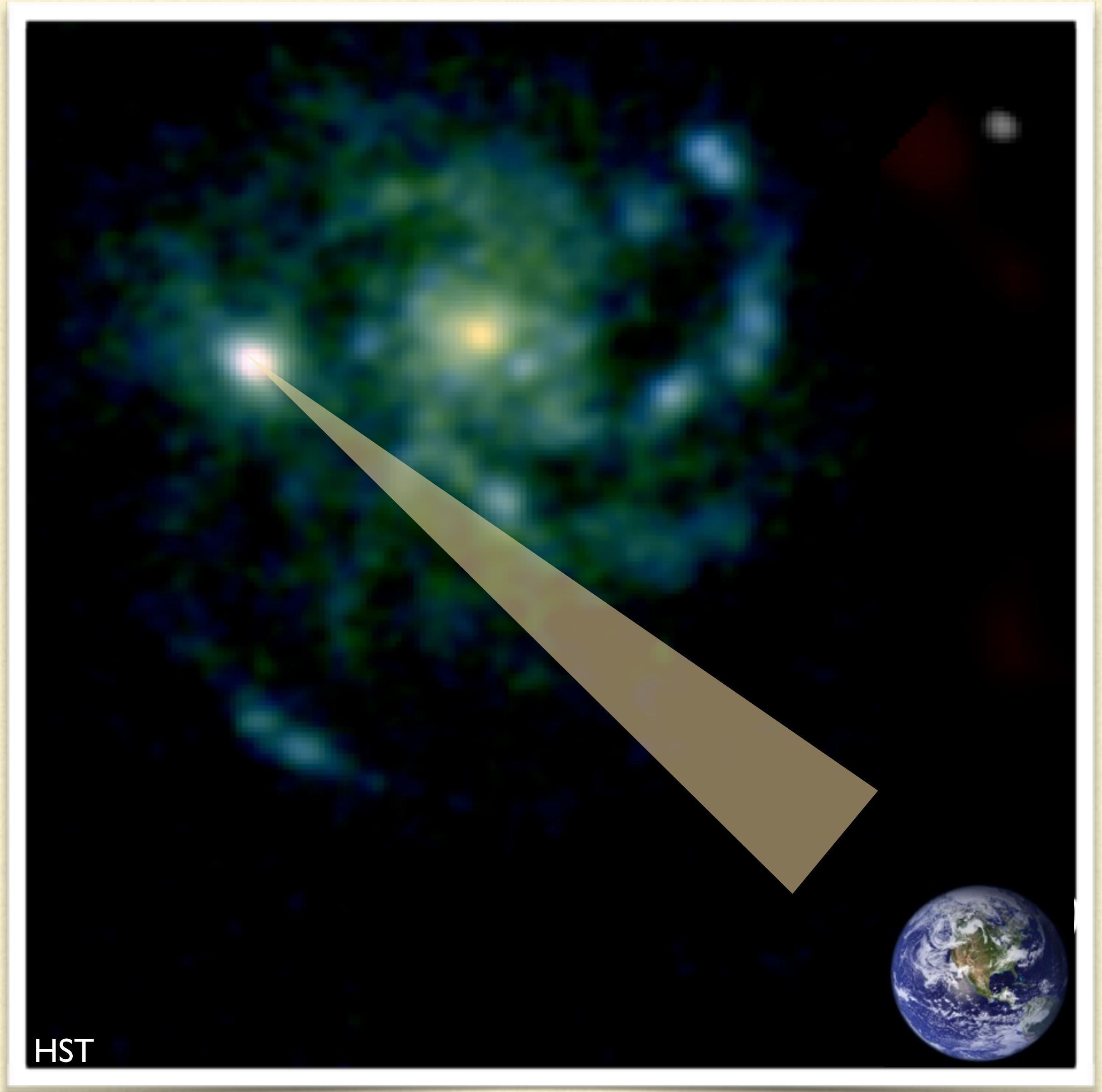
LGRBs / CCSNe connection

LONG GRBS ASSOCIATED WITH SN TYPE IC-BL

LONG GRBS ASSOCIATED WITH MASSIVE STARS

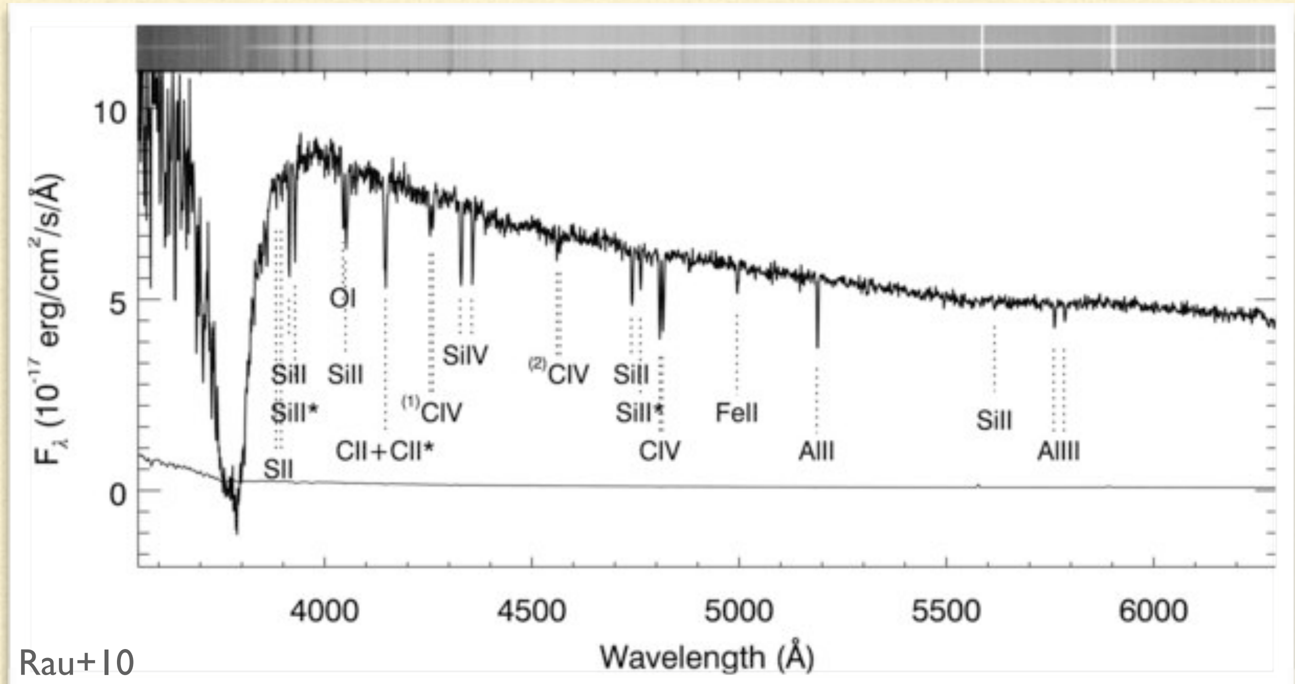


AFTERGLOW SPECTROSCOPY



- Study the disk / star-forming region gas

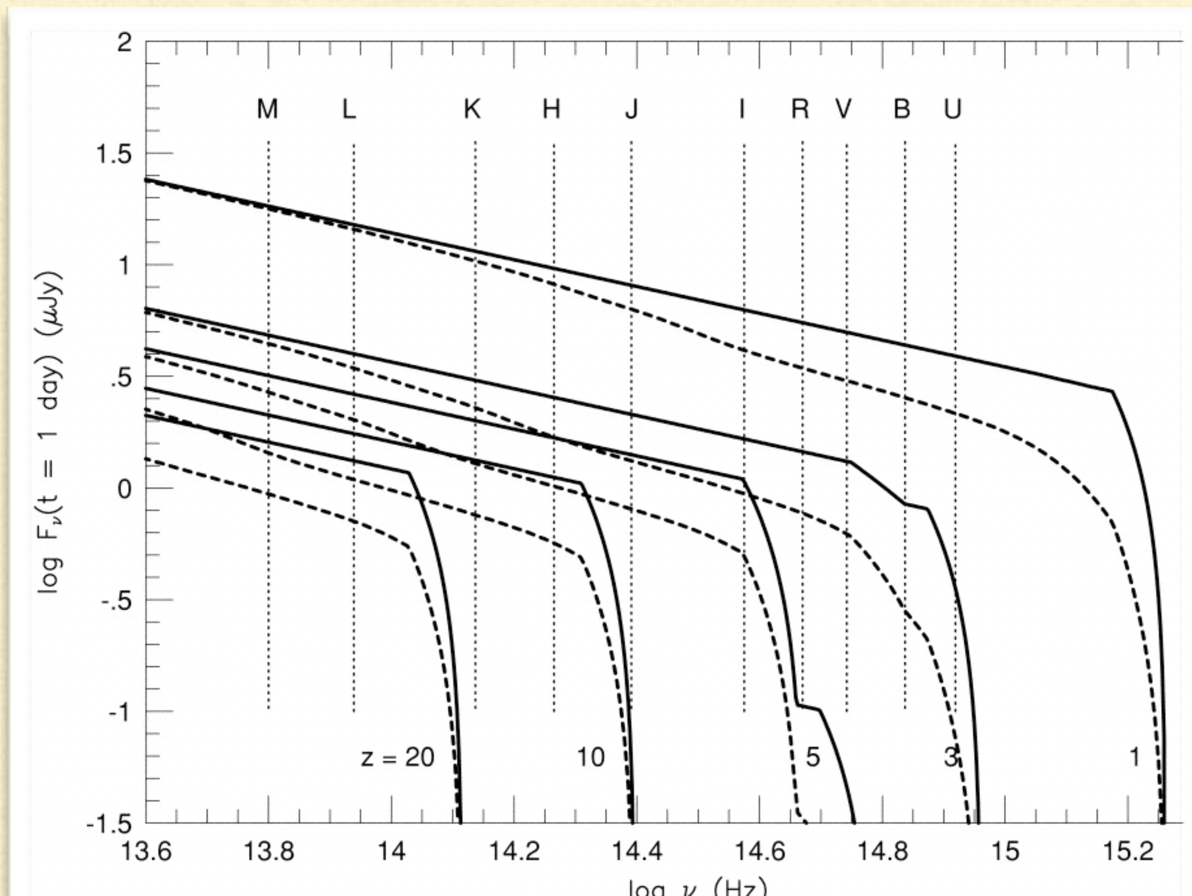
AFTERGLOW SPECTROSCOPY



Rau+10

- Study the disk / star-forming region gas

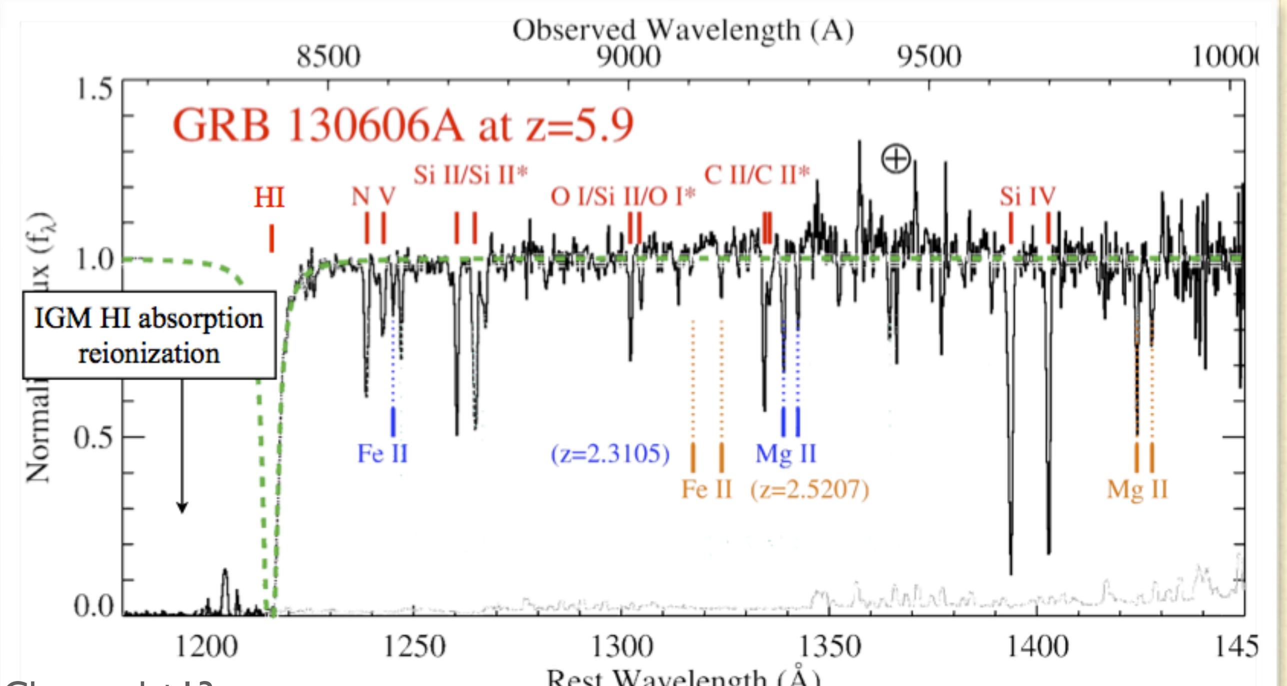
AFTERGLOW SPECTROSCOPY



Reichart&Loeb

- at any z! (record holder z=8.2)

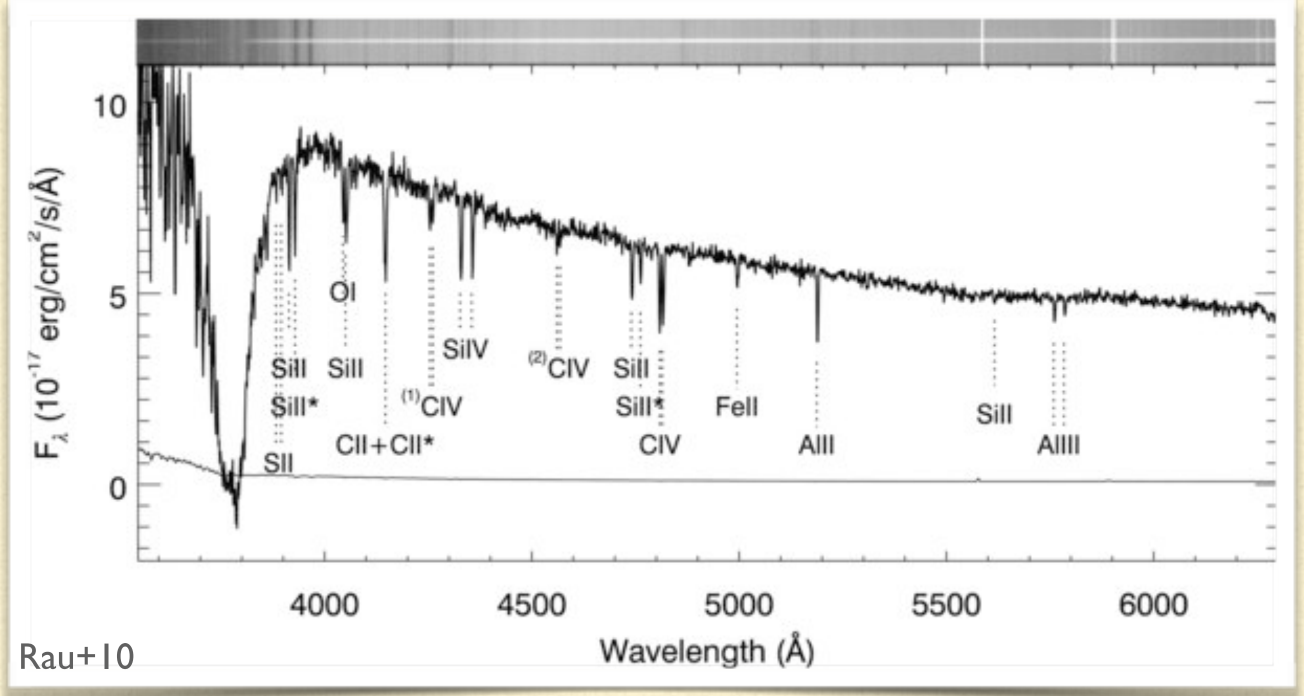
AFTERGLOW SPECTROSCOPY



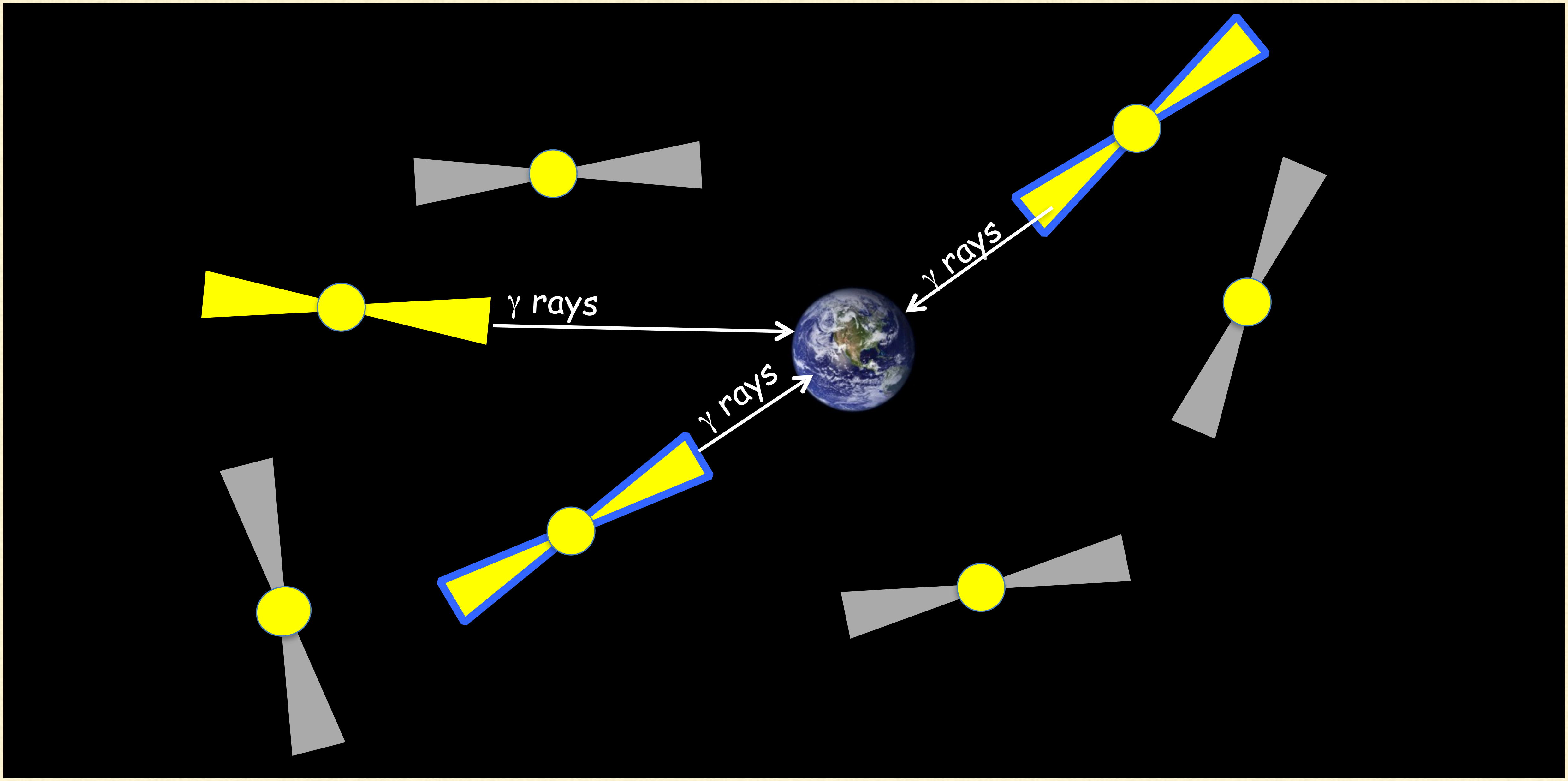
Chornock+13

- at any z! (record holder z=8.2)

AFTERGLOW SPECTROSCOPY



- Study the disk / star-forming region gas
- Time variation of fine structure lines : gas cloud distances
- > 50pc (hard X-ray ionisation at smaller radii)



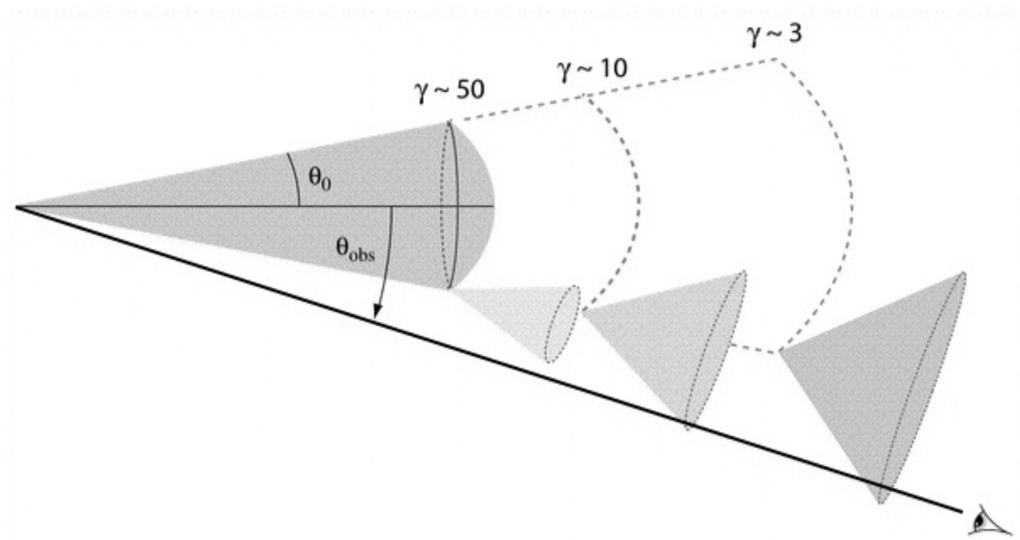
Courtesy of G. Ghirlanda

GAMMA-RAY BURST ORPHAN AFTERGLOWS

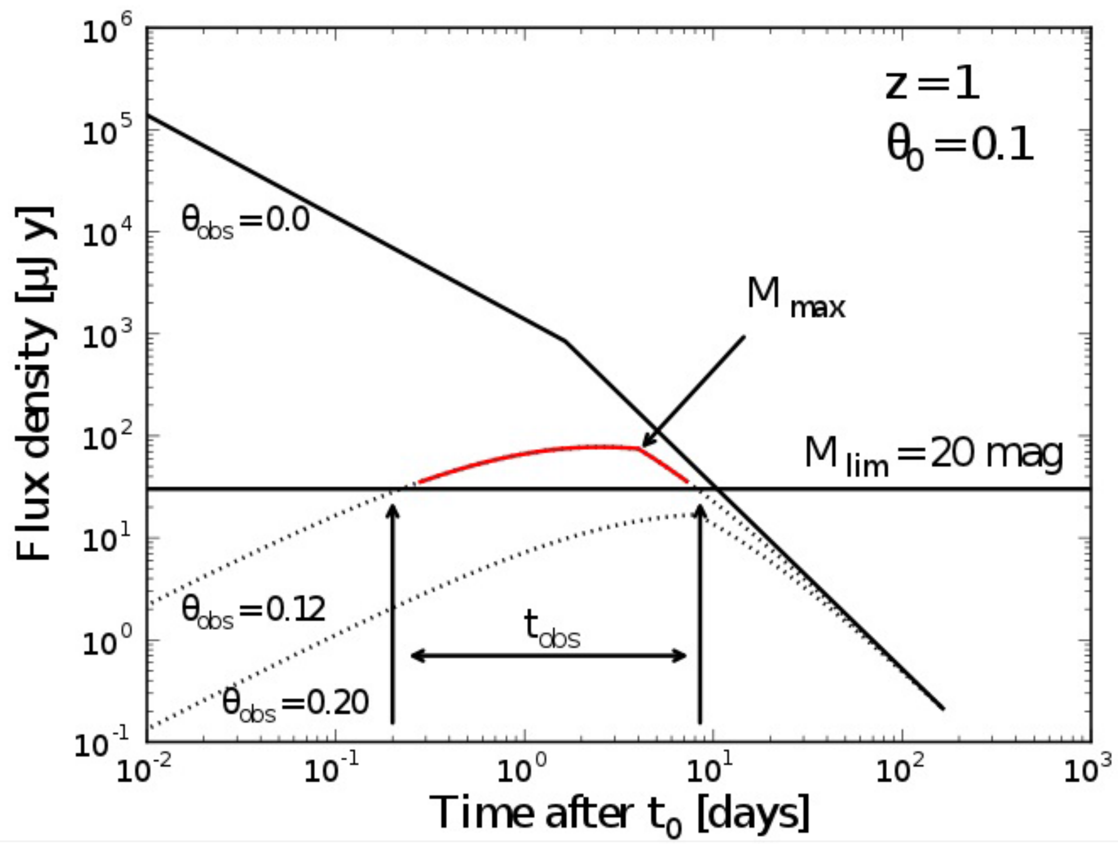
Norph ~ Ngrb(2/theta^2)

~300 orphan afterglows for each on-axis GRB!

Granot+05



Japelj&Gomboc11



GAMMA-RAY BURST ORPHAN AFTERGLOWS

Expected Gaia light-curve

Survey	FOV (deg^2)	Cadence	F_{lim} (mJy)	Coverage (deg^2 $night^{-1}$)	Lifetime days	R_{OA} (deg^{-2} yr^{-1})	$\langle T \rangle$ days	# OA yr^{-1}
PTF	7.8	1m–5d	1.17×10^{-2}	1000		1.5×10^{-3}	1[0.2-3.8]	1.5
ROTSE–II	3.4	1d	1.17×10^{-1}	450		5.2×10^{-4}	0.4[0.1-1.7]	0.1
CIDA–QUEST	5.4	2d–1yr	4.60×10^{-2}	276		8.0×10^{-4}	0.5[0.1-2.3]	0.1
Palomar–Quest	9.4	0.5h–1d	1.17×10^{-2}	500	2003–2008	1.5×10^{-3}	1[0.2-3.8]	0.8
SDSS–II SS	1.5	2d	2.68×10^{-3}	150	2005–2008	3.2×10^{-3}	1.6[0.4-6.3]	0.8
Catilina	2.5	10m–1yr	4.60×10^{-2}	1200		8.0×10^{-4}	0.6[0.1-2.4]	0.6
SLS	1.0	3d–5yr	5.60×10^{-4}	2	2003–2008	5.2×10^{-3}	2.8[0.8-11]	0.03
SkyMapper	5.7	0.2d–1yr	7.39×10^{-2}	1000	2009–...	6.4×10^{-4}	0.5[0.2-2.0]	0.3
Pan–STARRS1	7.0	3d	7.39×10^{-3}	6000	2009–...	2.0×10^{-3}	1[0.3-4.4]	12
LSST	9.6	3d	4.66×10^{-4}	3300	2022–...	5.1×10^{-3}	3[0.8-11]	50
Gaia	0.5x2	20d	3.00×10^{-2}	2000	2014–2019	10^{-3}	1[0.5-5]	2
ZTF *	42.0	1d	2.00×10^{-2}	22500	2017–...	1.1×10^{-3}	0.8[0.4-4.8]	20
RASS	3.1	...	4.00×10^{-5}	12000	6 months	8.0×10^{-4}	1[0.3-4.4]	10
eROSITA	0.8	6 months	2.00×10^{-6}	4320*	4 years	3.0×10^{-3}	2[0.5-6.5]	26

Ghirlanda+15

ORPHAN AFTERGLOWS & SURVEYS

Gaia can see them!

THE IMPORTANCE OF ORPHAN AFTERGLOWS

- to confirm the GRB jet model
- to put constraints on the jet opening angle and structure
- Not (or less) affected by hard-X rays:
  unique access to the pristine gas surrounding massive stars at any z!
- GW

HOW CAN WE RECOGNIZE THEM?

- First hints with light-curve
- Optical spectroscopy: z, continuum, HI & metal absorption line, fine structures lines
- we had a VLT ToO program with X-Shooter, now DDT?
- we need to improve the Gaia Alert Pipeline and flags!

SUGGESTIONS FOR GAIA ALERTS

- As fast response as possible (automatised after downloading?)
- include the following info in the Alert (script readable): blue/red, hostless?, last non-detection
- access to light curves

CONCLUSIONS

- GRB orphan afterglow detection will bring unique info on GRB models
- GRB orphan afterglow detection will give unique access at any z to the pristine gas surrounding massive stars
- we can obtain VLT ToO observations: we need to improve the Gaia Alert Pipeline and flags!

THANKS!