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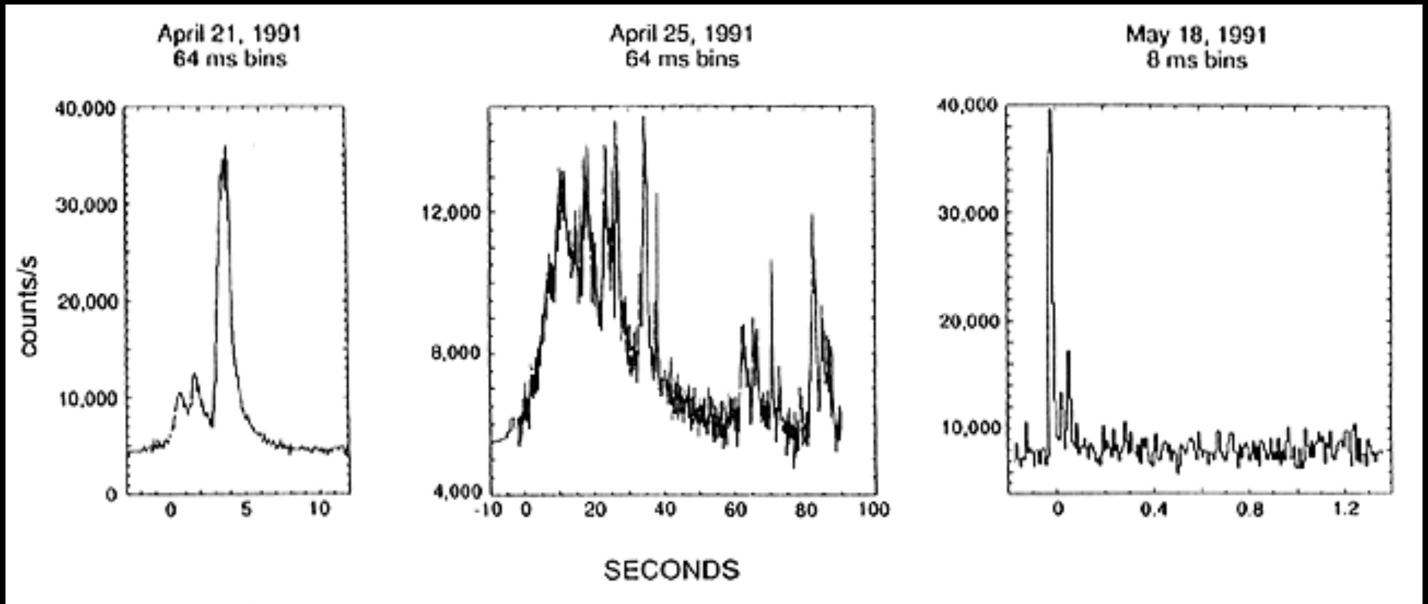
STUDY OF ORPHAN (OFF-AXIS) AND PARENT (ON-AXIS) GAMMA-RAY BURSTS WITH LSST (A SMALL DROP IN THE TRANSIENT SKY)

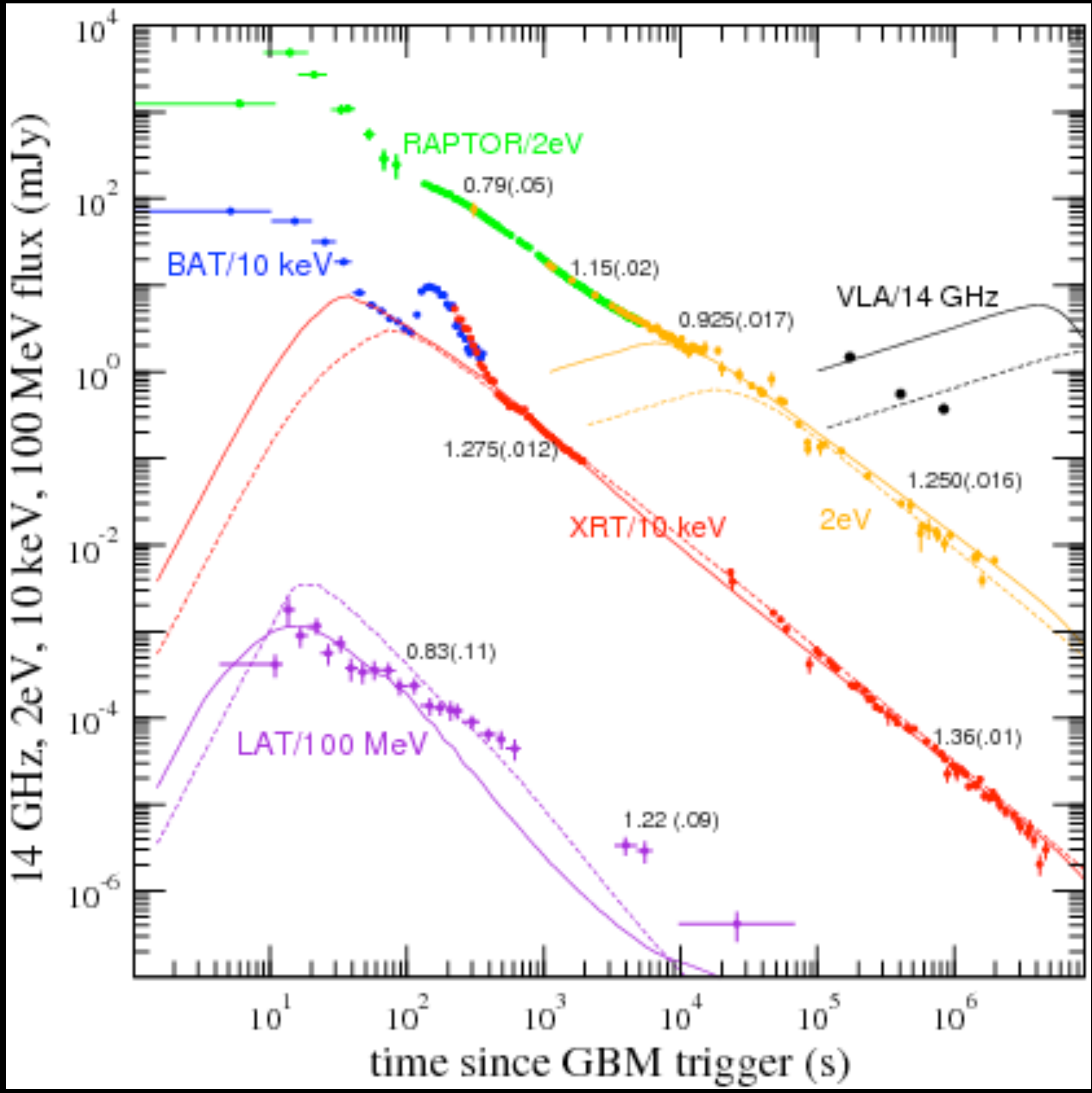
WHAT ARE GRBS?



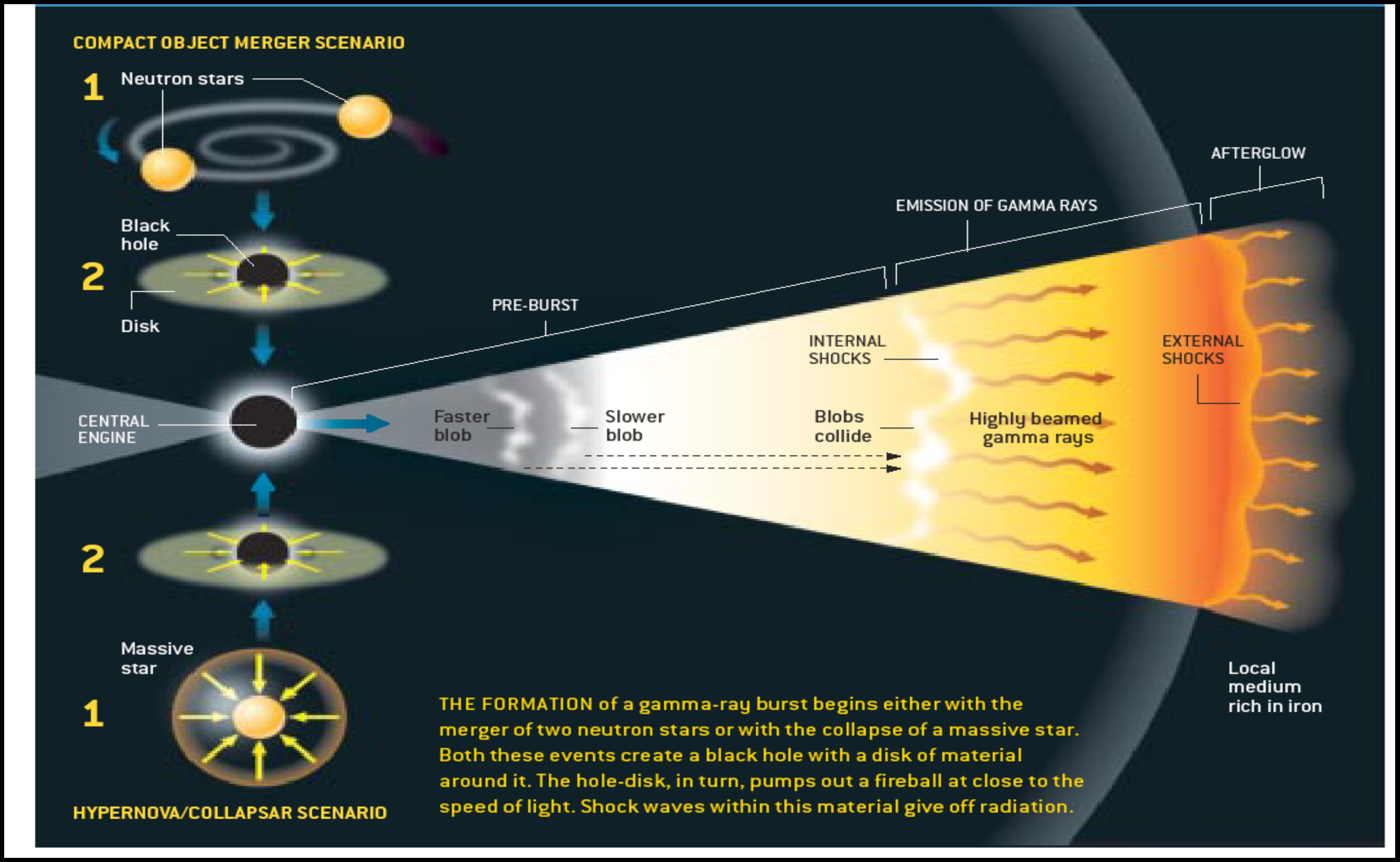
Intense (brightest in the sky), short (<10^3 s) emission of gamma-rays

FOLLOWED by

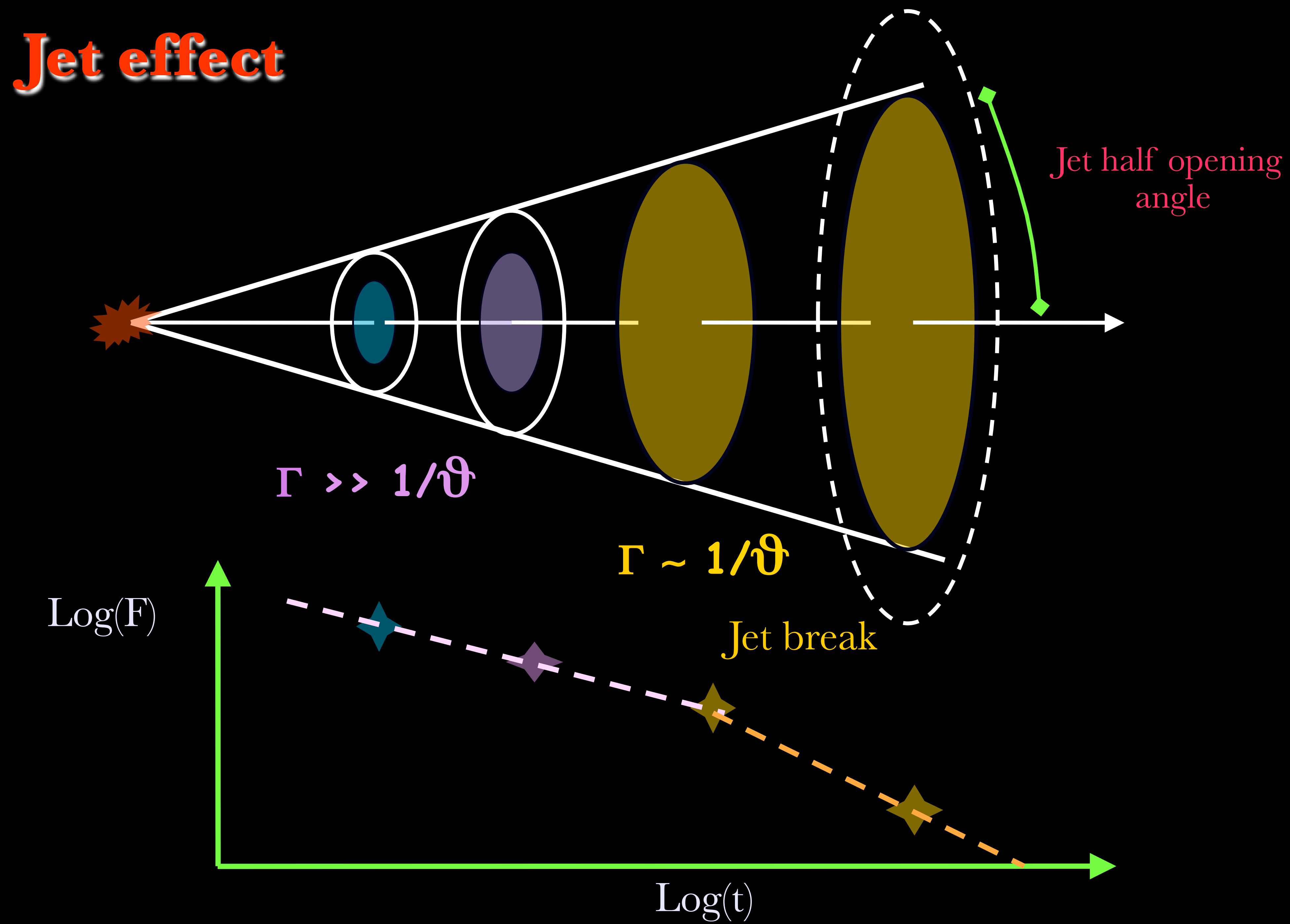
the afterglow



GRB STANDARD MODEL

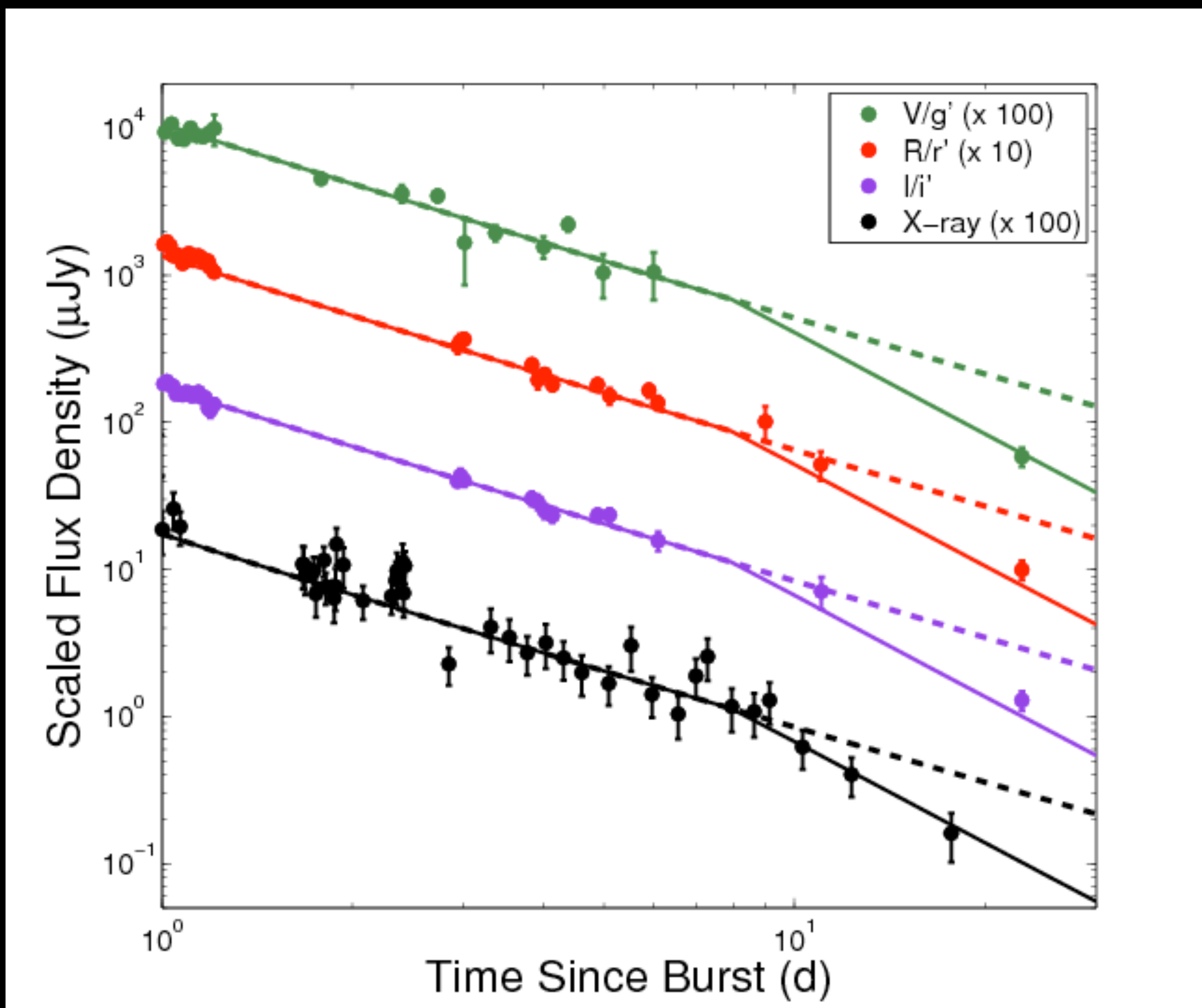


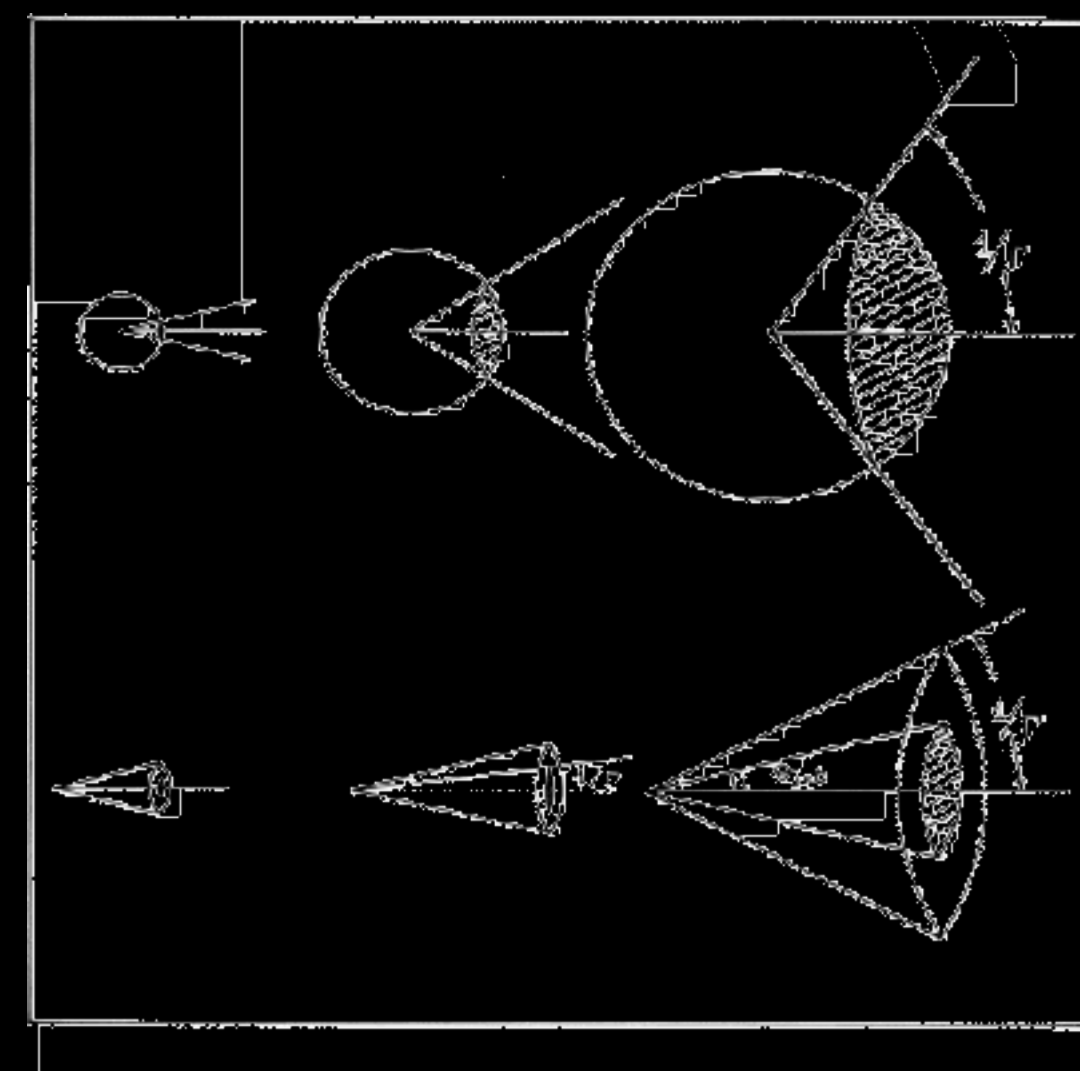
AFTERGLOW EMISSION IS COLLIMATED



JETS

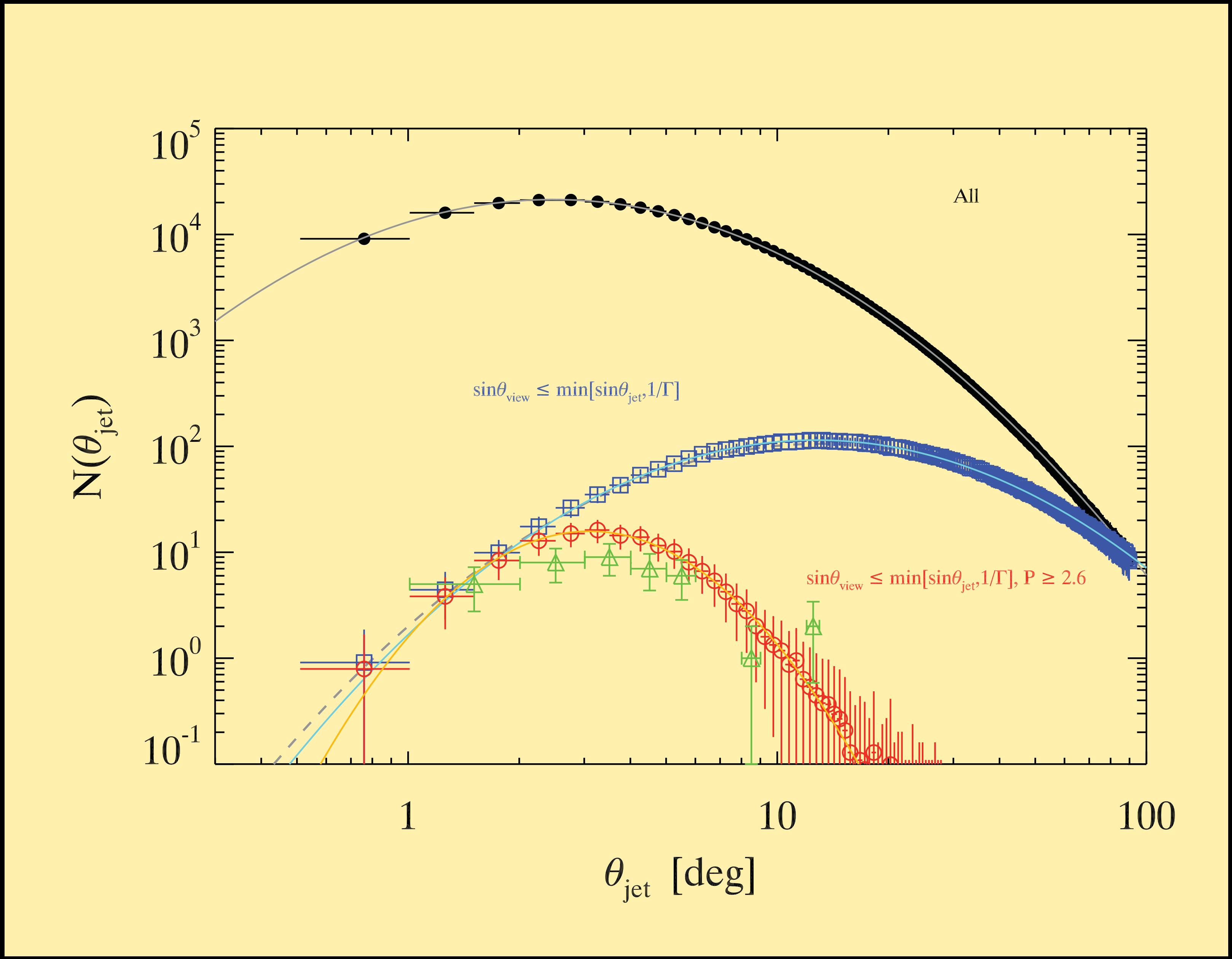
Achromatic breaks





GRB OPENING ANGLE DISTRIBUTION

Ghirlanda et al. 2013



Mean angle ~ 3 deg

Correction factor

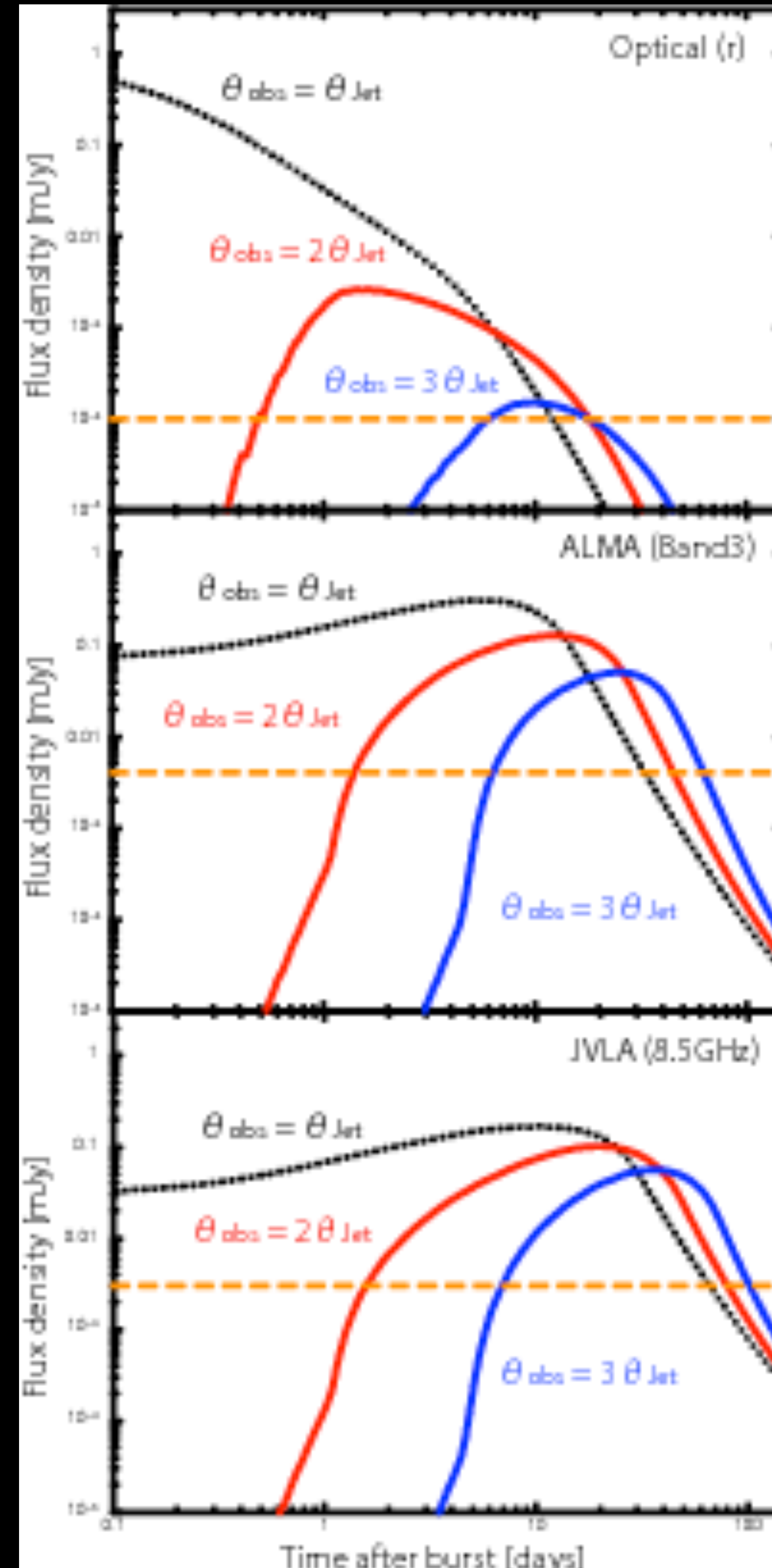
$(1-\cos\theta)^{-1}$

~730

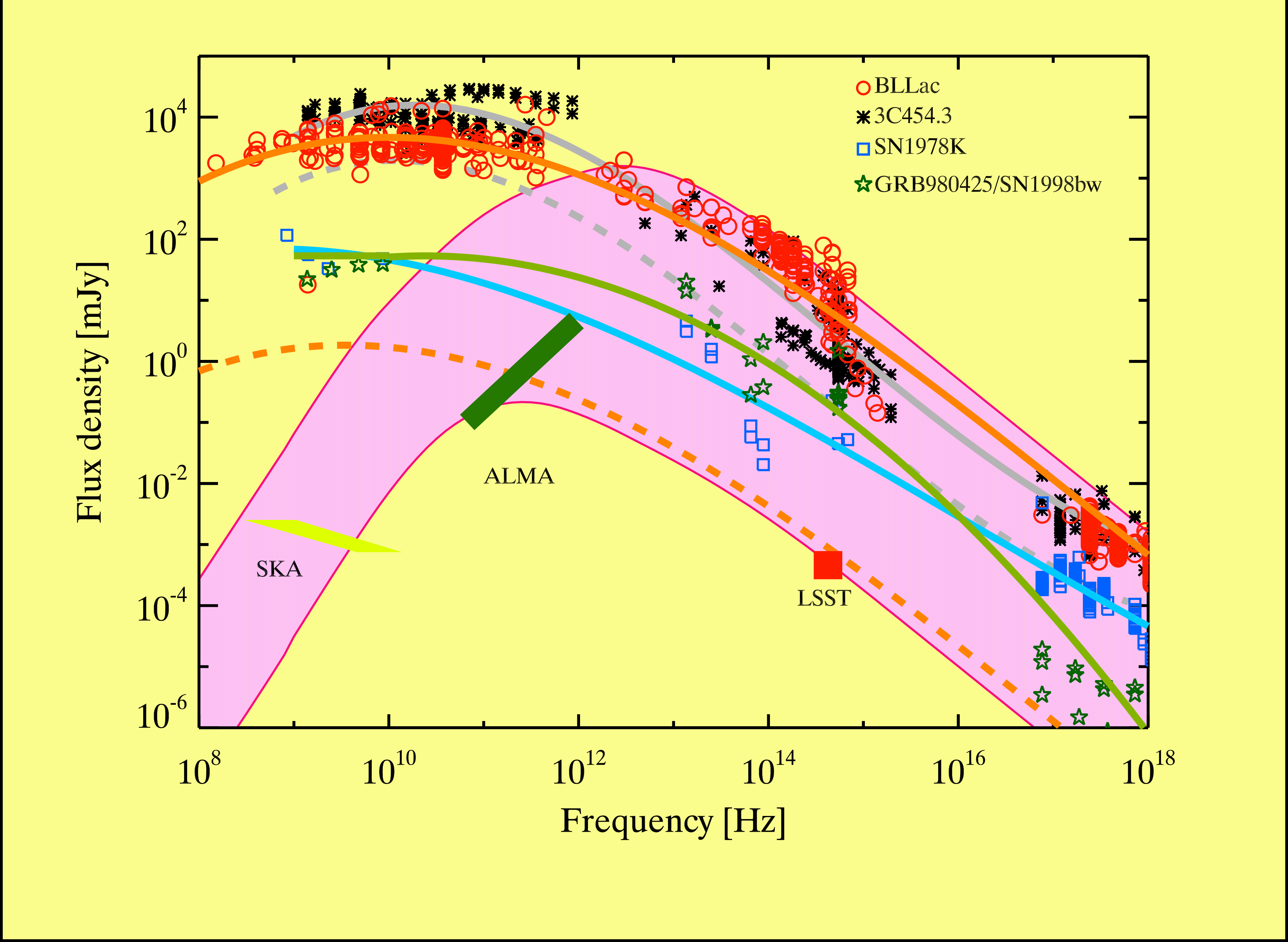
ORPHAN AFTERGLOW

Off-axis orphan afterglows are much dimmer than on-axis afterglows at all wavelengths

Urata et al. 2015



PREDICTIONS FOR LSST



Ghirlanda et al. 2015

(CONSERVATIVE) NUMBERS

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

Early LSST prediction ~1,000 /yr

WHY? (LONG GRBS)

- study of the collimation of GRBs: the number of orphan vs. on-axis GRBs is a unique tool to assess the energy distribution along the jet
- true rate of GRBs and connections with SN Ic (and magnetars, and superluminous-SN, etc.)
- spectroscopic studies of pristine ISM (even at high redshift) with no photoionisation effects

WHY? (SHORT GRBS)

- collimation angle NS-NS merger events (do all mergers give rise to an afterglow?)
- true rate and predictions for GW events
- relations with kilonovae
- GW searches

CONCLUSIONS (AND POINTS FOR THE DISCUSSION)

- Large **SYNOPTIC** Survey Telescope is a **TRANSIENT** searching machine (time-domain)
- need for a **SPECTROSCOPIC** follow-up (SOXS)