Gamma-Ray Burst Supernovae

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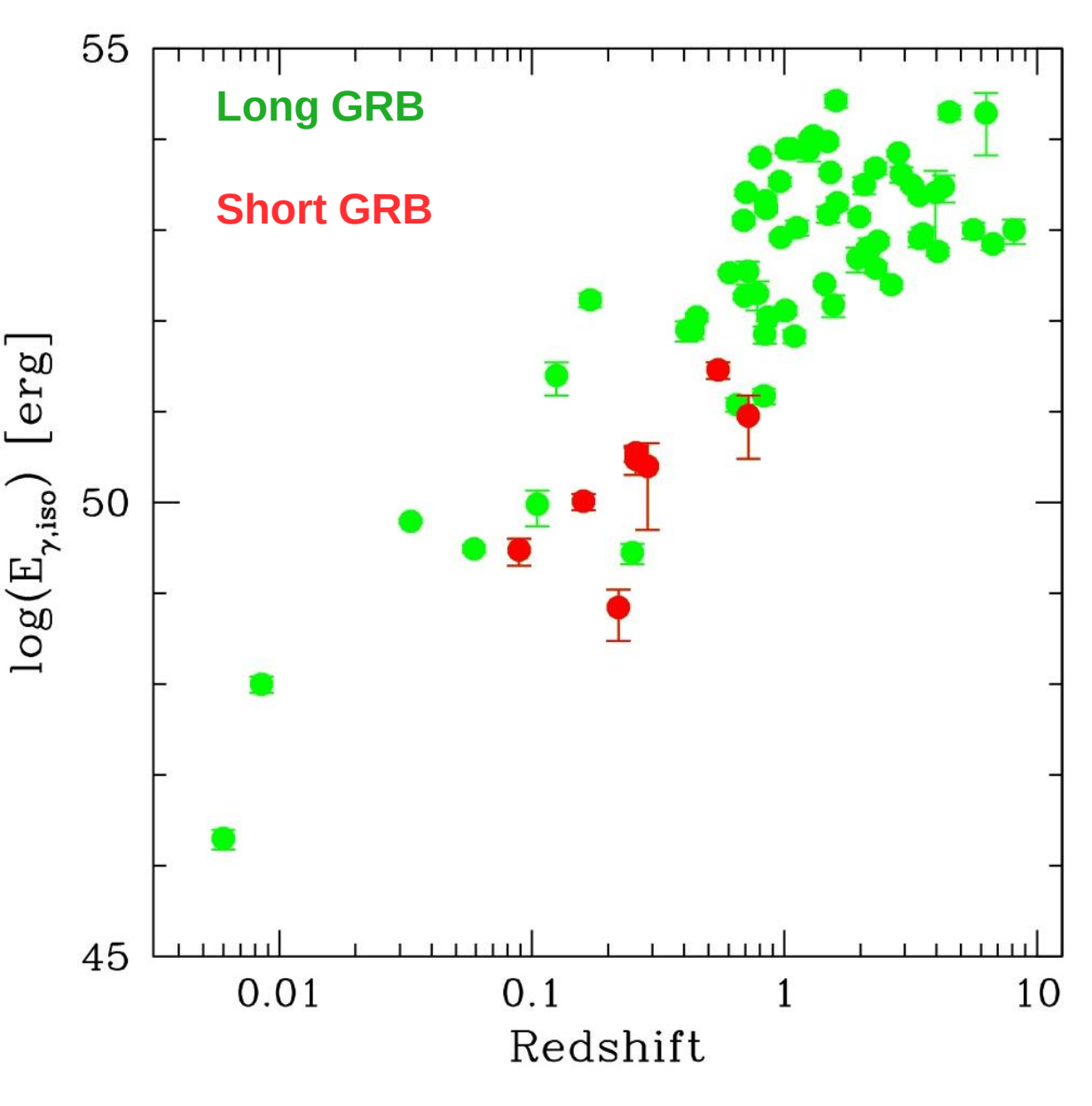
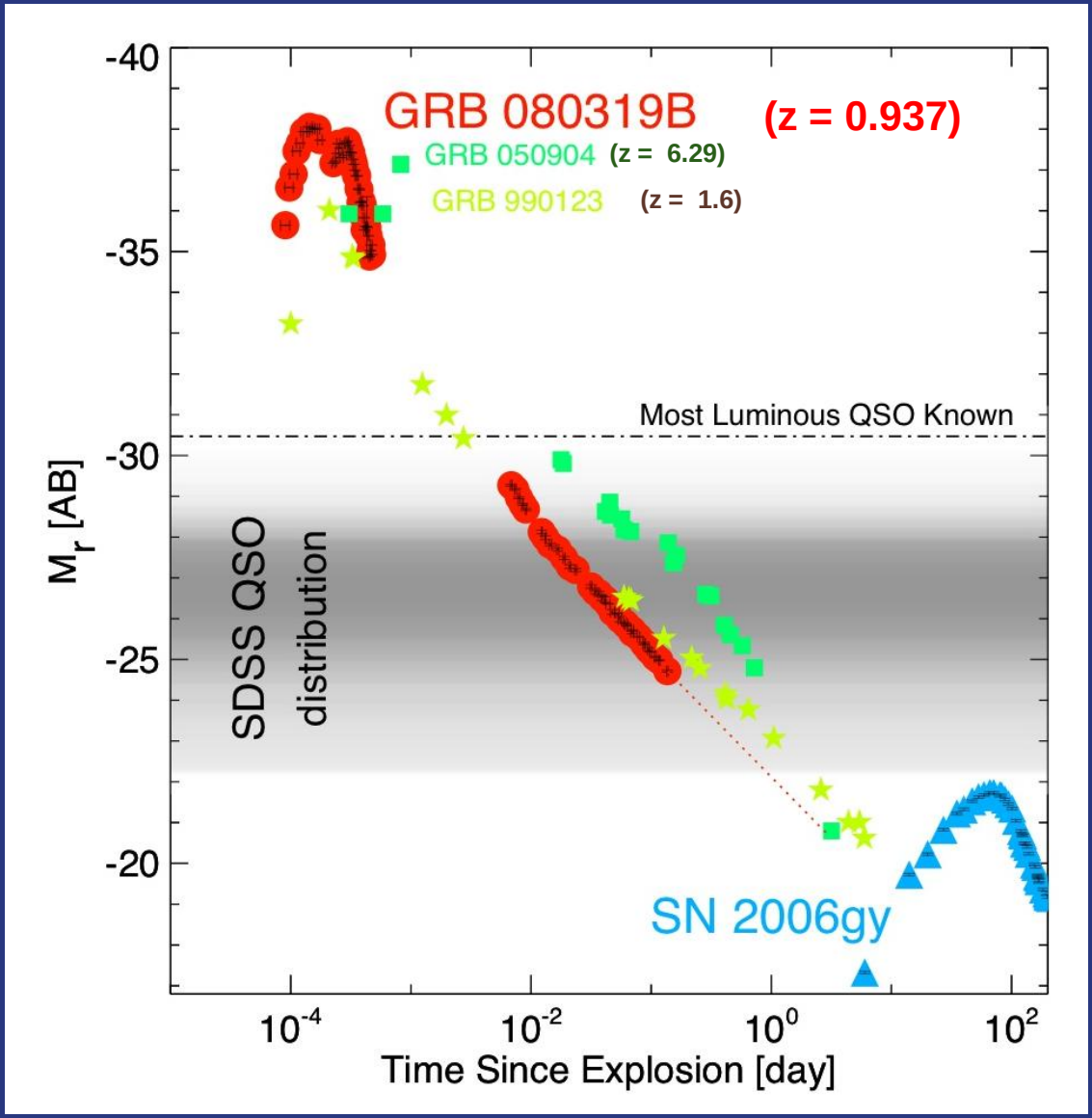
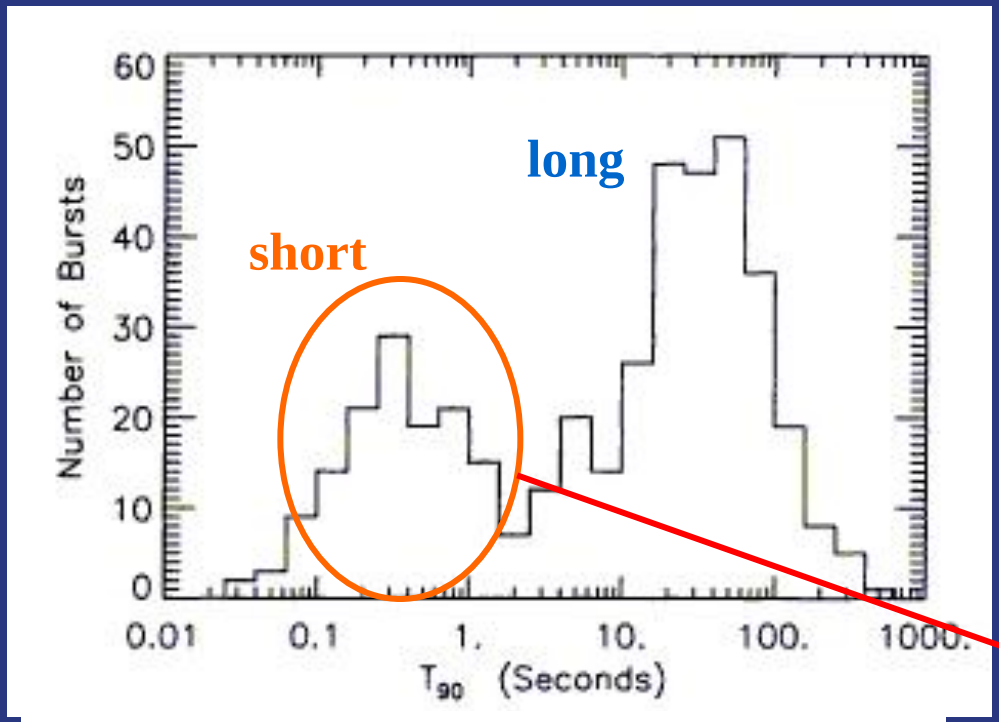
Isotropic irradiated γ–ray energy vs redshift

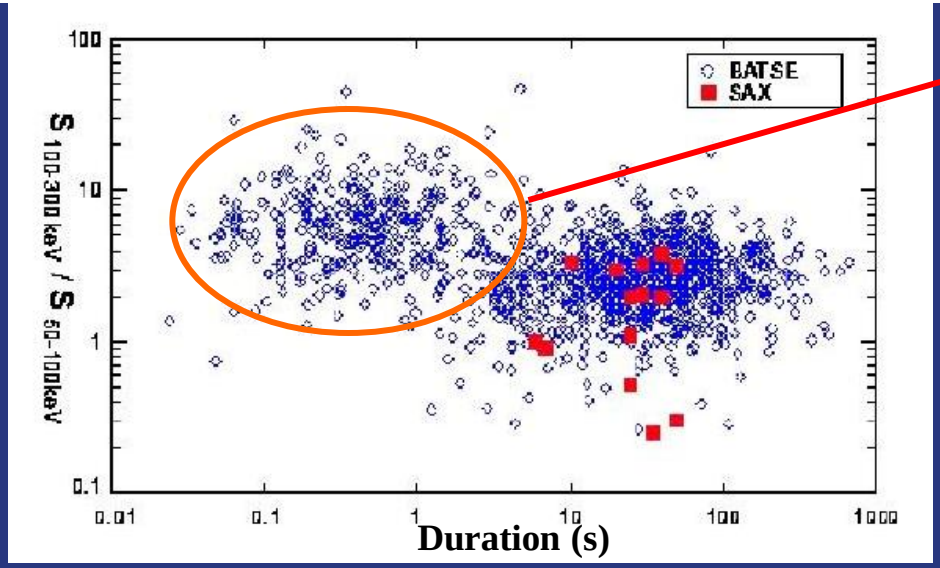


Early Multiwavelength Counterparts



Bloom et al. 2008





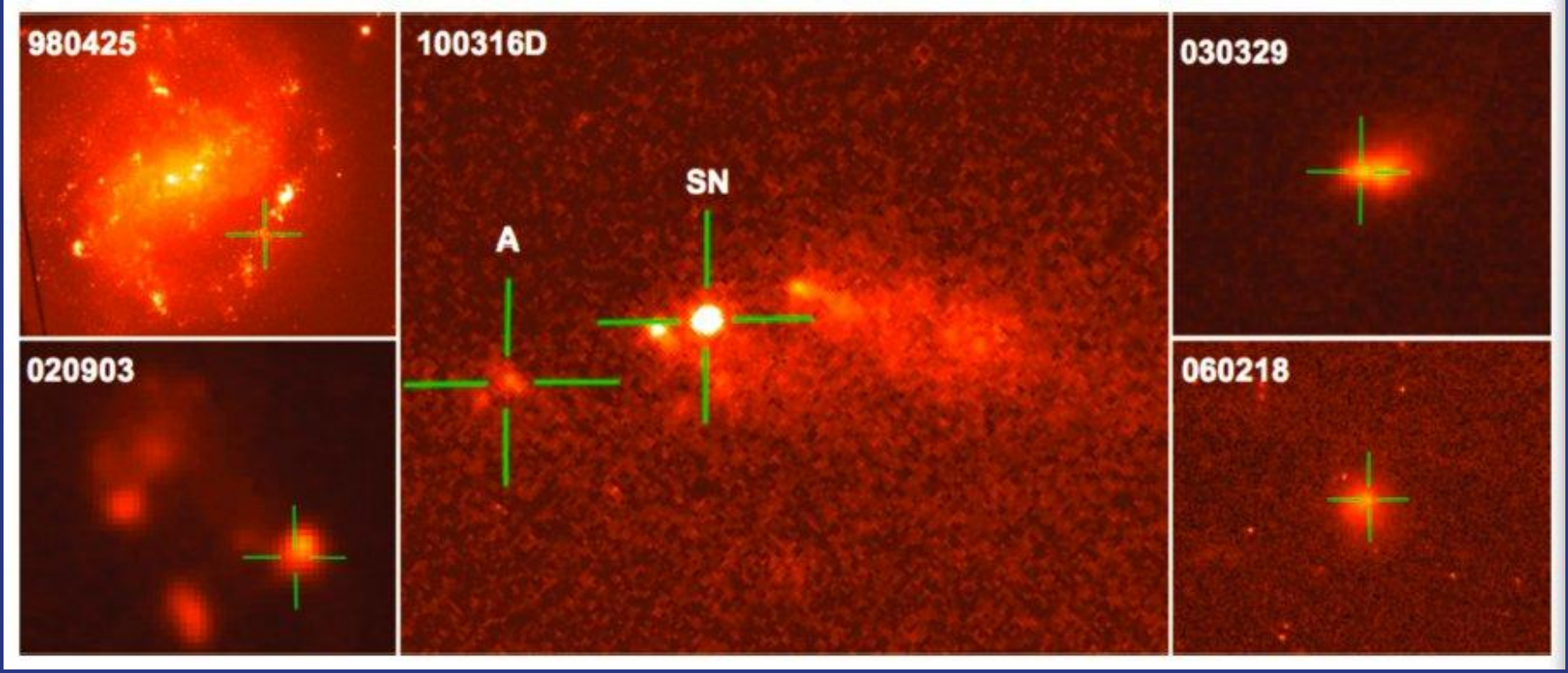
Bimodal distribution of GRB durations

Different progenitors: SNe vs binary NS mergers

Kulkarni 2000

HST Fields of GRBs

(physical scale across each image is about 7 kpc)



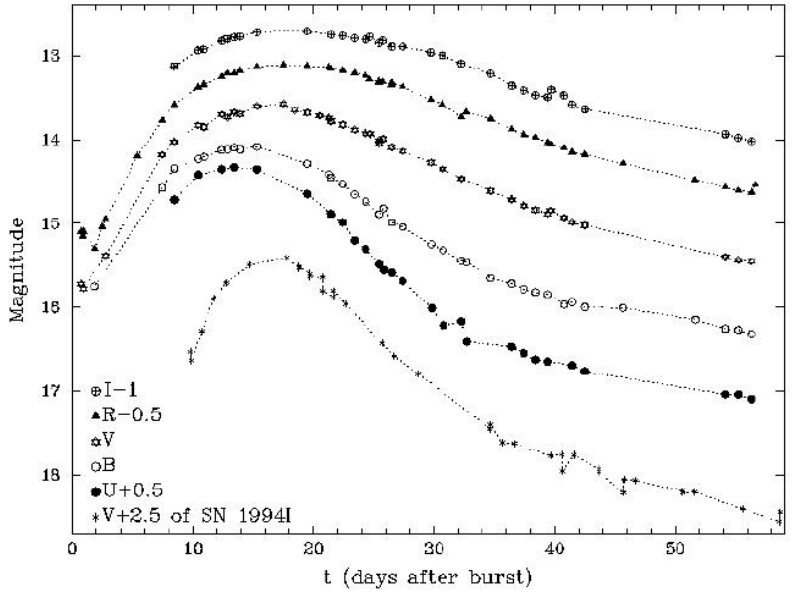
Starling et al. 2011

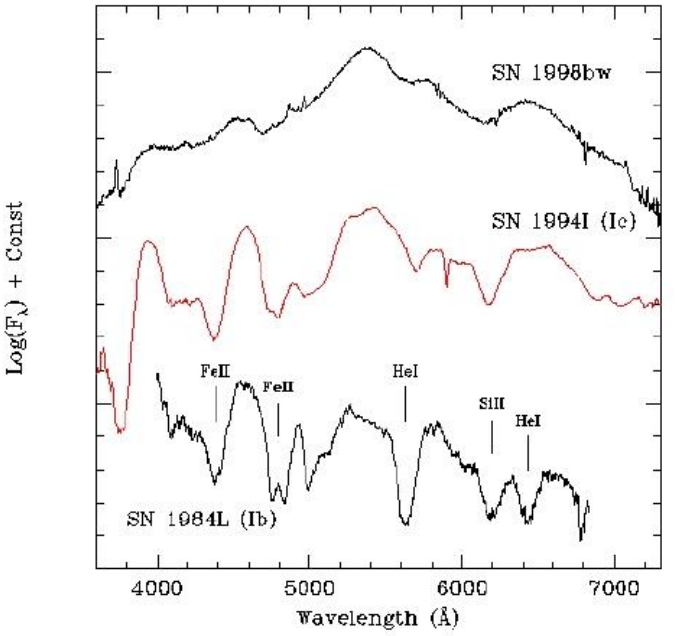
GRB980425
Supernova 1998bw (Type Ic)

SN 1998bw in Spiral Galaxy ESO184-G82

z = 0.0085

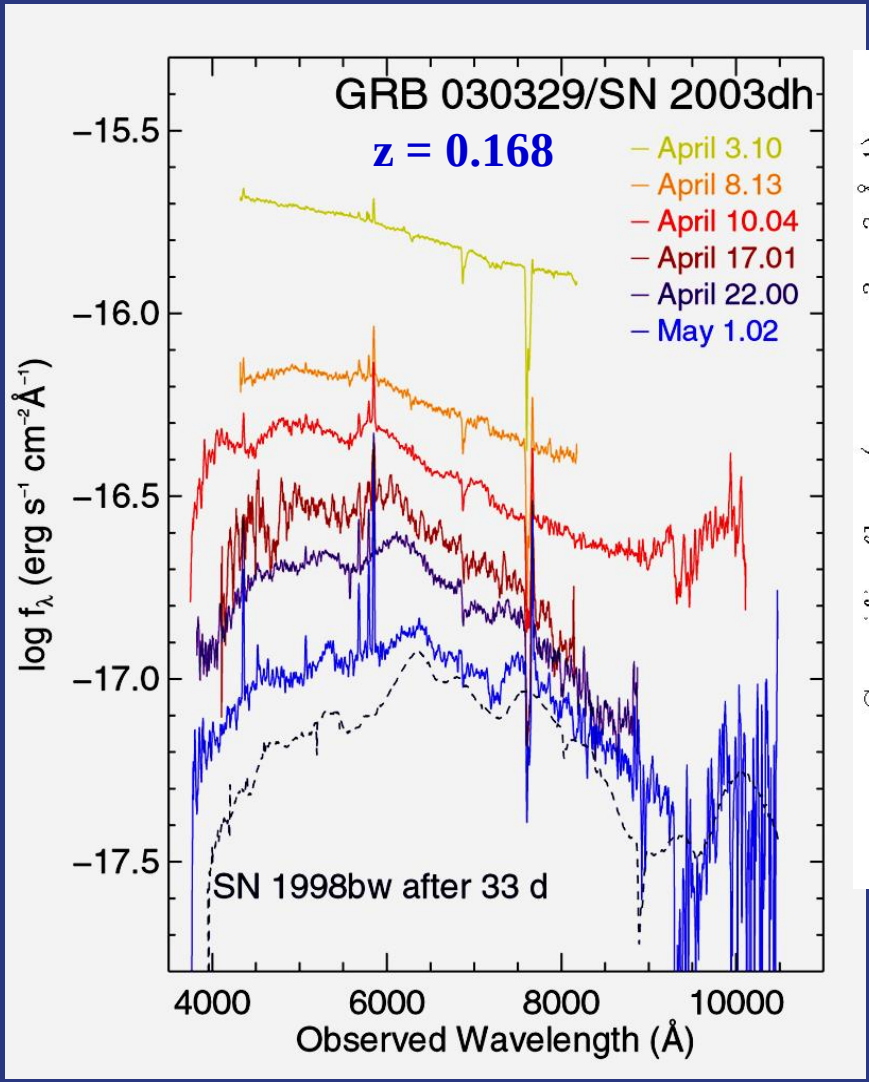
ESO PR Photo 39a/98 (15 October 1998)





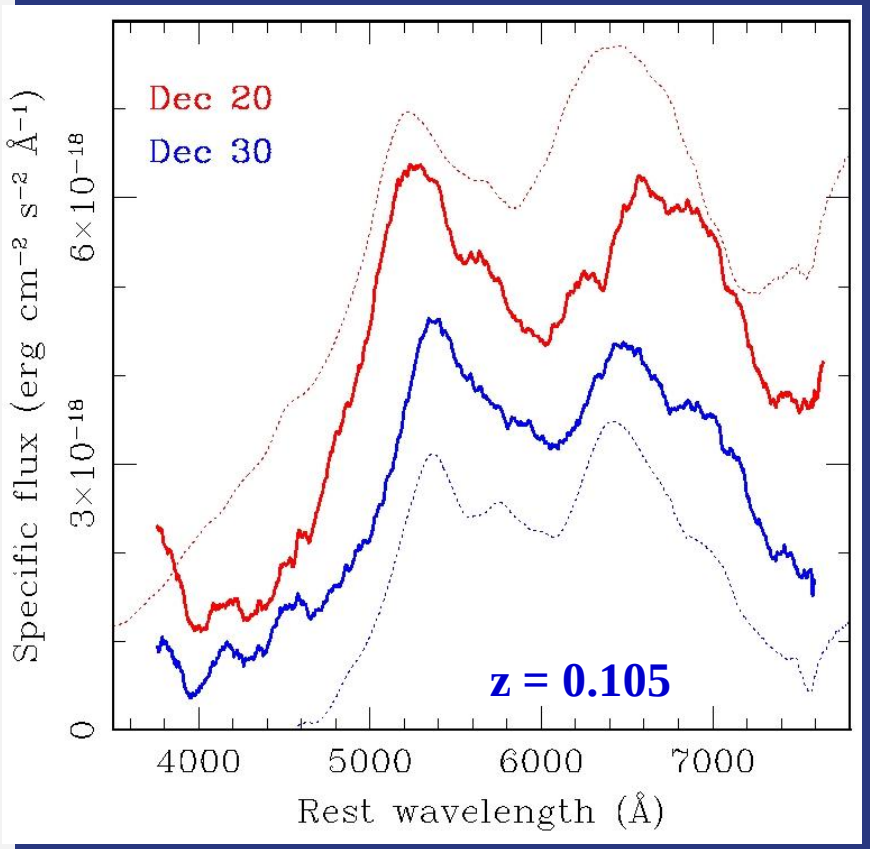
Galama et al. 1998

GRB-Supernovae with ESO VLT+FORS



Hjorth et al. 2003

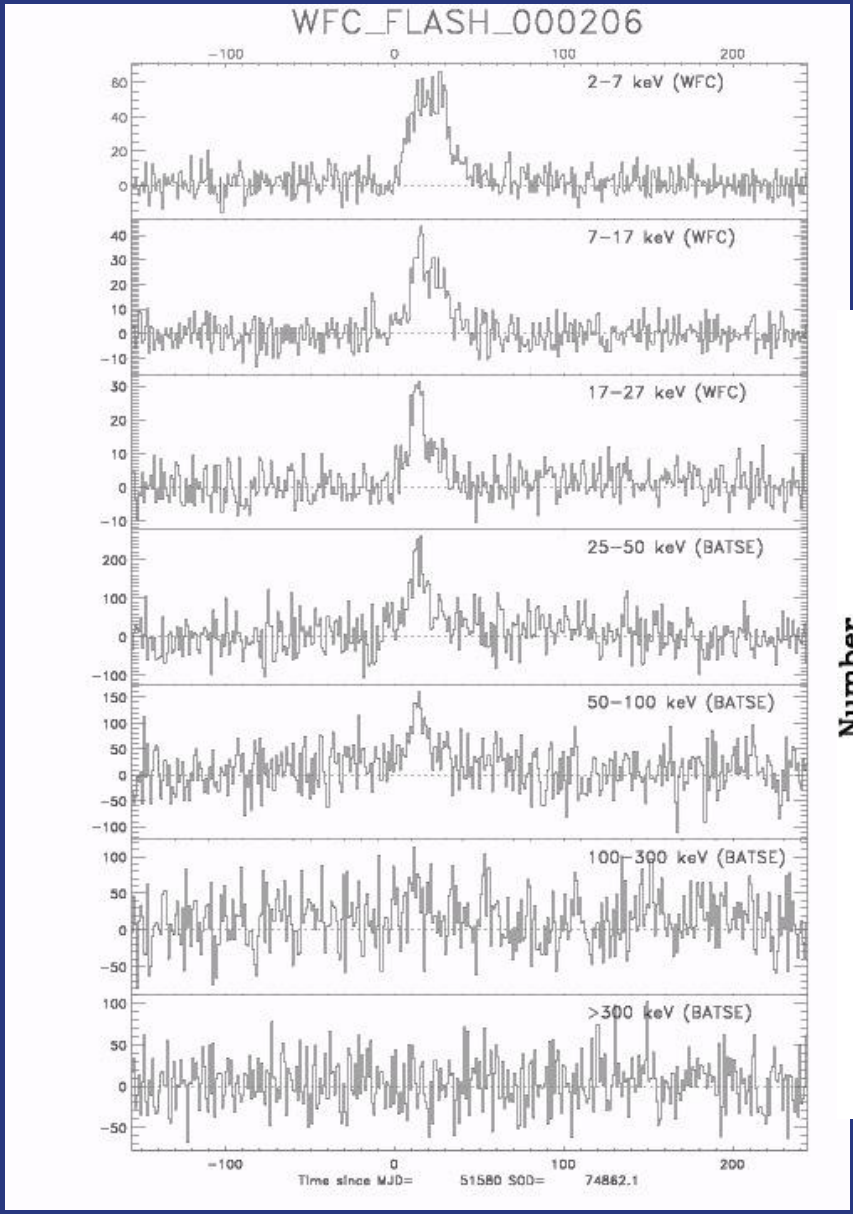
GRB031203/SN2003lw

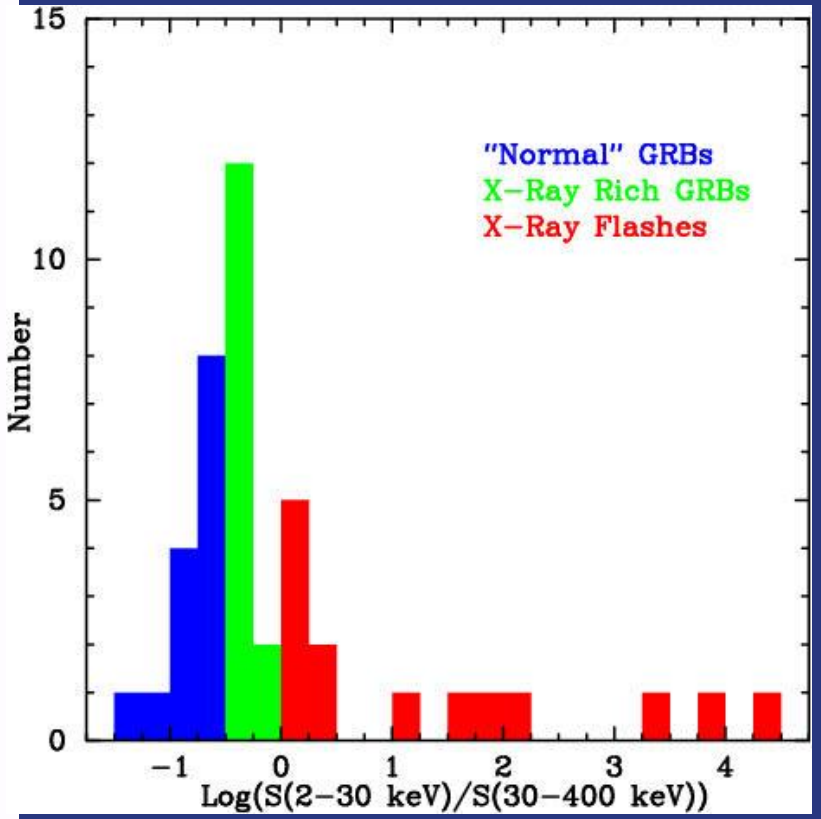


Malesani et al. 2004

GRB-SNe have kinetic energies exceeding those of normal SNe by an order of magnitude (e52 erg)

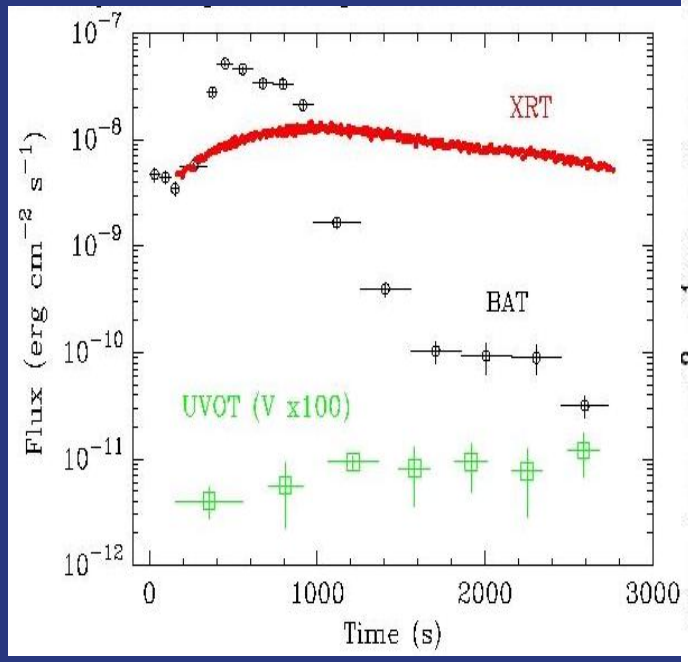
X-ray Flashes

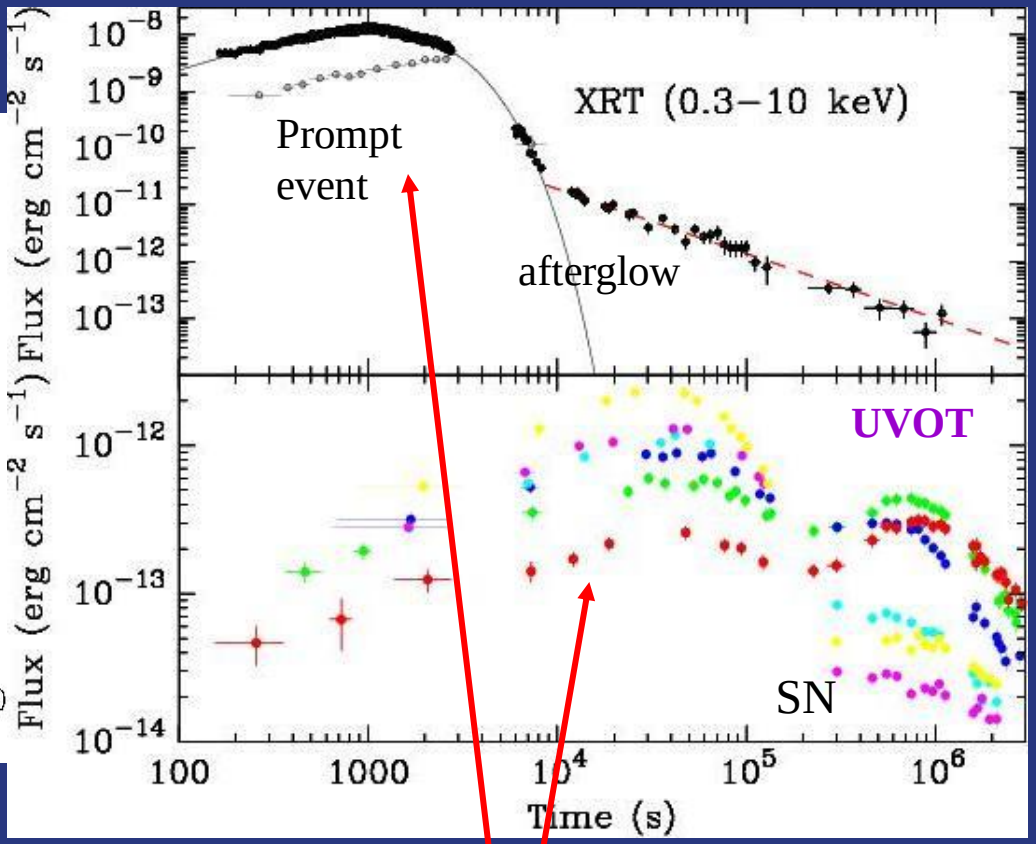




Swift was triggered by XRF060218 on Feb 18.149, 2006 UT

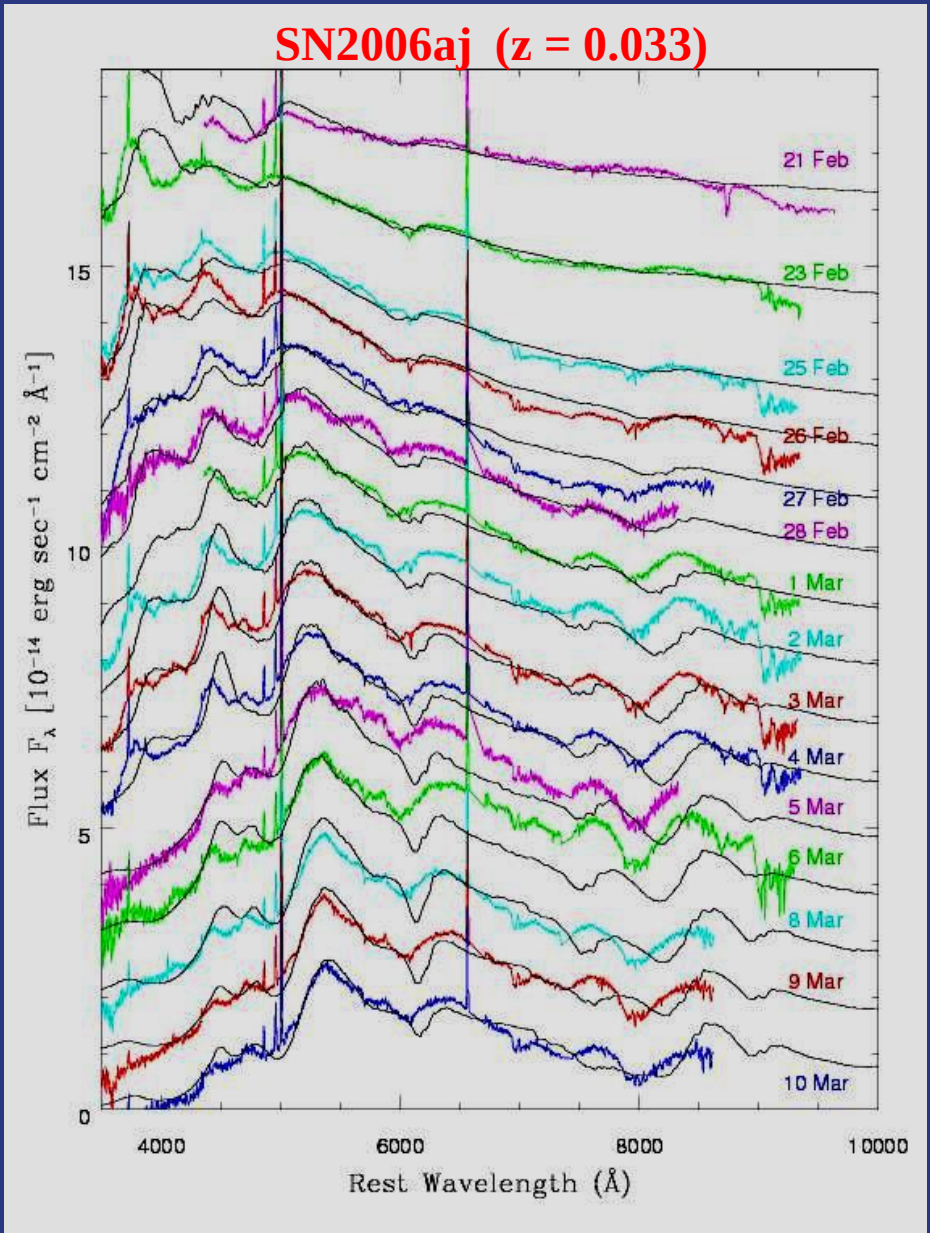
Campana et al. 2006





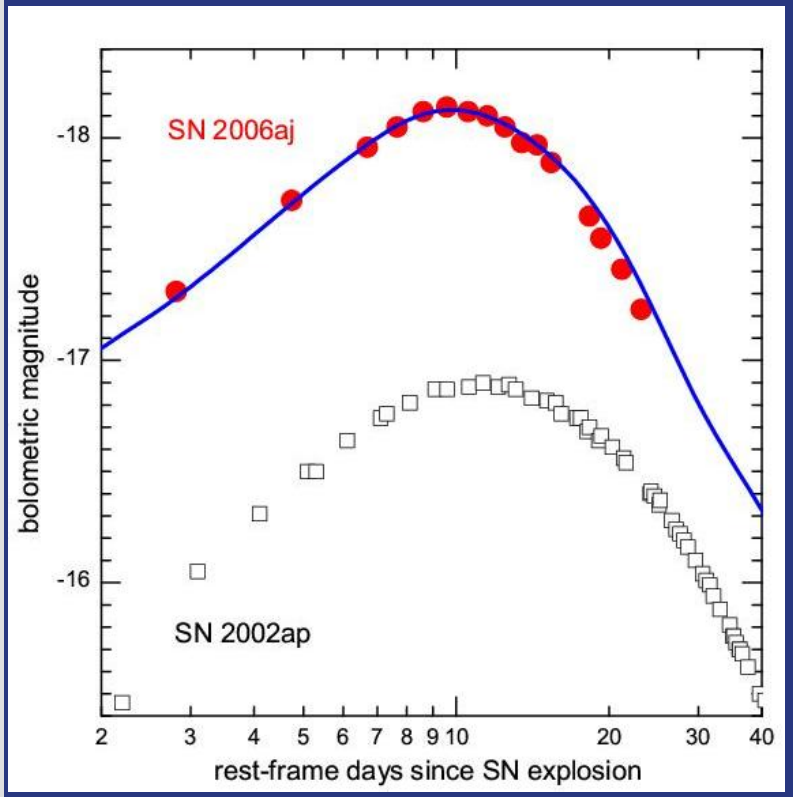
z = 0.033

Shock breakout or jet cocoon interaction with CSM,
Or central engine, or synchrotron + inverse Compton ?



M(56Ni) = 0.2 Msun
M(progenitor) = 20 Msun

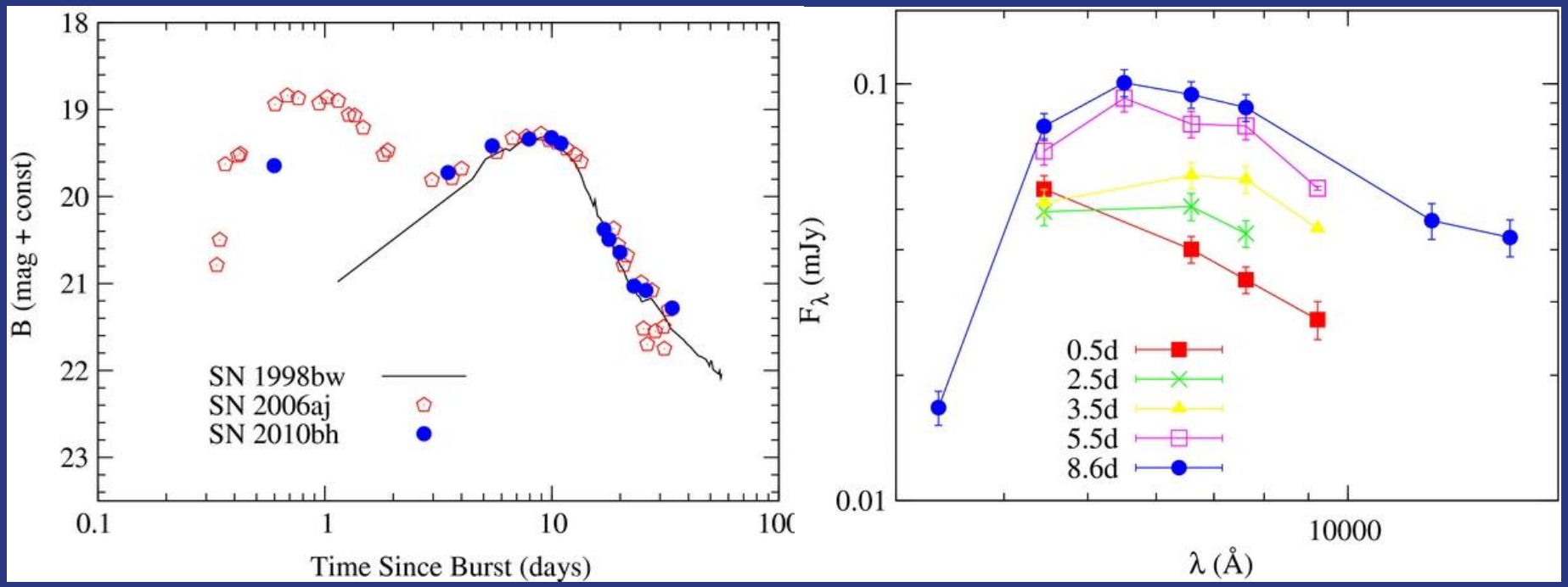
Mass of remnant is compatible With <u>neutron star</u> rather than Black hole



Pian et al. 2006; Mazzali et al. 2006; Ferrero et al. 2006

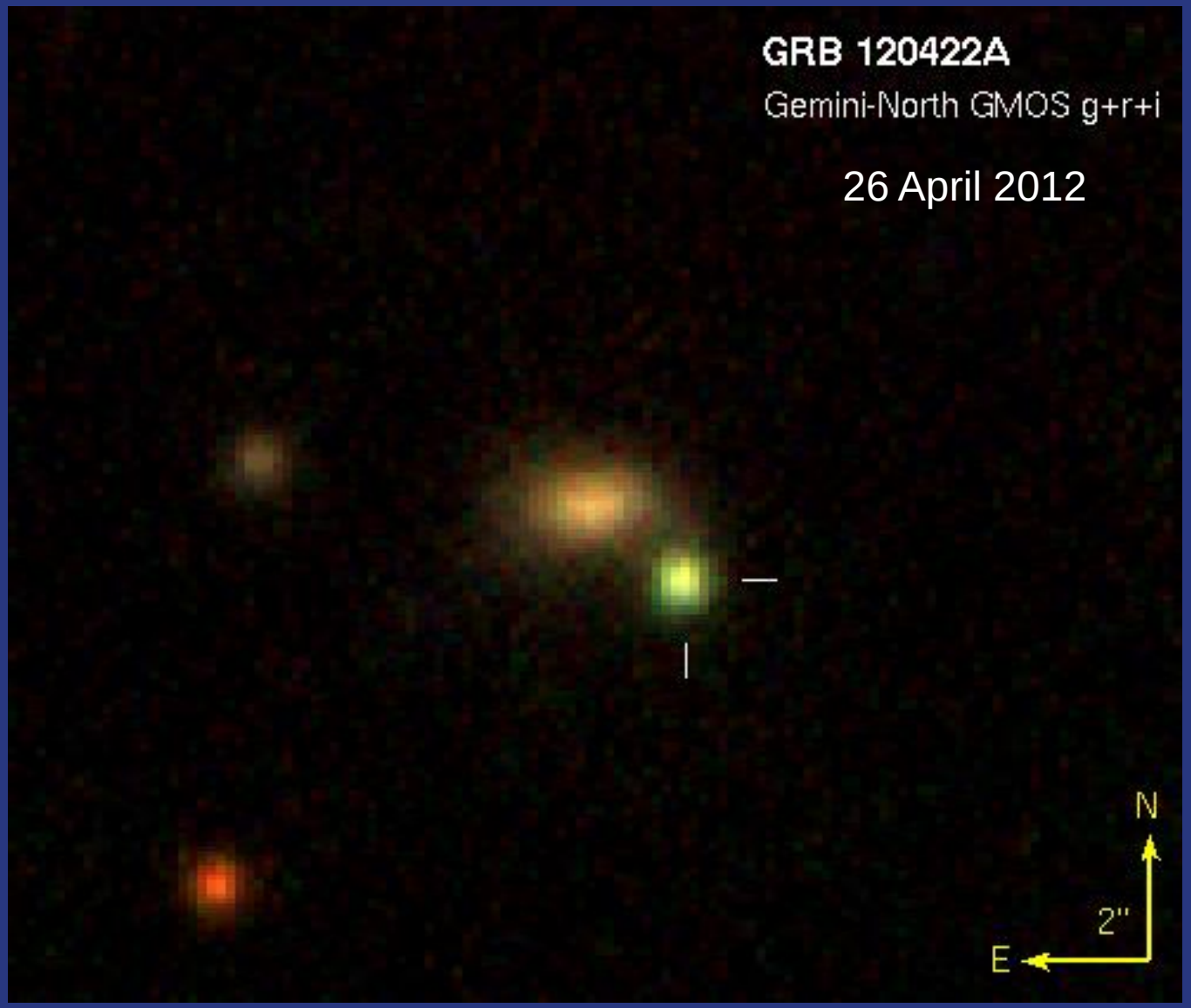
Shock breakout in SN2010bh (z = 0.059)

Gemini-South, Faulkes telescope, HST



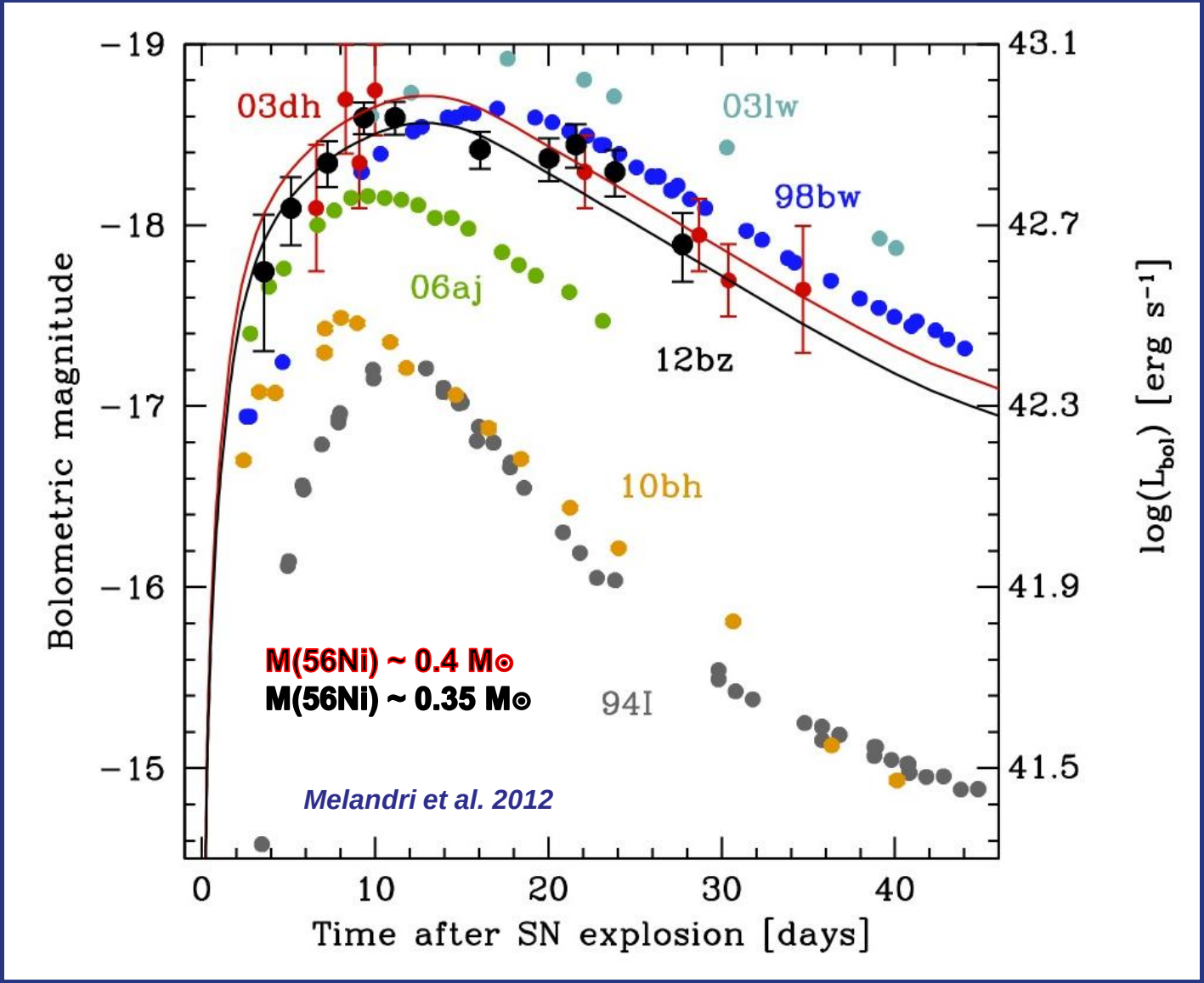
Cano et al. 2011

GRB120422A/SN2012bz (z = 0.283)

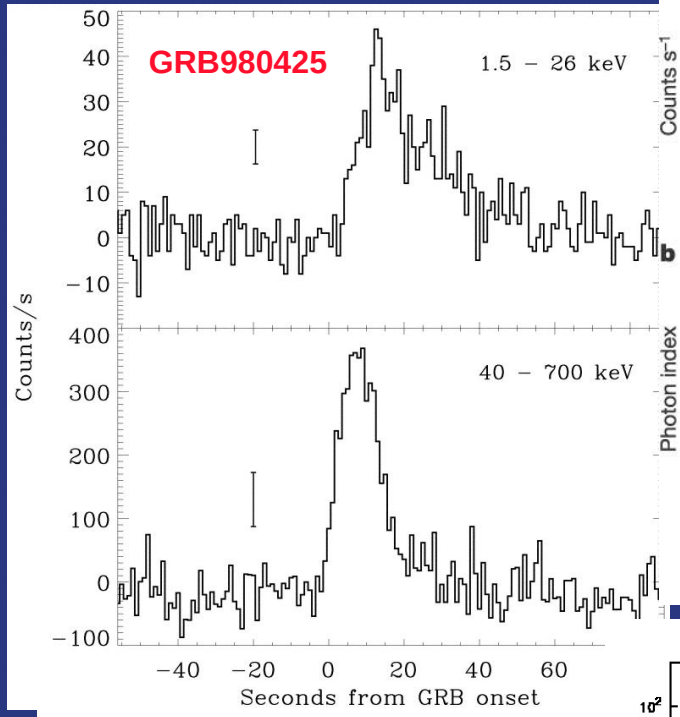


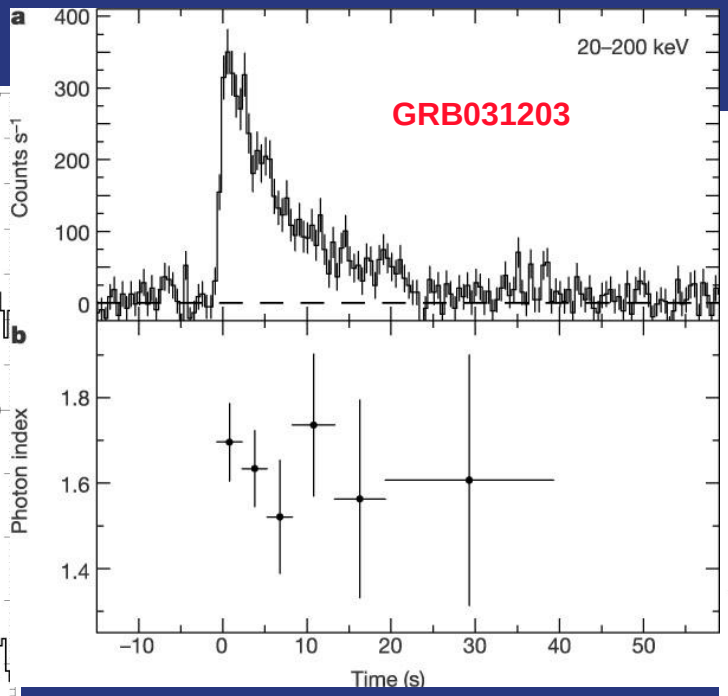
Perley et al. 2012

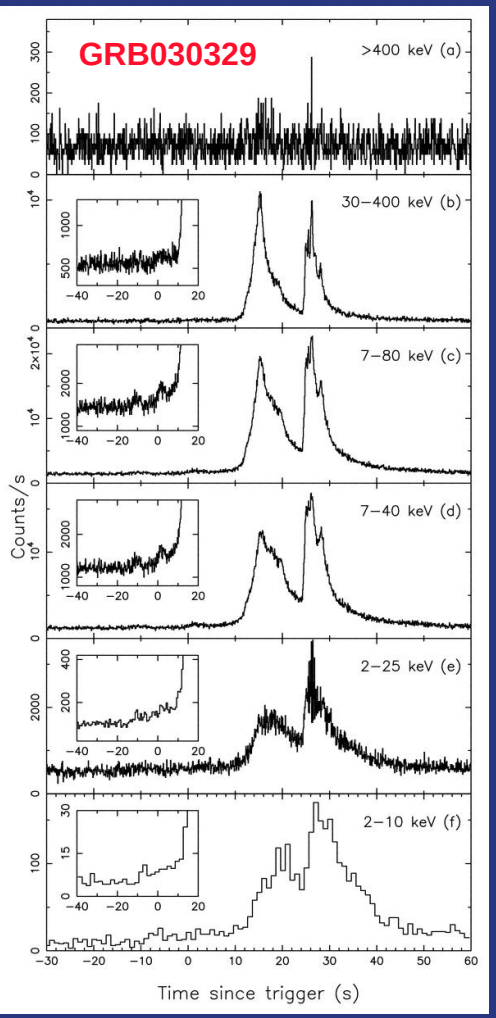
Light Curves of GRB and XRF Supernovae at z < 0.3

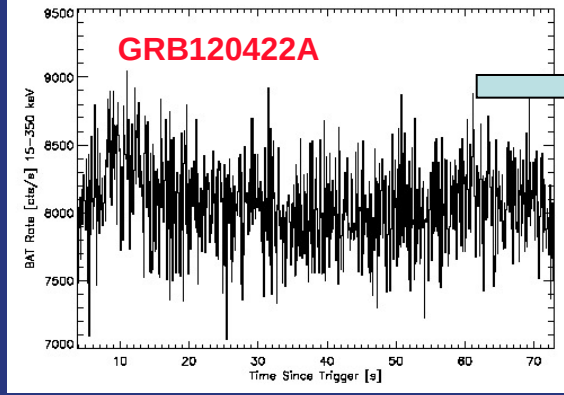


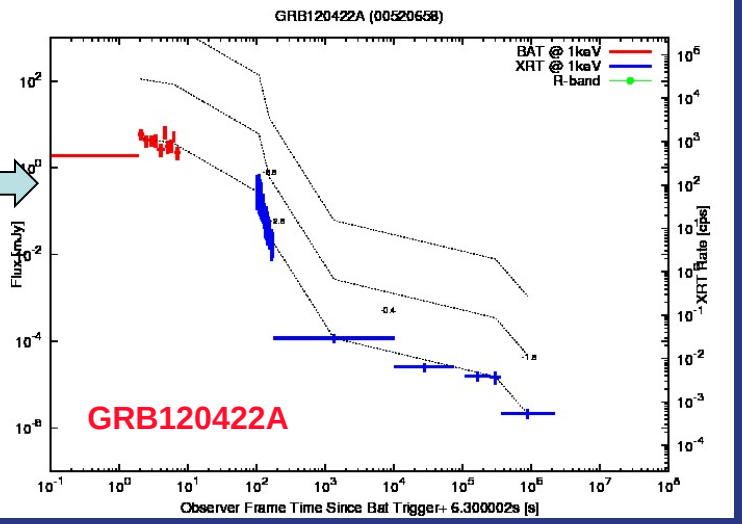
GRBs with supernovae



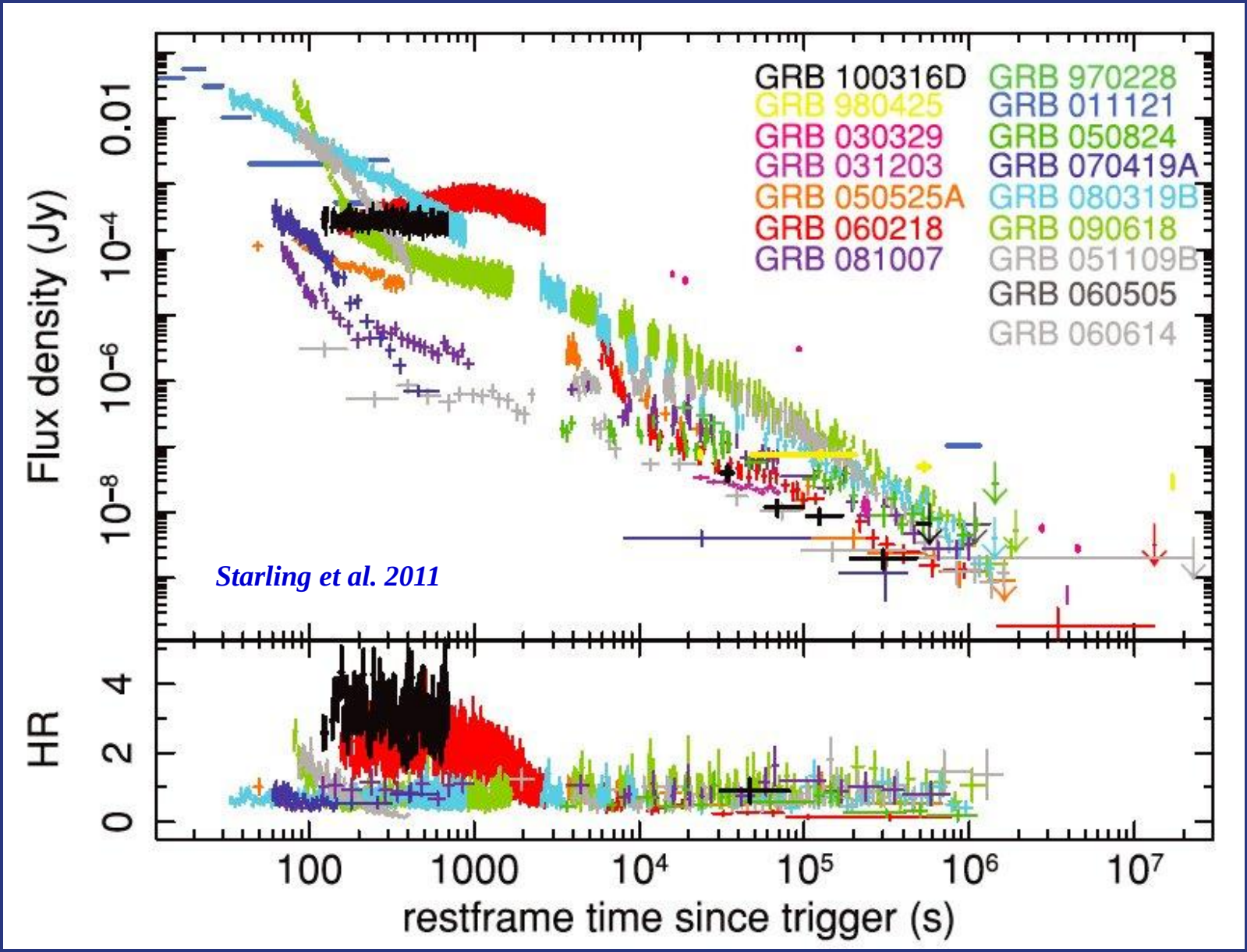




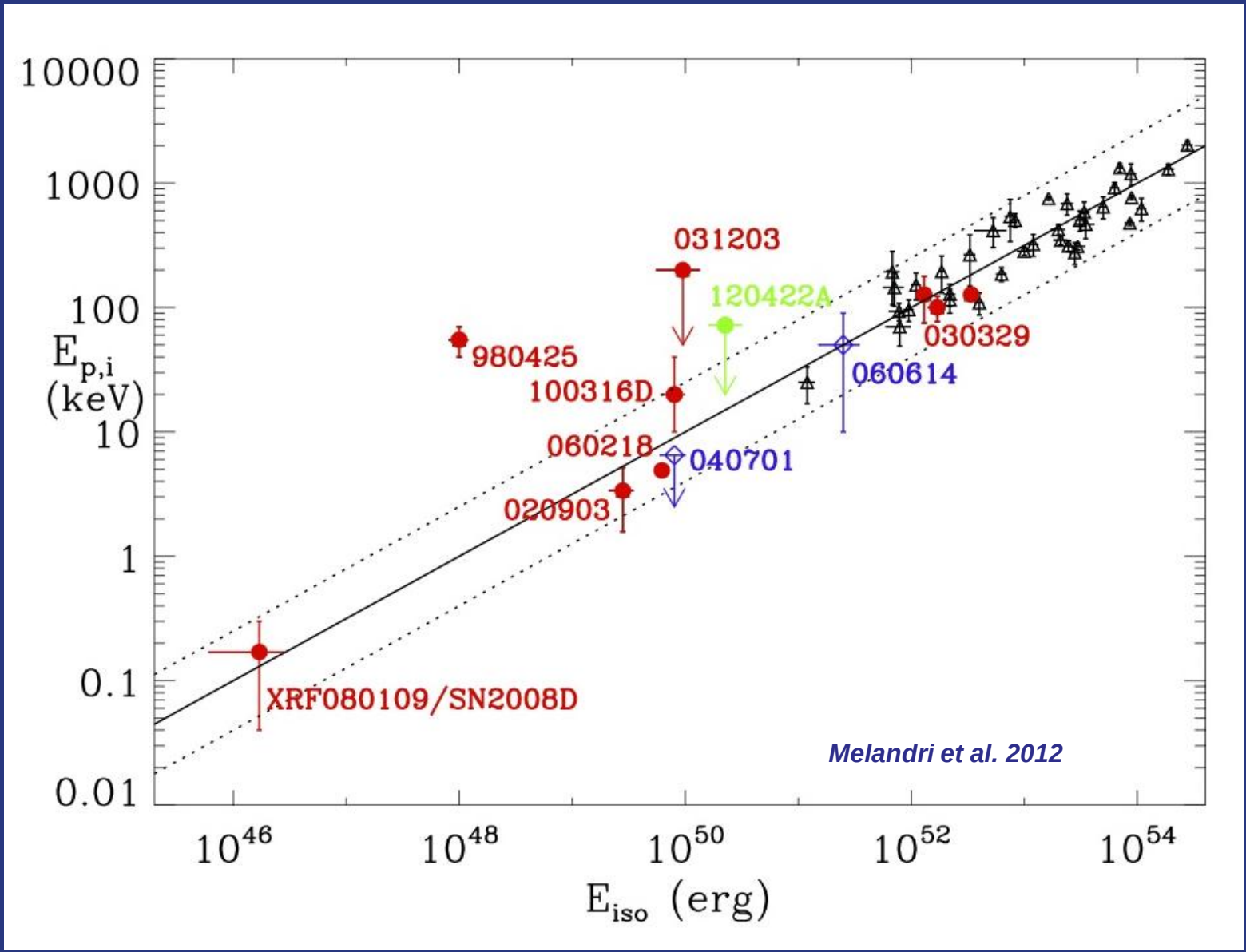




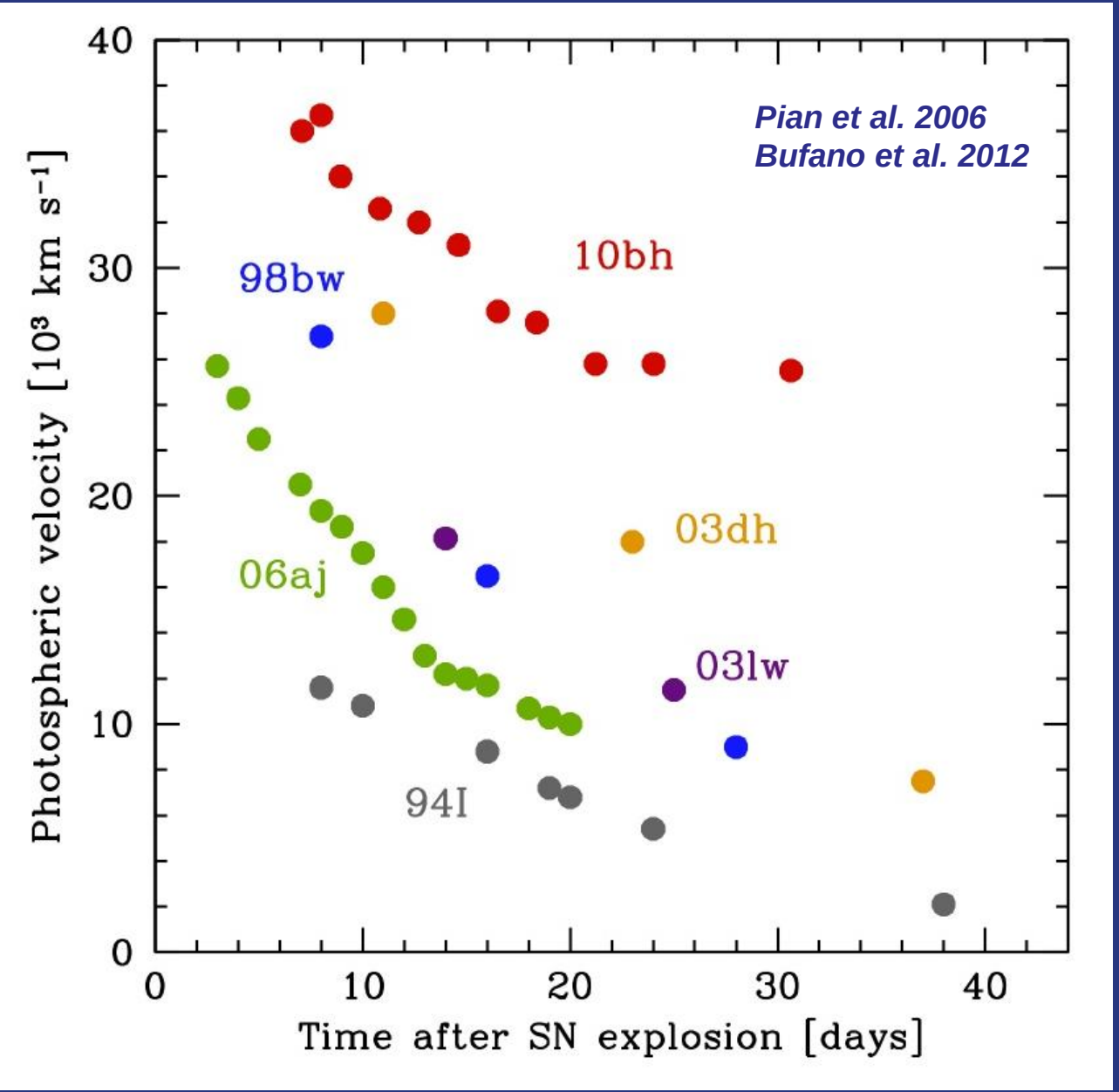
X-ray light curves of low-redshift GRBs



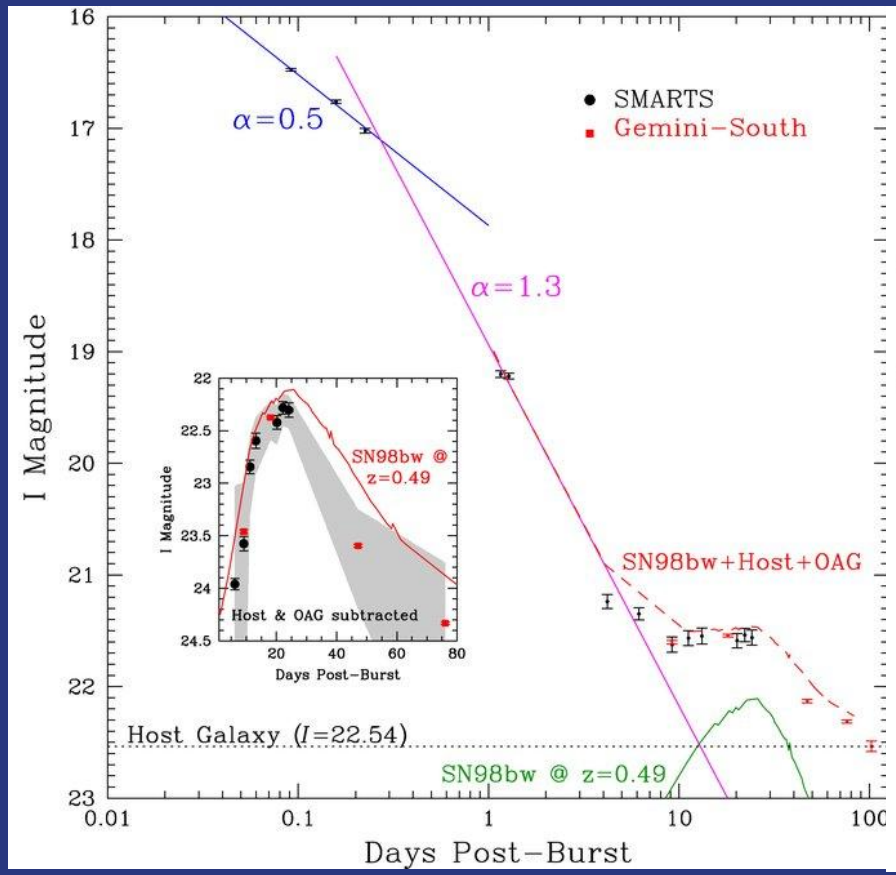
Amati Relationship

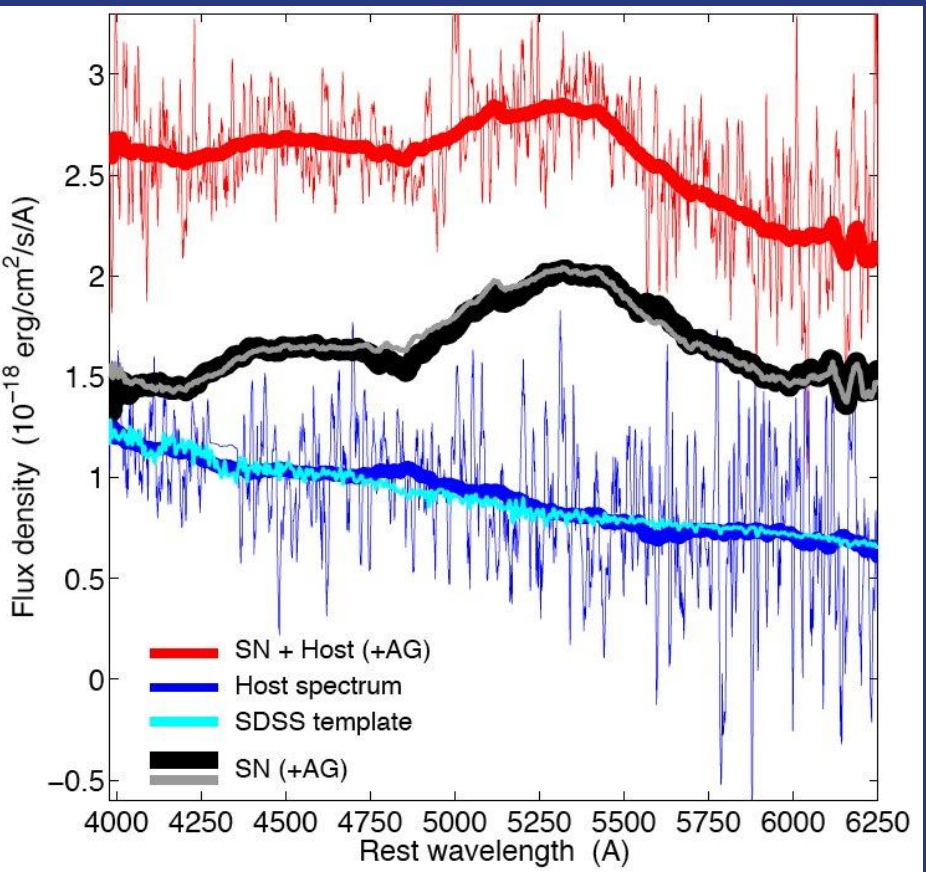


Photospheric velocities of Type Ic SNe



GRB091127/SN2009nz (z = 0.49)

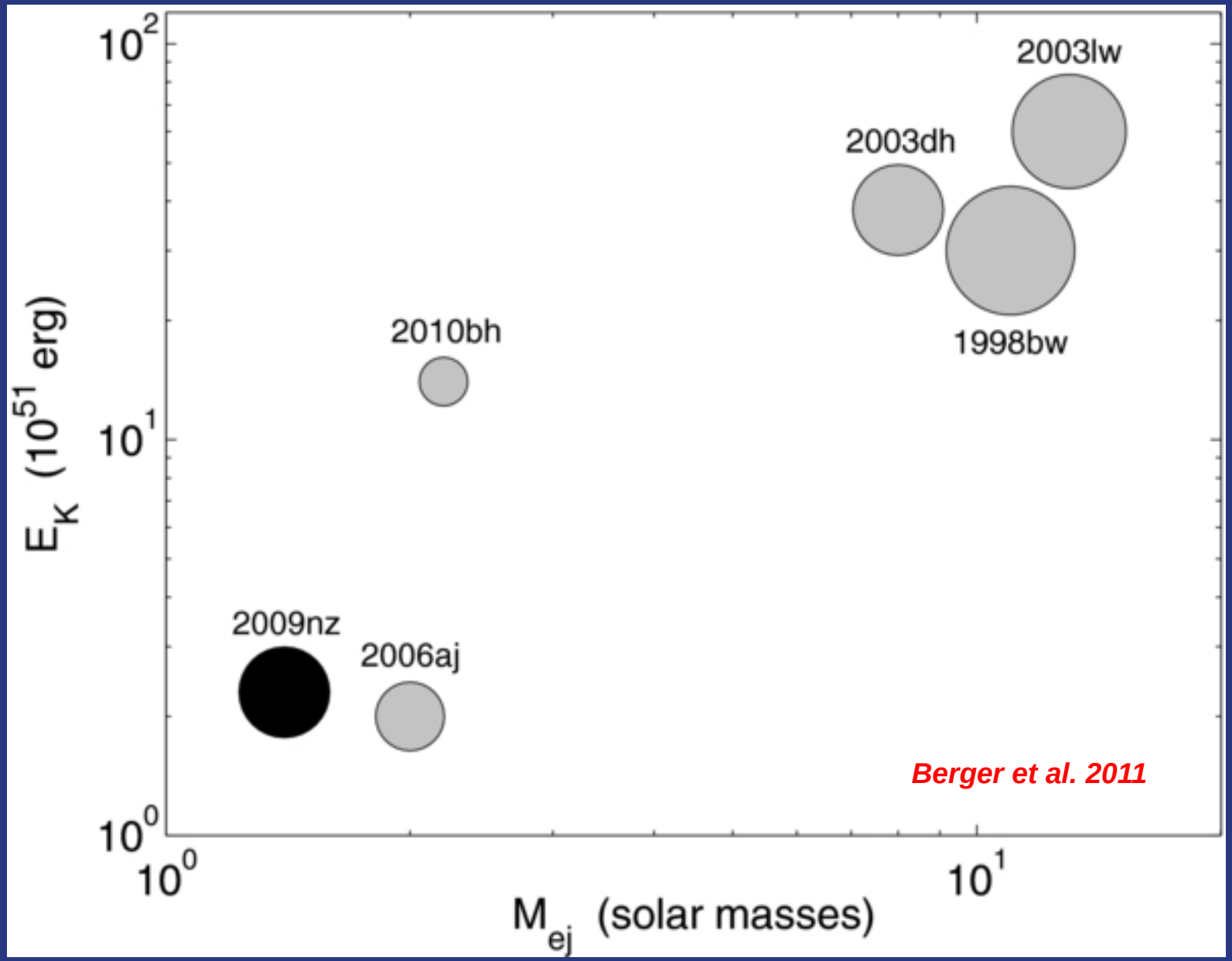




Cobb et al. 2010

Gemini/GMOS, Berger et al. 2011

Properties of GRB-SNe



Summary and open problems

Most long GRBs and XRFs are associated with energetic spectroscopically identified Type Ic Sne. SNe associated with GRBs are more luminous than XRF-Sne

Mechanisms:
Collapsar: a BH forms after the core collapses, and rapid accretion on it feeds the GRB jet.
Magnetar: the NS spin-down powers a relativistic jet

Is the early high energy emission due to an engine (jet) or to shock breakout?

Not all Type Ic SNe make GRBs.
Can these be misaligned with
Respect to the line of sight?