KITP, 29 March 2007

The Progenitors of Long and Short Gamma-Ray Bursts

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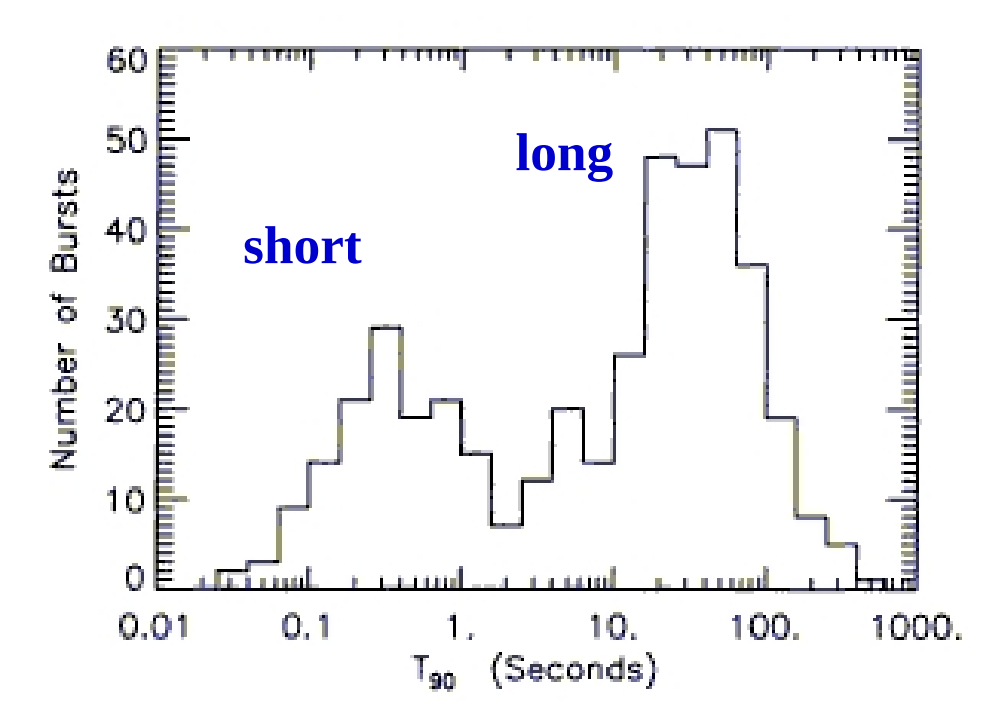
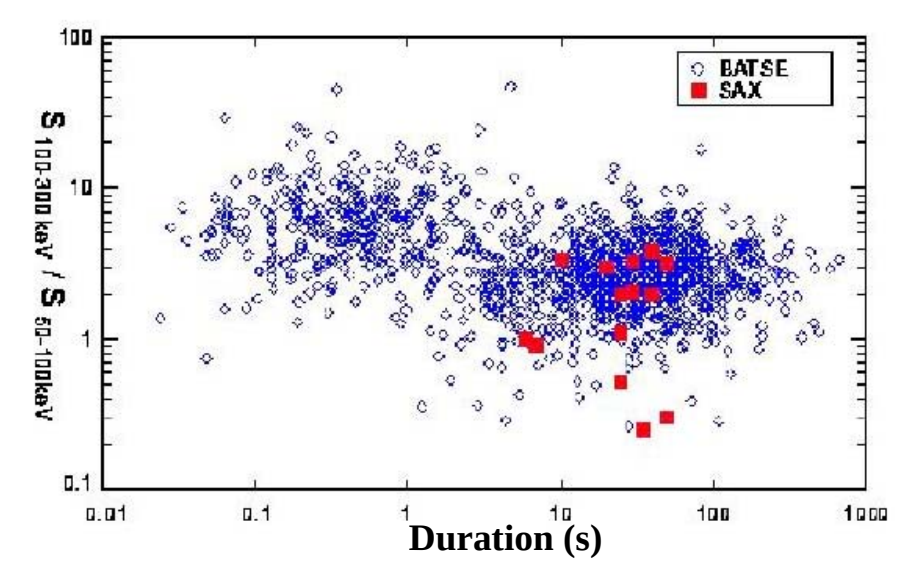
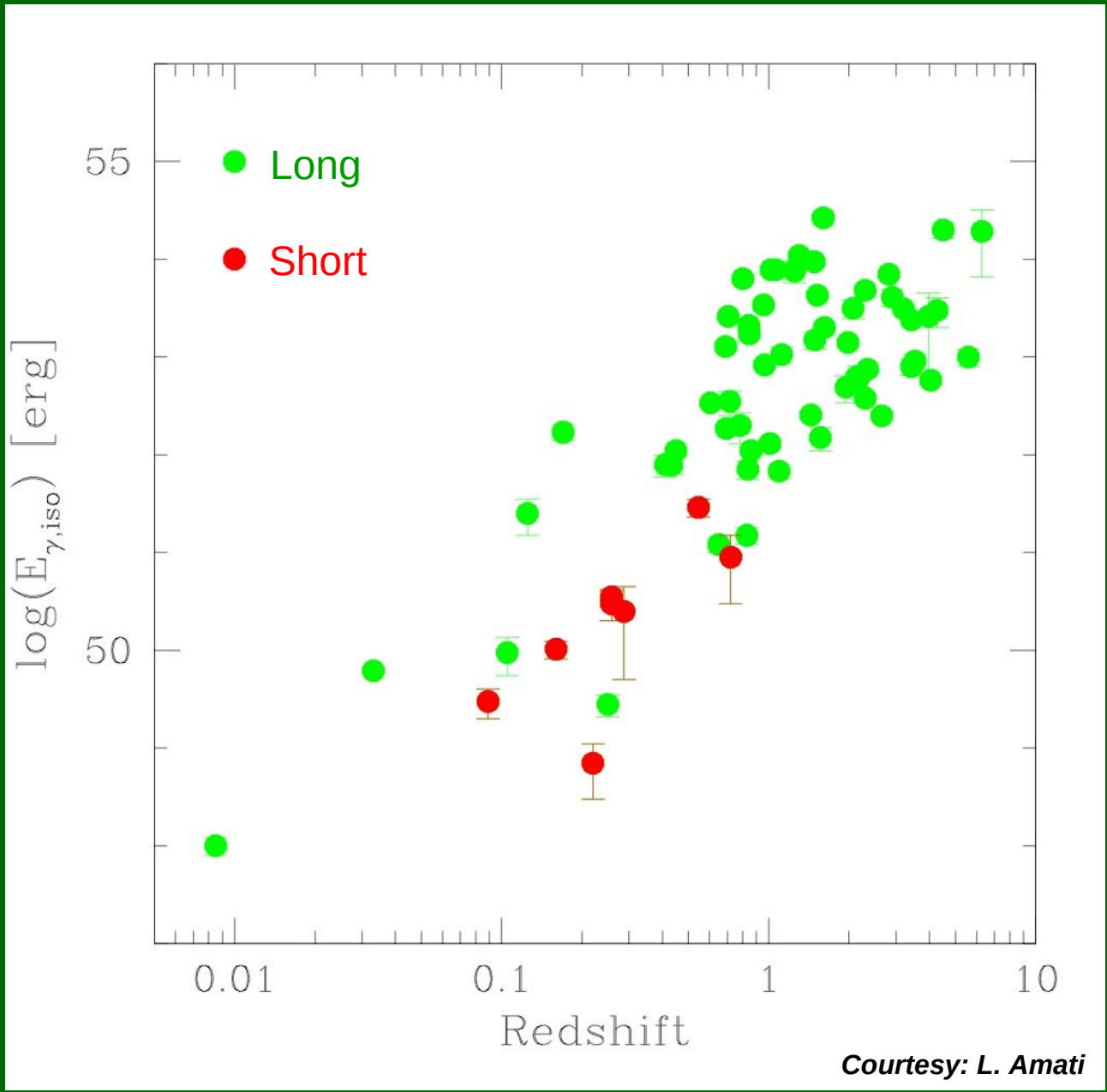




Bimodal distribution of GRB durations

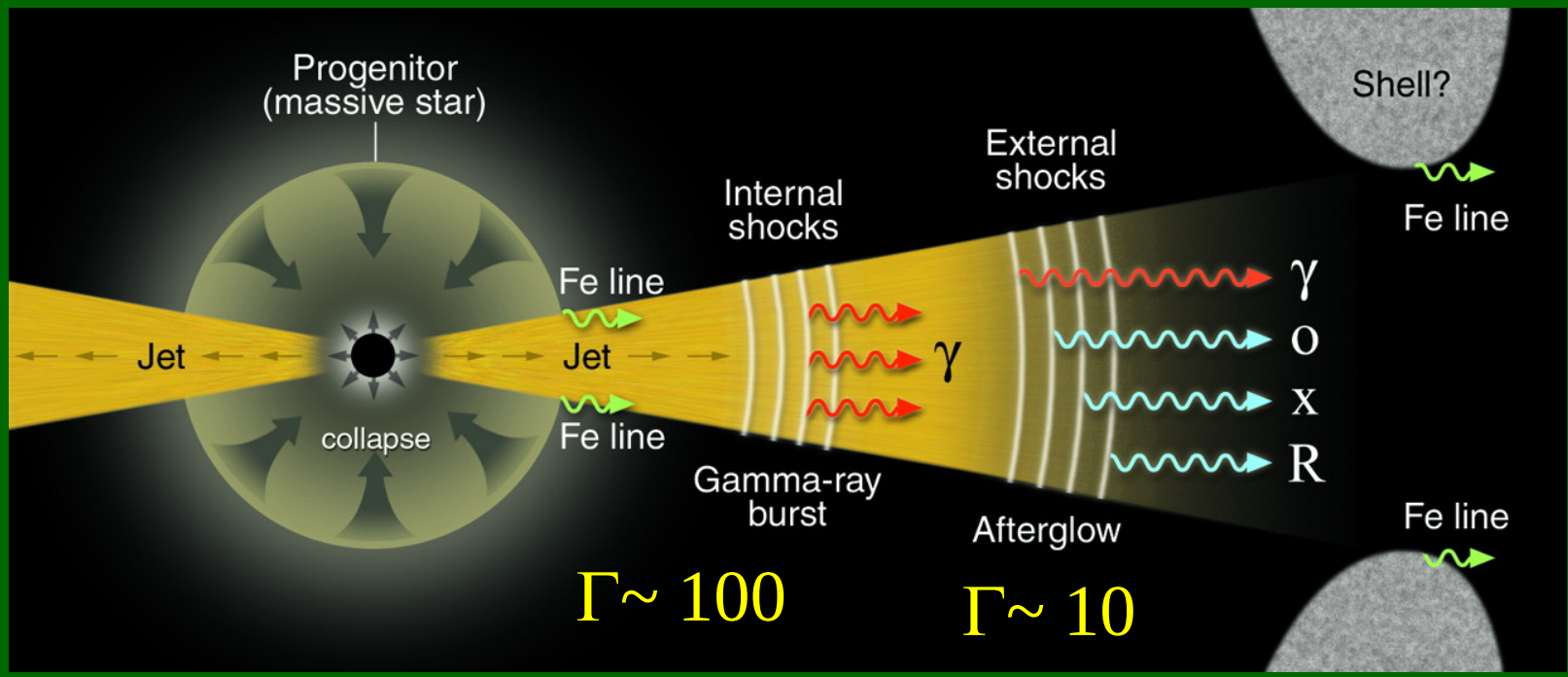
Kouveliotou 1993; Kulkarni 2000

Isotropic irradiated γ–ray energy vs redshift



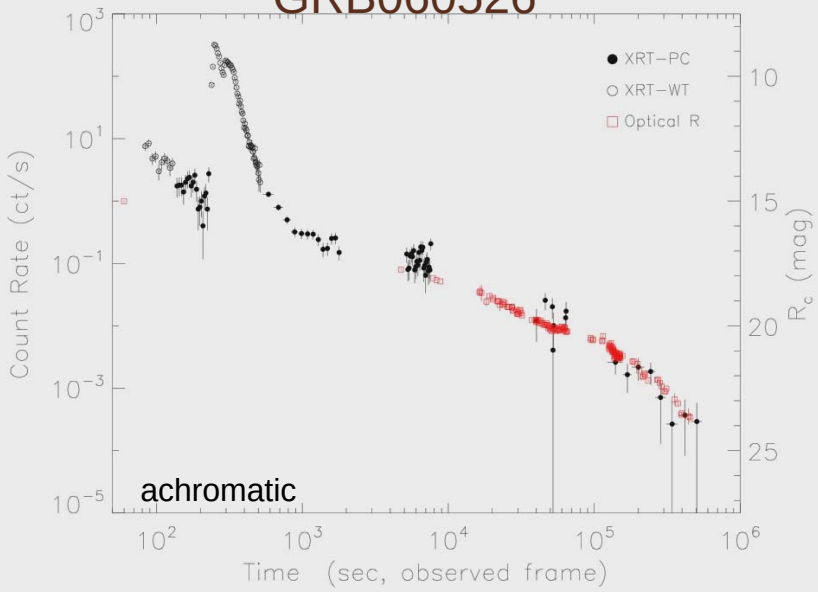
Courtesy: L. Amati

Breaks in the afterglow light curves are related To the jet aperture

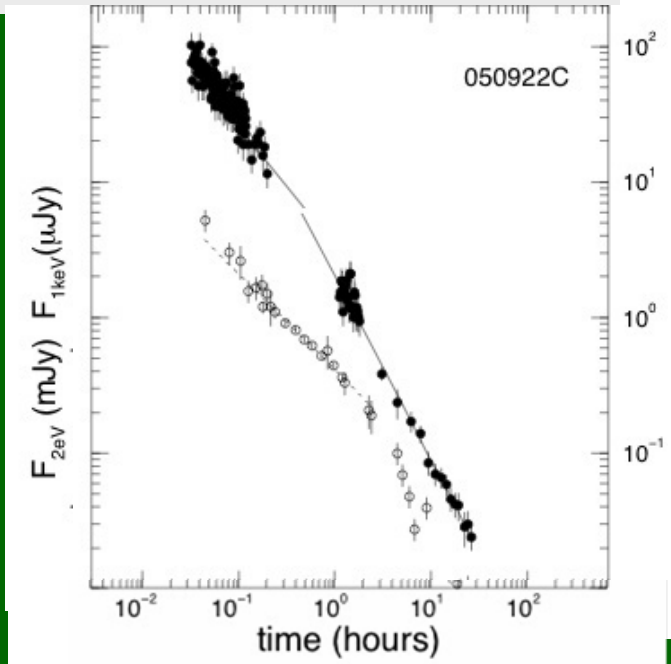


Multiwavelength breaks in long GRBs

GRB060526

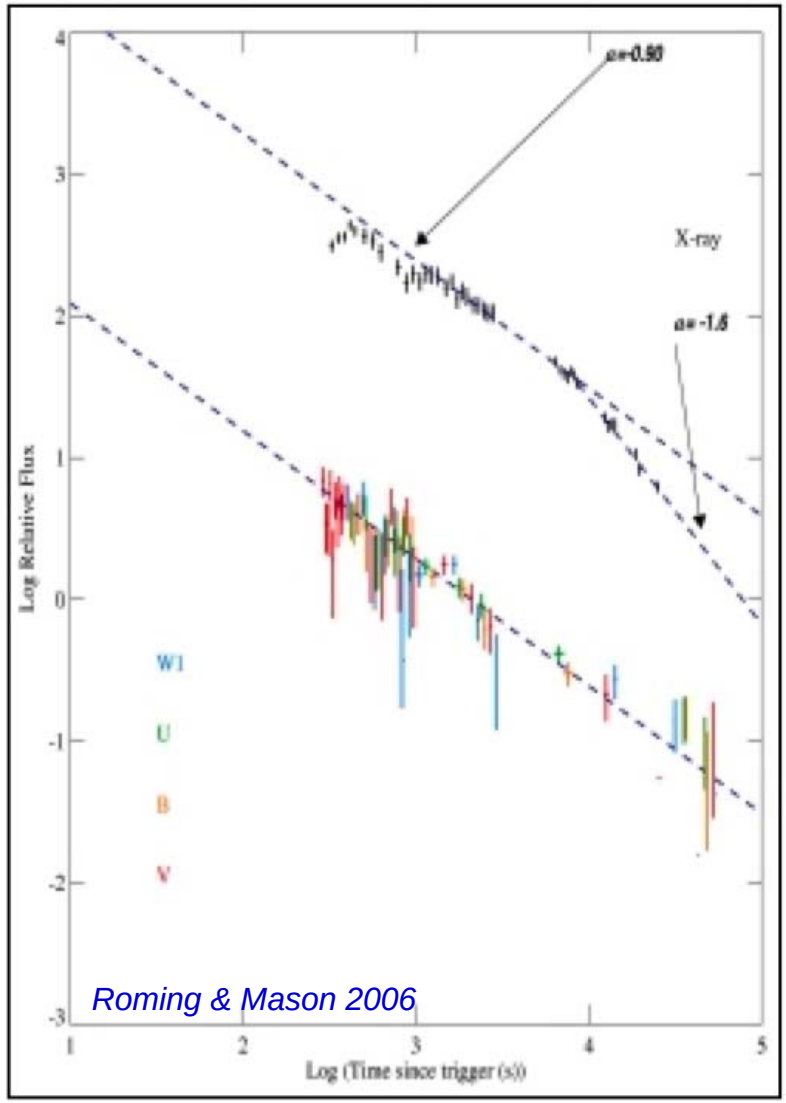


Dai et al. 2006



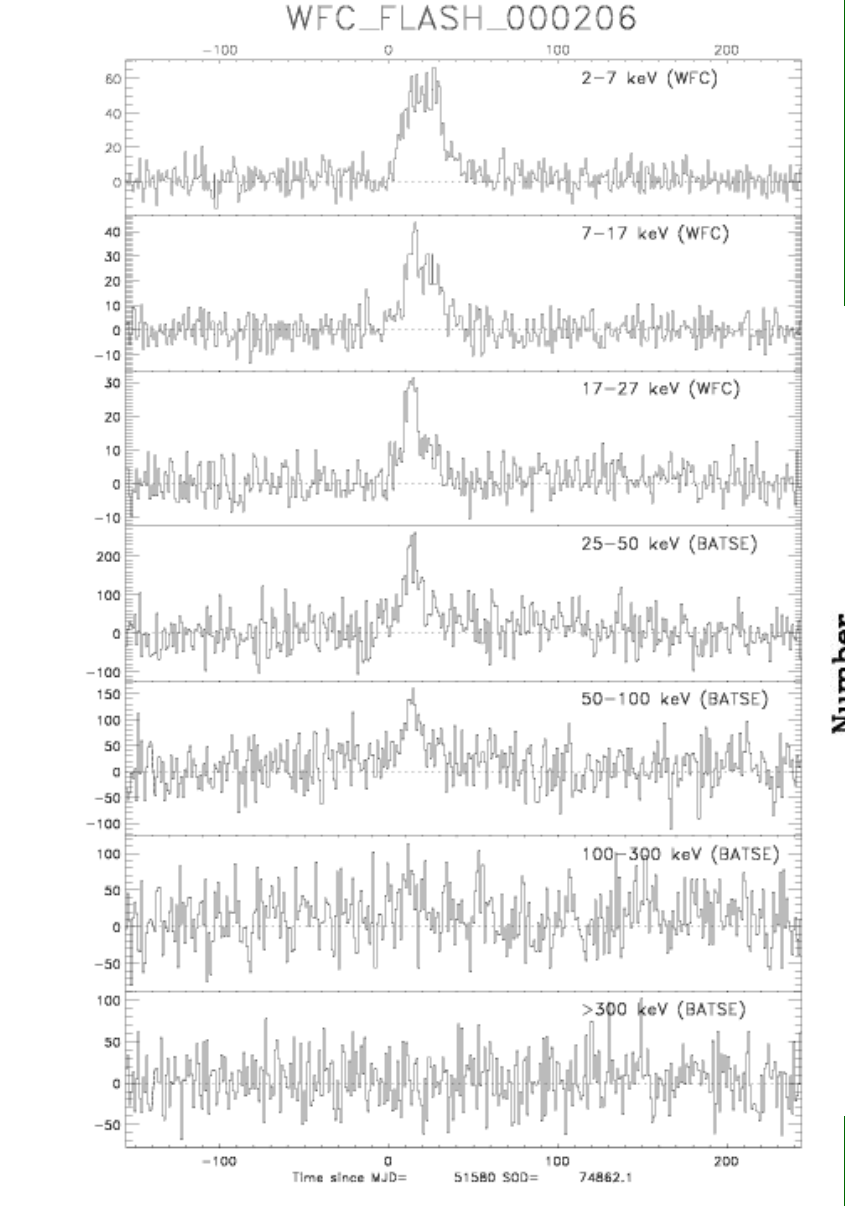
Panaitescu et al. 2006

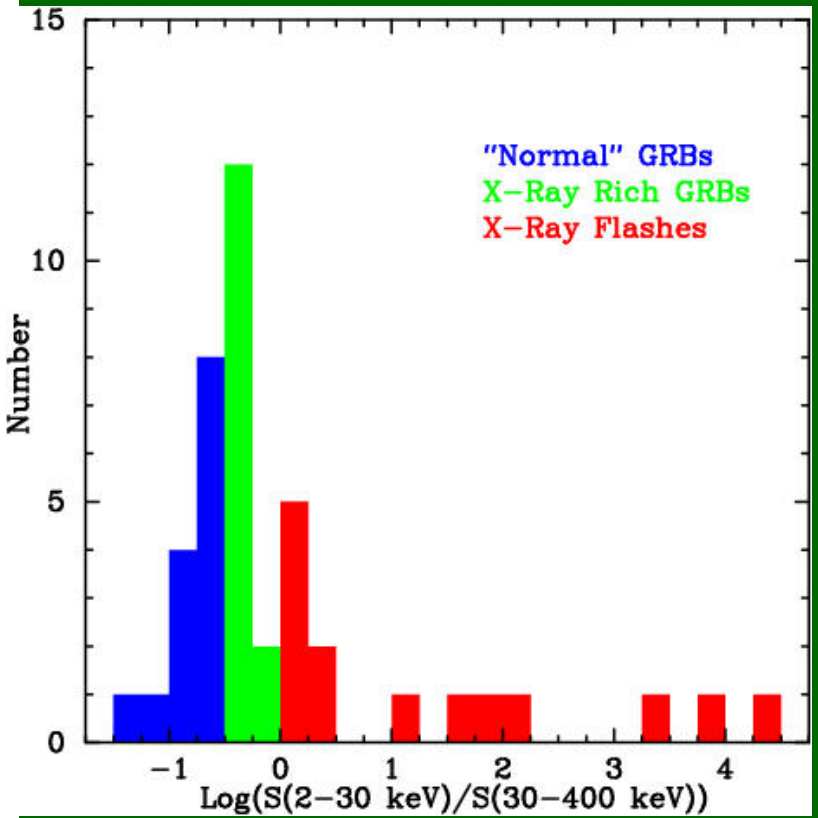
GRB050802



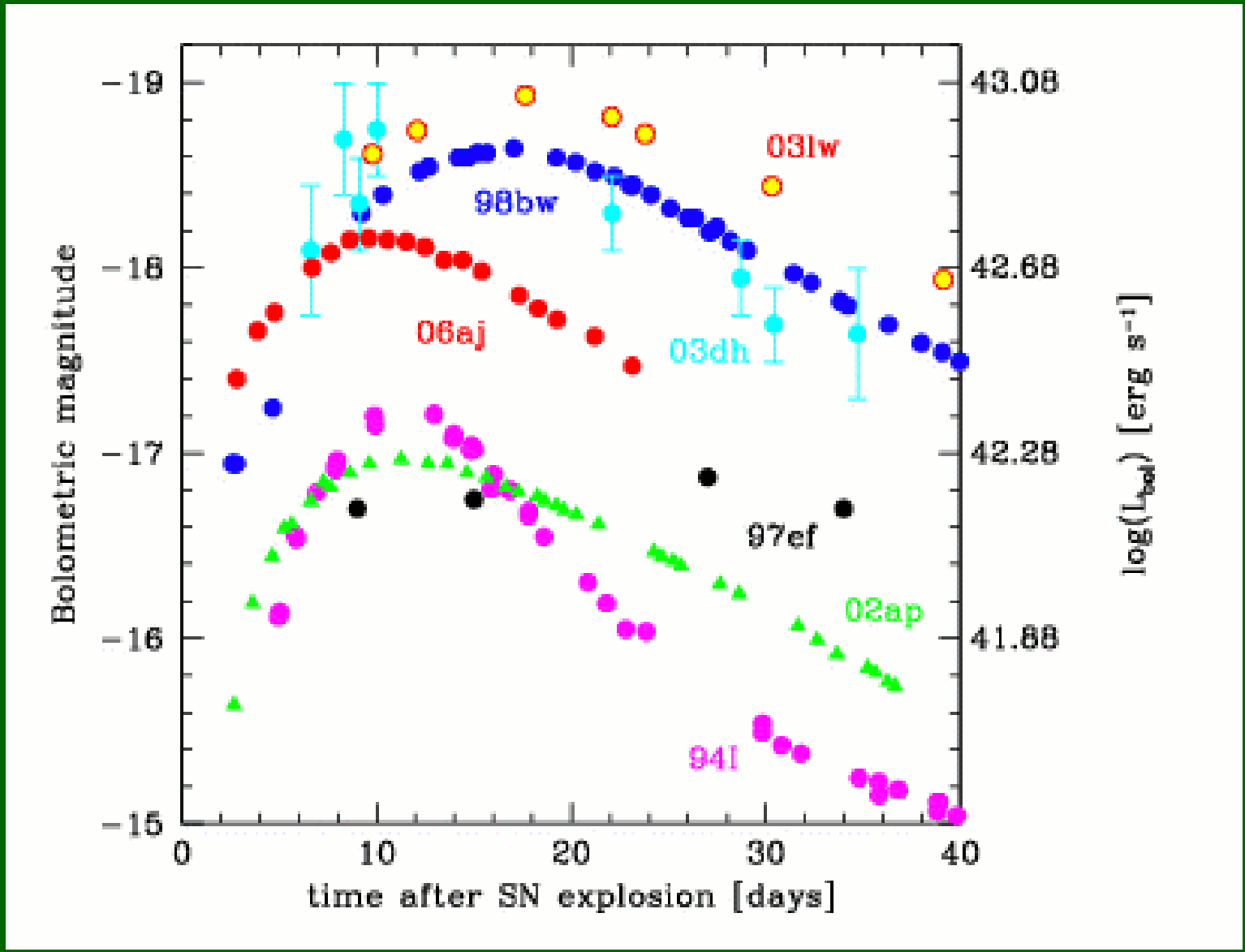
Roming & Mason 2006

X-ray Flashes



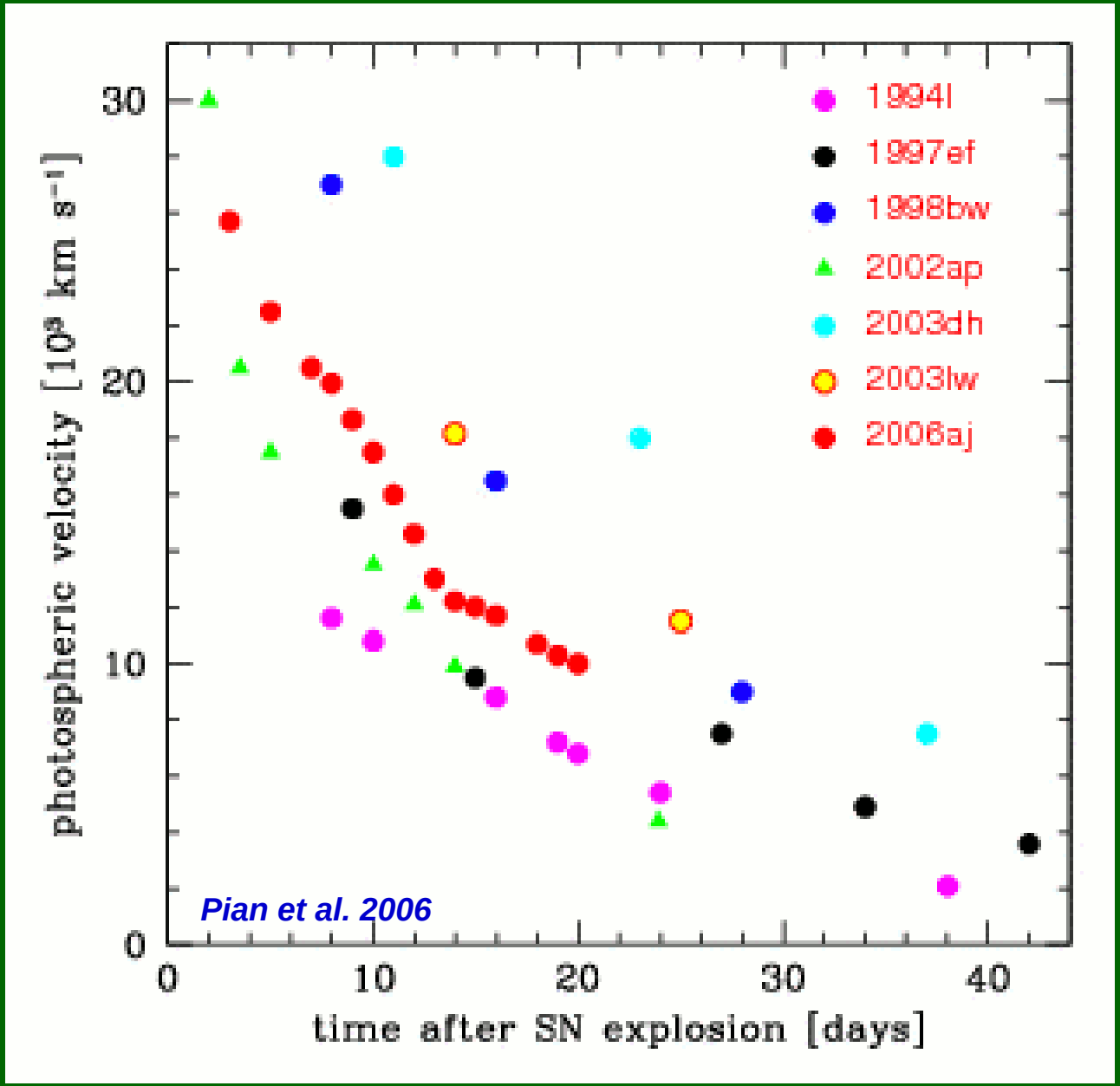


Light curves of Ic SNe: GRB-SNe, broad-lined SNe, normal SNe



Pian et al. 2006

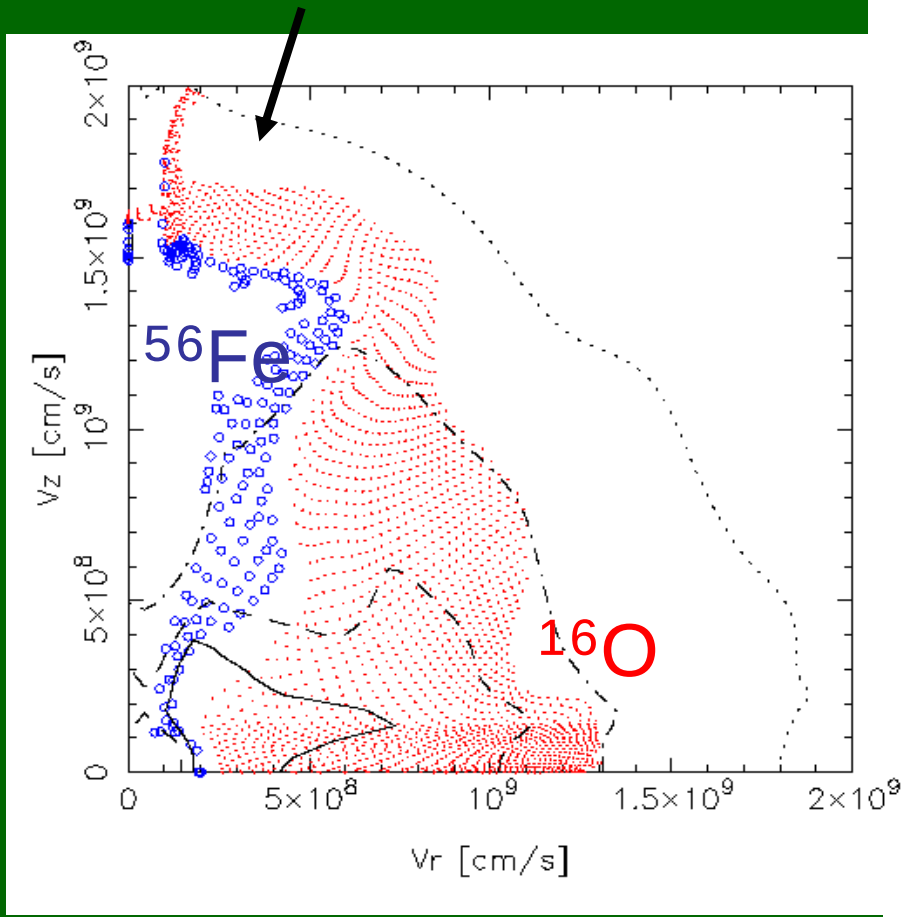
Photospheric velocities of Ic SNe



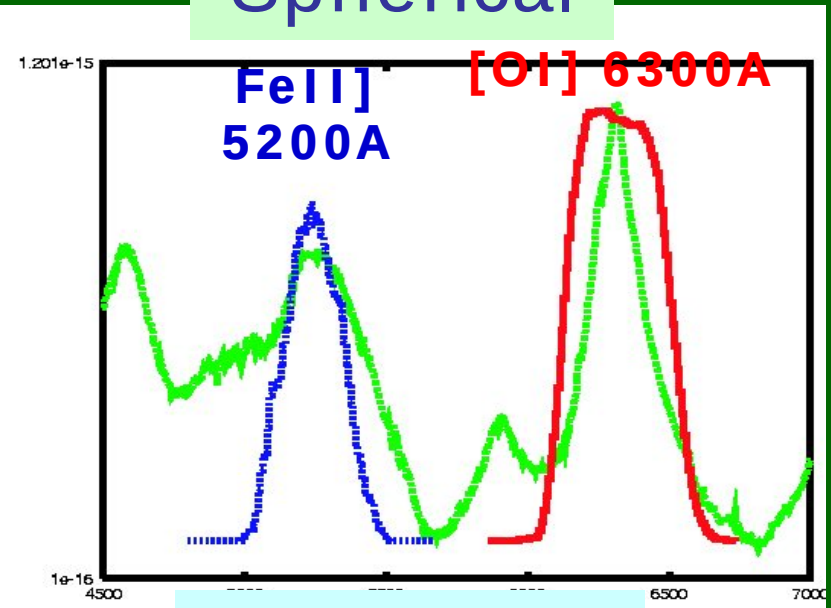
Aspherical explosion:

confined nucleosynthesis

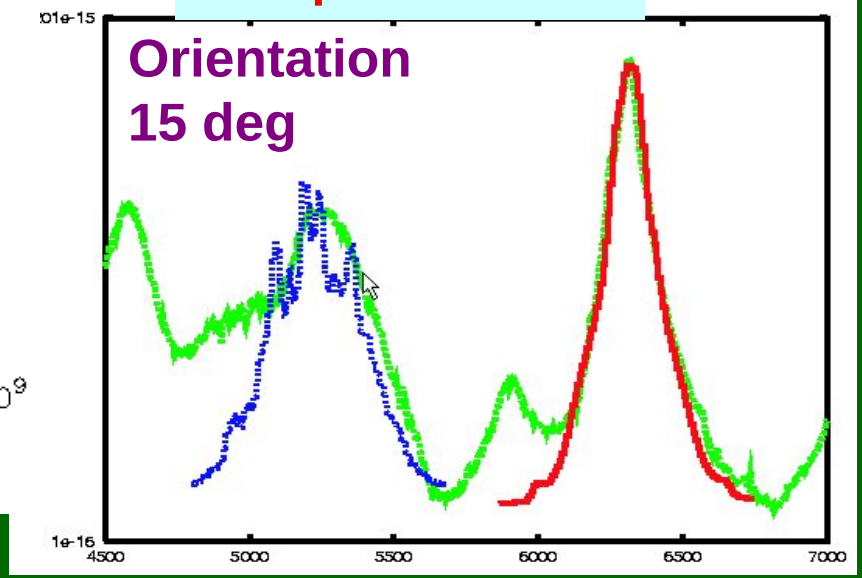
SN 1998bw



Spherical

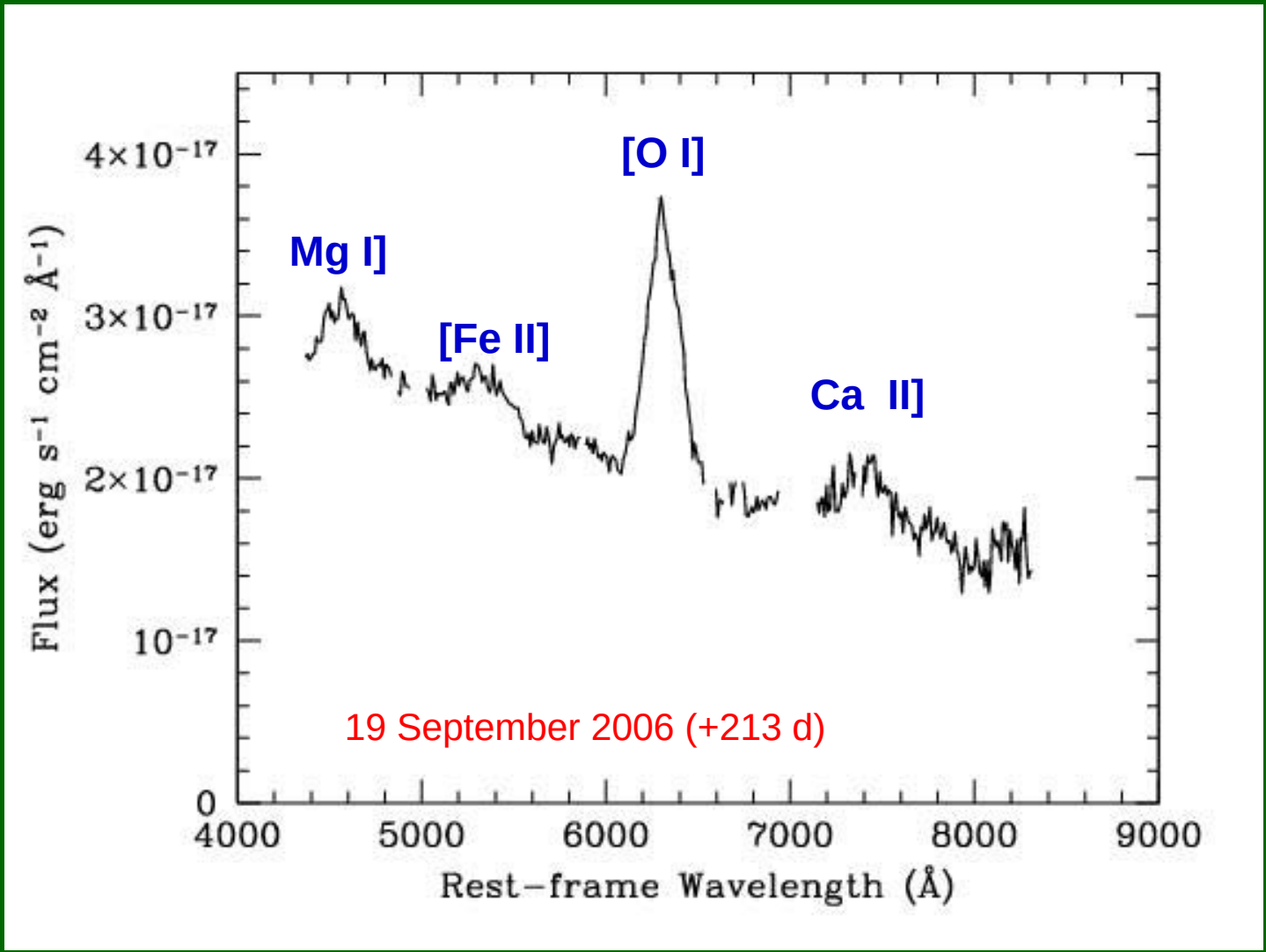


Aspherical

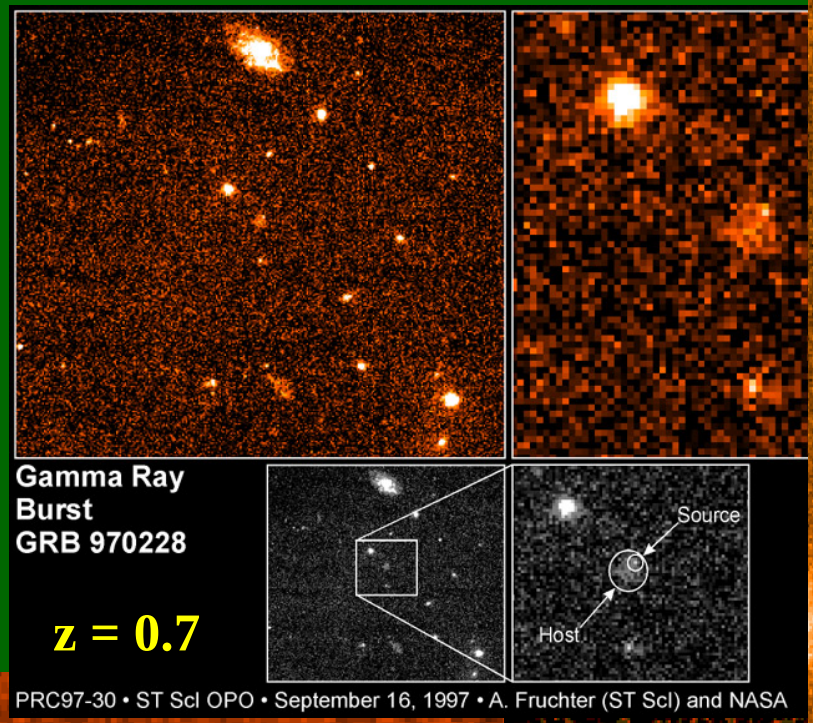


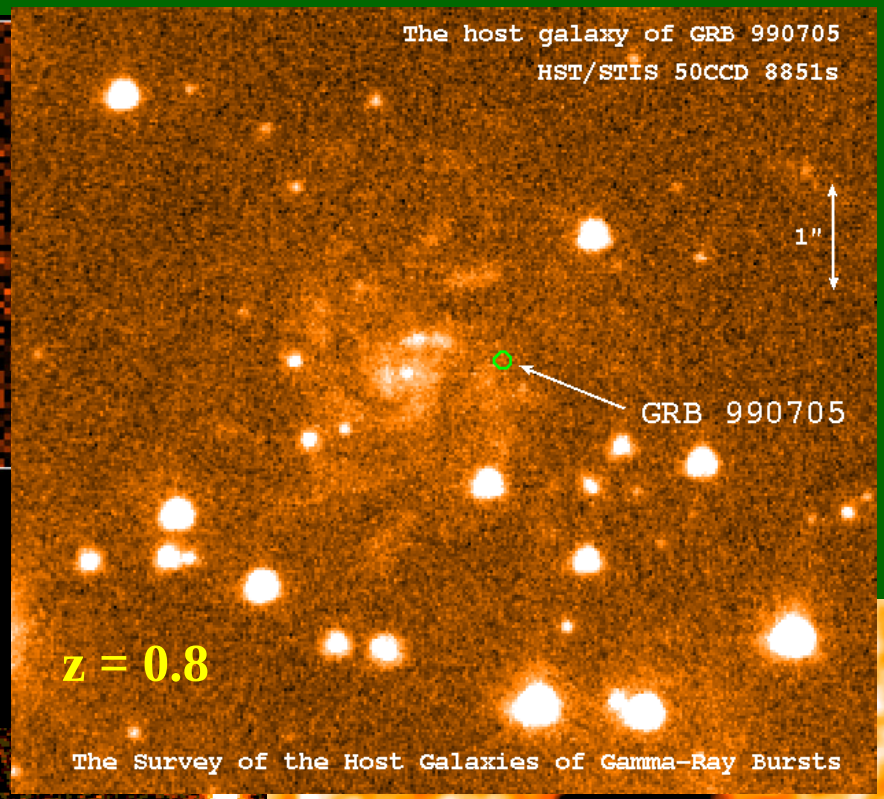
Maeda et al. 2002

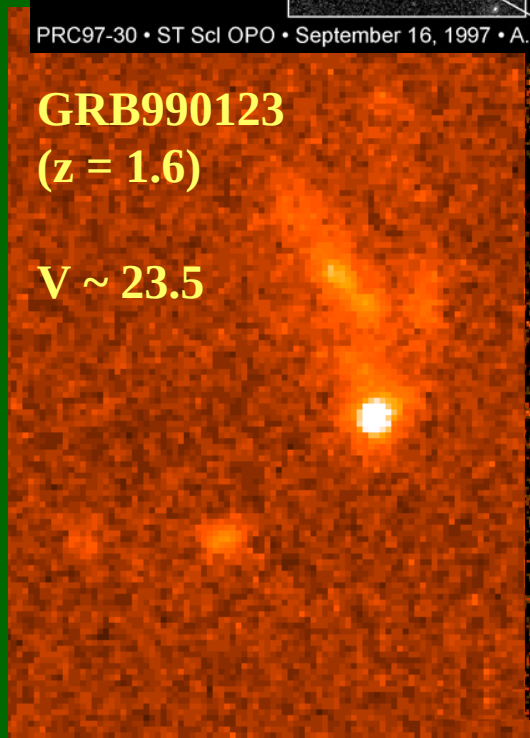
SN2006aj: VLT+FORS spectrum

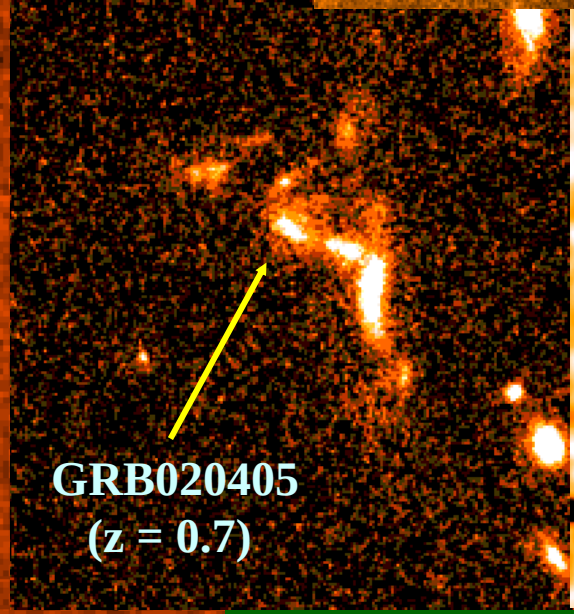


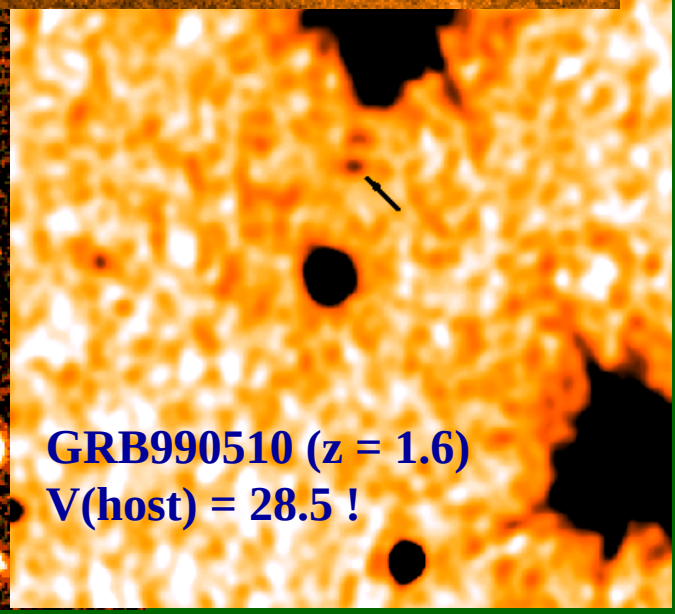
Mazzali et al. 2007


Gamma Ray
Burst
GRB 970228
z = 0.7
Source
Host
PRC97-30 • ST ScI OPO • September 16, 1997 • A. Fruchter (ST ScI) and NASA


The host galaxy of GRB 990705
HST/STIS 50CCD 8851s
1"
GRB 990705
z = 0.8
The Survey of the Host Galaxies of Gamma-Ray Bursts

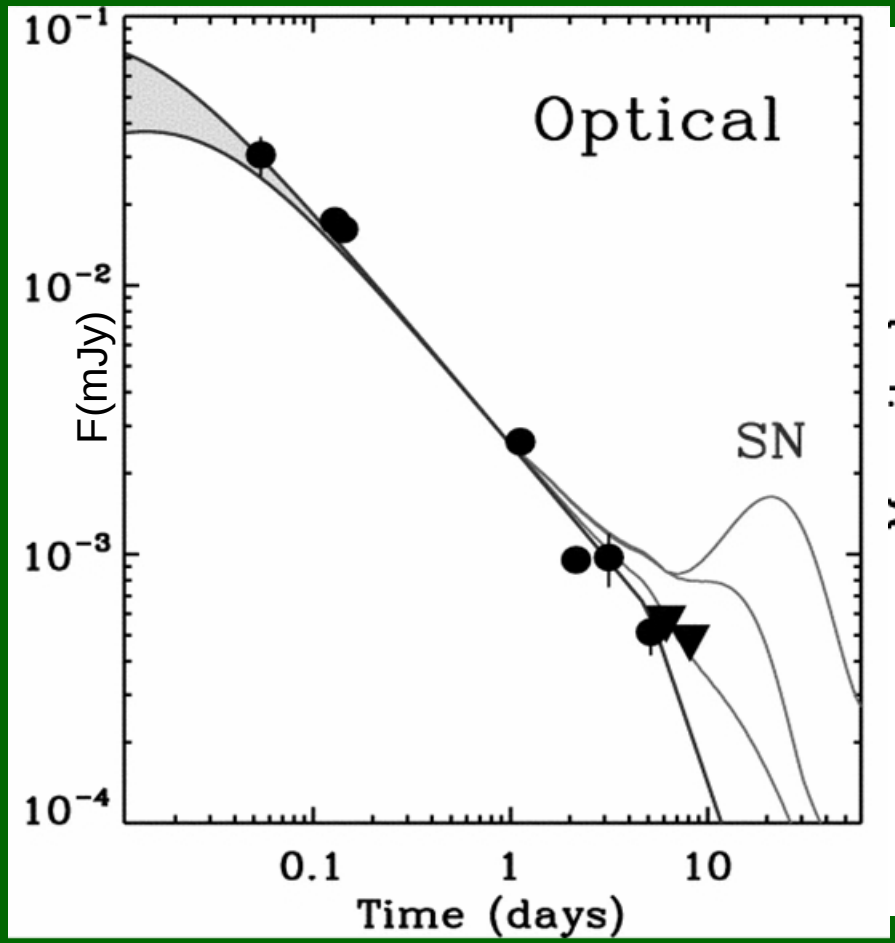

GRB990123
(z = 1.6)
V ~ 23.5


GRB020405
(z = 0.7)


GRB990510 (z = 1.6)
V(host) = 28.5 !

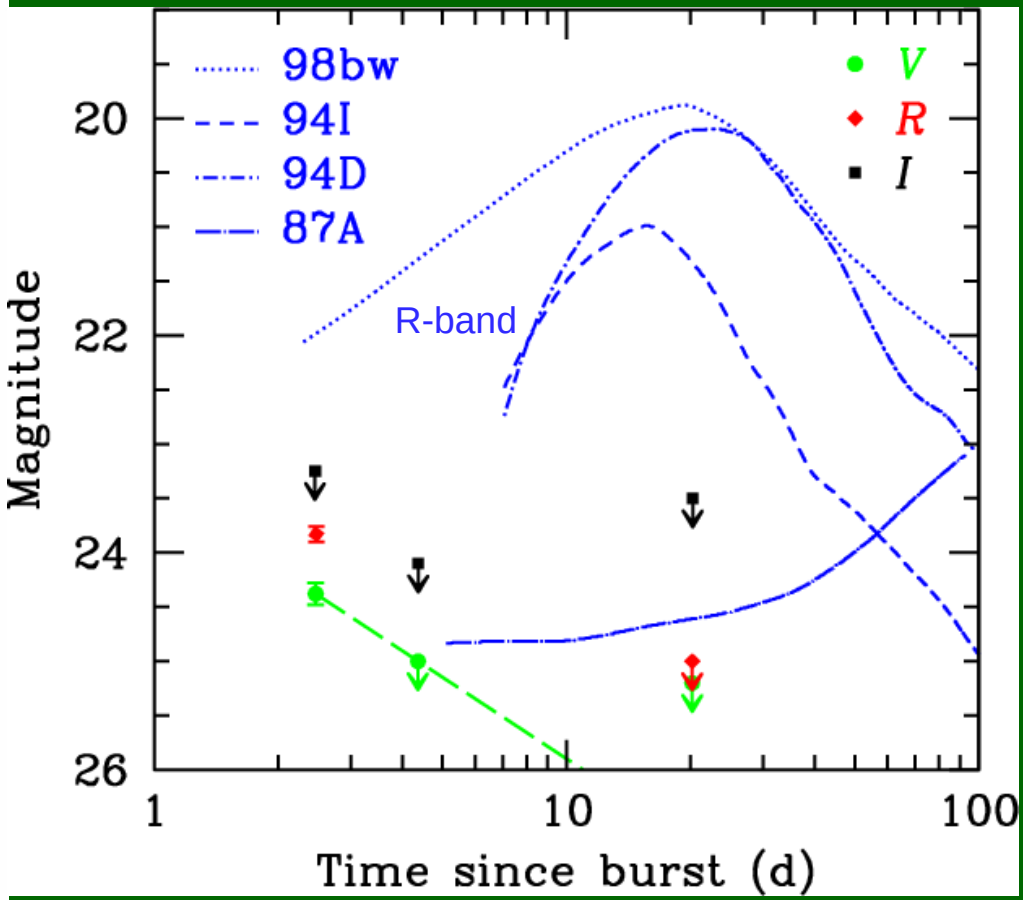
Supernova search in short GRBs

GRB051221A (z = 0.546)



Soderberg et al. 2006

GRB050709 (z = 0.16)

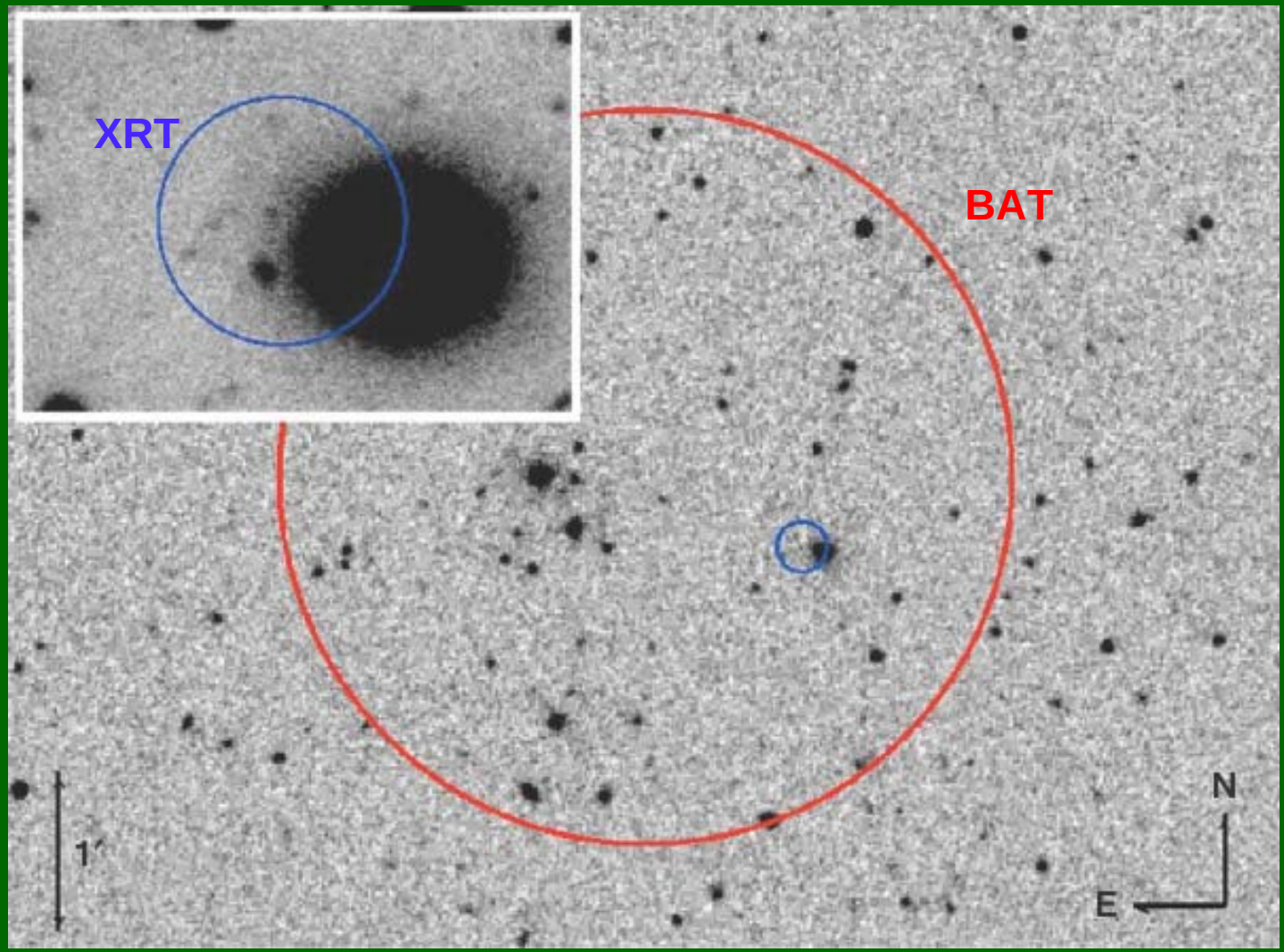


Covino et al. 2005

Short GRBs: GRB050509b (z = 0.225)

Elliptical host

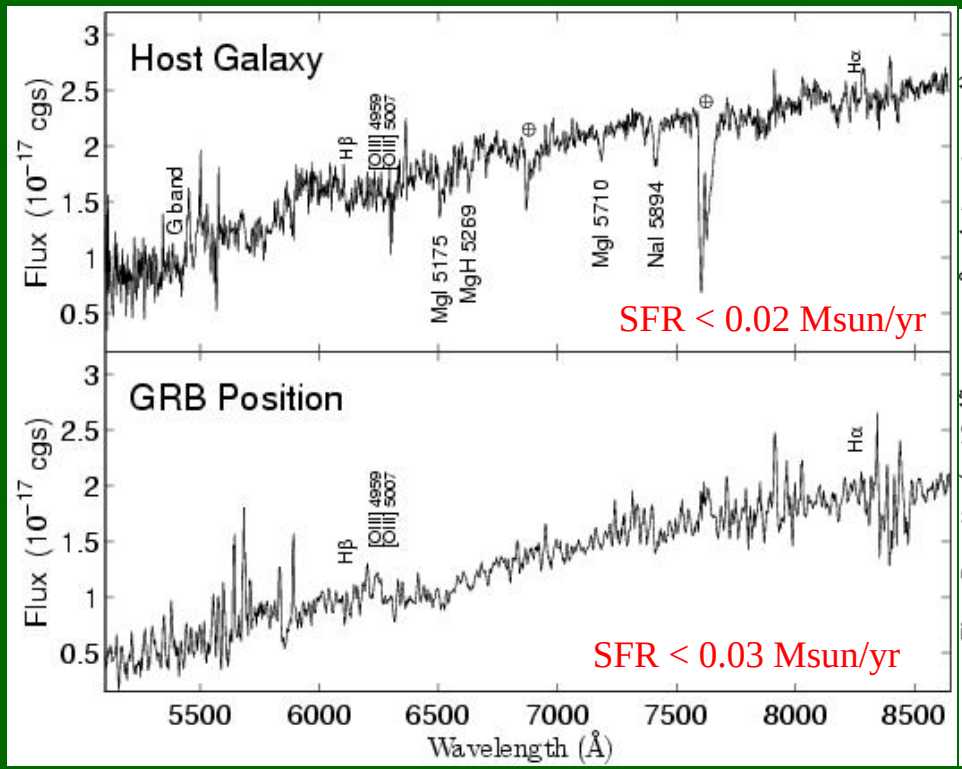
Gehrels et al. 2005



Host Galaxies of Short GRBs

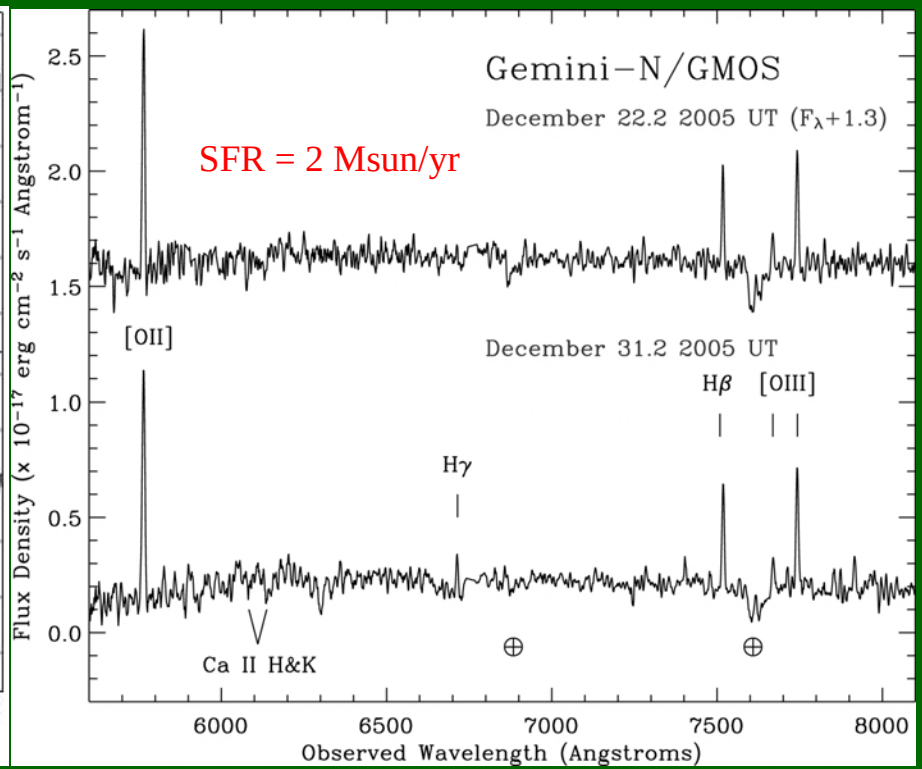
Morphologies and star formation rates vary widely

GRB050724 (z = 0.257)



Berger et al. 2005

GRB051221A (z = 0.546)



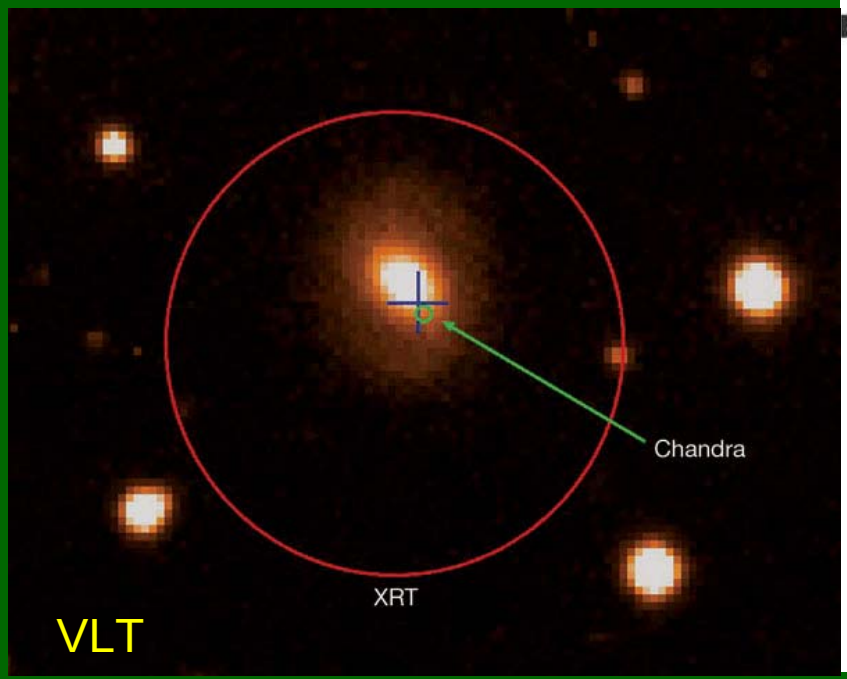
Soderberg et al. 2006

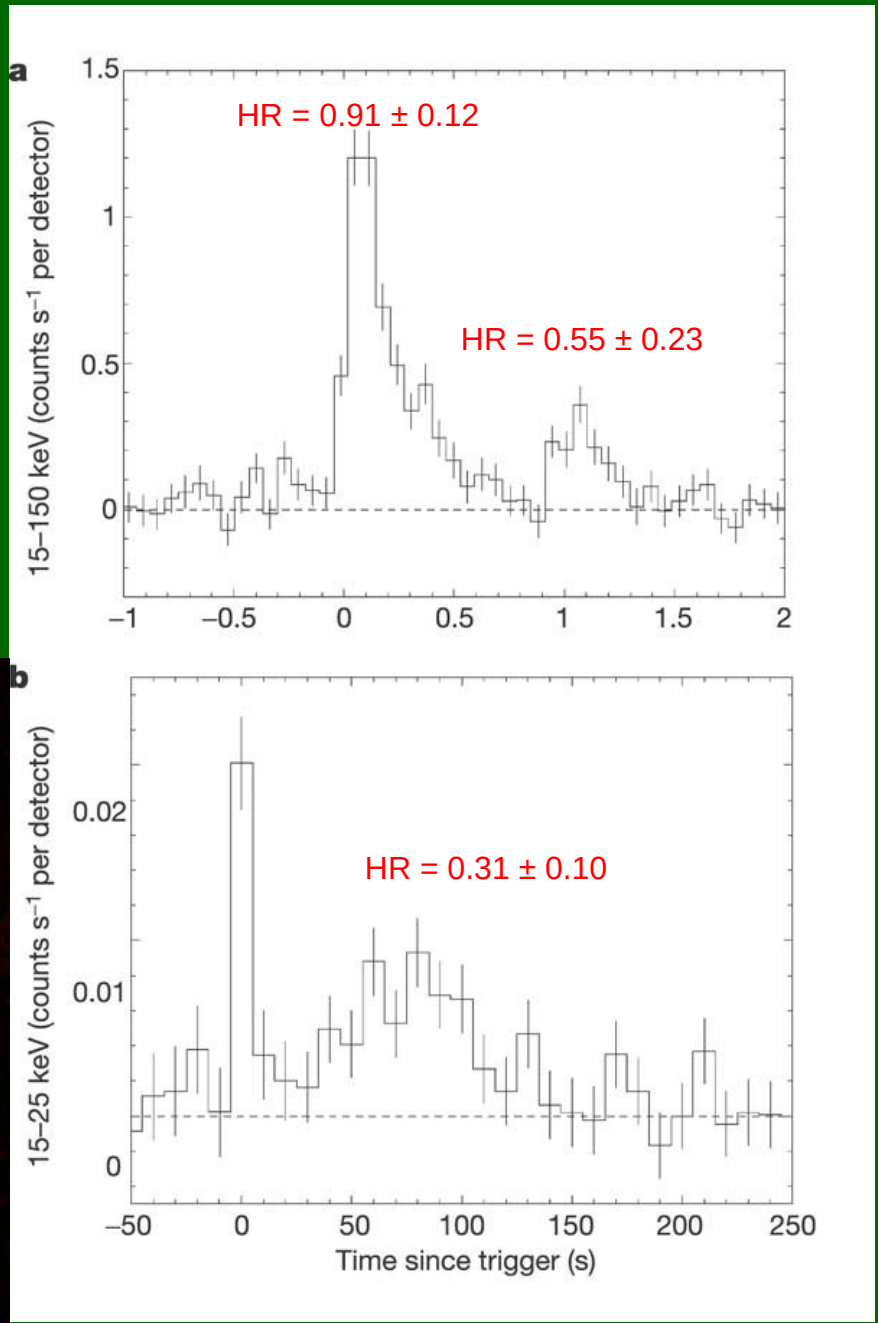
Short GRBs: GRB050724 (z = 0.257)

trailing soft component

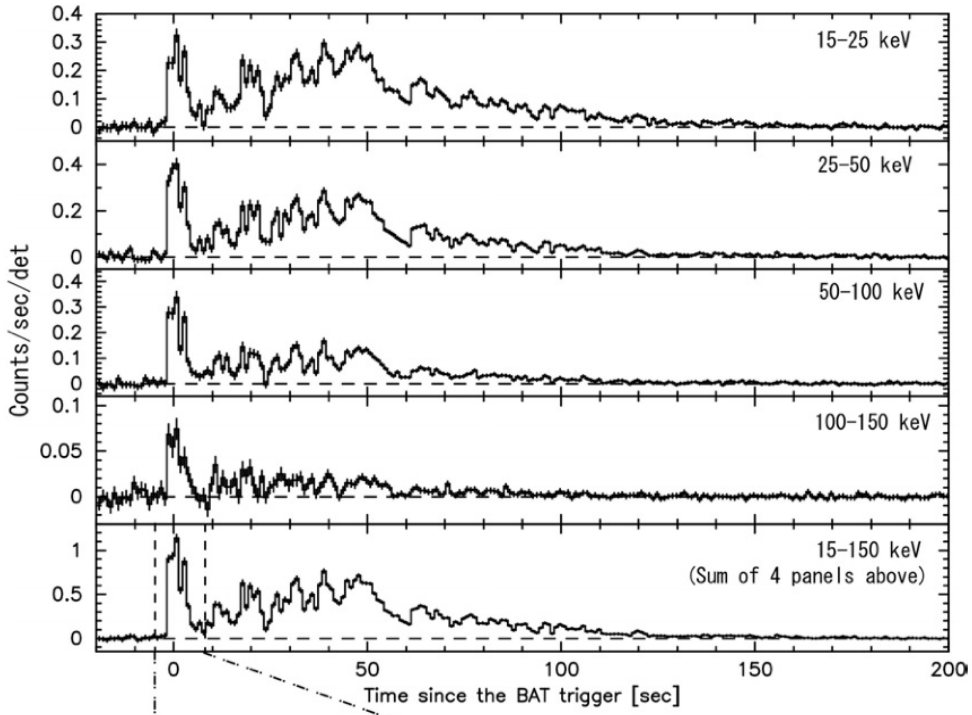
HR = f(50.100 keV)/f(25-50 keV)

Barthelmy et al. 2005



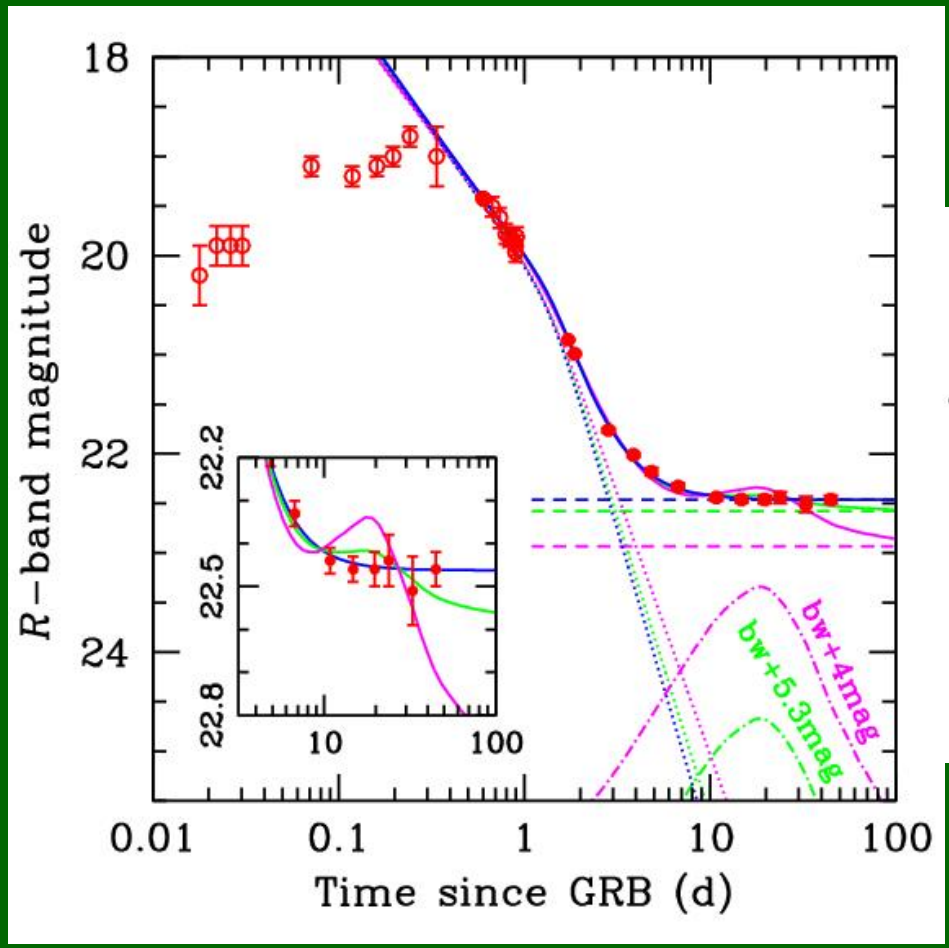


GRB060614 (z = 0.125)

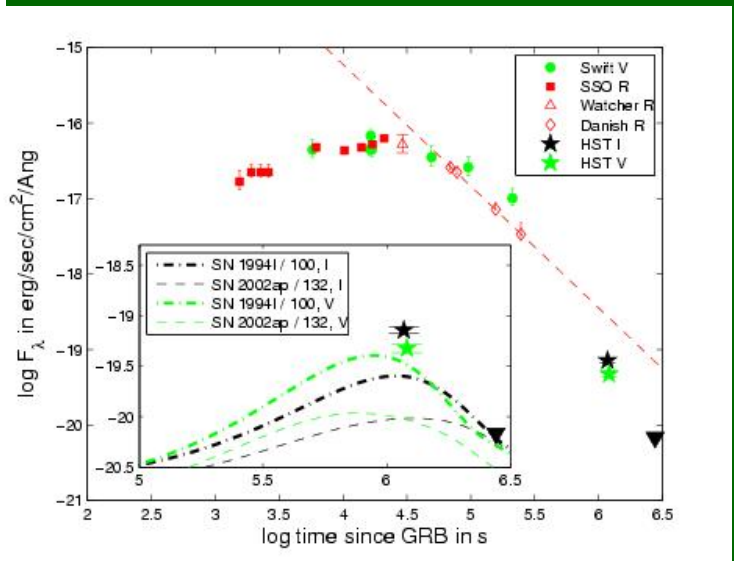


Gehrels et al. 2006

Light curves of the optical afterglow of the Long (~100 s) GRB060614 (z = 0.125)

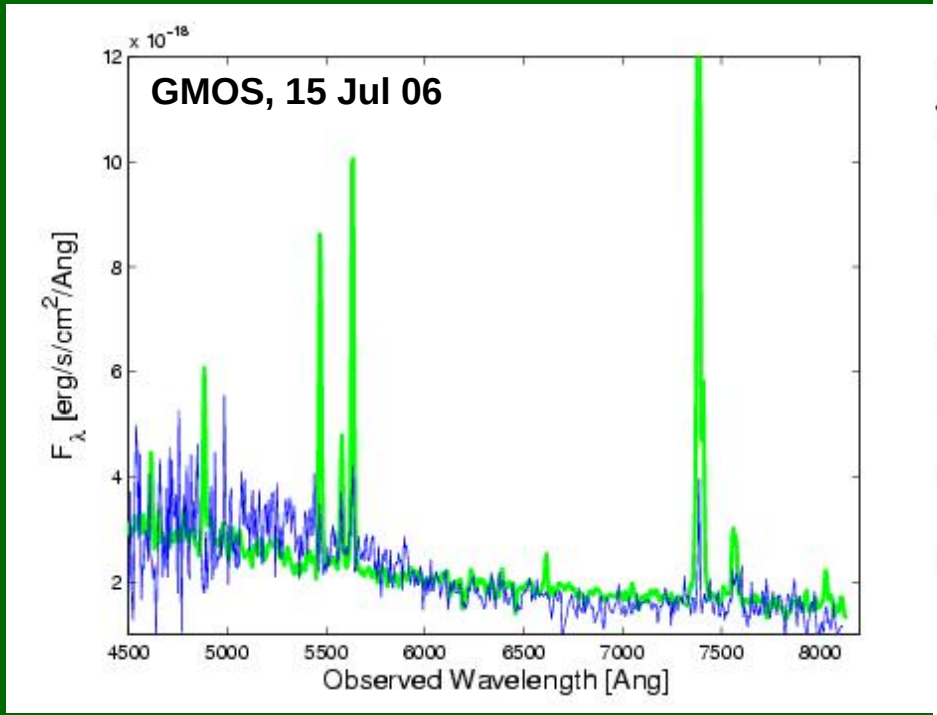


Della Valle et al. 2006

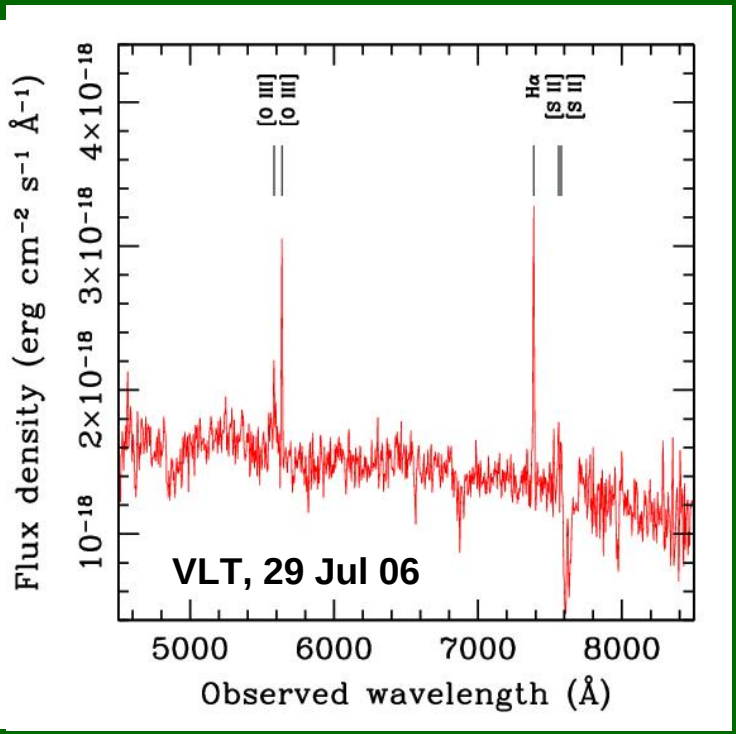


Gal-Yam et al. 2006

spectra of GRB060614 (z = 0.125): no SN features

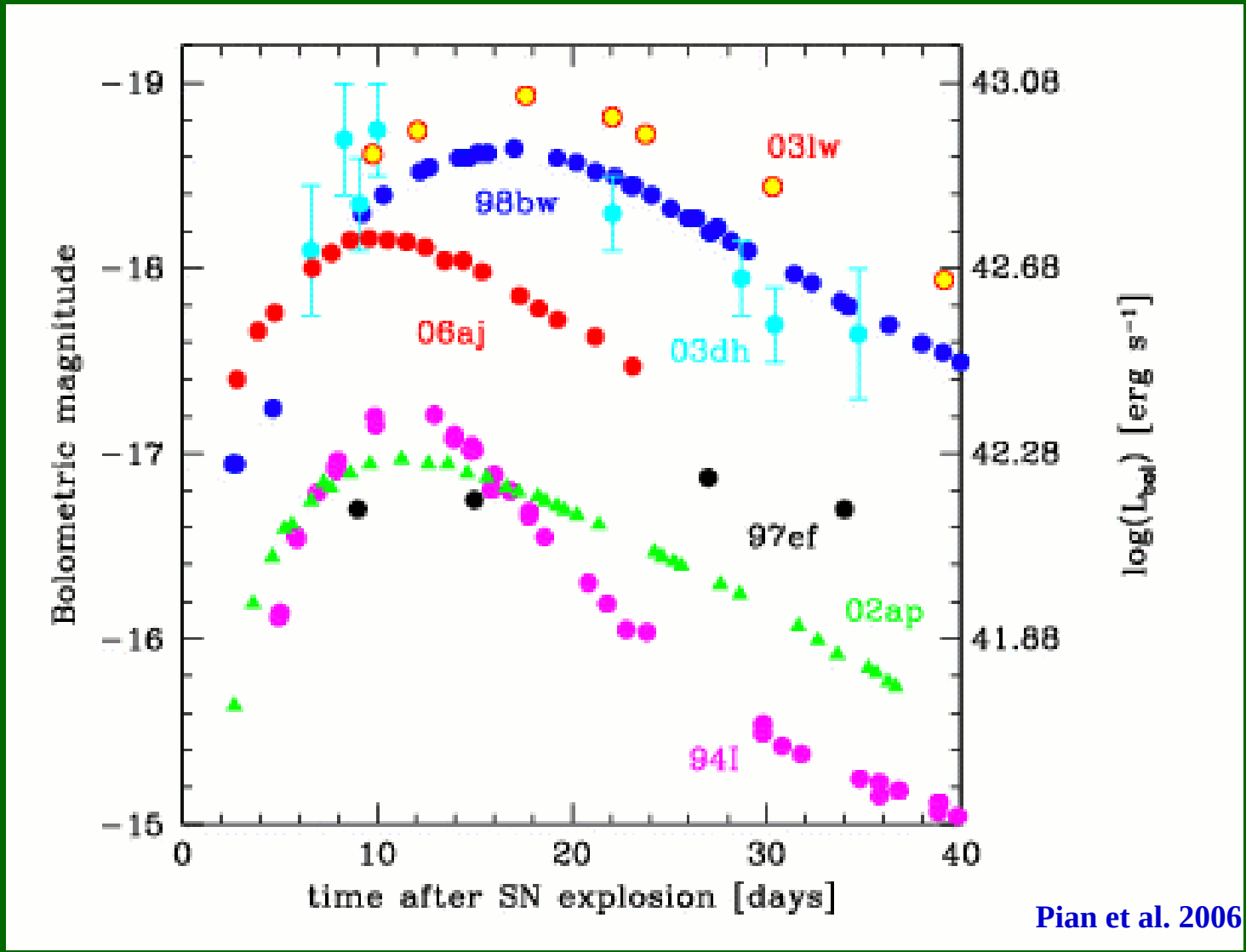


Gal-Yam et al. 2006



Della Valle et al. 2006

Light curves of Ic SNe: GRB-SNe, broad-lined SNe, normal SNe



Pian et al. 2006

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Courtesy: M. Della Valle

GRB060614 (z = 0.125): no accompanying SN

- Despite being 100-seconds long, this may be a “short-like” GRB (Gehrels et al. 2006; Zhang et al. 2007)

- Narrow jet with low energy deposition rate: less than e-3 Msun of 56Ni (Tominaga et al. 2007)

- Merger of a neutron star and a massive white dwarf (King et al. 2007)
  Example: PSRJ1141-6545

- ONeMg WD ???? (Usov 1992)

Summary

GRBs are collimated, but it is not completely clear whether their afterglow light curves are related to the jet geometry. Obviously, the cosmological speculations based on GRBs depend critically on this

Long GRBs (> 2 seconds) are usually in star-forming environments and all low-redshift ones are accompanied by LUMINOUS Type Ic supernovae, with possibly one exception (GRB060614, z = 0.125)

Short GRBs are not accompanied by luminous supernovae, and may be rather related to mergers of compact stars. They are detected in a variety of environments

Are we starting to detect GRB events with “bridging” properties between the 2 sub-classes? Do they represent a third class of GRBs and progenitors?