INTEGRAL GRBs

- INTEGRAL has detected 62 GRBs since launch in October 2002 up to January 2009 ~1/month

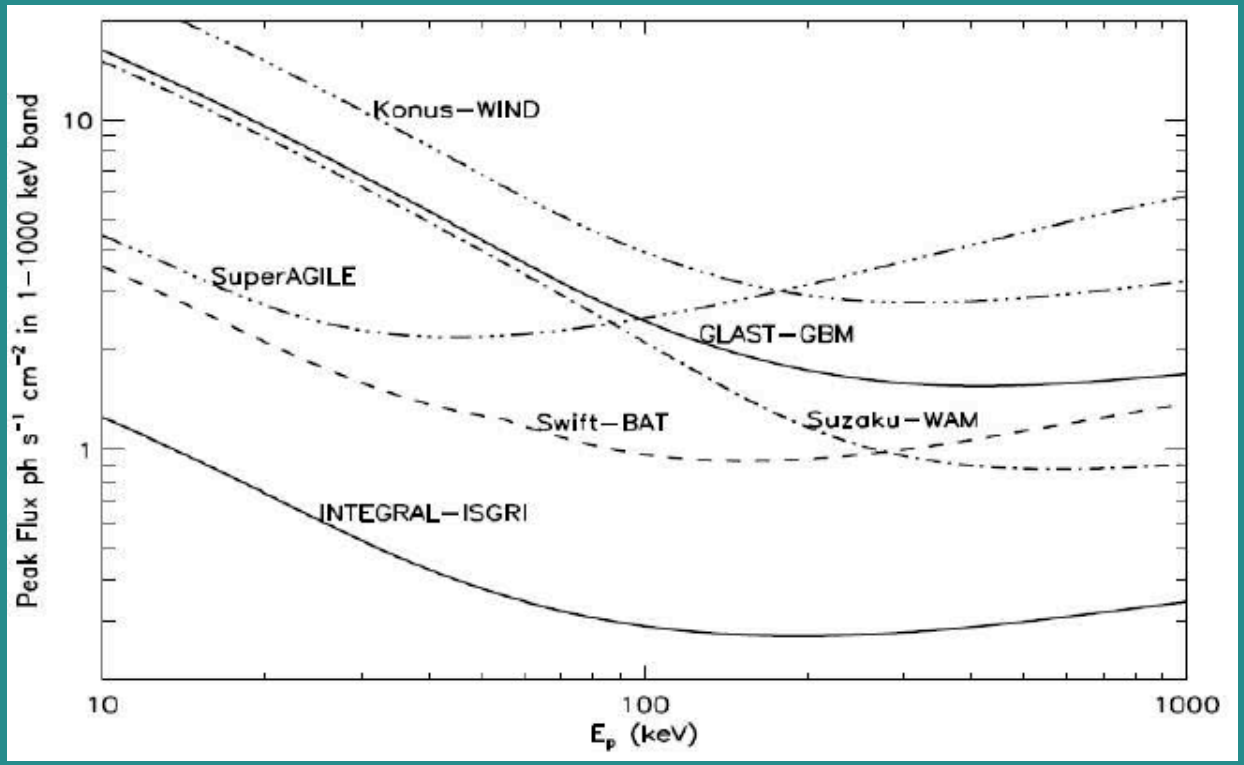
- Sub luminous population ?

- Variable Polarisation ?

- Population of low luminosity long-lag close-by GRB 12/60?

- new software/calibration to improve the sesitivity to low fluence GRBs

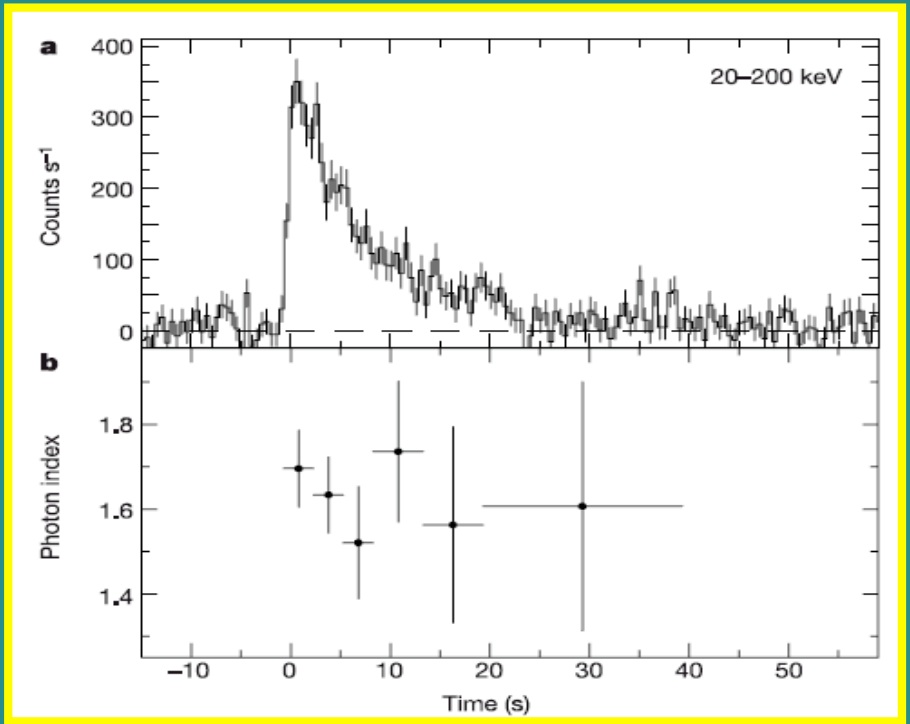
IBIS vs BAT sensitivity to weak GRBs



The answer could be that Integral has a factor of 2-4 better sensitivity to weak GRBs and an efficiency extending up to several MeV.

The detection sensitivity of a number of γ-ray missions, shown as the peak flux threshold (1–1000 keV) to a GRB with a given Epeak.

GRB 031203: unusually low luminosity, nearby burst



On 2003 December 3 at 22:01:28 UTC, IBIS detected a pulse of 40 s duration, with a simple profile. The spectrum was also typical, with a single power law model that constrained E_{peak}>190 keV.

The burst fluence in the 20–200 keV band implied an isotropic energy of $(4\pm1)\times10^{49}$ erg at z=0.1.

Sazanov et al., Soderberg et al., 2003, worth 2 Nature papers

Is sub-energetic as GRB 980425, associated with the nearby (z=0.0085) SN 1998bw, that had $E_{iso}<10^{48}$ erg and violates the E_{iso}–E_{peak} relation, that would predict E_{peak}<10 keV, as GRB 980425.

The 2 nearest long GRBs are clearly sub-energetic in the γ-ray band, and their proximity (and hence implied abundance) makes it of great interest to understand their origin and relation to the more distant cosmological GRBs.
Searches for associated GW signals were perform by LIGO in coincidence with this GRB (Abott et al., 2005)

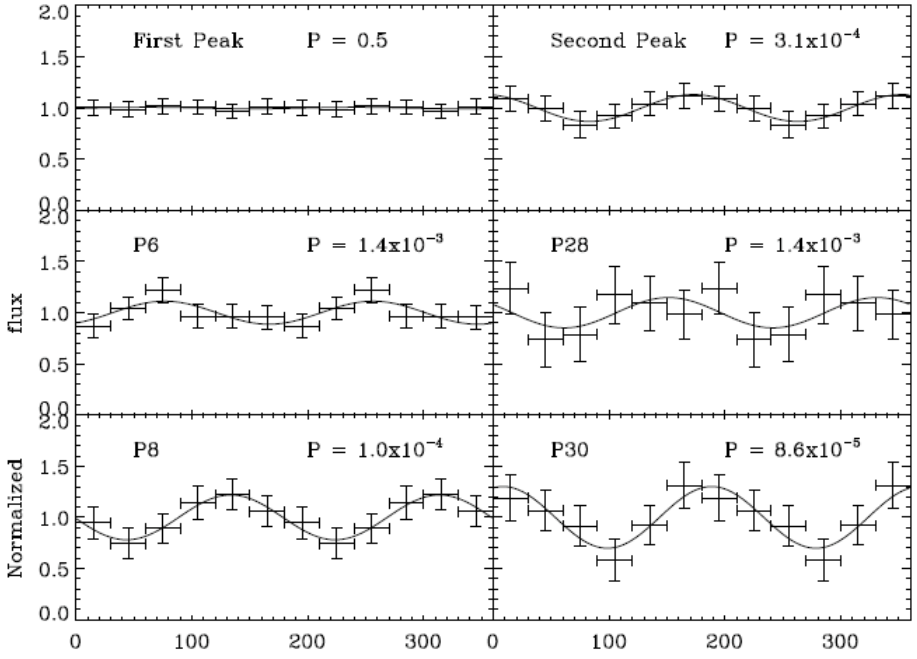
GRB 041219a b): polarization studies

Measuring the polarization of the prompt GRB can significantly improve our understanding of both the emission mechanisms as well as the underlying engine driving the explosion.

The technique was to use the IBIS telescope on board the INTEGRAL to measure the polarization of the prompt gamma-ray emission of the long and bright GRB 041219A in the 200–800 keV energy band.

Gotz et al. 2009

No polarization signal found integrating over the whole first peak, and the upper limit is 4%. On the other hand, a modulated signal is seen in the second peak corresponding to 43 ± 25%. Integrating over smaller portions of the GRB, give highly polarized signals, especially in P8, P9 and P30 (Gotz et al. 2009, but see also McGlynn et al. 2007, Kalemci et al. 2007).

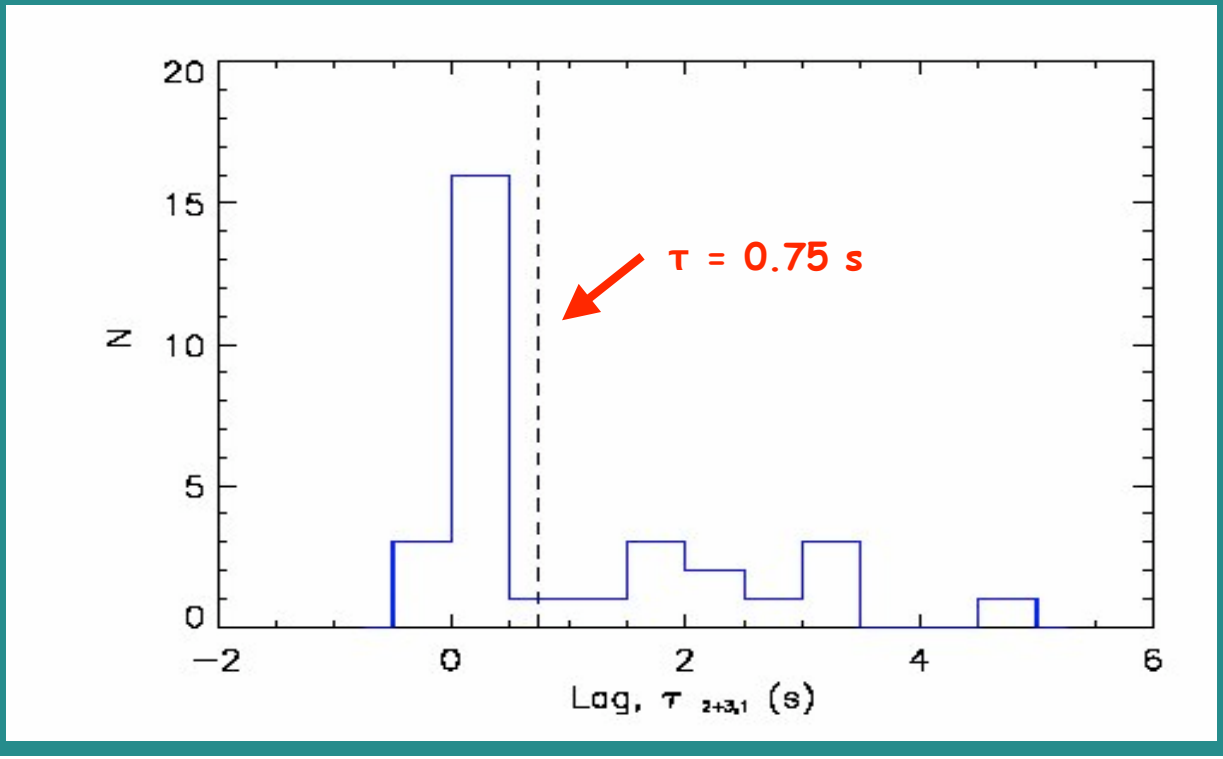


Light curve of GRB 041219A. The analyzed intervals, are shown with dashed lines. P8 is omitted for clarity.

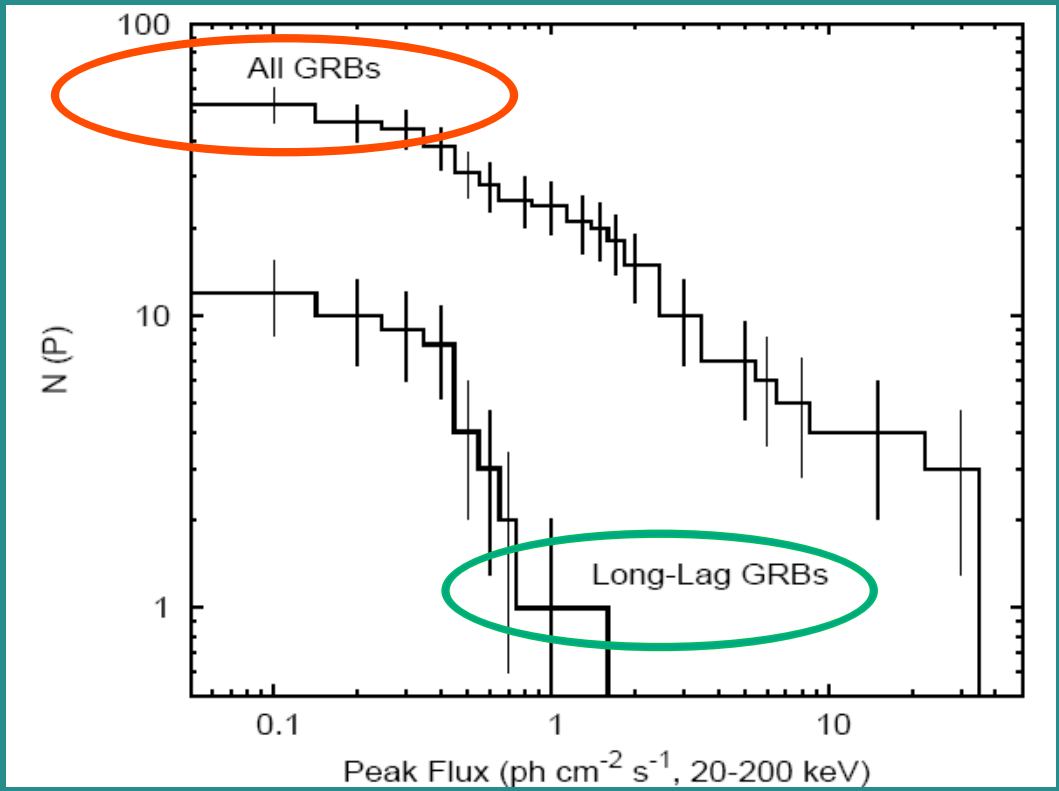
Azimuthal distributions of the flux in the different time intervals. Chance prob. of a non-polarized signal reported in each panel.

INTEGRAL Spectral Lag Distribution

- Lags determined for 30 GRBs in the sample between the 25-50keV and 50-300keV energy bands
- No negative lags observed (i.e. low energy photons leading high energy photons)
- the are 12 Long-lag GRBs with τ > 0.75 seconds



New Observational Results with Integral

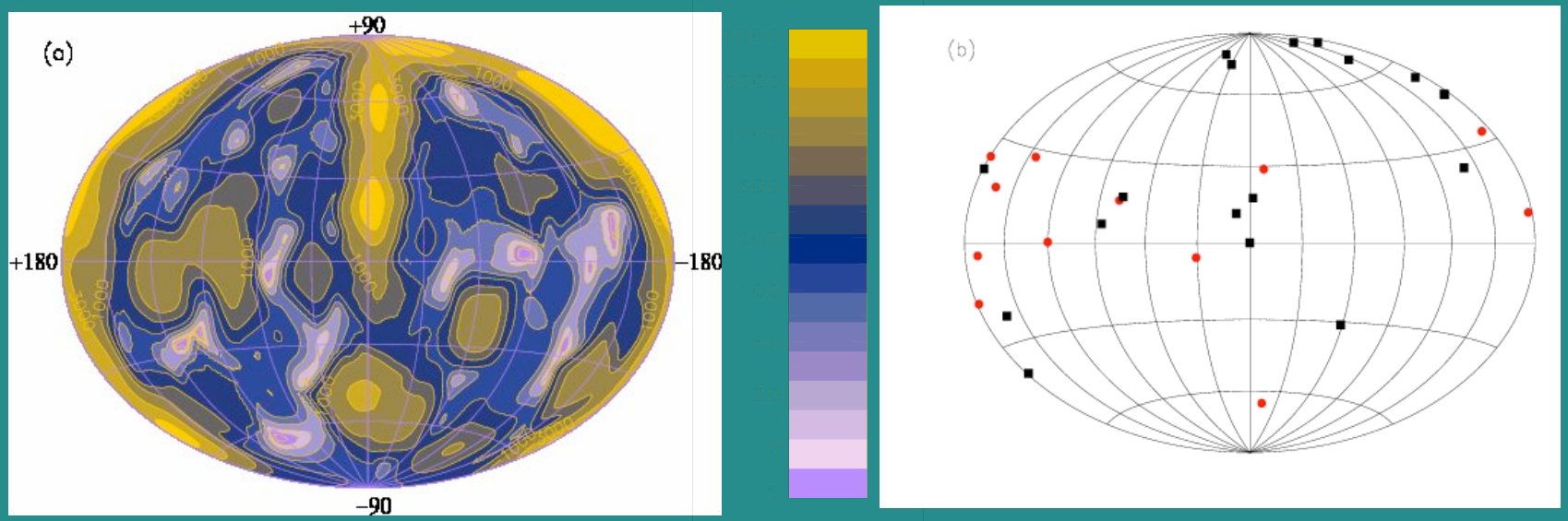


Cumulative logN-log P distribution of the 55 GRBs detected by IBIS (20–200 keV) with the small subset of 12 long-lag GRBs shown separately.

The distribution is biased by the lower sensitivity of IBIS at large off-axis angles, but they looks different.

INTEGRAL GRB Distribution in supergalactic Coordinates

Foley et al. 2008 A&A



. INTEGRAL exposure map and GRB distribution in Supergalactic Coordinates

- Supergalactic plane – plane containing local superclusters of galaxies, web of filaments and sheets rather than an isolated pancake structure, superclusters evident out to ~400 Mpc
- 10/12 Long-lag GRBs within ± 30º of Supergalactic plane
- Quadrupole Moment = -0.225 ± 0.090 for long-lag GRBs

Long-Lag GRBs: distance Scale & Rate of Low-Luminosity GRBs

- A number of low-luminosity GRBs at low redshift detected e.g. GRB980425 (36 Mpc, τ=2.8s) and GRB060218 (145 Mpc, τ=66s)

- Weak BATSE bursts are correlated with galaxies out to ~150 Mpc (Chapman et al. 2007)

- 8 Long-lag GRBs in the partially coded field of view of IBIS (0.1sr)
- Assume 2 are at high redshift
- Adopt a distance of 250 Mpc for the remainder

- All-sky rate ~2500 Gpc^{-3} yr^{-1} for these GRB with a large uncertainty due to $distance^3$ factor
- This exceeds the upper limit of 300 Gpc^{-3} yr^{-1} of Type 1b/c SNe which produce GRBs, assuming that all low-luminosity GRBs produce a SN (However not all GRBs produce SNe, e.g. low-luminosity GRB060505)
- Galaxy clusters may play a role – new progenitor?

INTEGRAL GRB Summary 1

- INTEGRAL has detected 62 GRB up to January 2009 and provides localisations for ~ 1 GRB / month

- detects proportionally more faint GRBs than Swift and appears to probe a low-luminosity population distinct from the high-luminosity one

- 12/30 GRBs for which a spectral lag was measured have long lags (τ > 0.75 s).

- In comparison, the 149 Swift GRBs with a measured lag, 12% have long lags, compared with 40% of the INTEGRAL sample, the median peak flux of the 17 Swift long-lag GRBs is 1.71 ph cm^{-2} s^{-1} a factor of 3 times higher than for INTEGRAL long-lag bursts

- Long-lag GRBs have low peak fluxes, long slow pulses faint optical and X-ray afterglows and appear to be associated with the Supergalactic plane, and appear to be distinct from high-luminosity population (Foley et al., 2008).

INTEGRAL GRB Summary 2

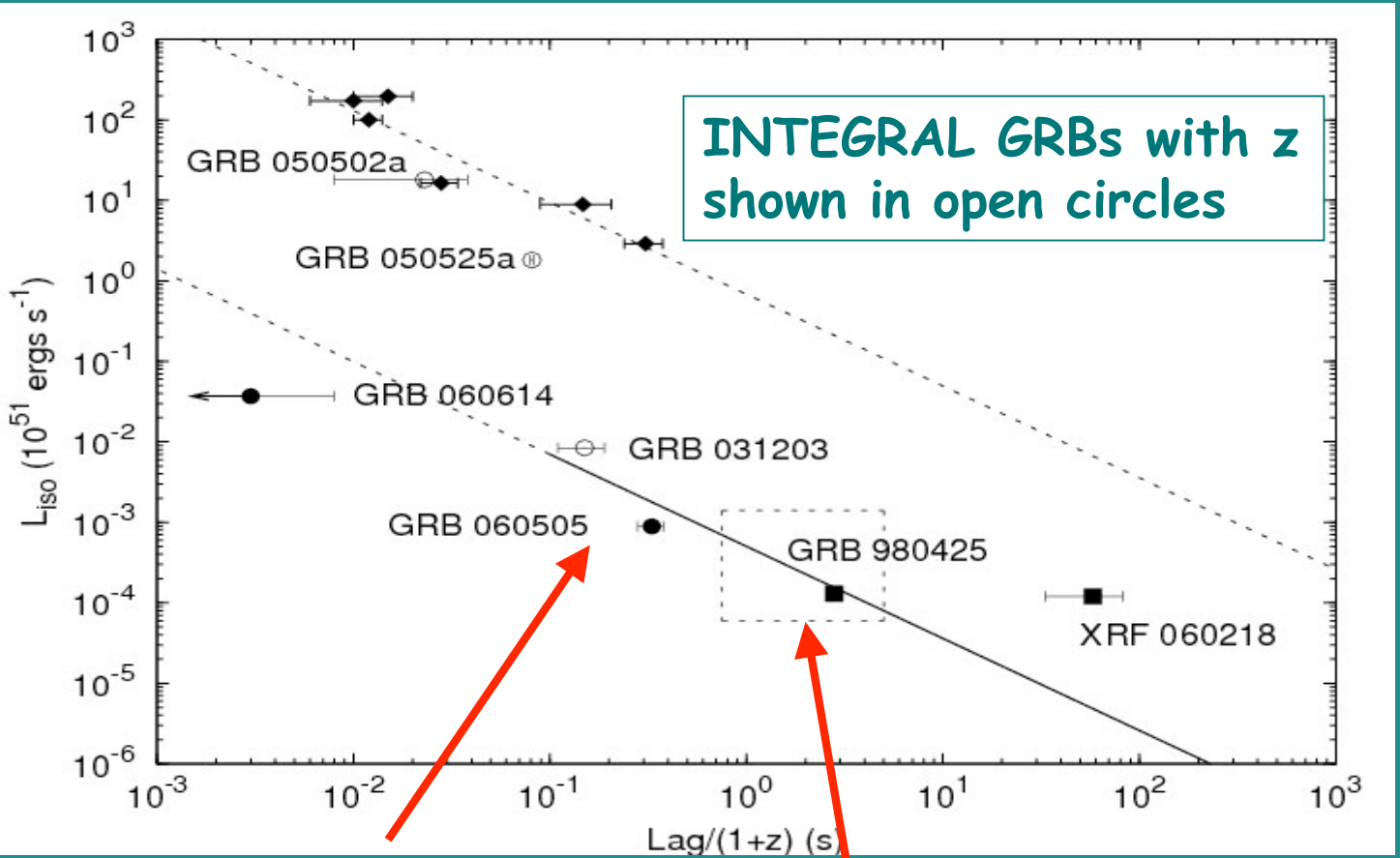
Some of these bursts could be produced by the collapse of a massive star without a supernova. Alternatively, they could result from a different progenitor, such as the merger of two white dwarfs or a white dwarf with a neutron star or black hole, possibly in the cluster environment without a host galaxy.

& no narrow gamma-ray lines (SPI)
Nor broad (IBIS)!

Finally, INTEGRAL detects a large proportion of faint, long-lag GRBs that are inferred to be local. The sensitivity of IBIS is such that it can detect very faint GRBs, allowing *INTEGRAL to probe the population of low-luminosity GRBs* with long lags. This population appears to be distinct from that of high-luminosity GRBs and dominates the local GRB population.

Thanks!

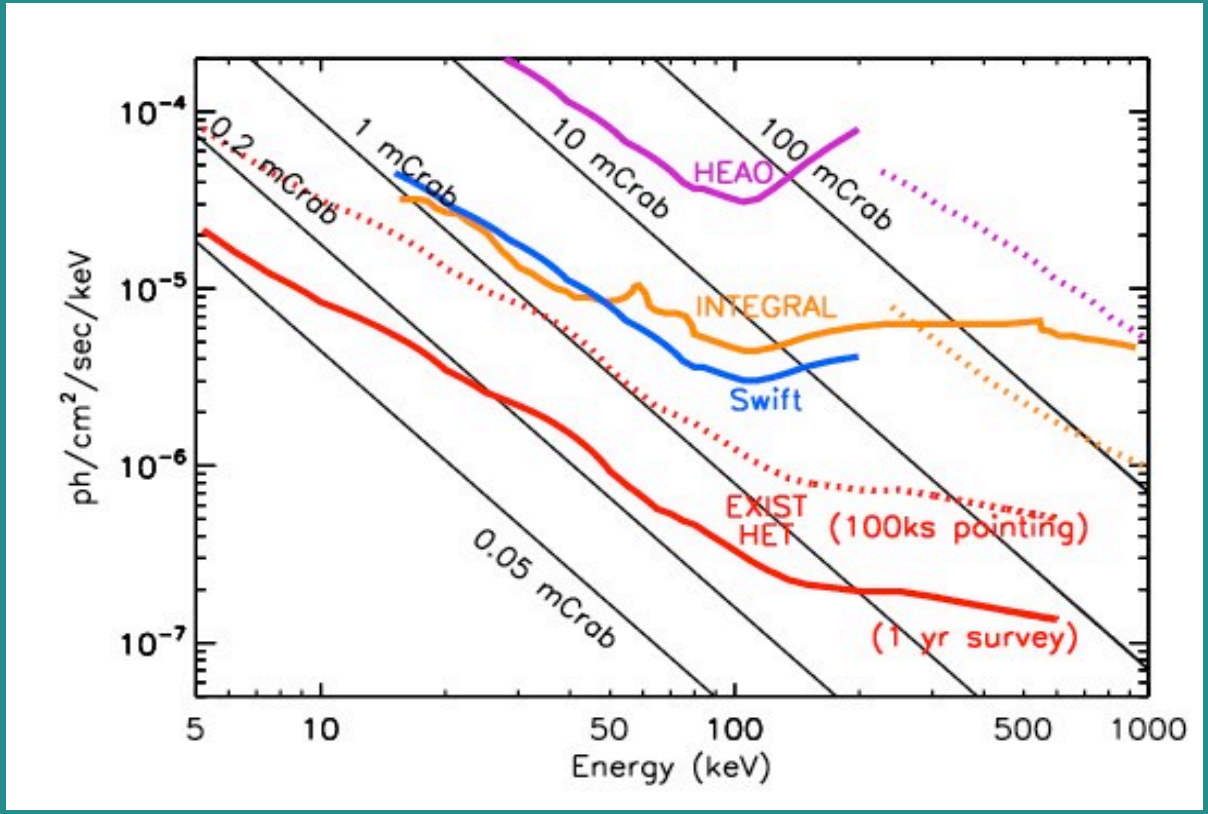
Lag-Luminosity Relation



Other low-luminosity GRBs that do not fit on the relation

Long-lag GRBs when a distance of 250 Mpc is adopted

IBIS vs BAT sensitivity to weak GRBs



EXIST will provide a larger area and better on-axis sensitivity with a SeXI X-Ray follow-up capability

Thanks!