Gamma-Ray Bursts and STROBE-X

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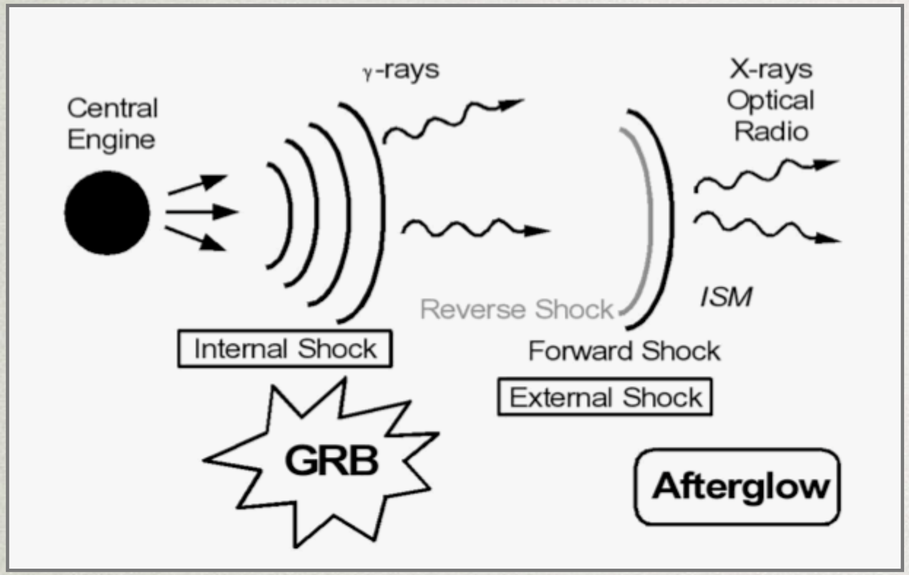
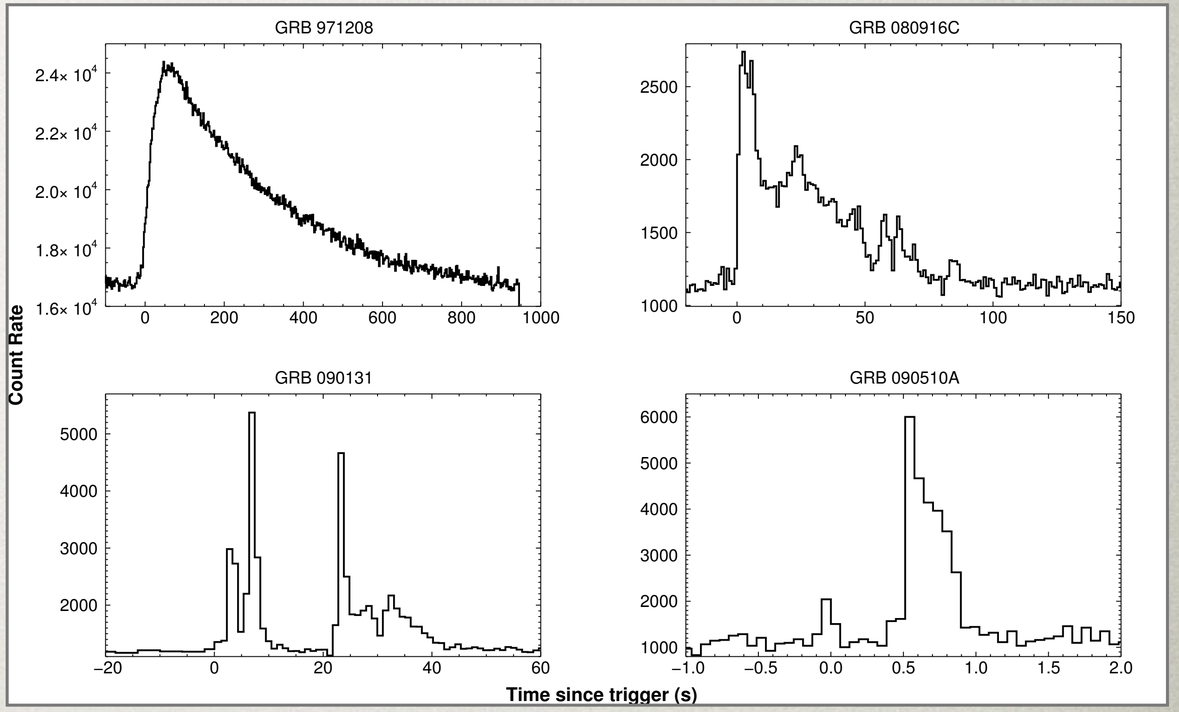
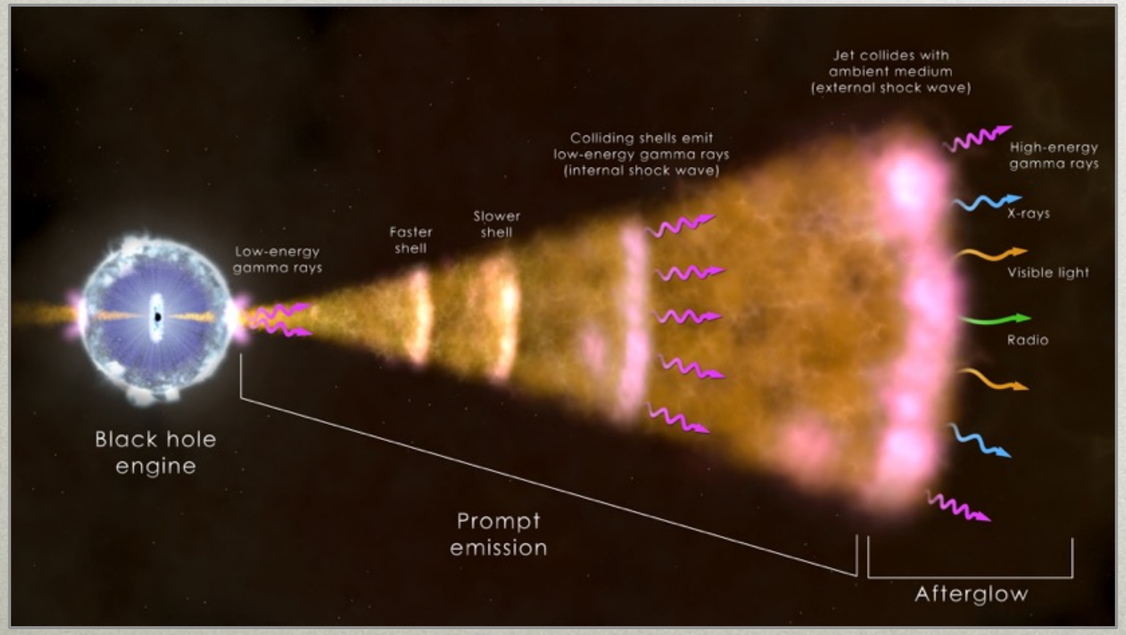
What are GRBs?

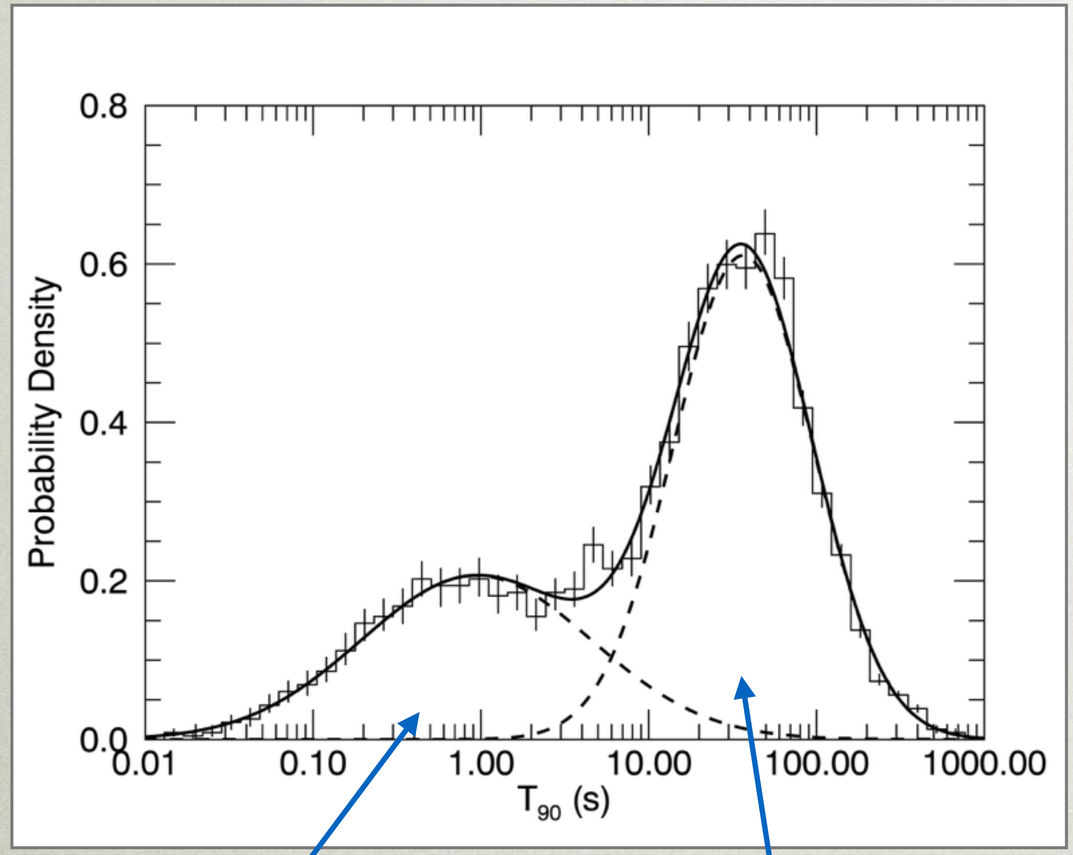


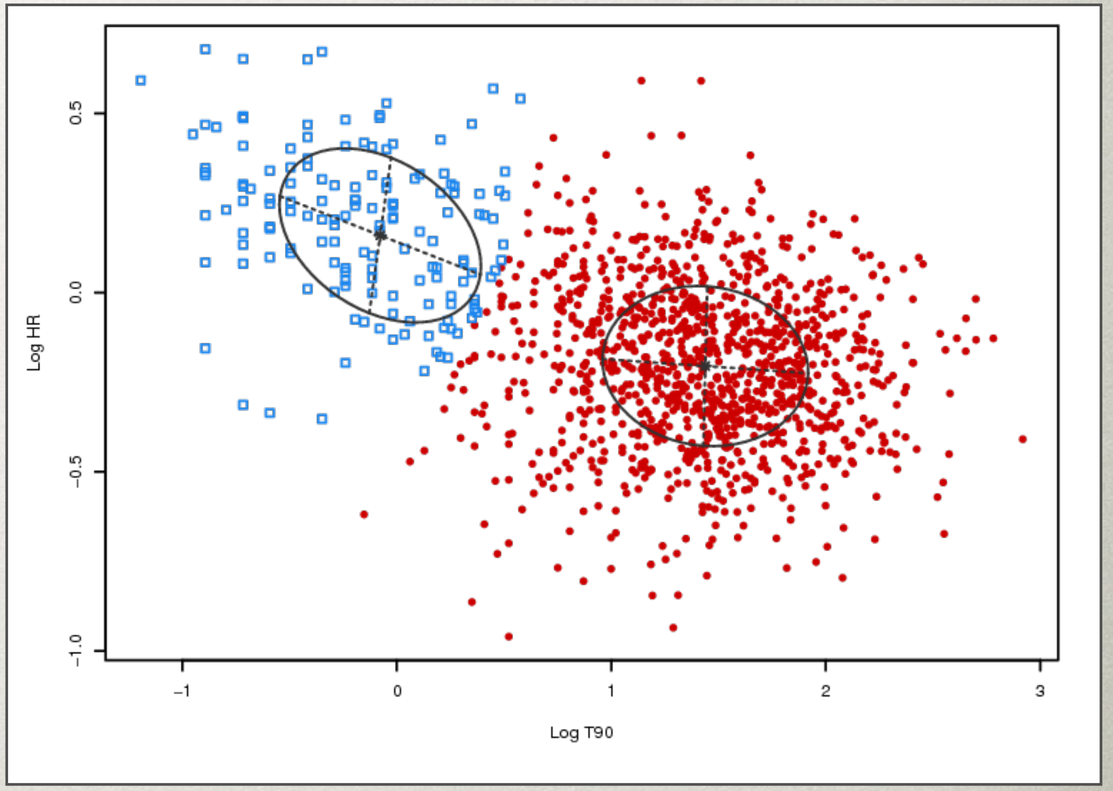




- Transient Relativistic Explosions
- Gamma-ray to Radio (GWs? Cosmic rays? Neutrinos?)
- timescales: few ms to years
- Extreme physics, fundamental physics

Two Observed Classes





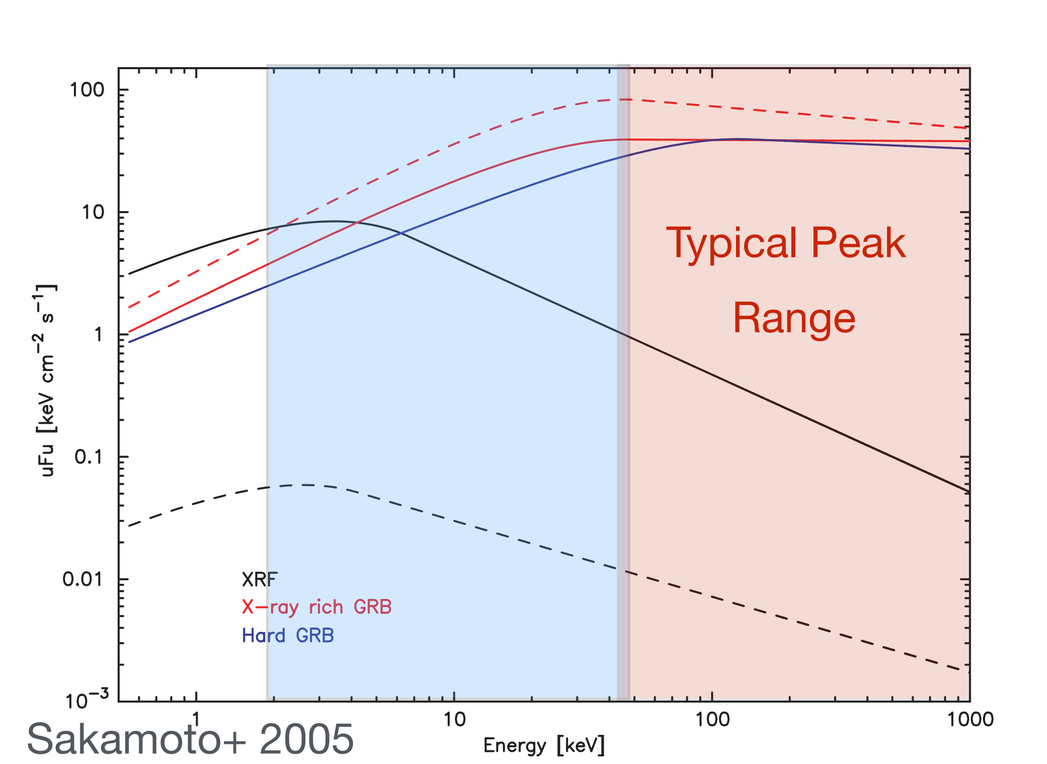
Short—Mergers

Long—Collapsars

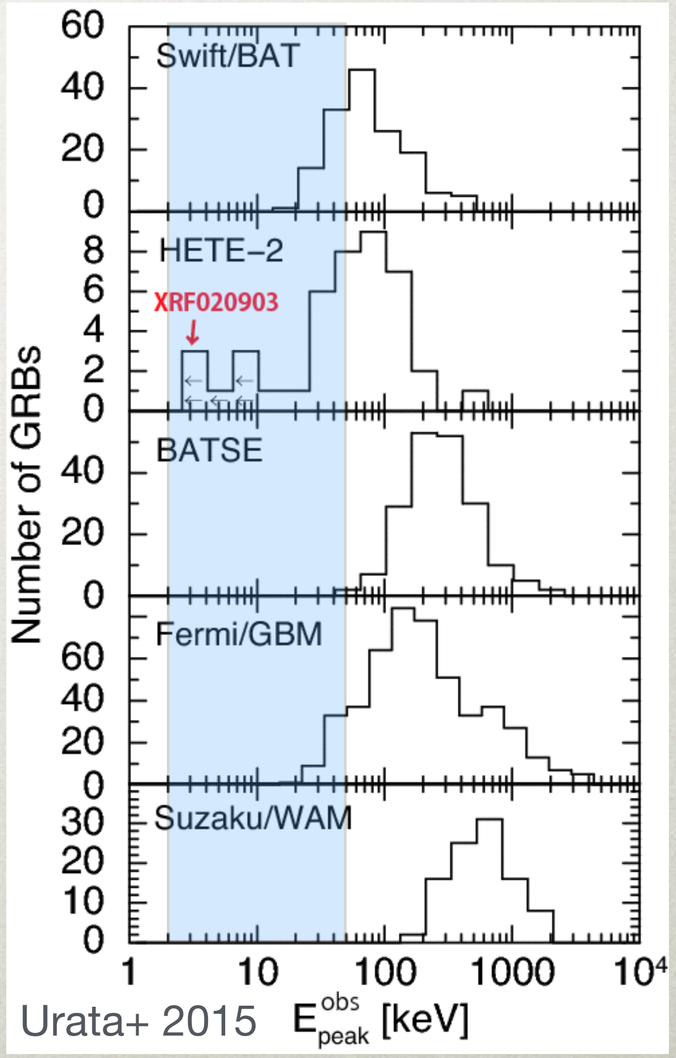
So What Do You Need for GRBs?

- Stable (or predictable) backgrounds, good triggering algorithms
  - Hard-to-soft evolution in GRBs means that the WFM may not be triggering on the start of the GRB, and the GRB soft emission is often less impulsive
- Optimize WFM for ~all-sky coverage, anti-Earth/anti-Sun pointing
- Onboard triggering, ability to repoint
- WFM modules ~co-pointed with XRCA
  - similar to Swift BAT & XRT, minimize amount of required repointing
- Low deadtime
- TDRSS wake-up capability to transmit real-time alerts, data

X-ray Flashes—Off-Axis Jets?

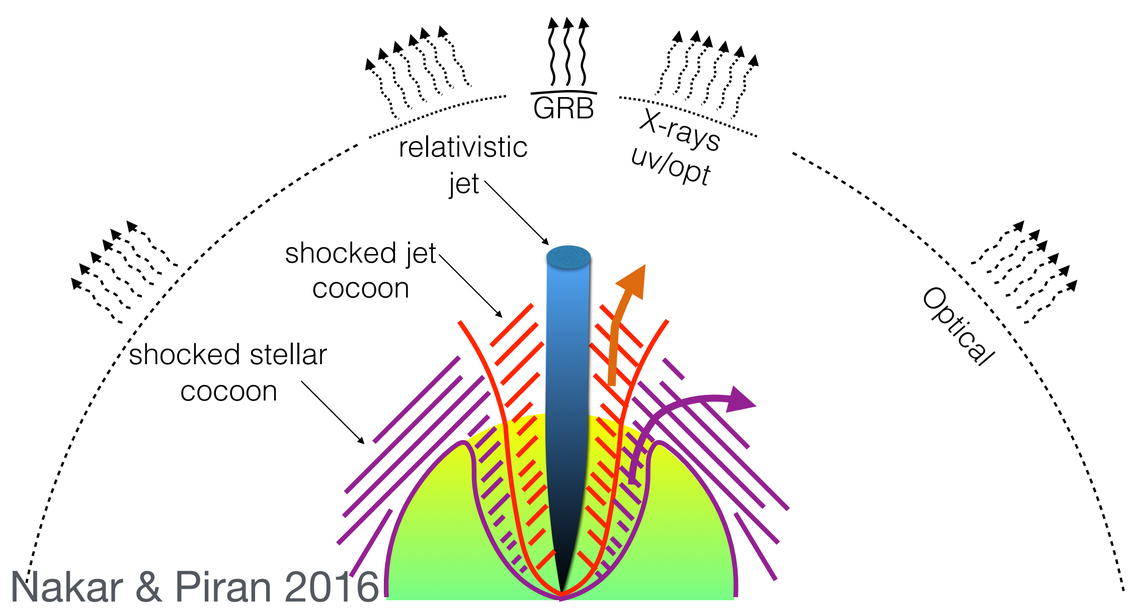


Sakamoto+ 2005

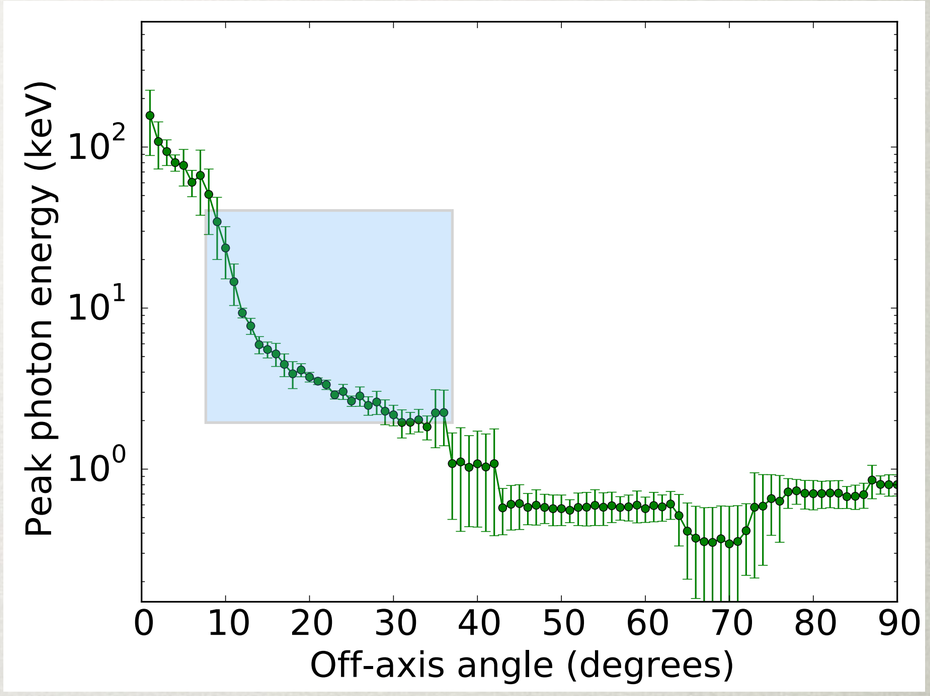


Urata+ 2015

Cocoon Emission from Off-axis Jets



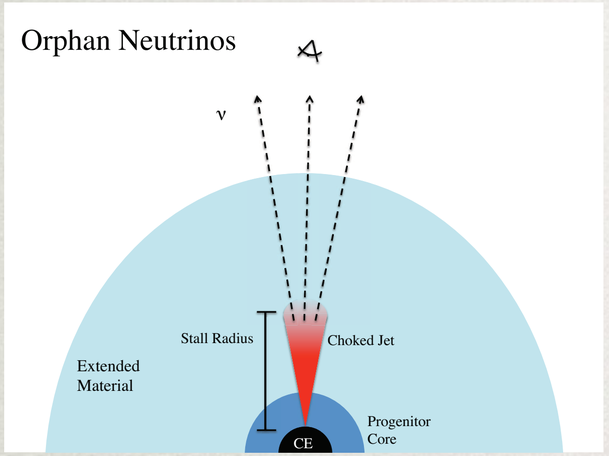
Lazzati & Begelman 2005

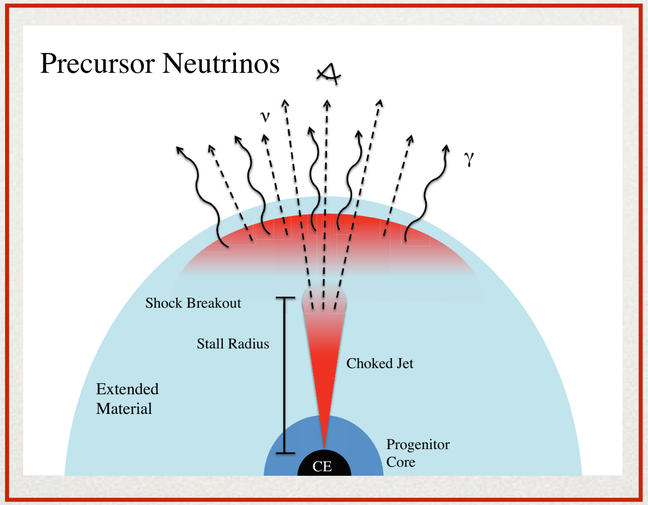


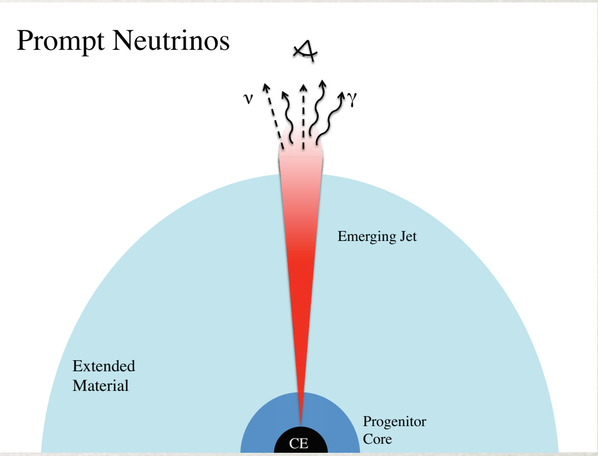
Lazzati+ arXiv:1709.01468

- Less luminous
- Less collimated
- Soft off-axis emission
  - ~1-100 keV thermal—quasi-thermal

Choked Jets





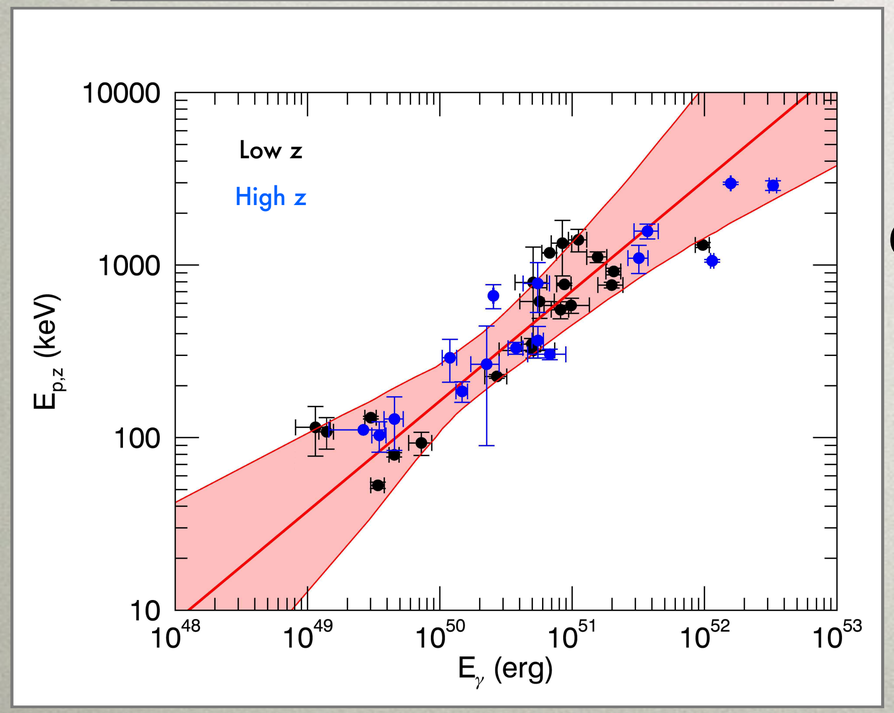


Senno+ 2016

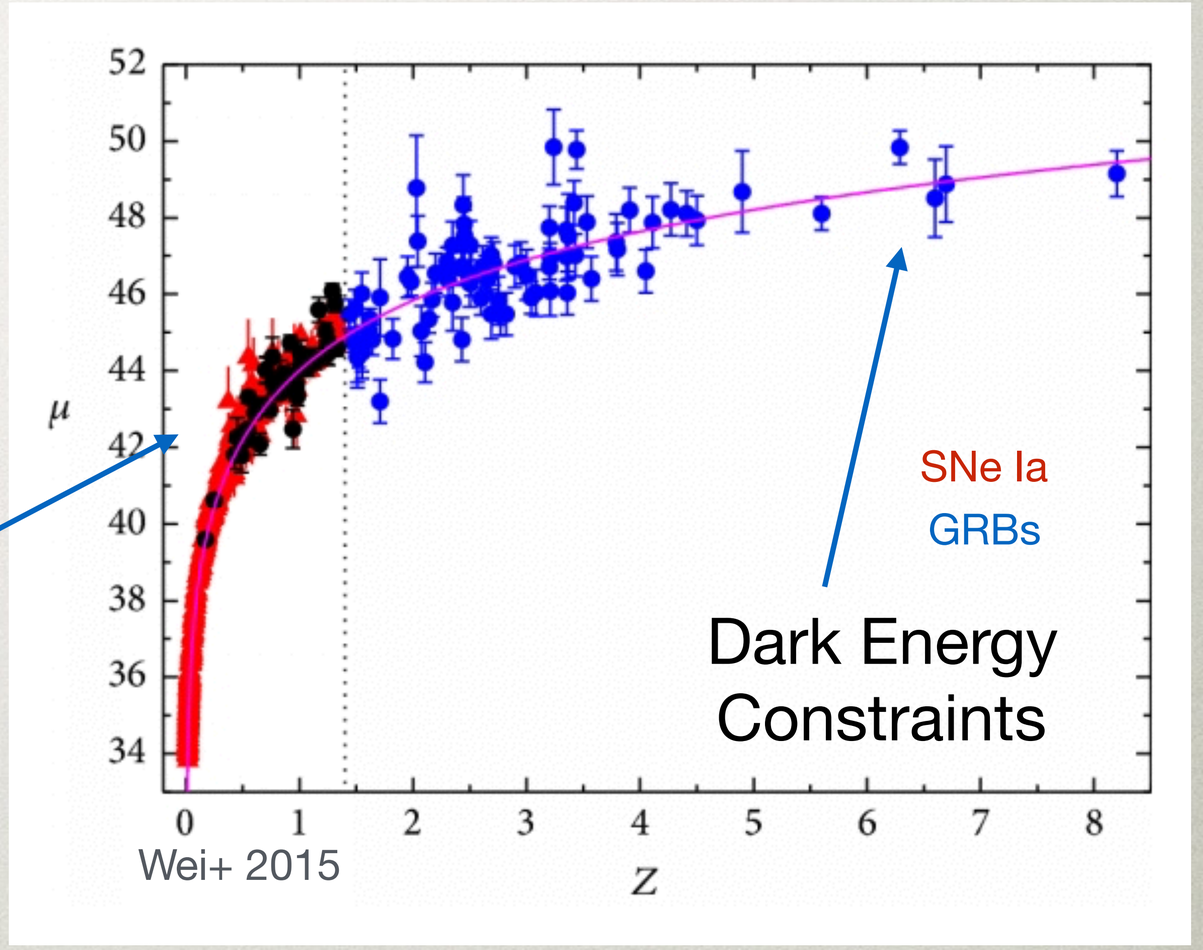
- Extended wind/outer envelope “chokes” jet
  - low luminosity
  - trans-relativistic to mildly relativistic
  - softer emission
- TeV neutrinos to precede burst

GRBs for Cosmology

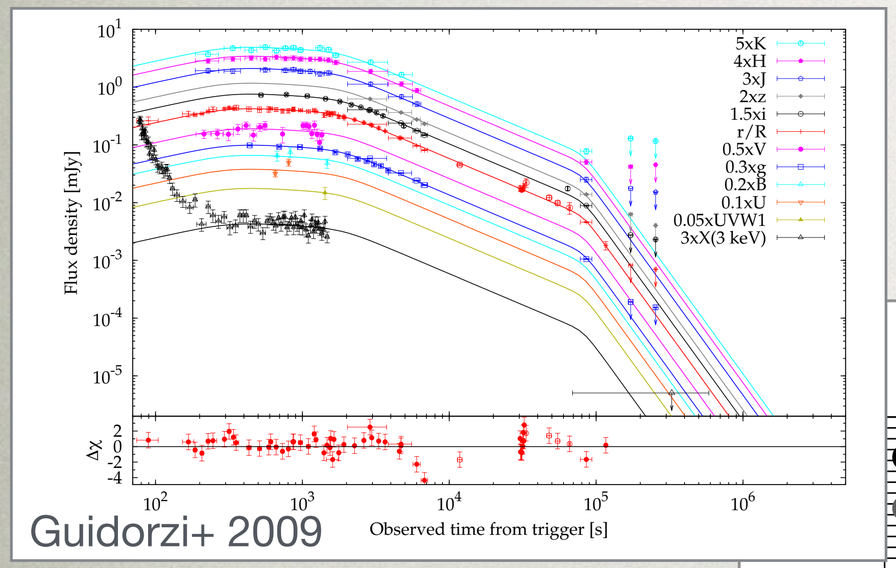
- Short GRBs with GW observations can help constrain H0
- Long GRBs + energetics correlations can help constrain dark energy EoS



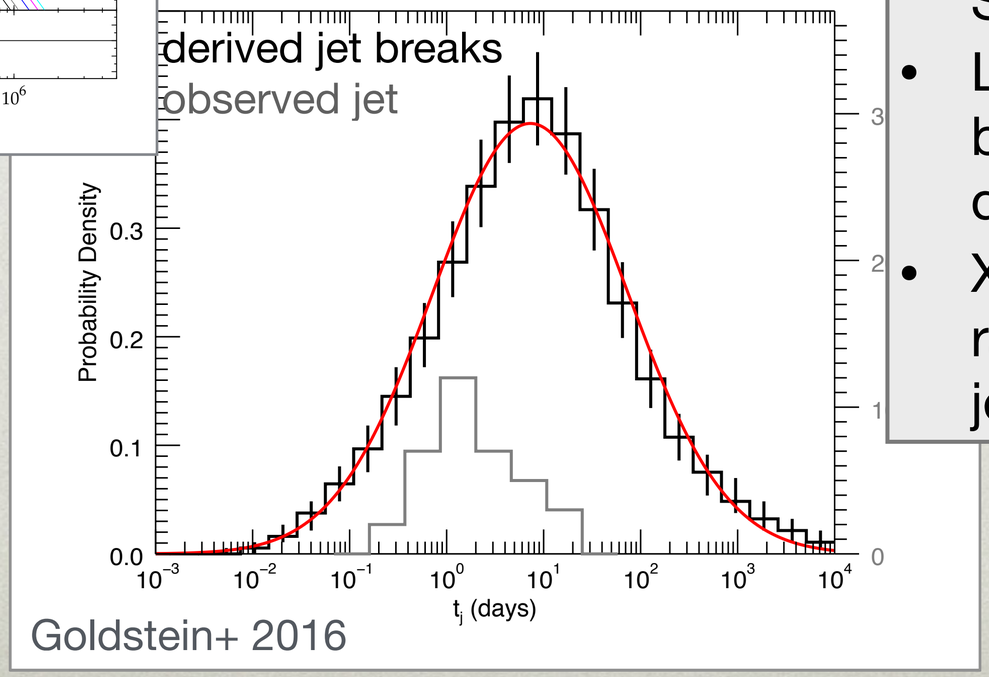
H0 constraints



X-ray Afterglow—Jet Breaks



Guidorzi+ 2009



Goldstein+ 2016

- Long GRB jet breaks time distribution likely biased
- Difficult to observe prompt afterglow jet breaks without a Swift BAT/XRT type mission
- Less collimation -> longer jet break time, difficult to observe due to fading flux
- XRCA could catch both prompt x-ray afterglow/jet breaks and late jet breaks out to O(10) days

GRB Science with STROBE-X

- **Long GRBs—Collapsars**
  - Choked Jets (coincident neutrinos)
  - Cocoon Emission
  - X-ray Flashes

- **Short GRBs—Mergers**
  - Gravitational-wave counterparts
  - Cocoon Emission
  - Constraining H0 (with GW)
  - Jet collimation (with GW)
  - Population studies with BNS & NSBH progenitors (with GW)

Design Trade - STROBE-X

- Difficult to do prompt spectroscopy for canonical long and short GRBs

- Generally, energetics will be difficult to estimate
  - May not contribute to the energetics correlations
  - May not contribute to high-z GRB cosmology
  - Only contribute to luminosity function at the very low end

- Triggering efficiency - lightcurves are less impulsive at lower energies

- Association of progenitors to GRBs—could be difficult if not observing over canonical energy band

These issues can be addressed if observational energy range is extended to 150 or 300 keV

Backup

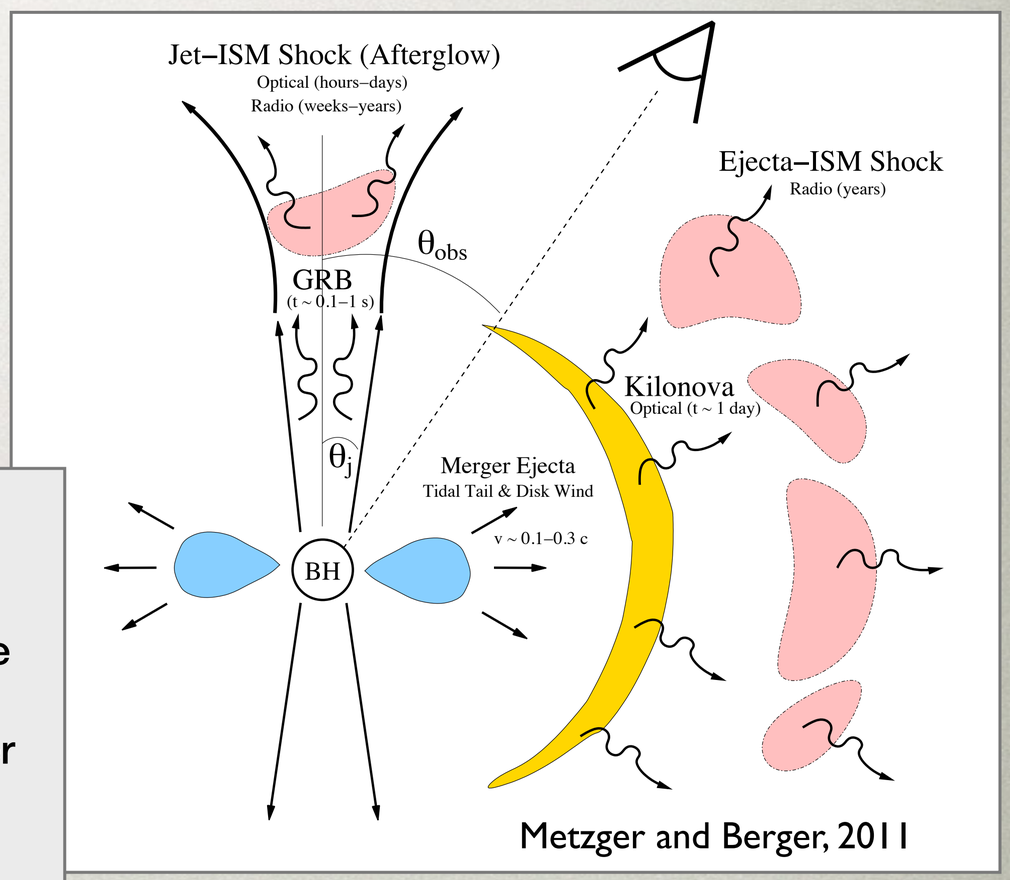
Short GRBs—Mergers

GW

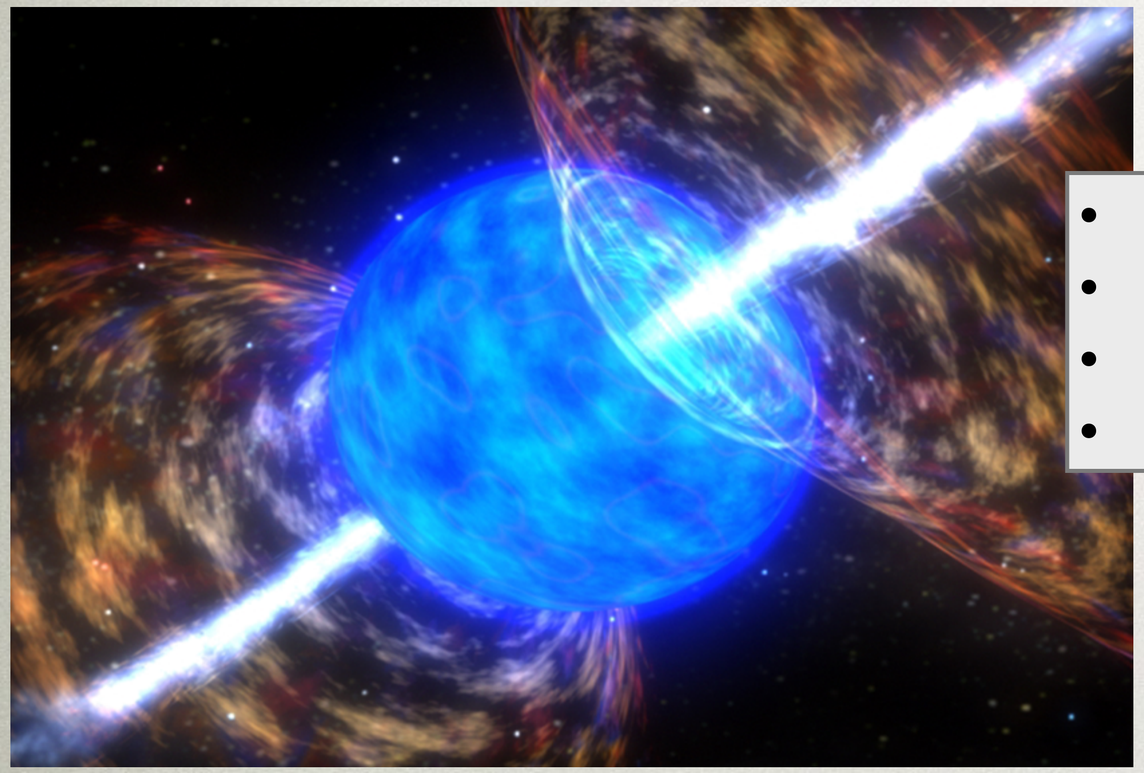
- In-spiral confirms CBC progenitor model
- Information about binary system parameters
- precise merger time
- standard candle -> luminosity distance

EM

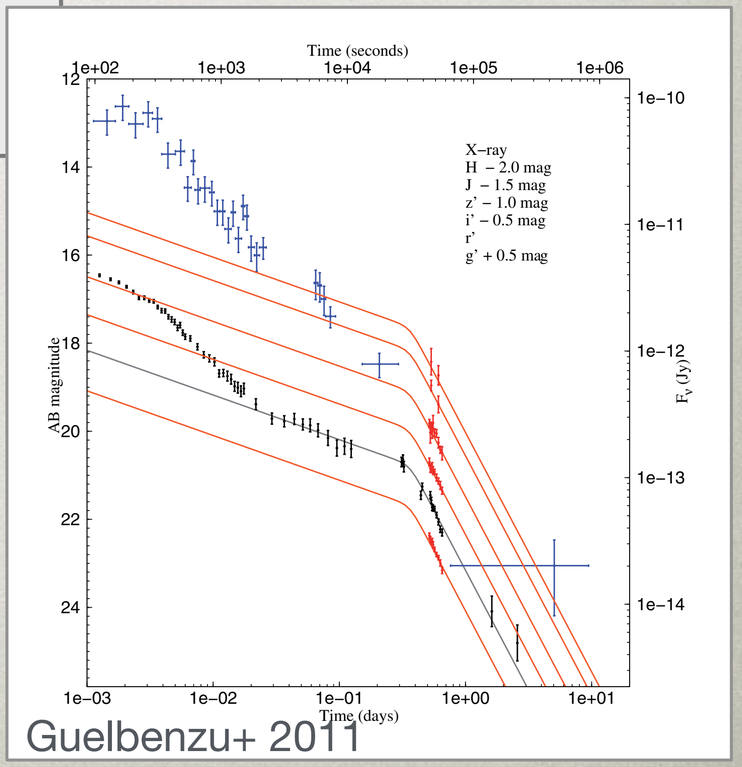
- Detection confidence
- EM energetics
- X-ray or optical afterglow gives precise location
- Breaks degeneracy in binary parameter estimation
- Host galaxy/redshift
- Local environment information



Long GRBs — Core-Collapse SNe



- X-Ray Flashes (XRFs)
- Jet Cocoons
- Choked bursts
- X-ray afterglow



Guelbenzu+ 2011