



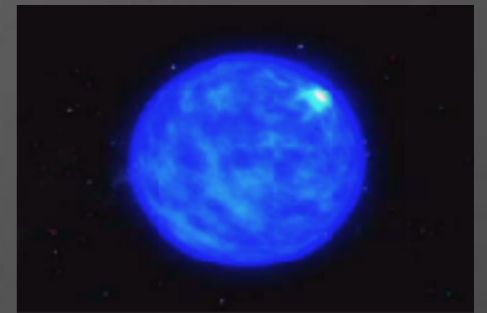
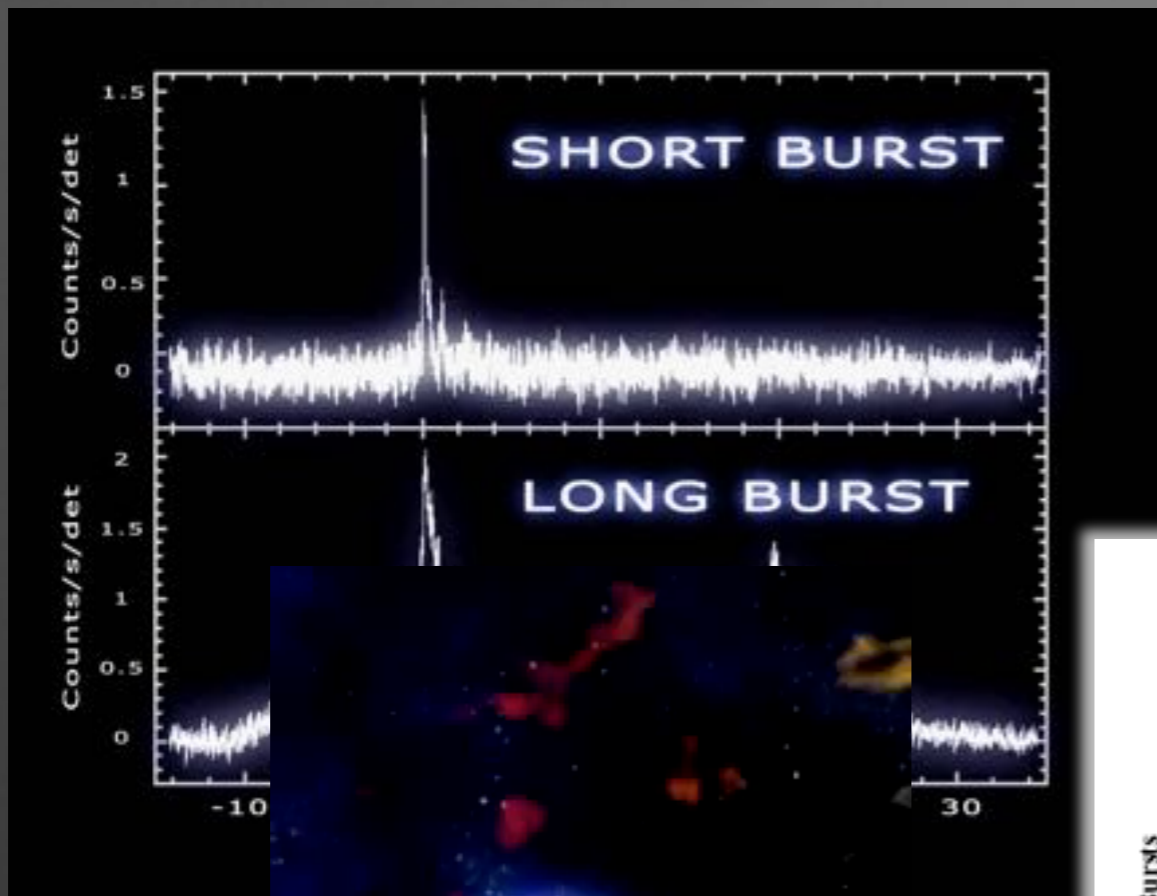
Berkeley

Long-duration Gamma-ray Bursts in the ngVLA era

Tanmoy Laskar
Jansky Fellow
NRAO / UC Berkeley

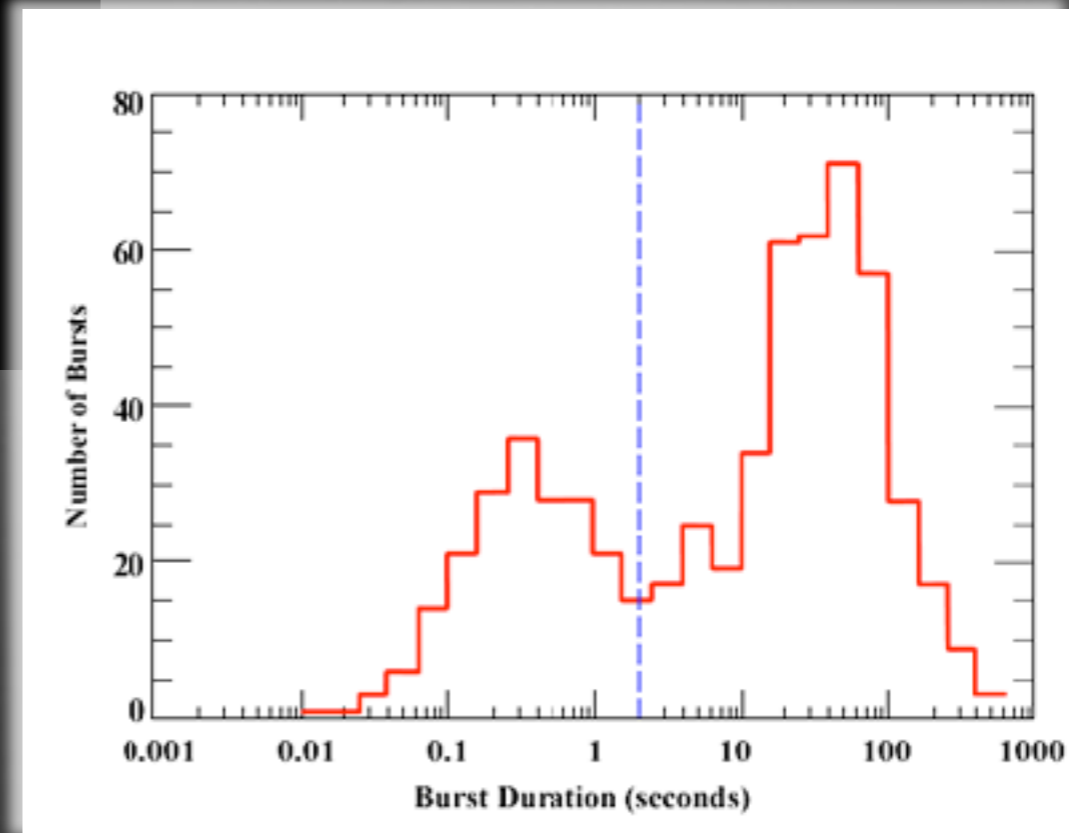


Gamma-ray Bursts: two classes



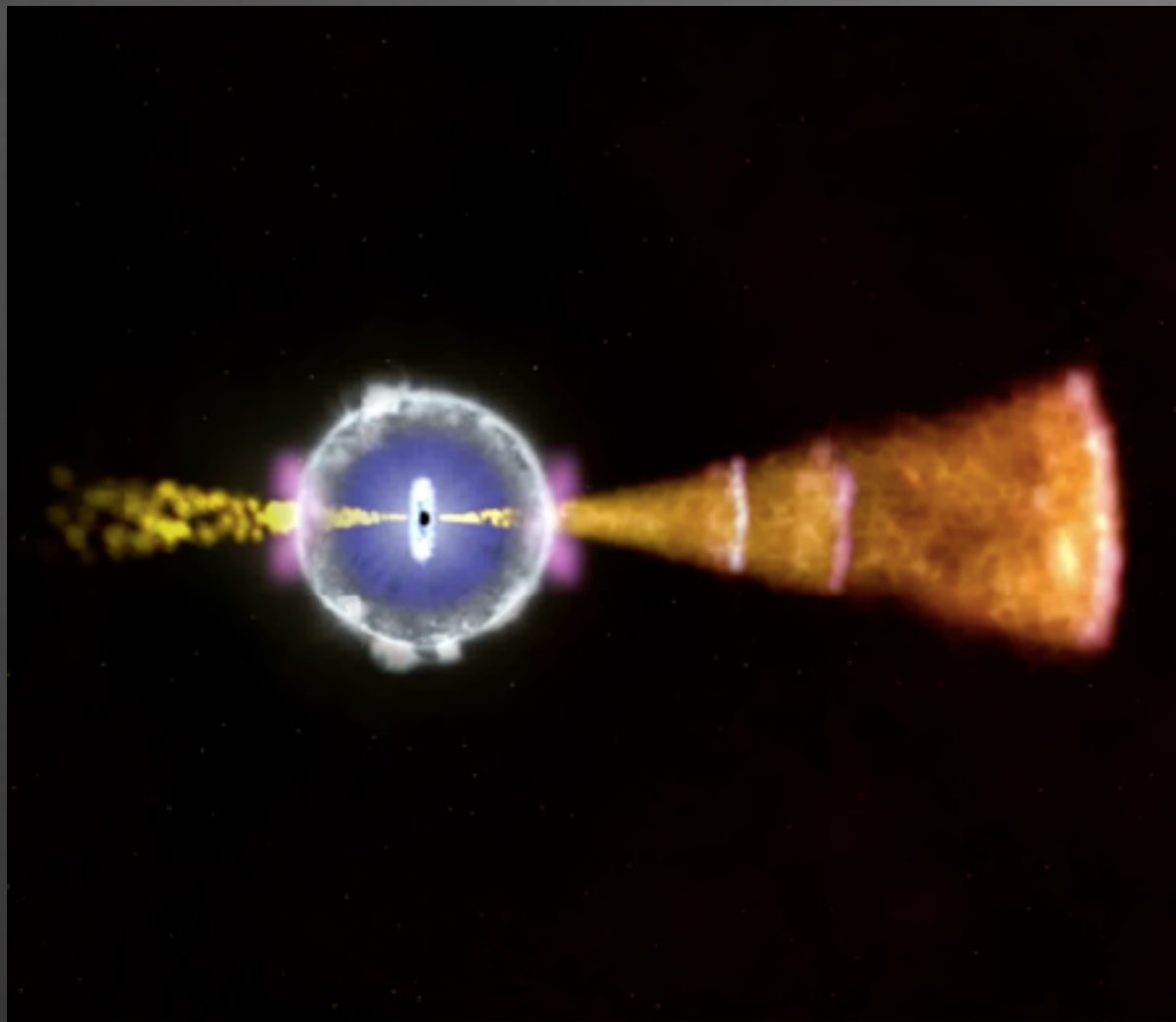
Short

Long



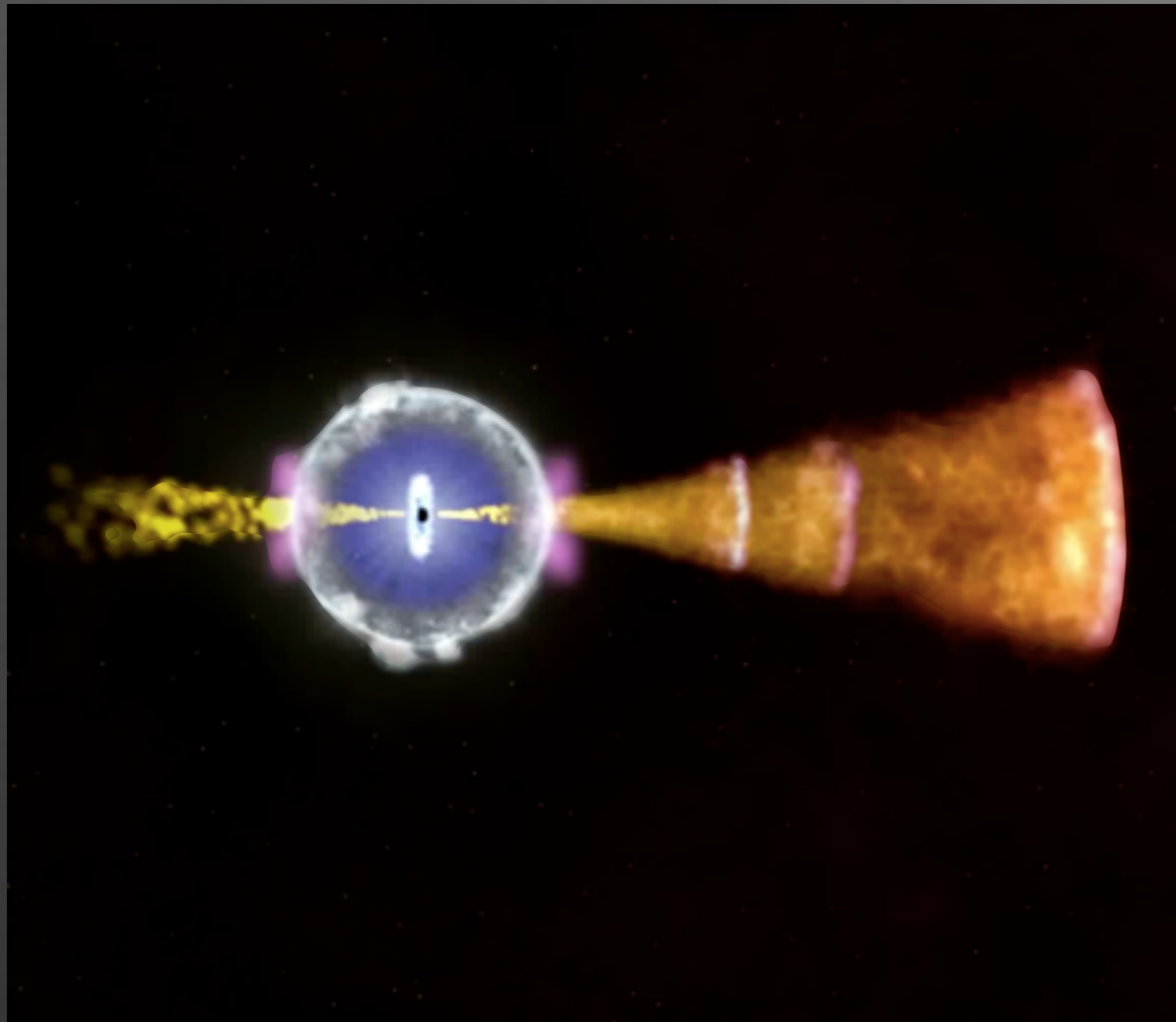
Long-duration Gamma-ray Bursts

Catastrophic death of a massive star



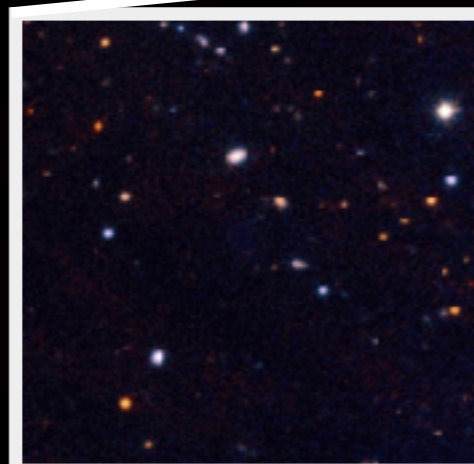
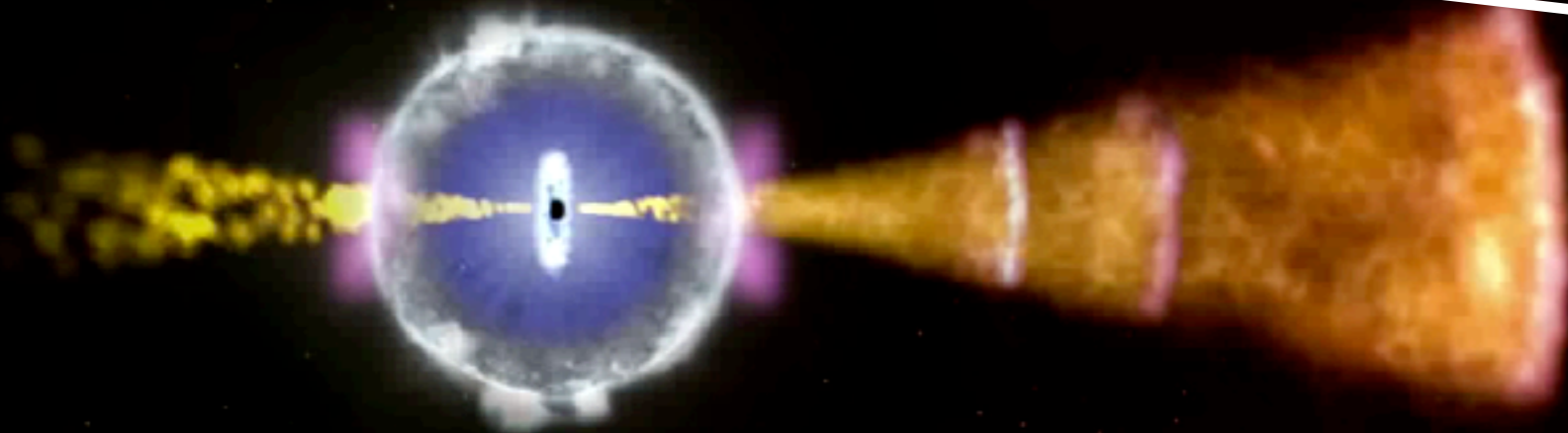
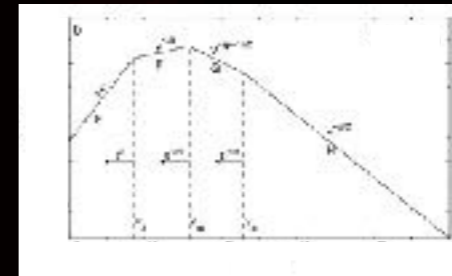
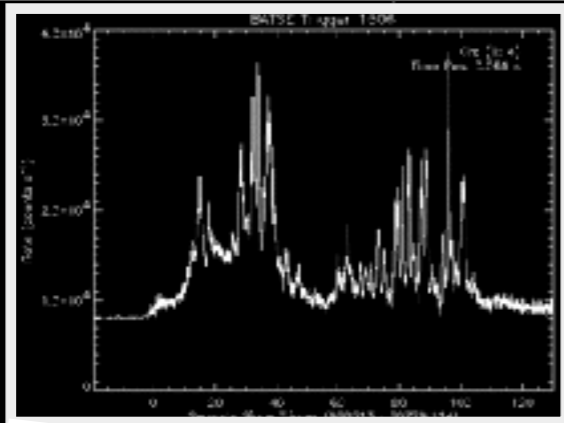
- Located in star forming regions of galaxies
- Associated with supernovae
- Most energetic explosions in the universe: $E_{\gamma,iso} \sim 10^{54}$ erg
- Visible to high redshifts ($z \sim 9$, and beyond!)
- Short durations (minutes) → Relativistic expansion
- Powered by compact central engine

GRBs as Probes

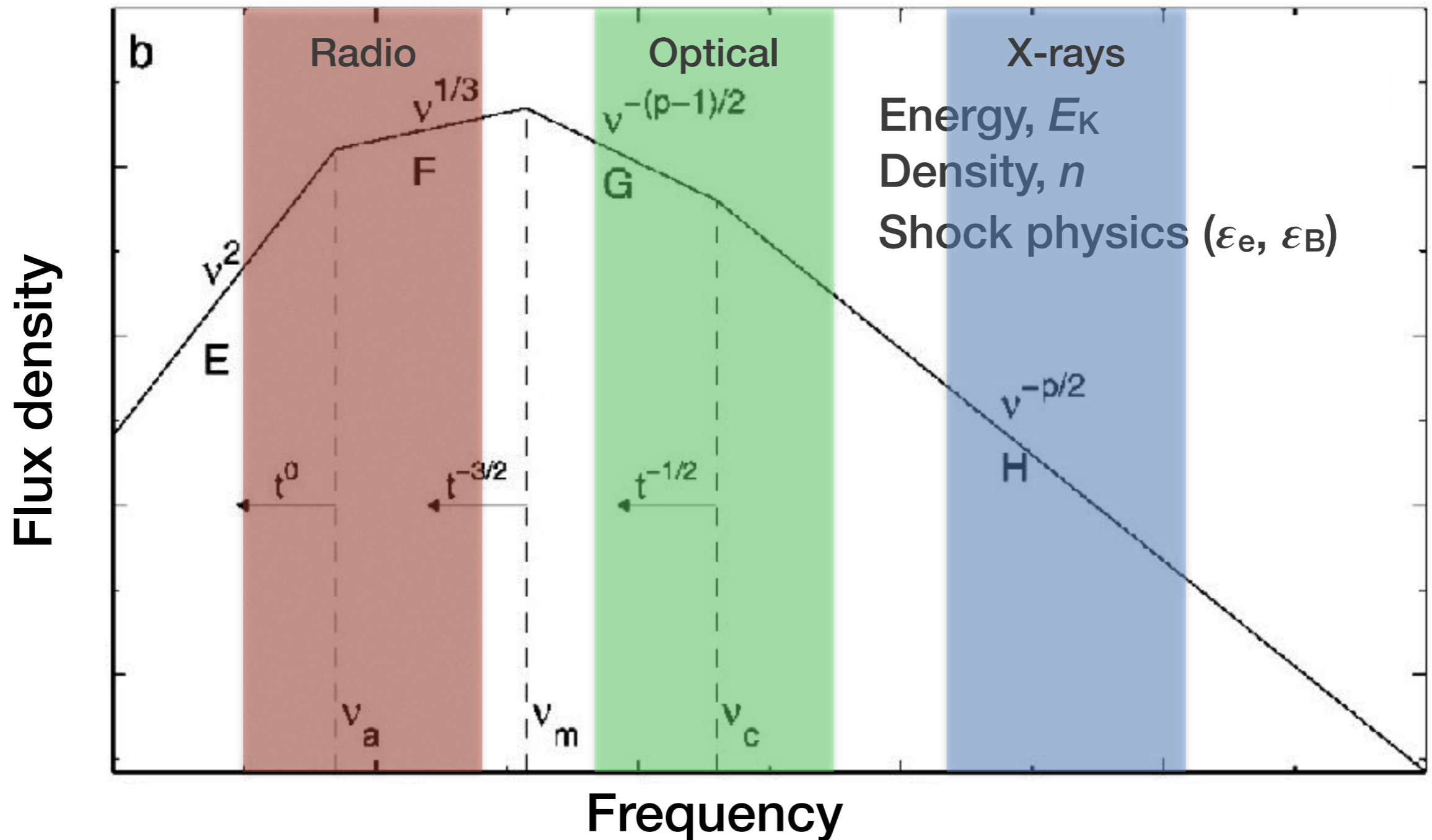


- Particle acceleration
- Stellar death & compact object formation
- The first stars & the high-redshift Universe
- Intergalactic medium & interstellar medium

Long-duration GRBs

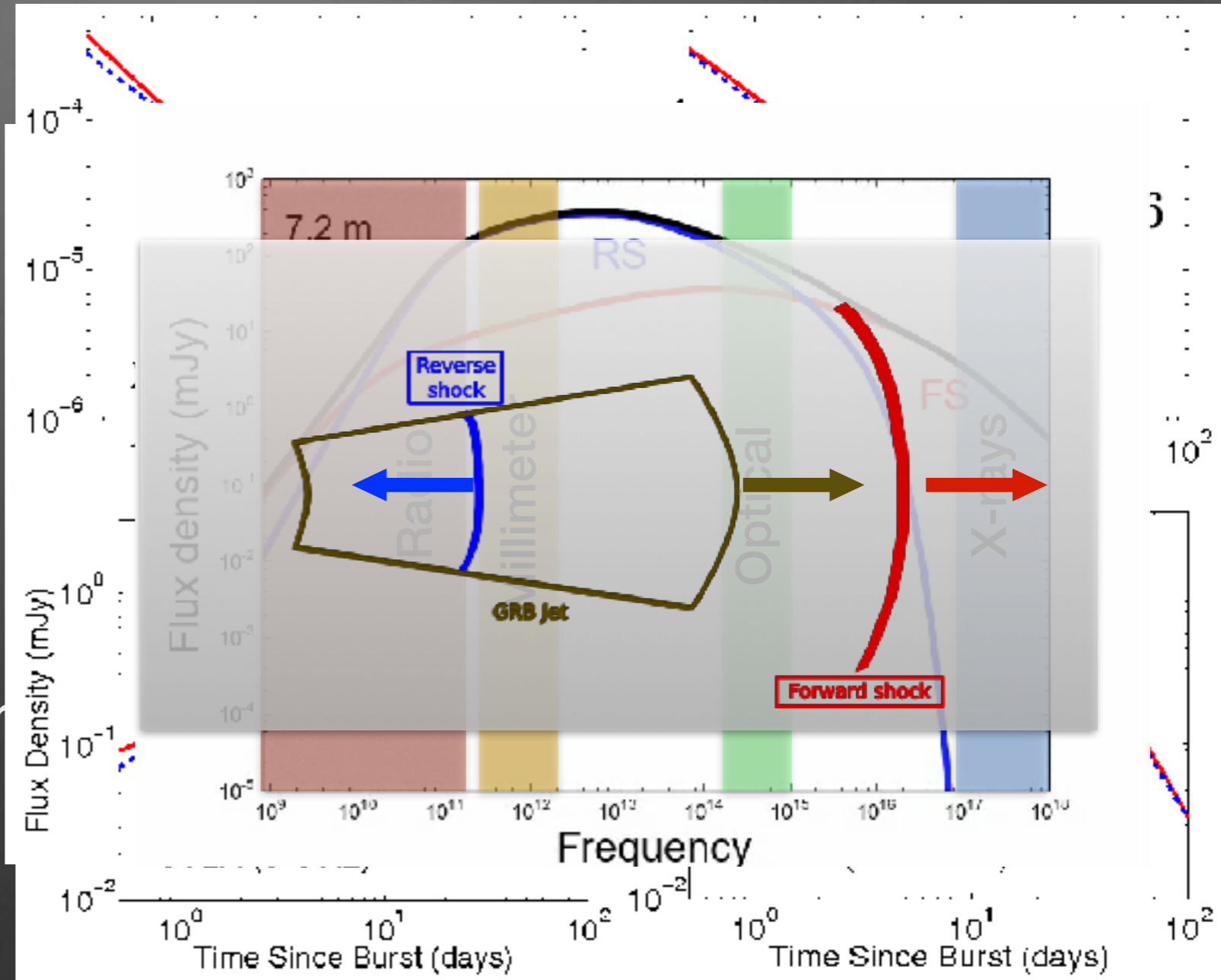


GRBs: The Radiation Mechanism

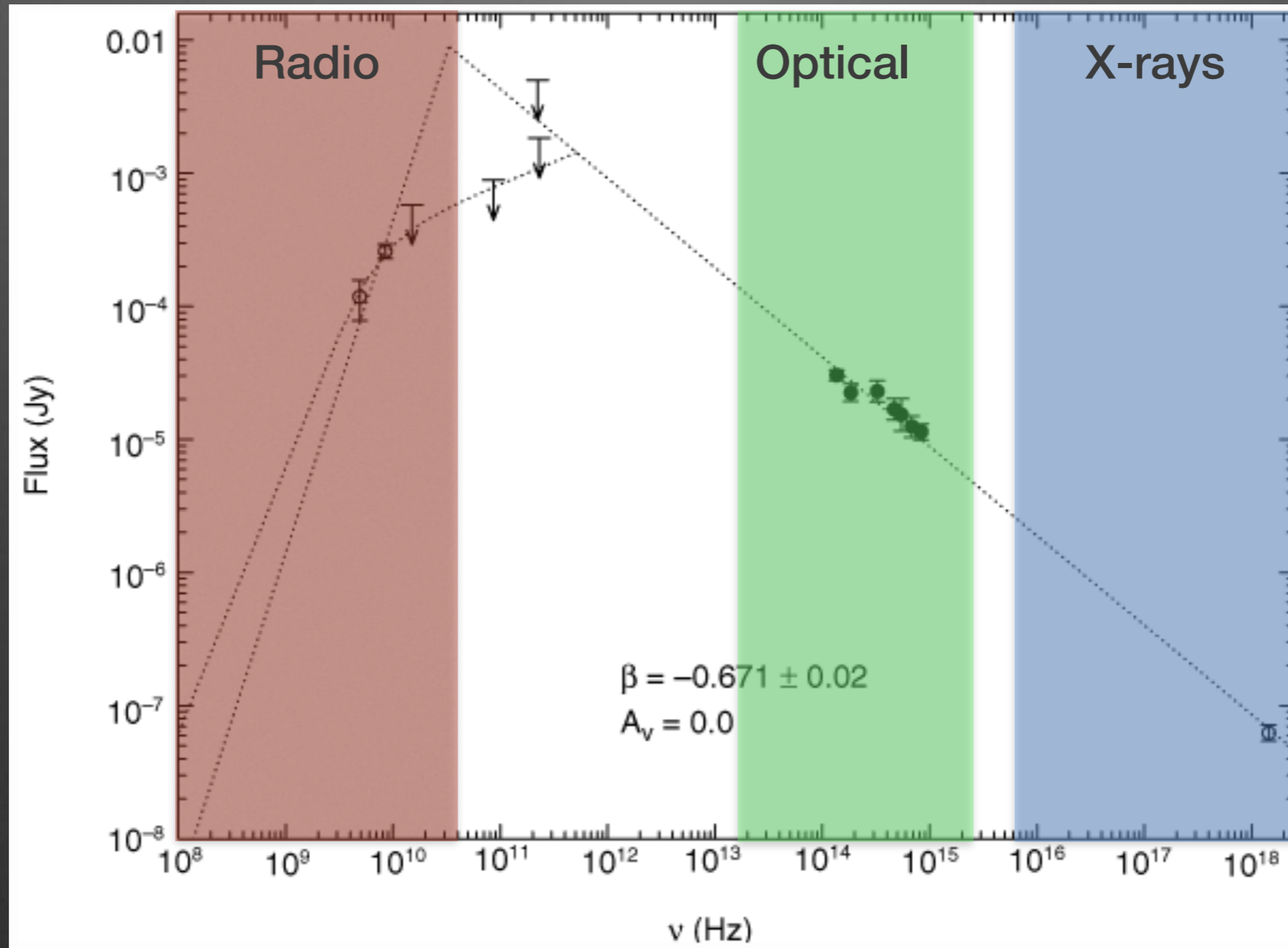


GRBs in the Radio

- Density (environment)
- Density profile (mass loss history)
- Lorentz factor & ejecta magnetization (jet launching mechanism)

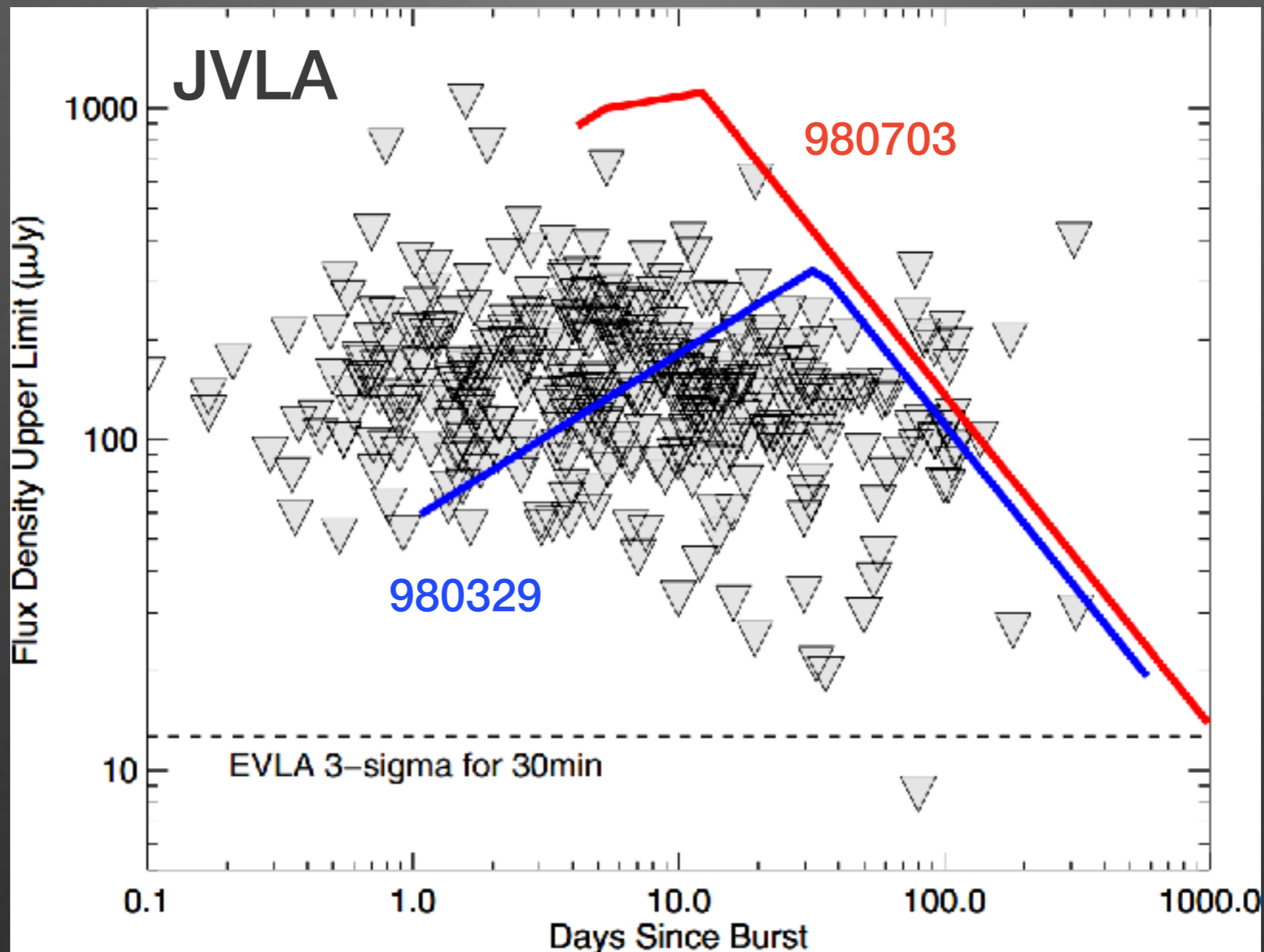


Past: VLA & CARMA era



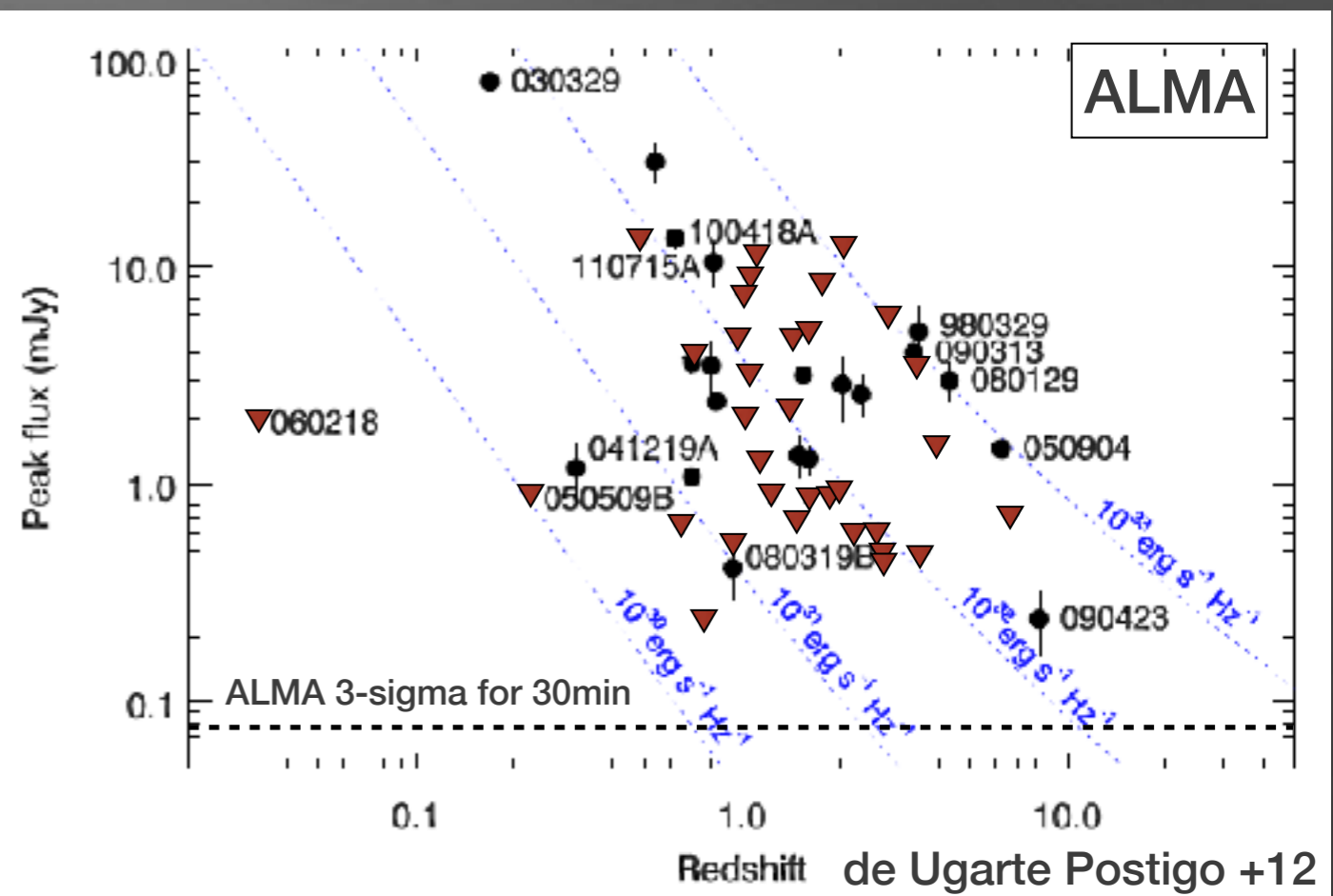
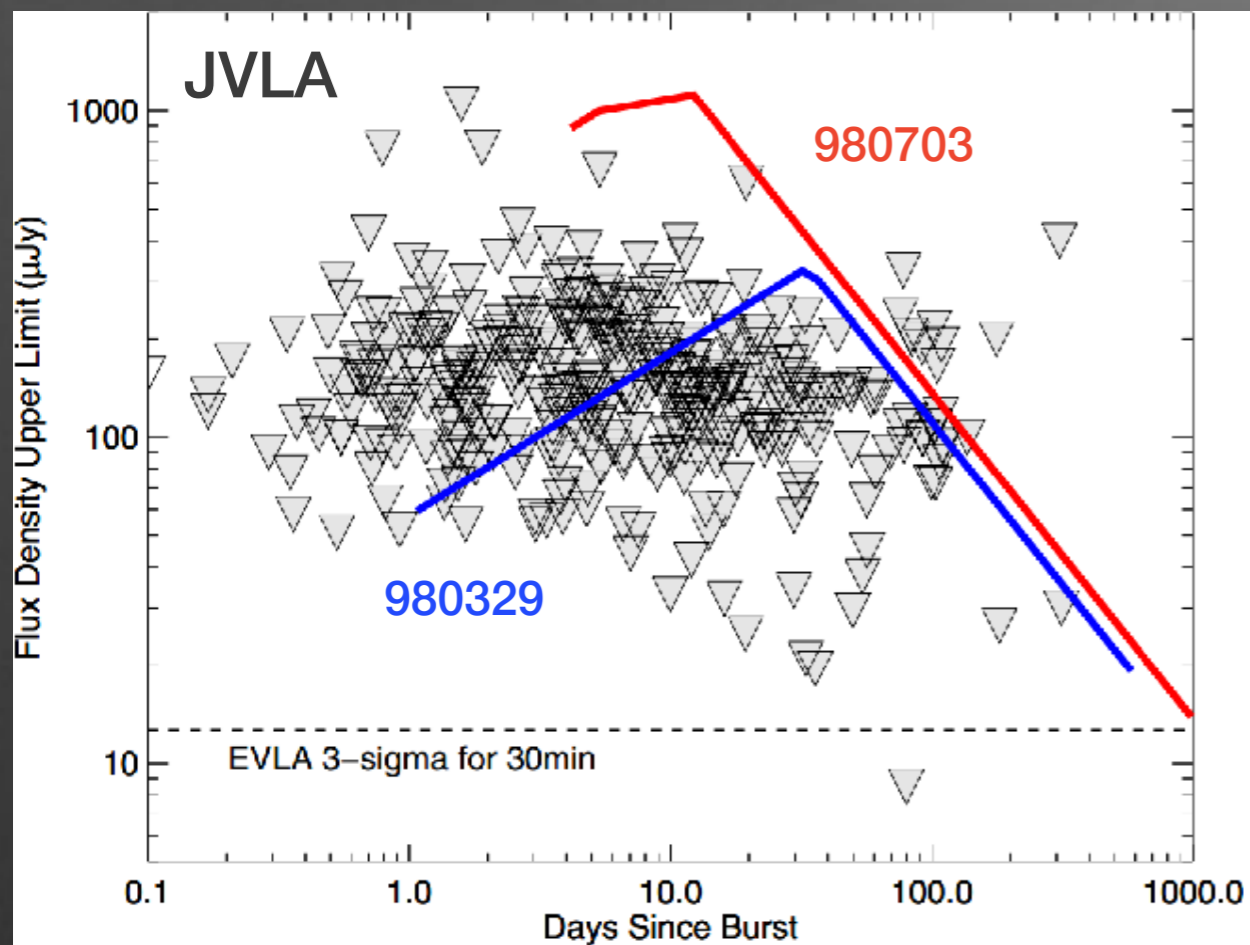
Galama et al. (1999)

Present: The Jansky VLA and ALMA era

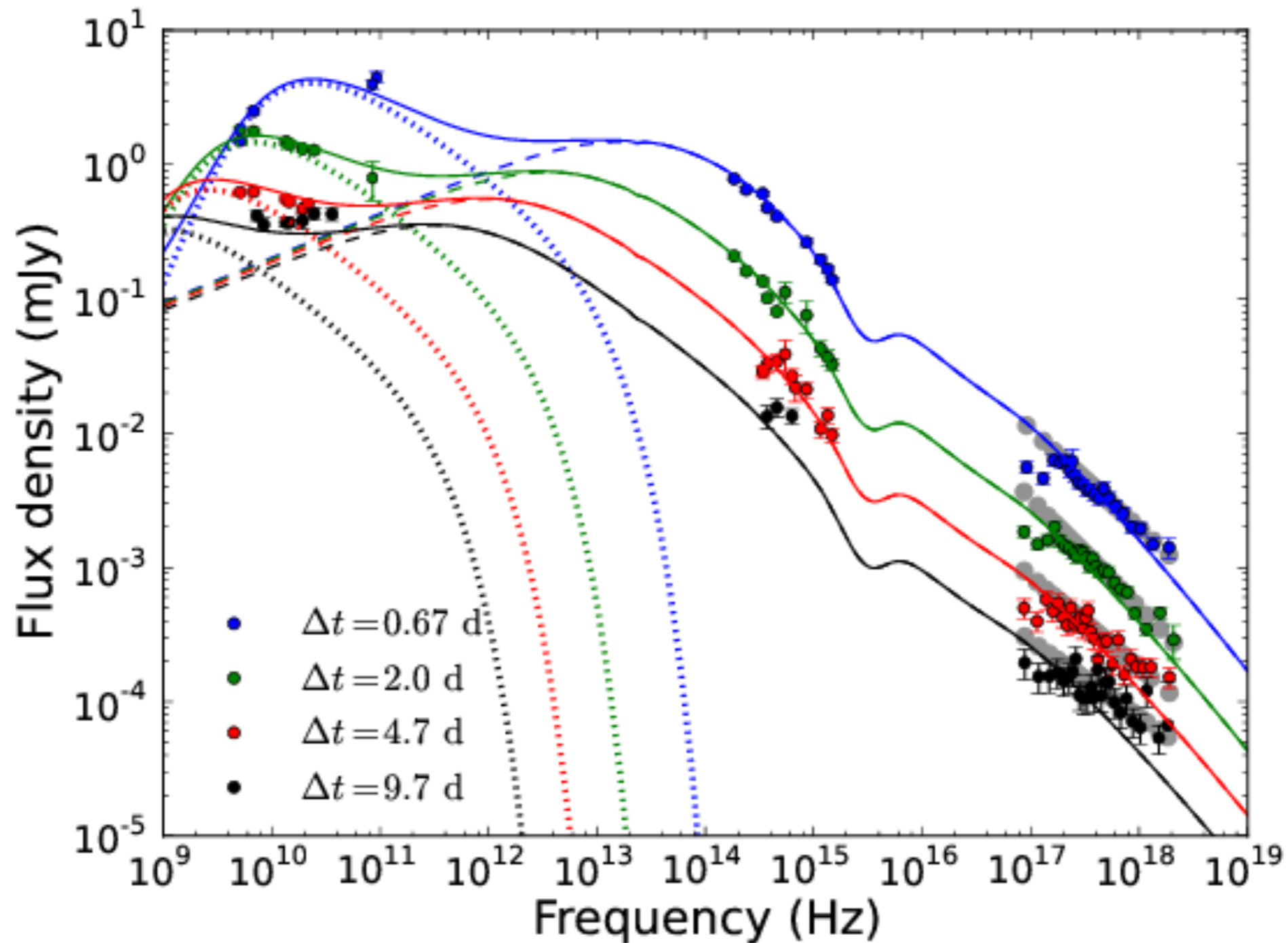


Chandra & Frail (2012)

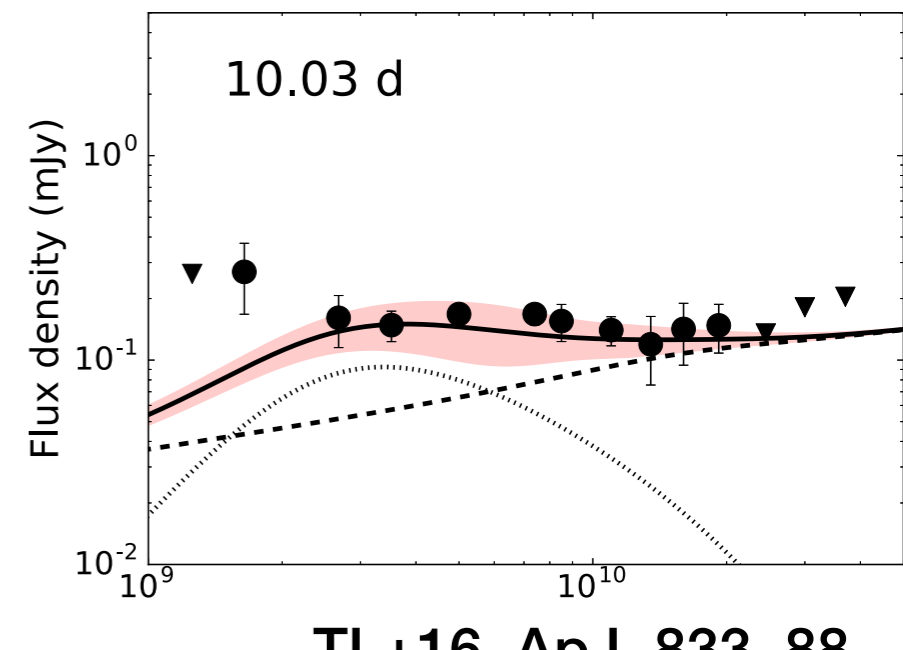
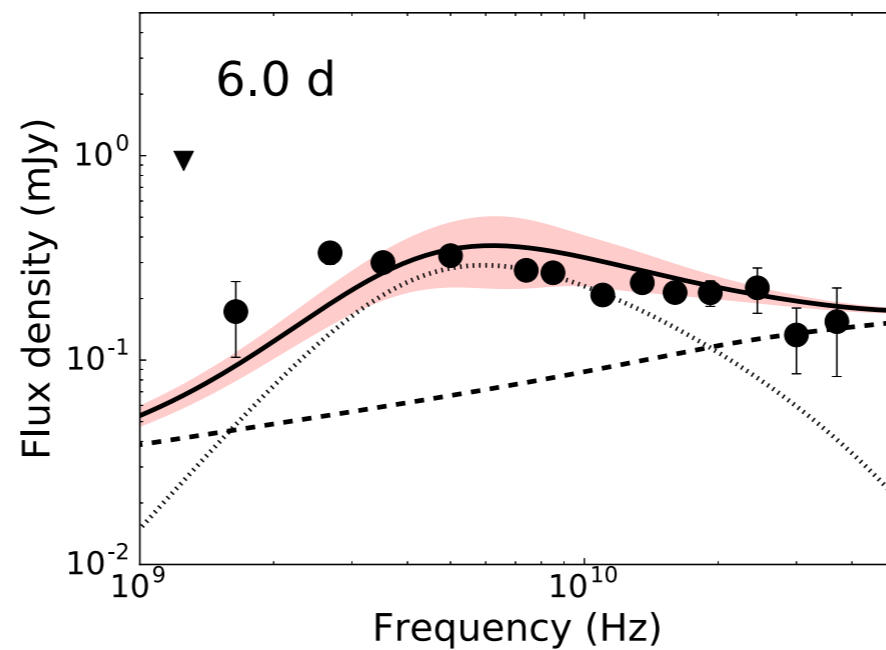
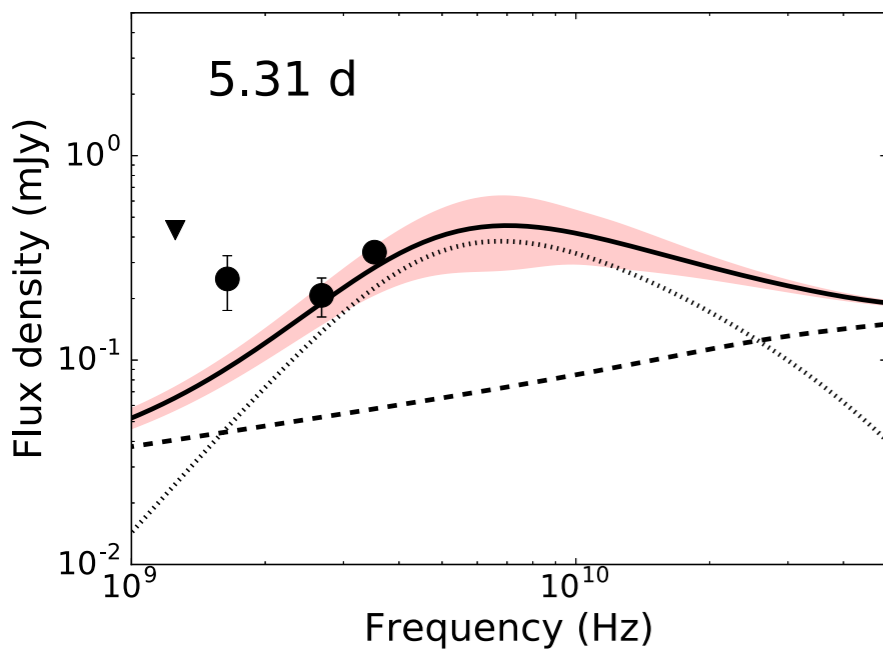
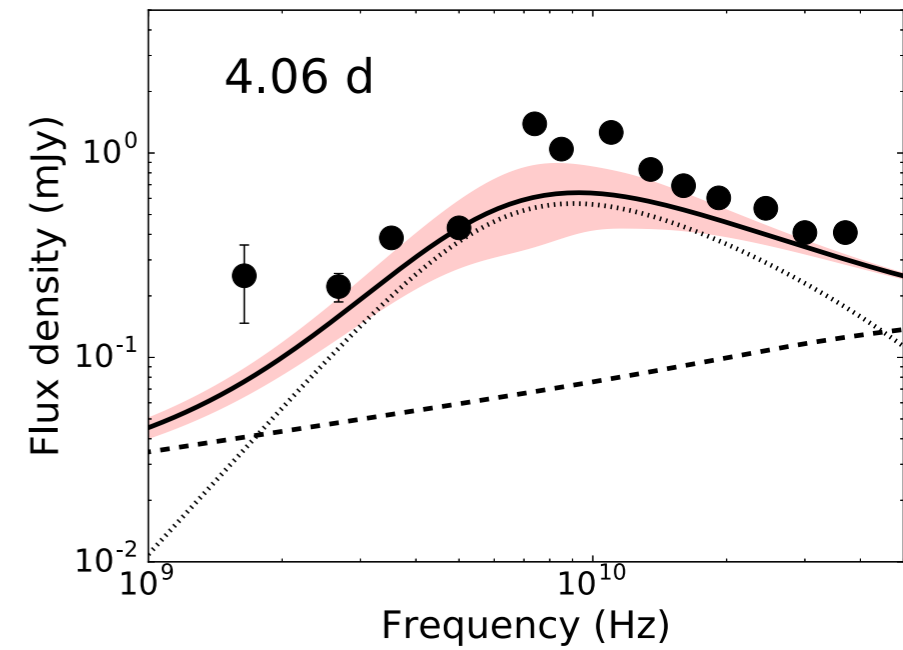
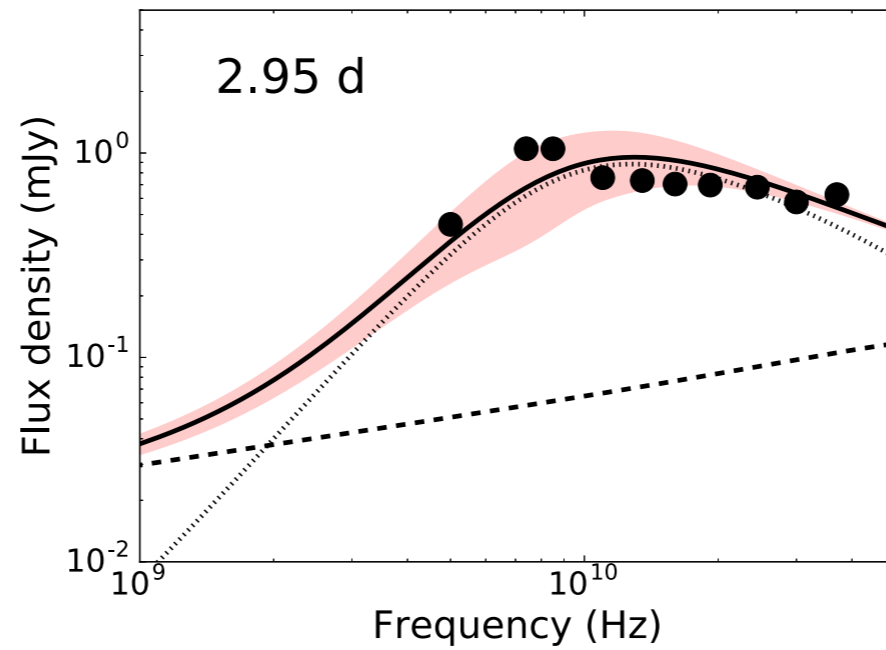
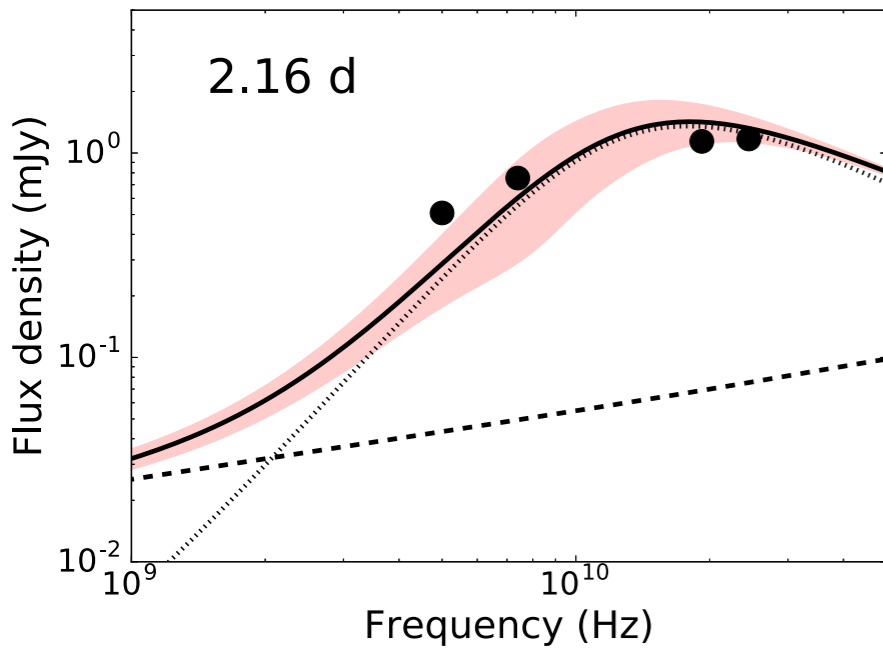
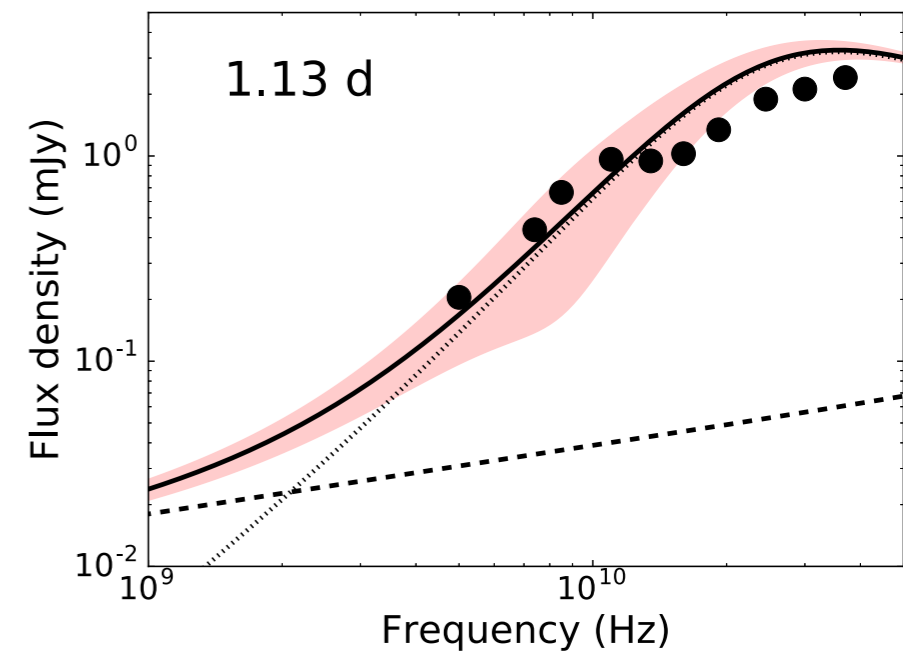
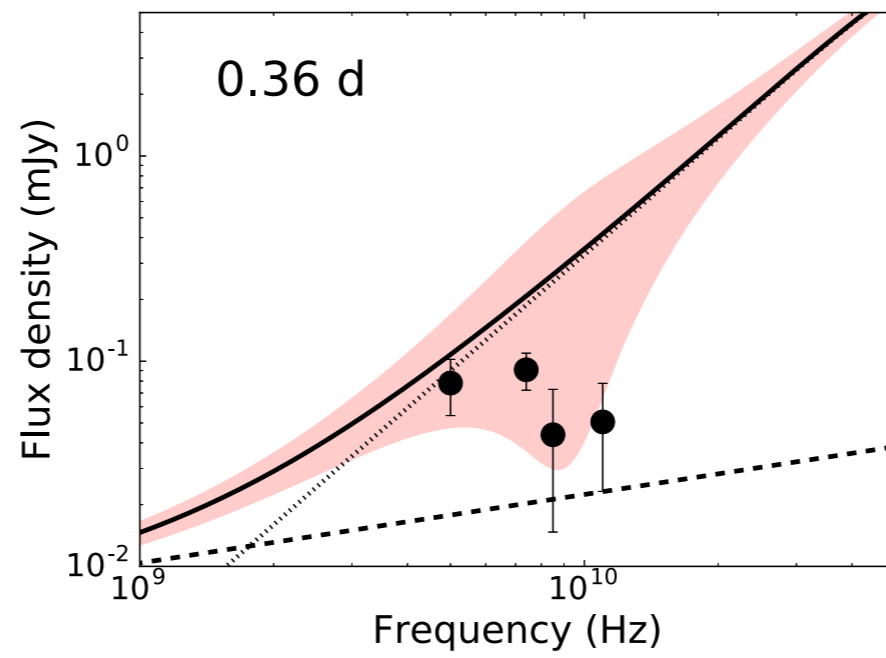
Present: The Jansky VLA and ALMA era



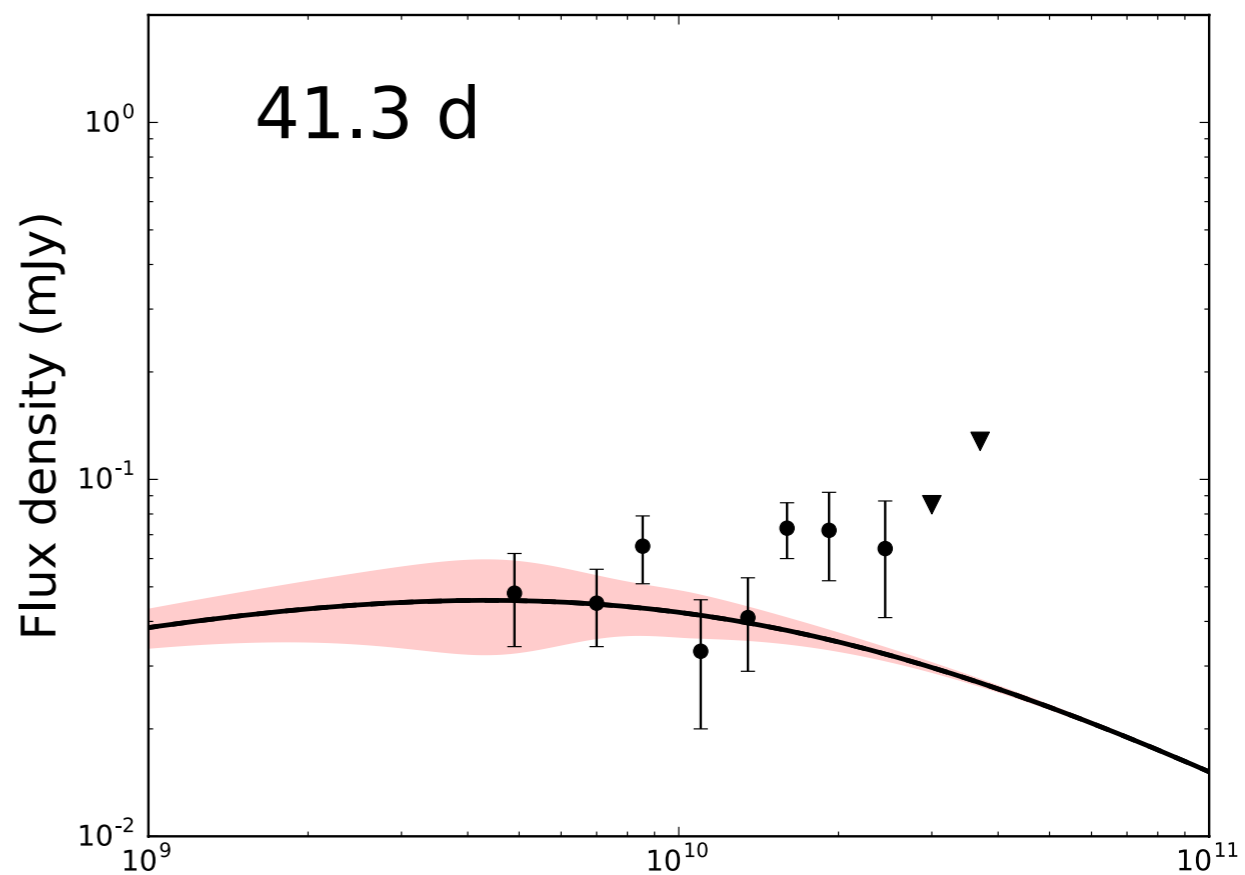
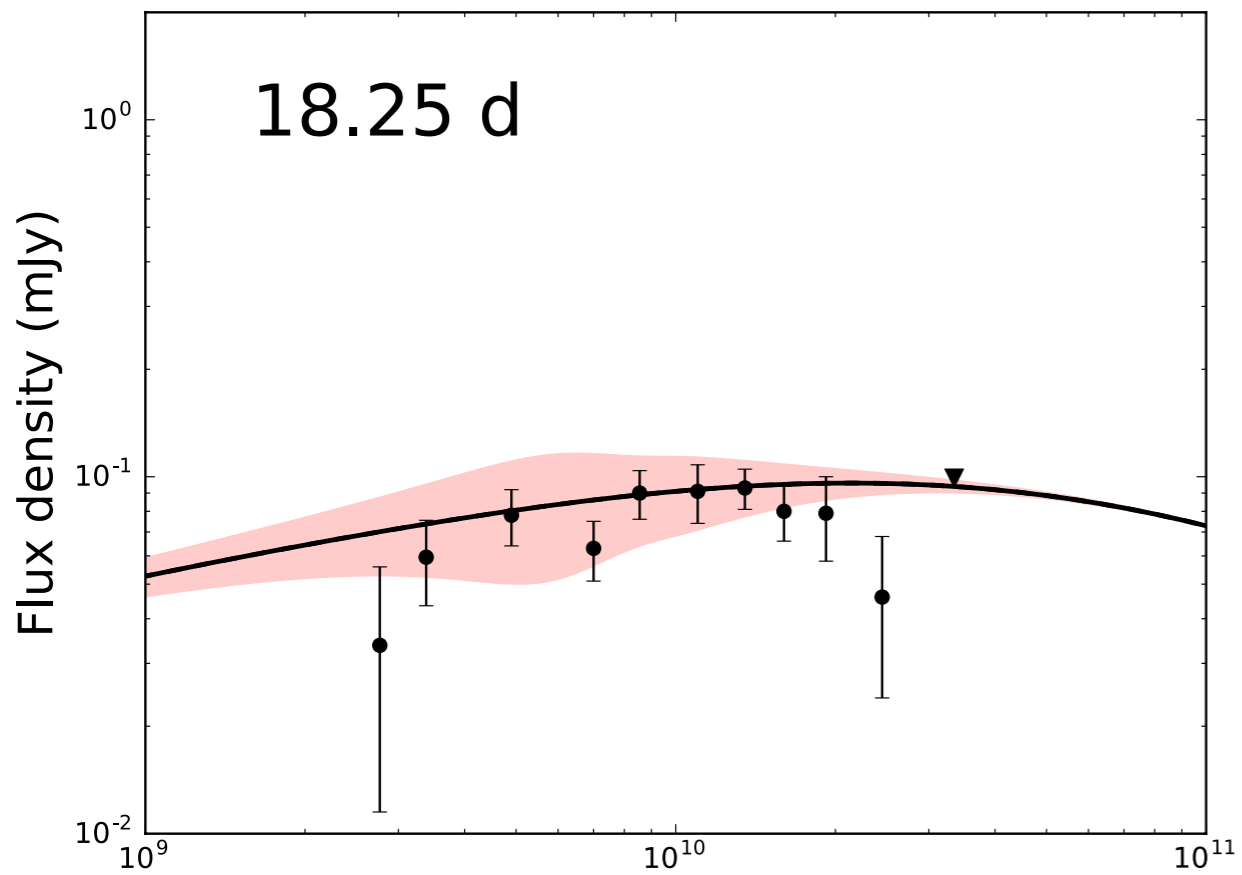
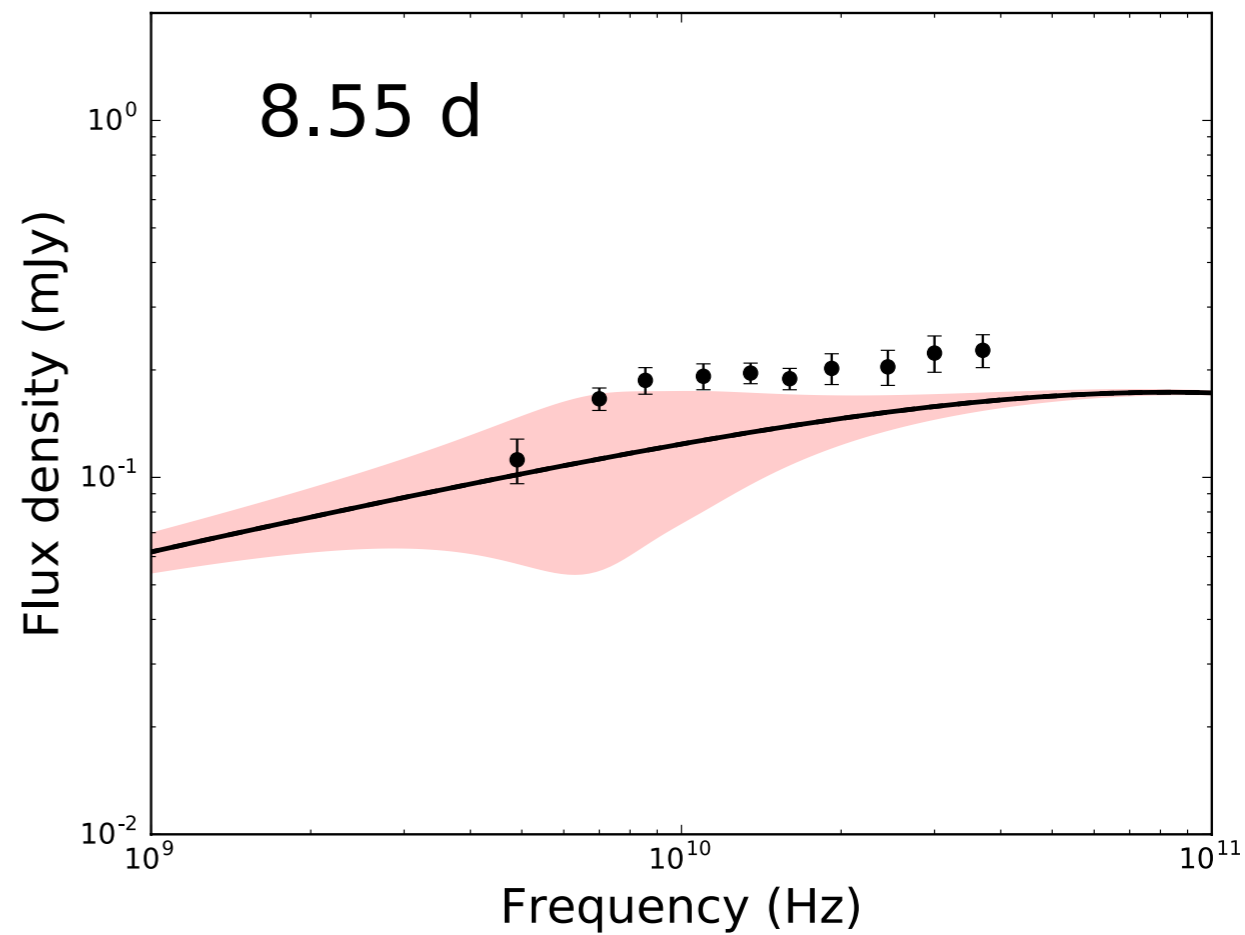
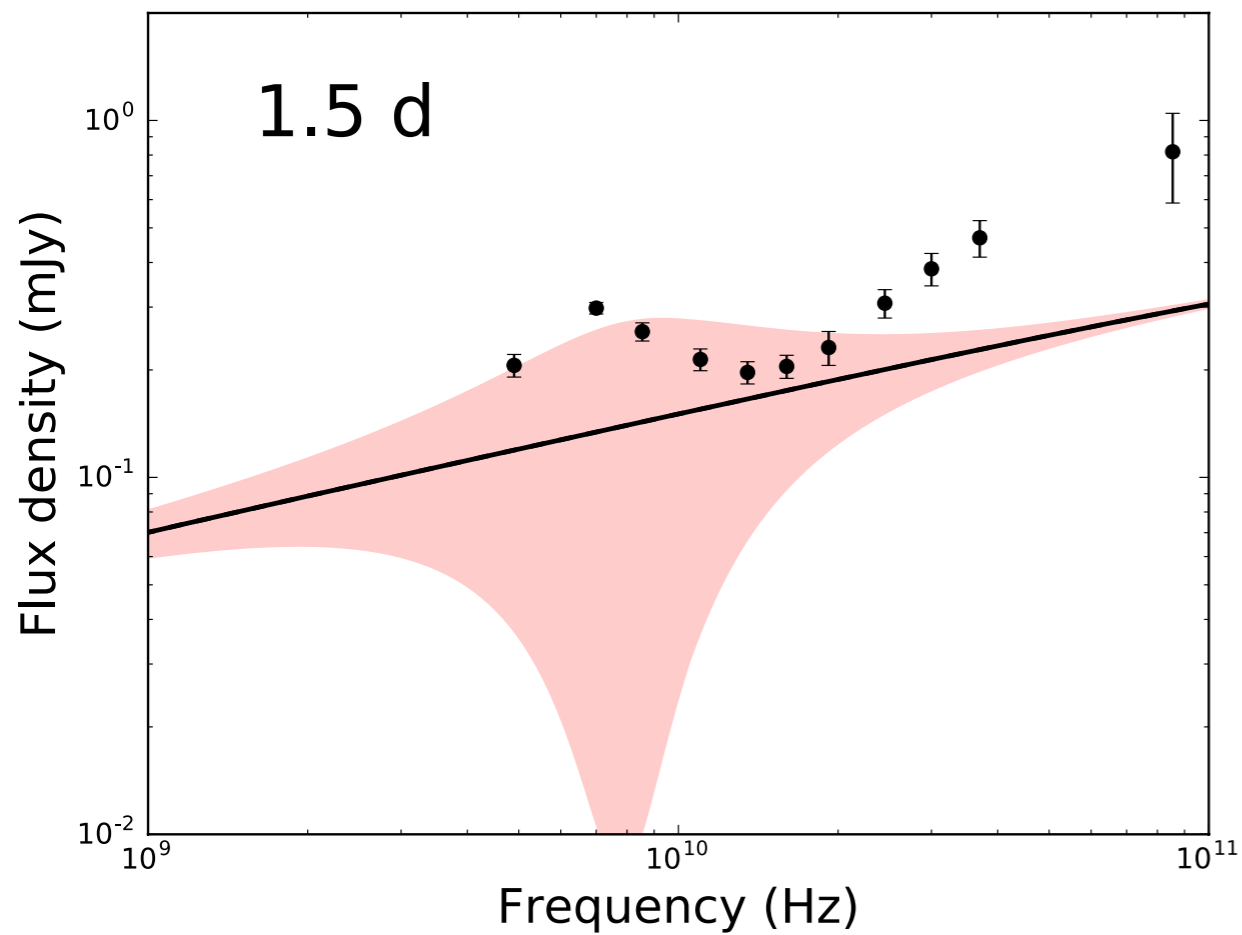
A Reverse Shock in GRB 130427A



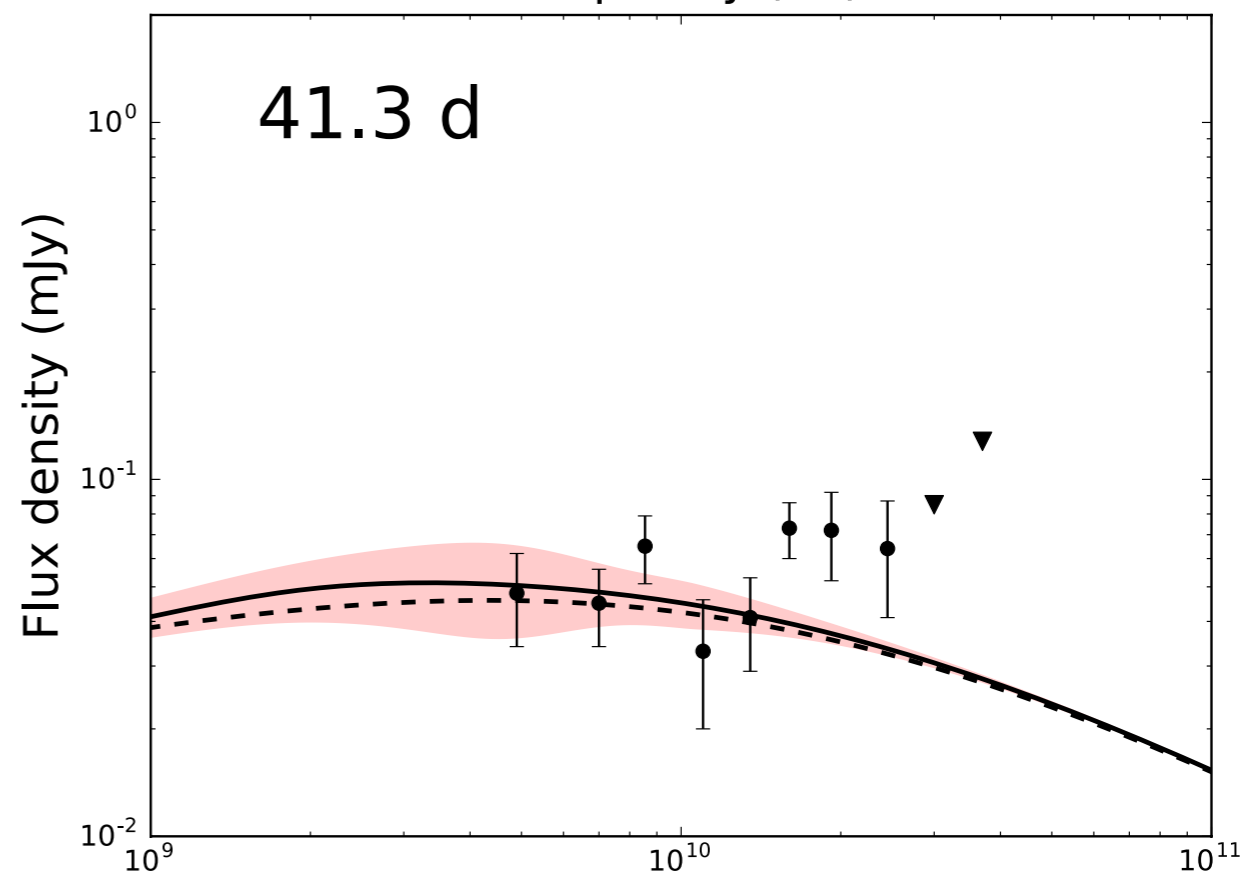
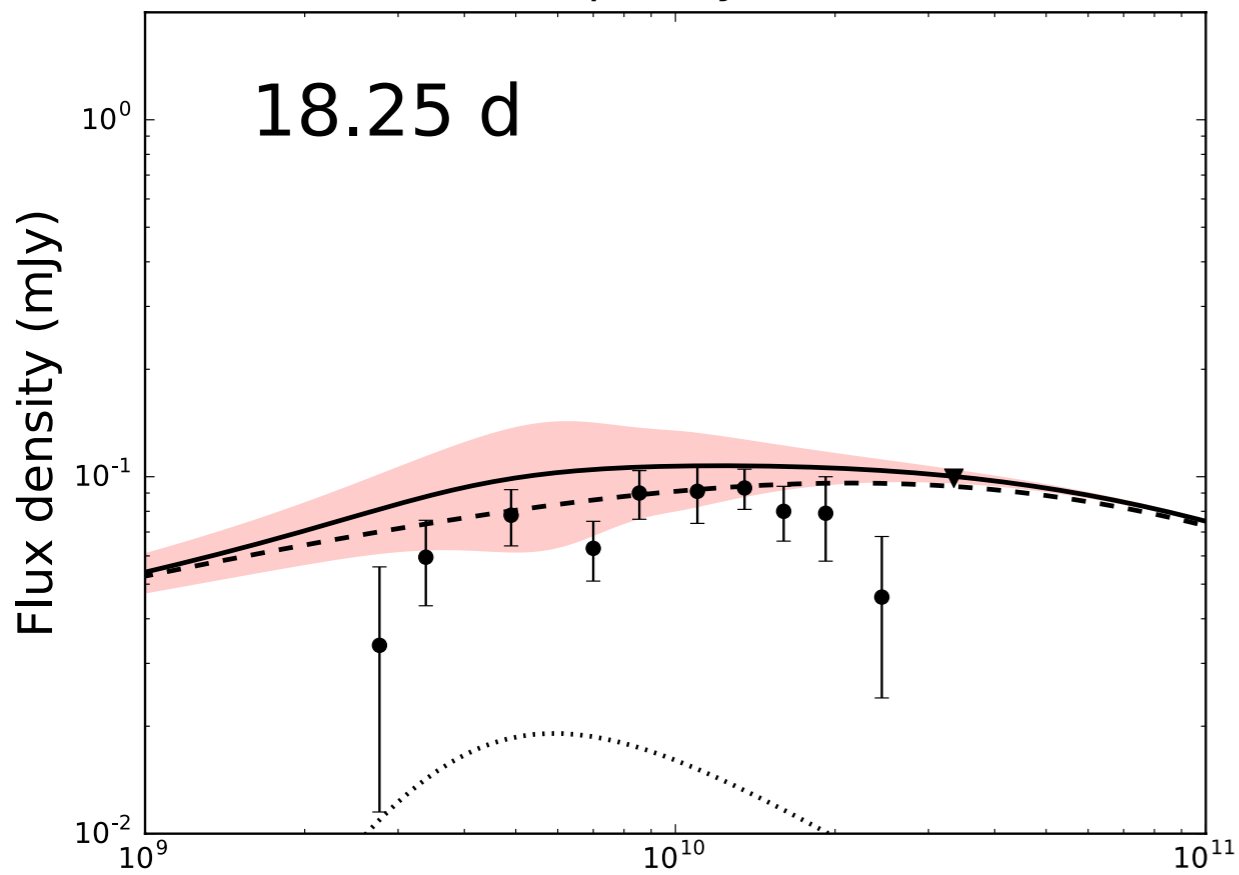
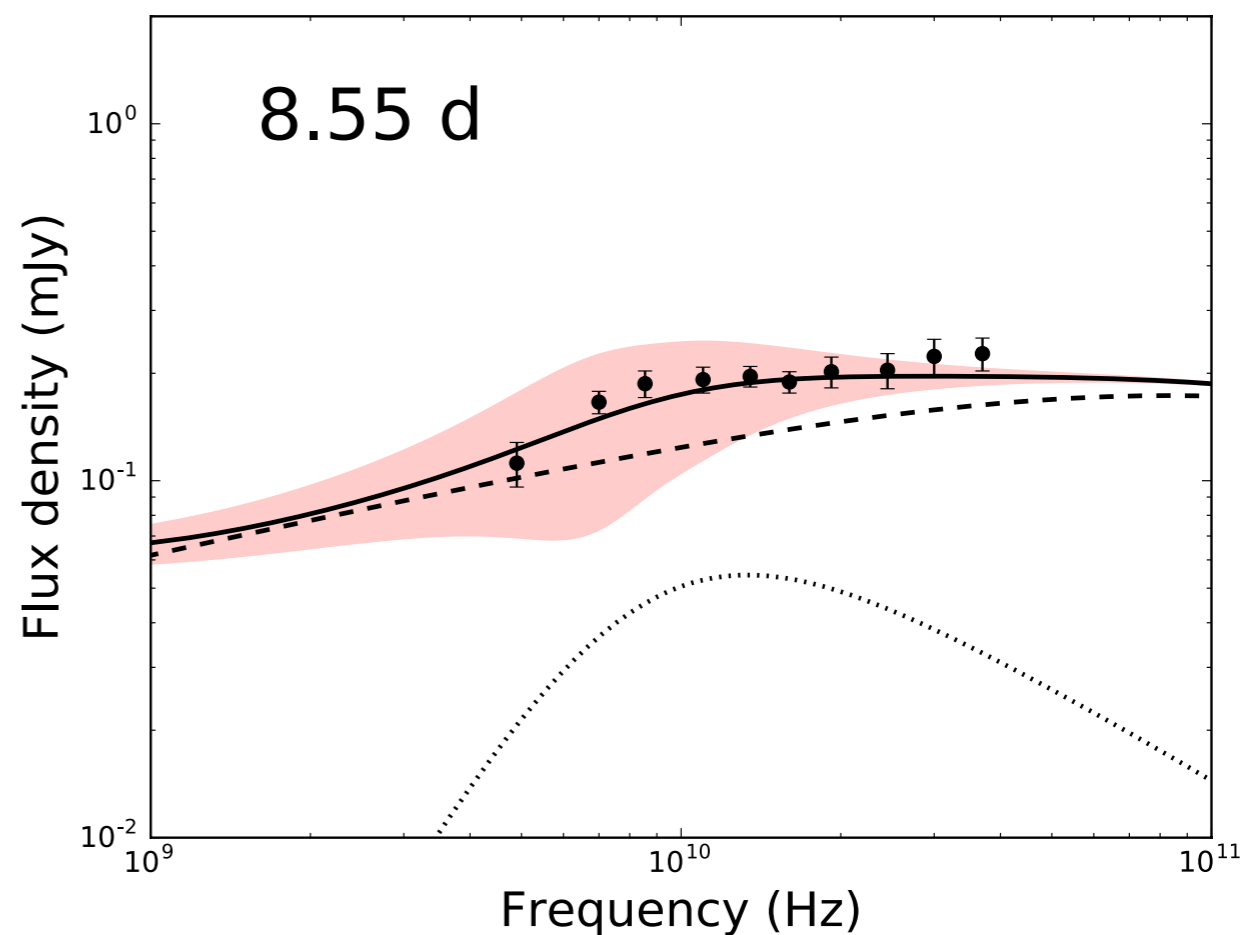
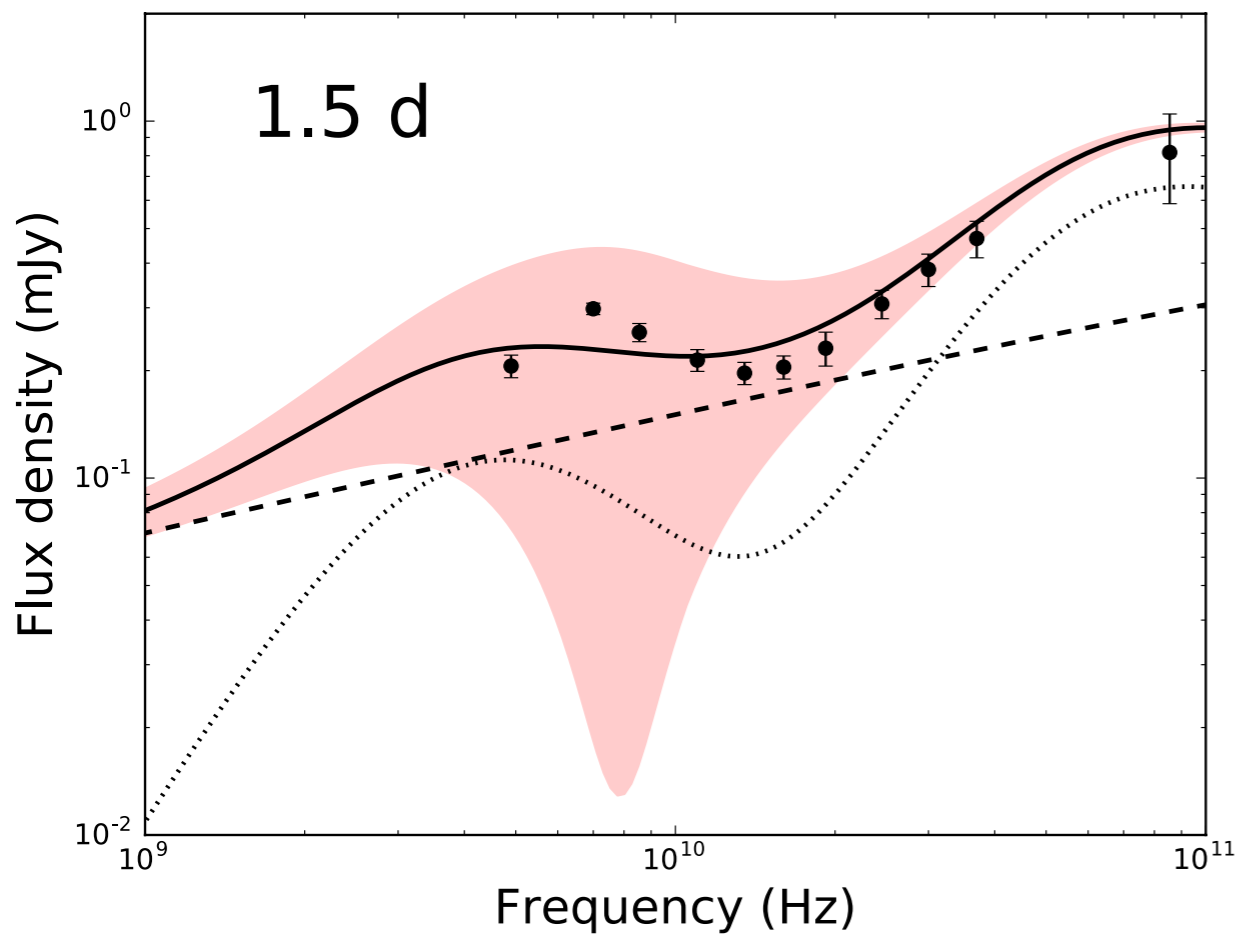
A Reverse Shock in GRB 160509A

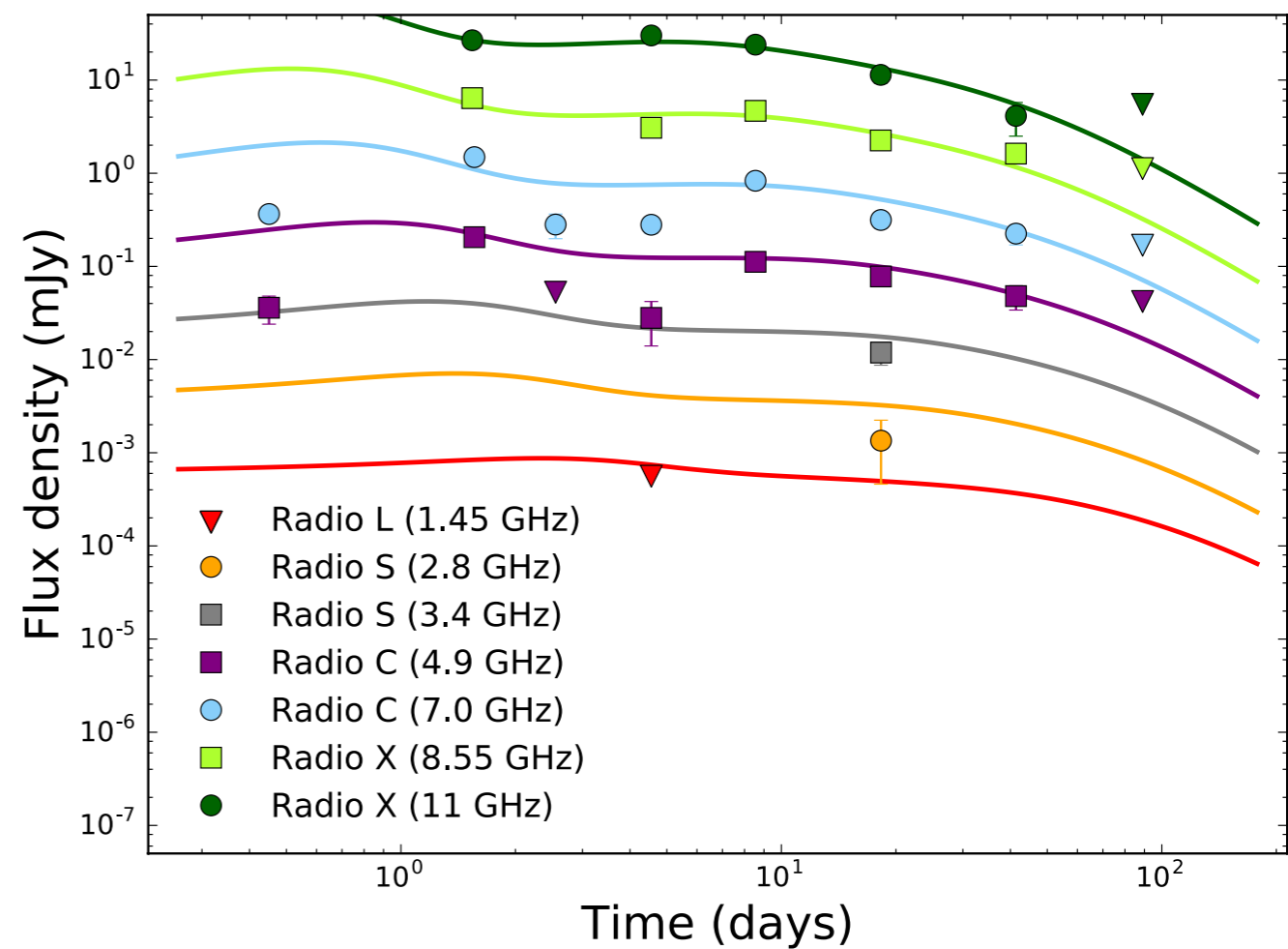
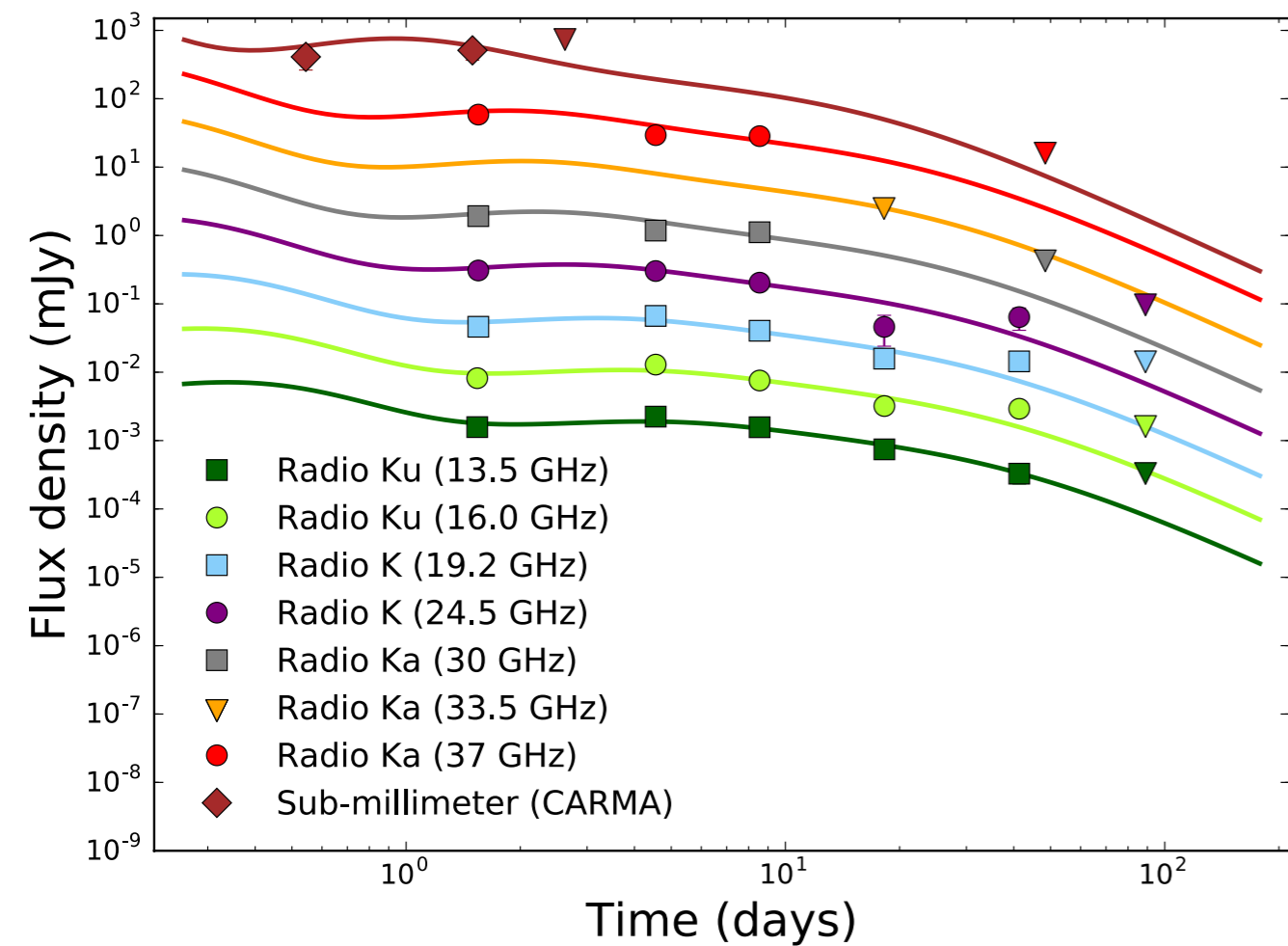
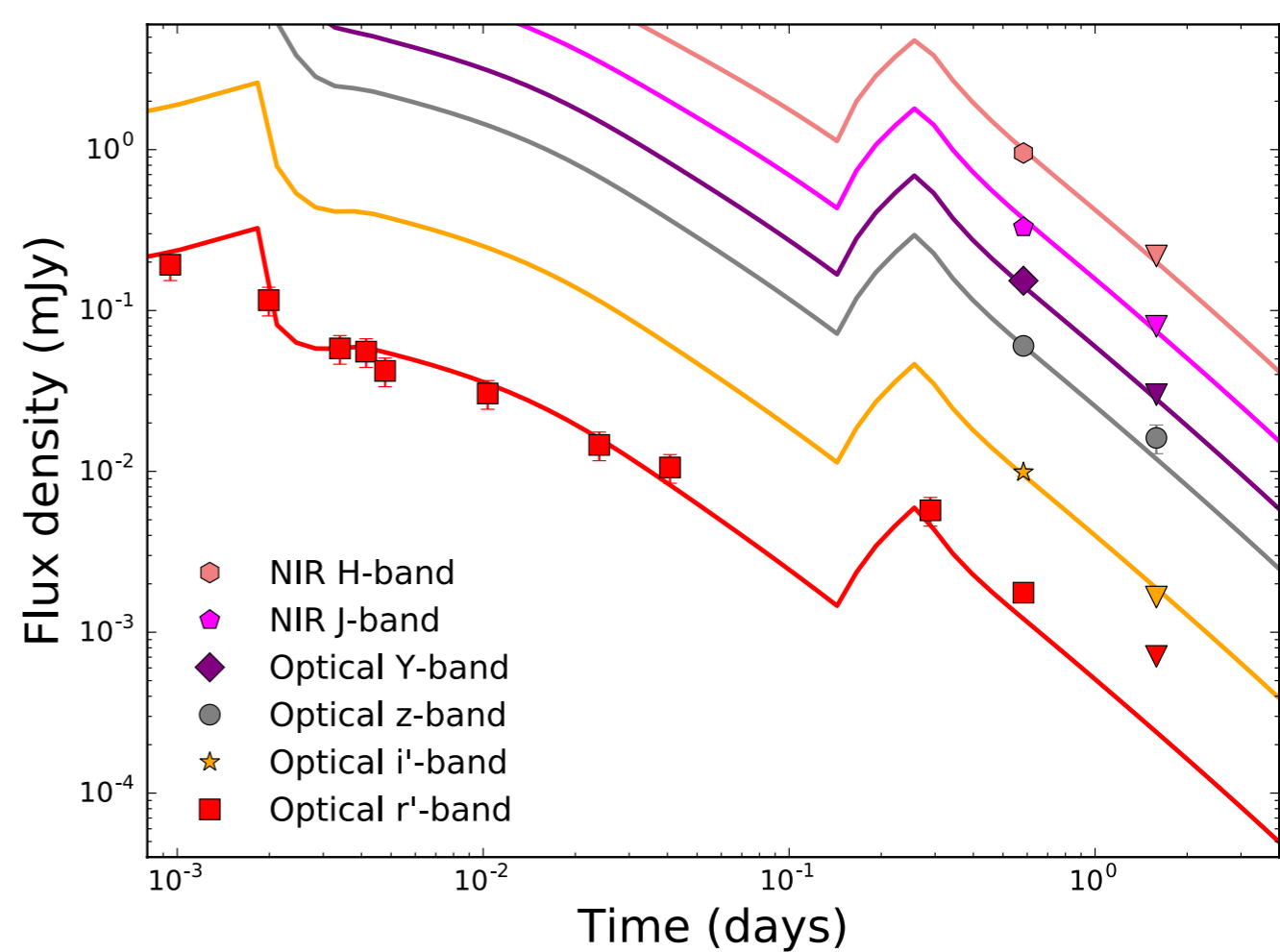
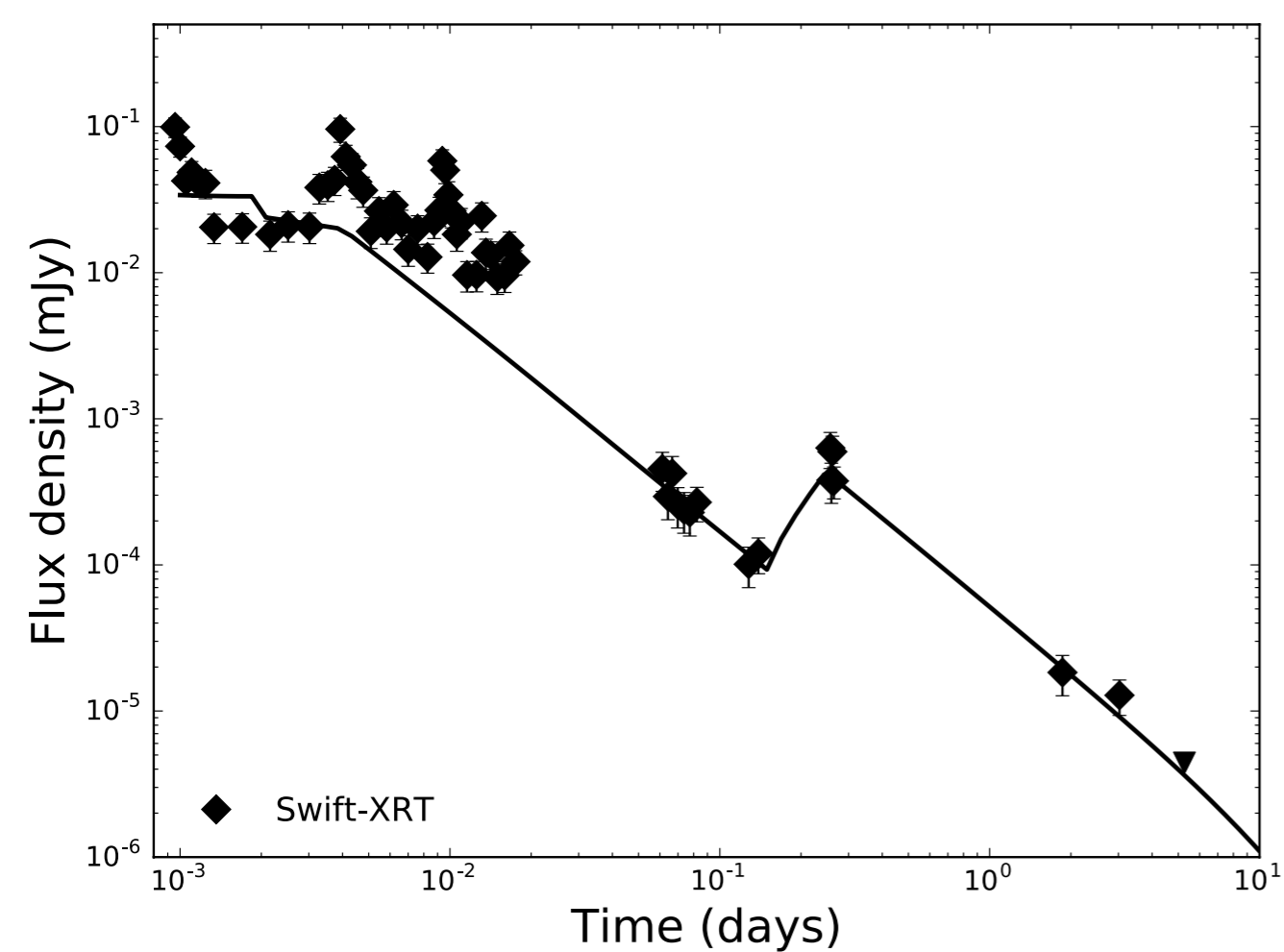


Multiple peaks in radio SEDs

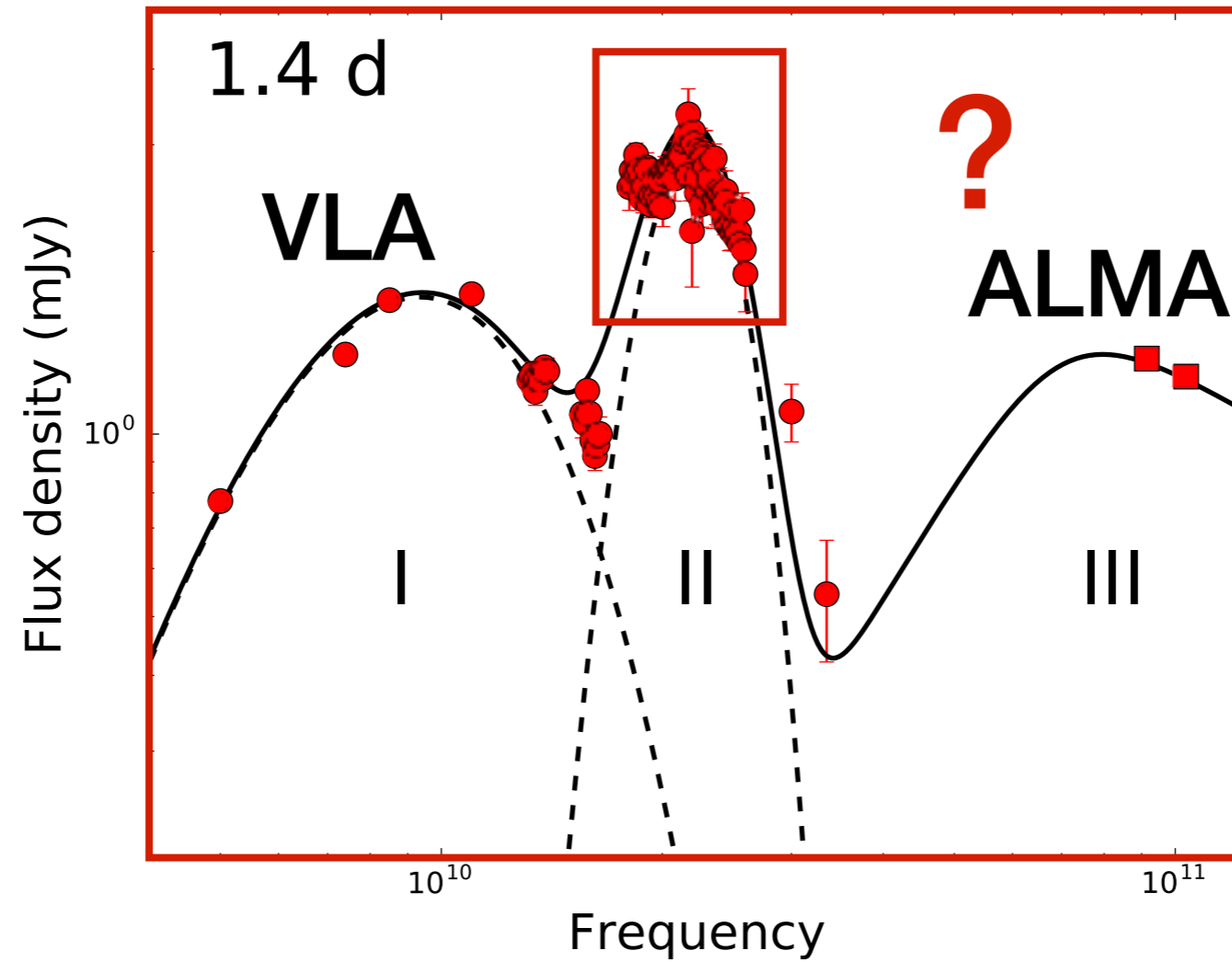


A collision of two relativistic shells

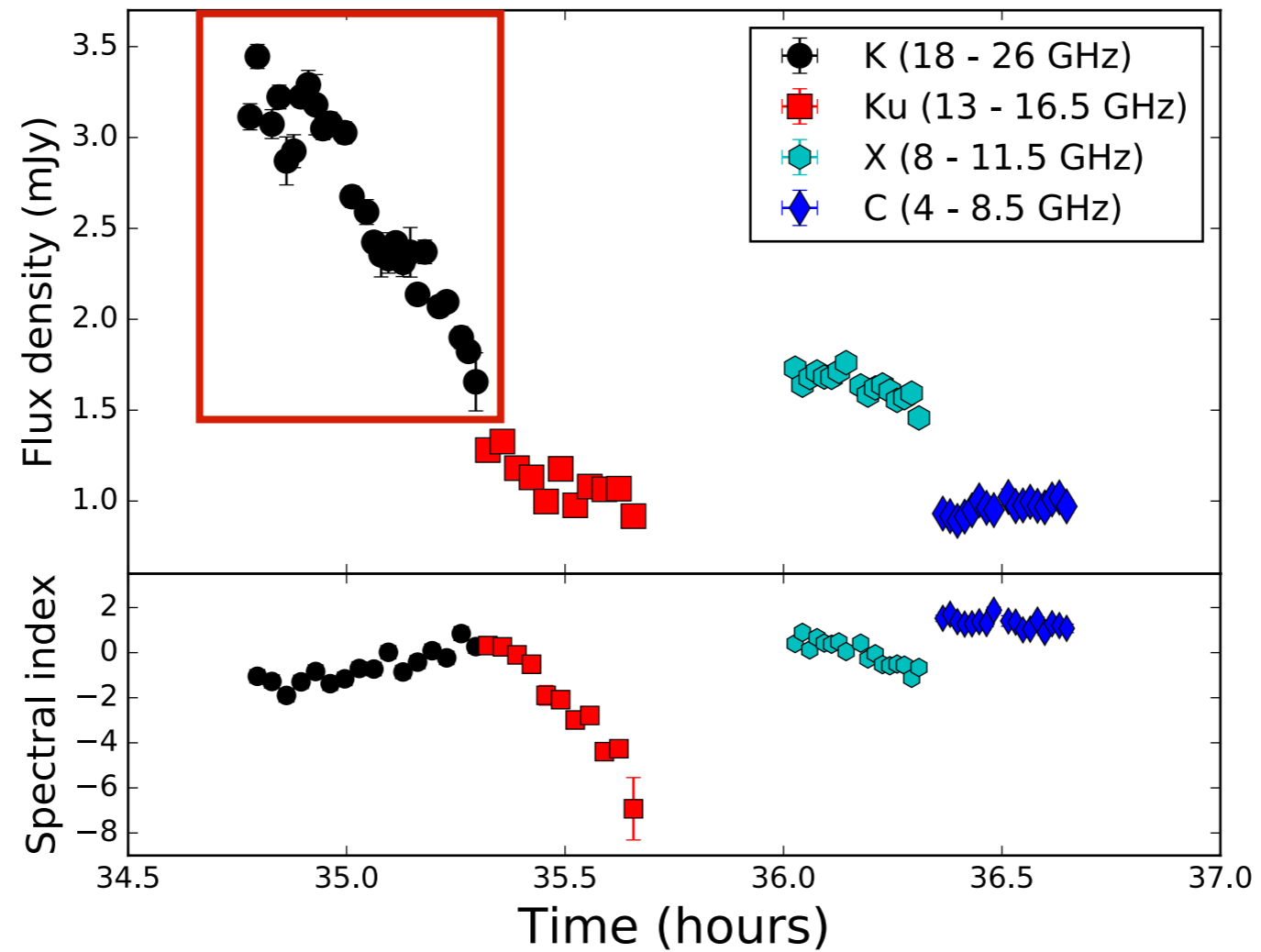




Unexpected features



... or rapid variability?



Relativistic Transients & the ngVLA

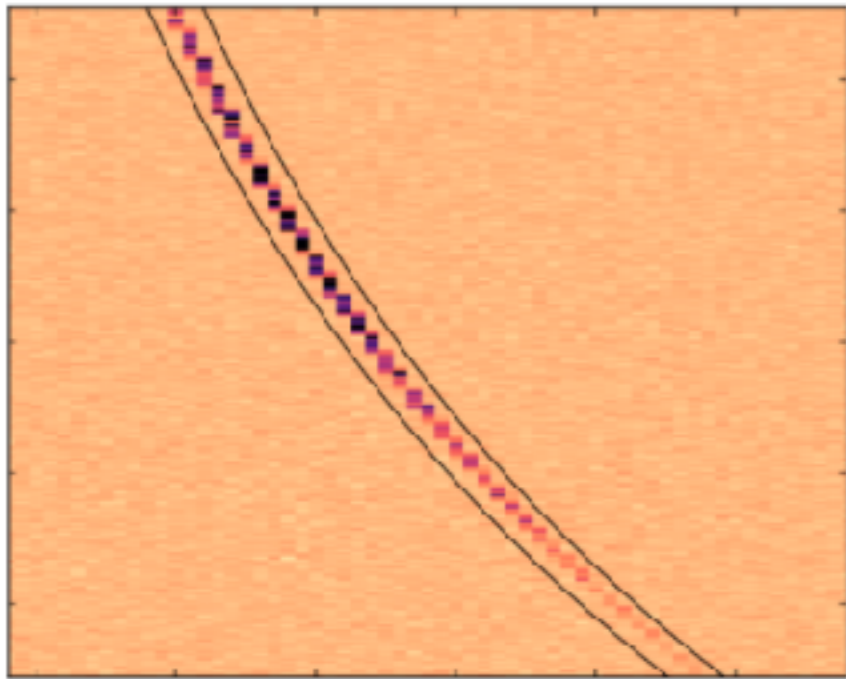
- Observe simultaneously at X, Ku, K bands (7 - 26 GHz)
- Continuous observations for ~4 hours / epoch
- Target several GRBs to probe different LOS through MW
- Simultaneous analysis with X-ray / optical / mm observations



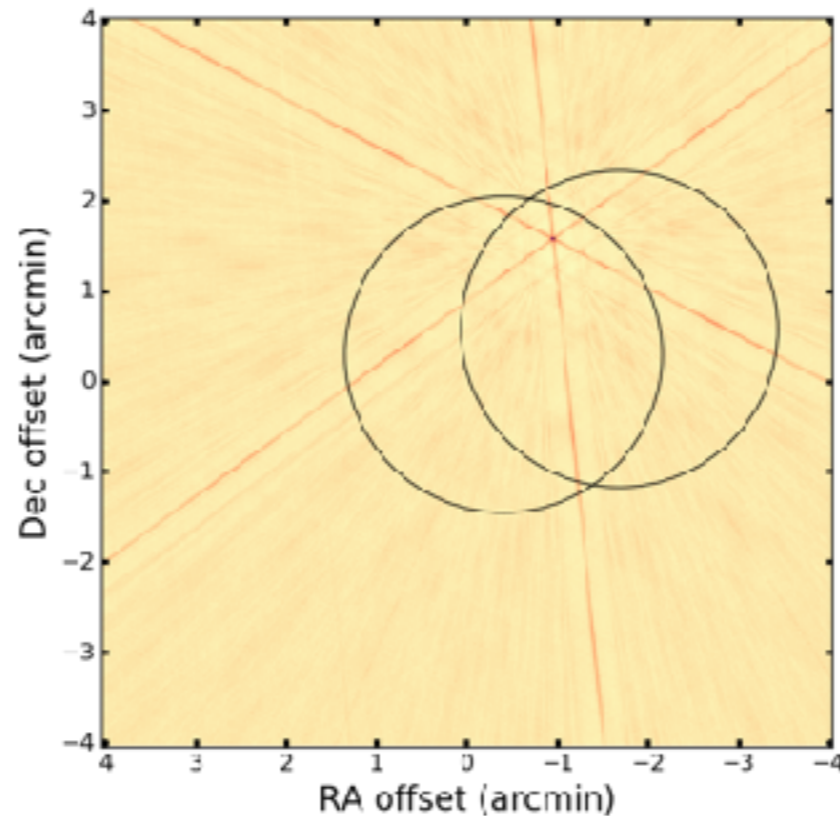
Relativistic Transients & the ngVLA

- Radio SEDs for relativistic transients
- Target of Opportunity capability
- Subarrays / wide bandwidths to *simultaneously* cover broad frequency range
- Polarimetry
- Rapid analysis
- Synergy with LSST, ELTs, JWST, ALMA+
— joint proposals!!

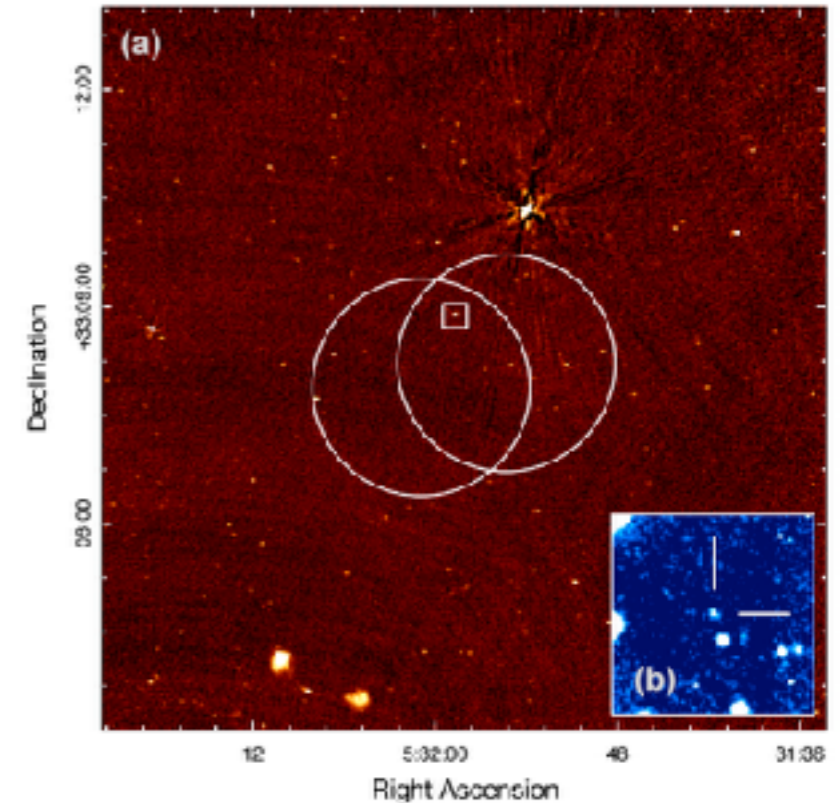
New frontiers: Fast Radio Bursts



Search



Localize



Associate

See also six papers on FRB 121102 this year:
Chatterjee et al, Tendulkar et al, Marcote et al, Bassa et al, Scholz et al, Law et al (2017)

Relativistic Transients & the ngVLA

- Probe a wide range of astrophysics
 - Stellar death & compact object formation
 - Shock physics & particle acceleration
 - High-redshift universe
 - Interstellar medium

Relativistic Transients & the ngVLA

- Probe a wide range of astrophysics
 - Stellar death & compact object formation
 - Shock physics & particle acceleration
 - High-redshift universe
 - Interstellar medium
- Multi-wavelength (radio — X-ray) data essential
- Radio observations critical
- Science goal requirement:
 - ~ μJy sensitivity; wide spectral coverage; rapid analysis