GRBs in radio (Meer)KAT(7) possibilities

Diagnostic value and future opportunities

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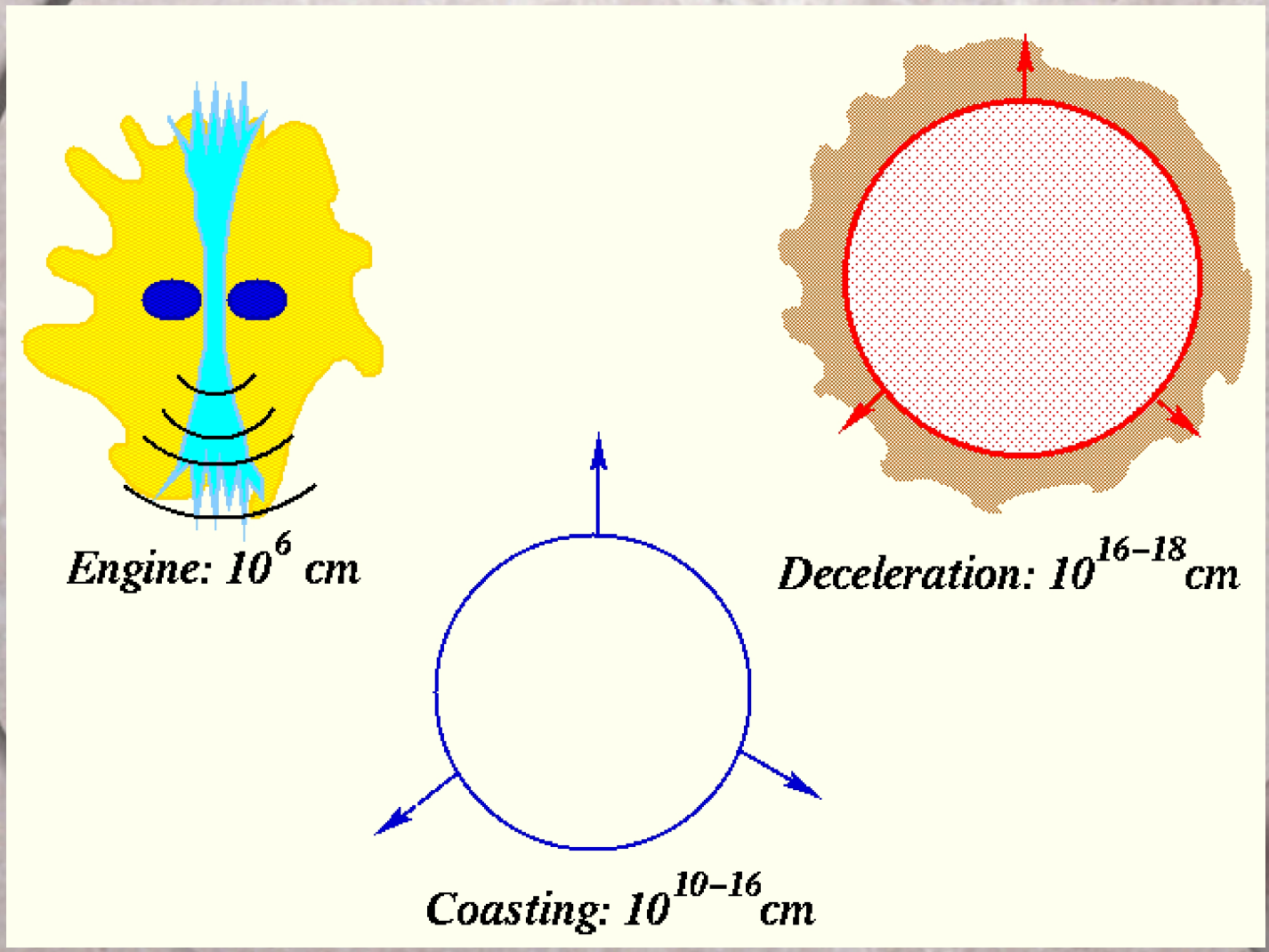
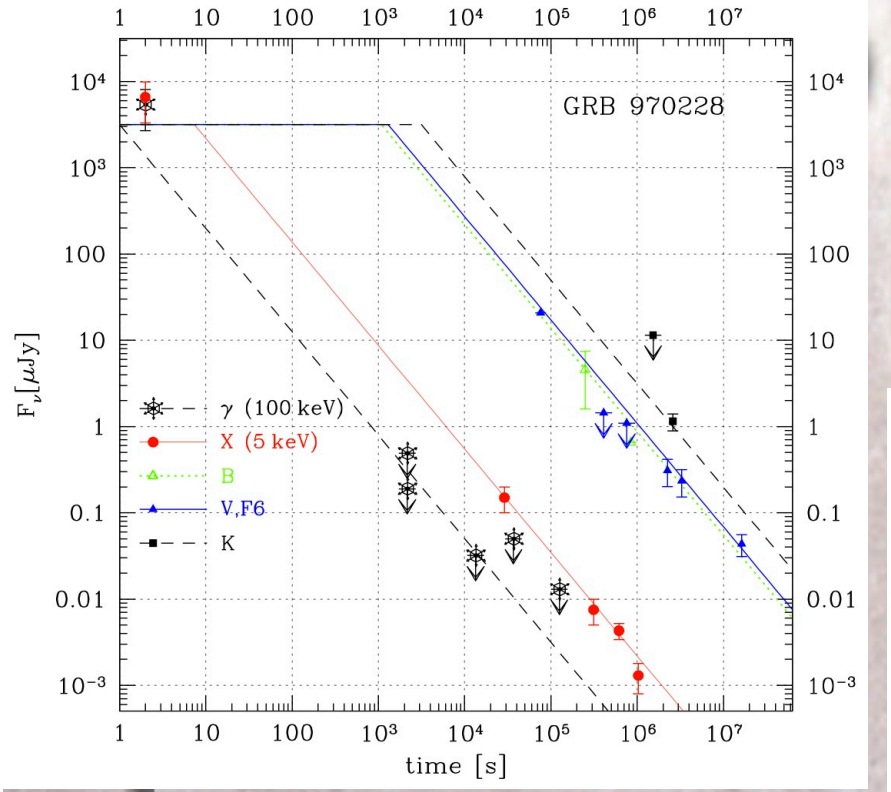
Plan of this talk

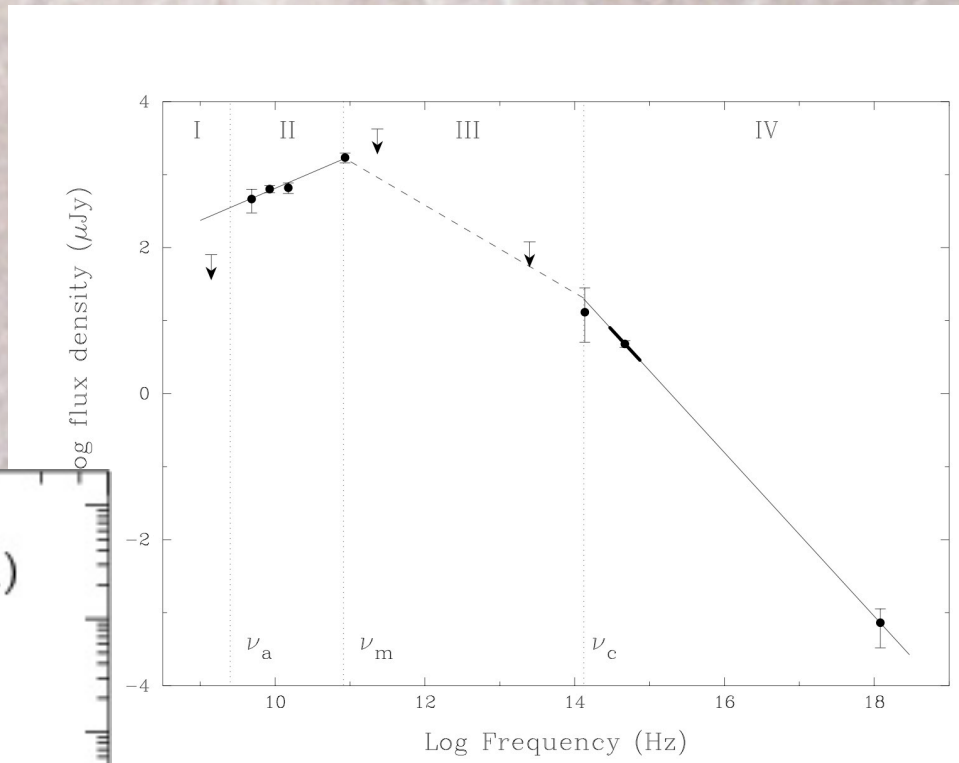
- Ultrabrief model context
- Discussion of specific radio contributions to clarifying the nature of GRBs
- Specific KAT7/MeerKAT goals

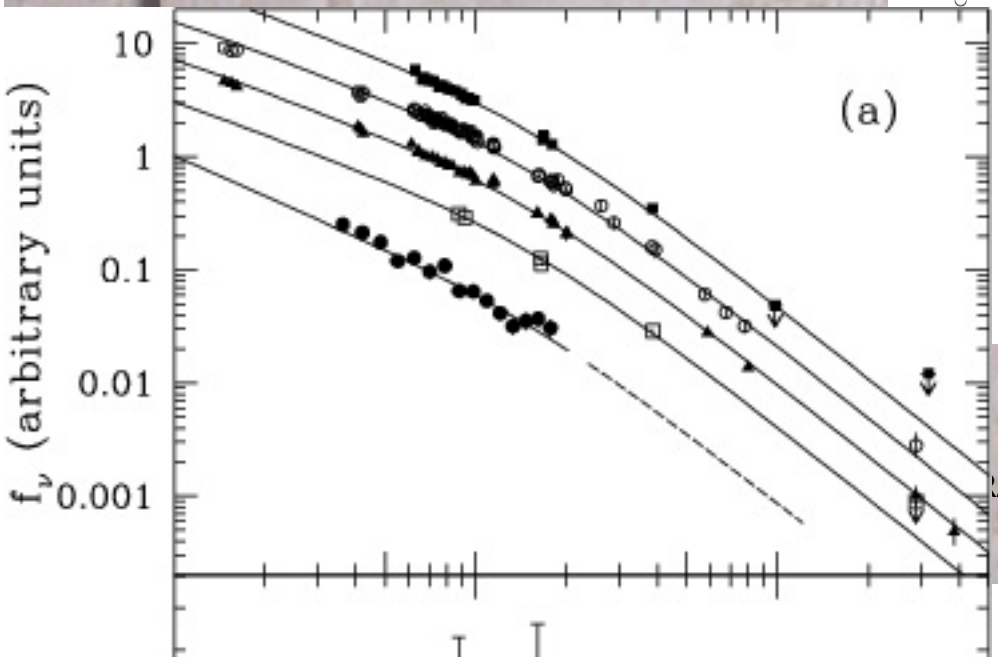
Fireball/blast wave: model sketch



Light curves and SEDs

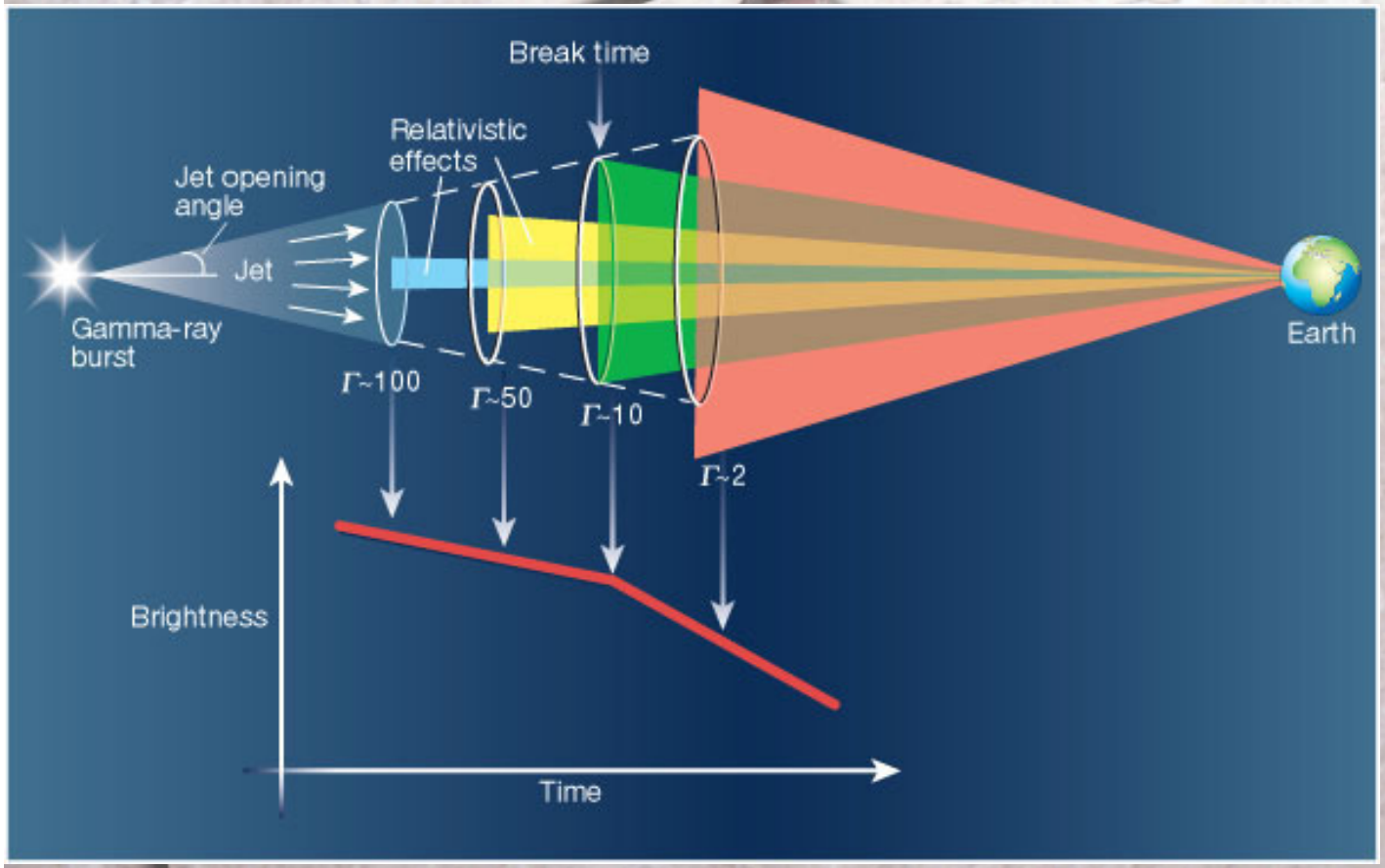






- Power laws....

Cartoon

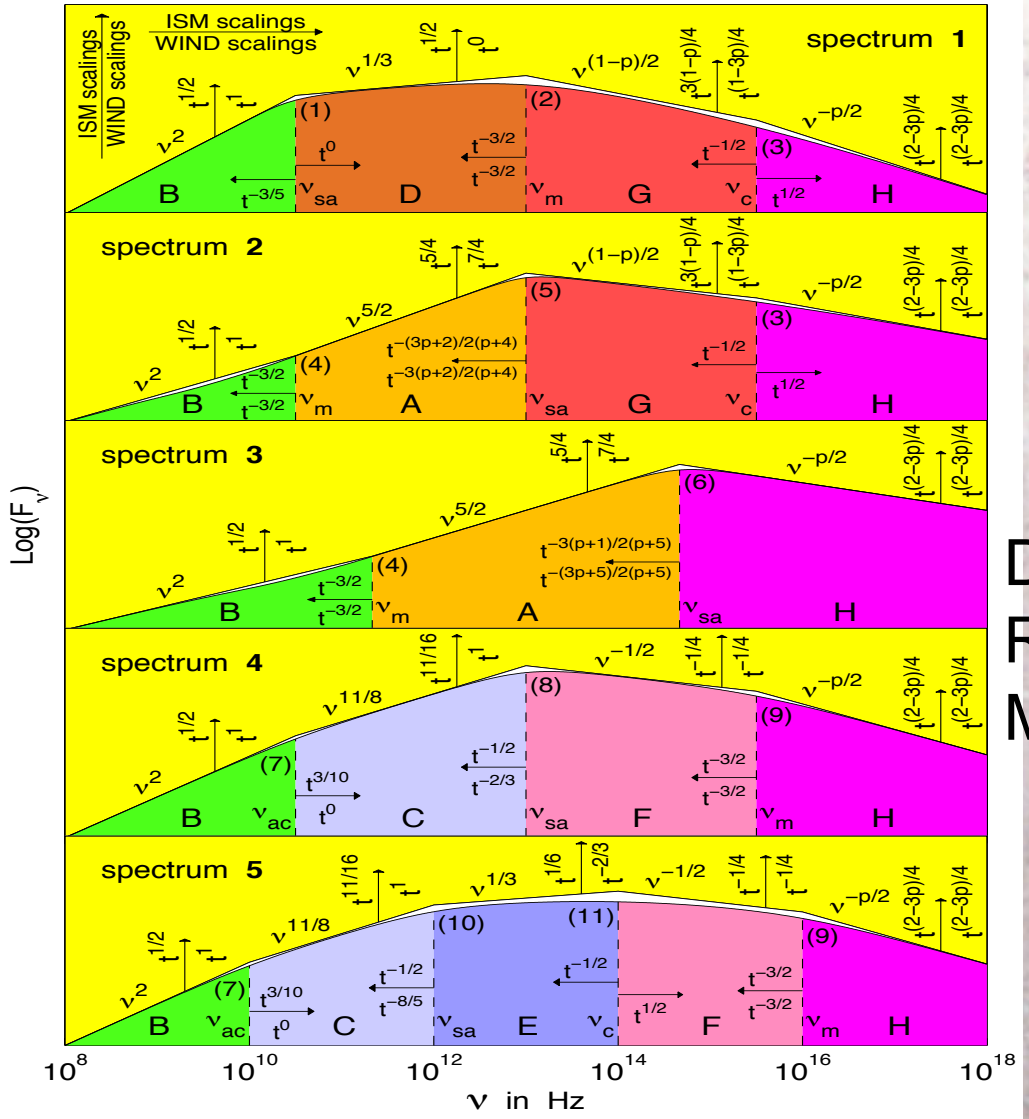


-Jet with Lorentz factor >100 ejected by dying star

-Decelerates and dissipates

- internally
- onto external medium

- Mostly synchrotron radiation



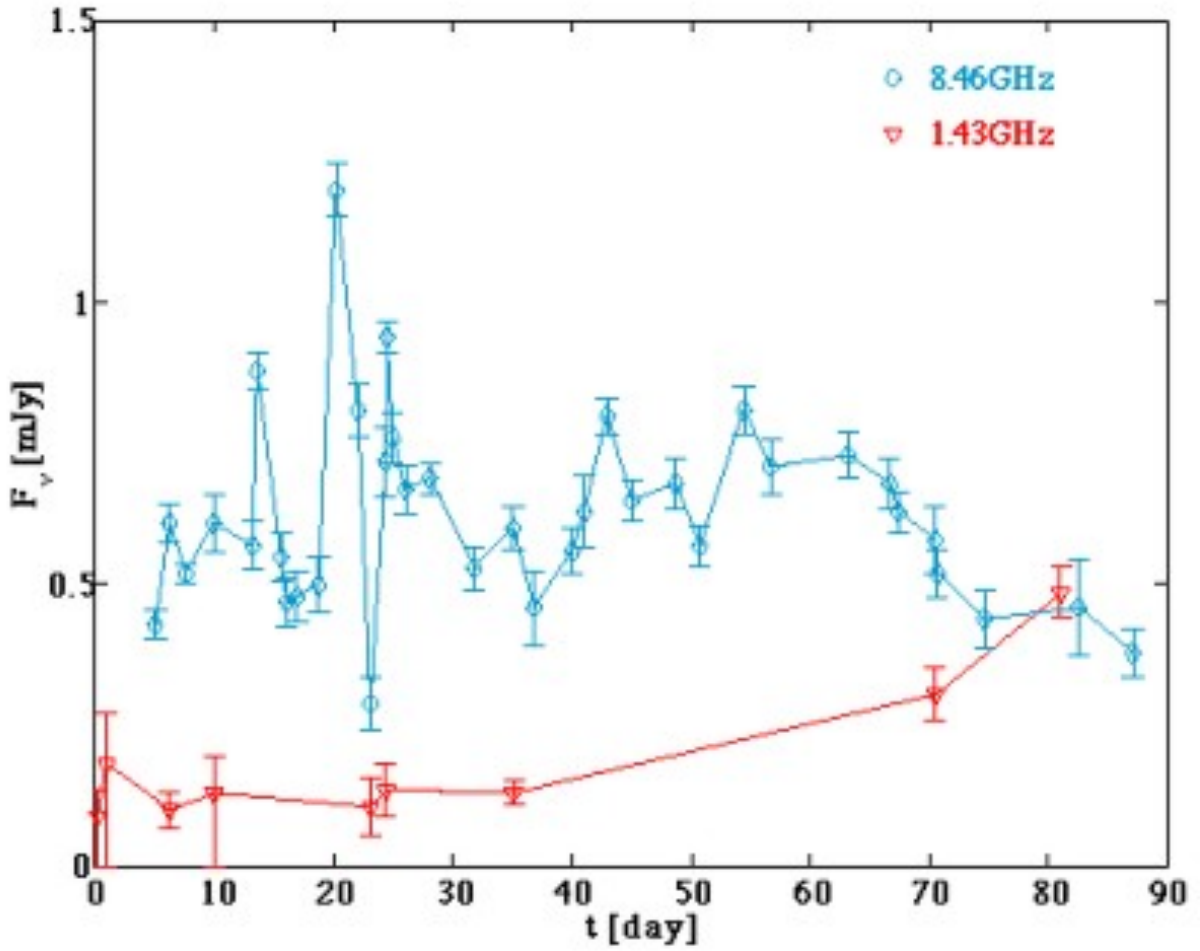
Simple models

Dynamics: Relativ. Blastwave
Radiation: Synchrotron
Microphysics: ε_e, ε_B (ignorance)

- E.g. Blandford & McKee 1977, Meszaros & Rees 1997, RW et al. 1997, Sari et al. 1998

What has radio contributed?

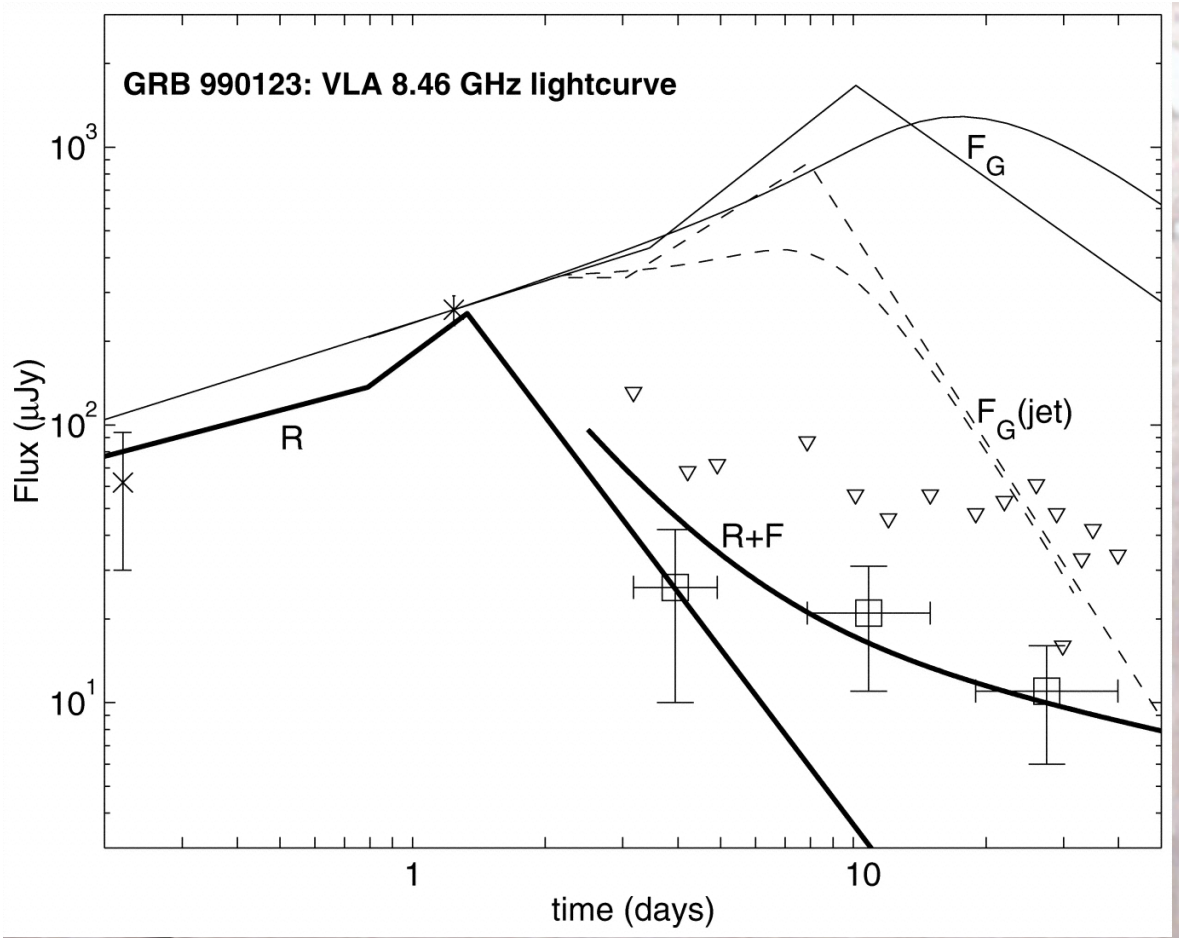
- Size measurement (scintillation and BB)
- Measure non-relativistic phase
  - Energy measurement (calorimetry)
  - Population census
- Star formation rate
- Complete physics parameters (multi-λ)



Size - scintillation

GRB970508
Frail etal 1998

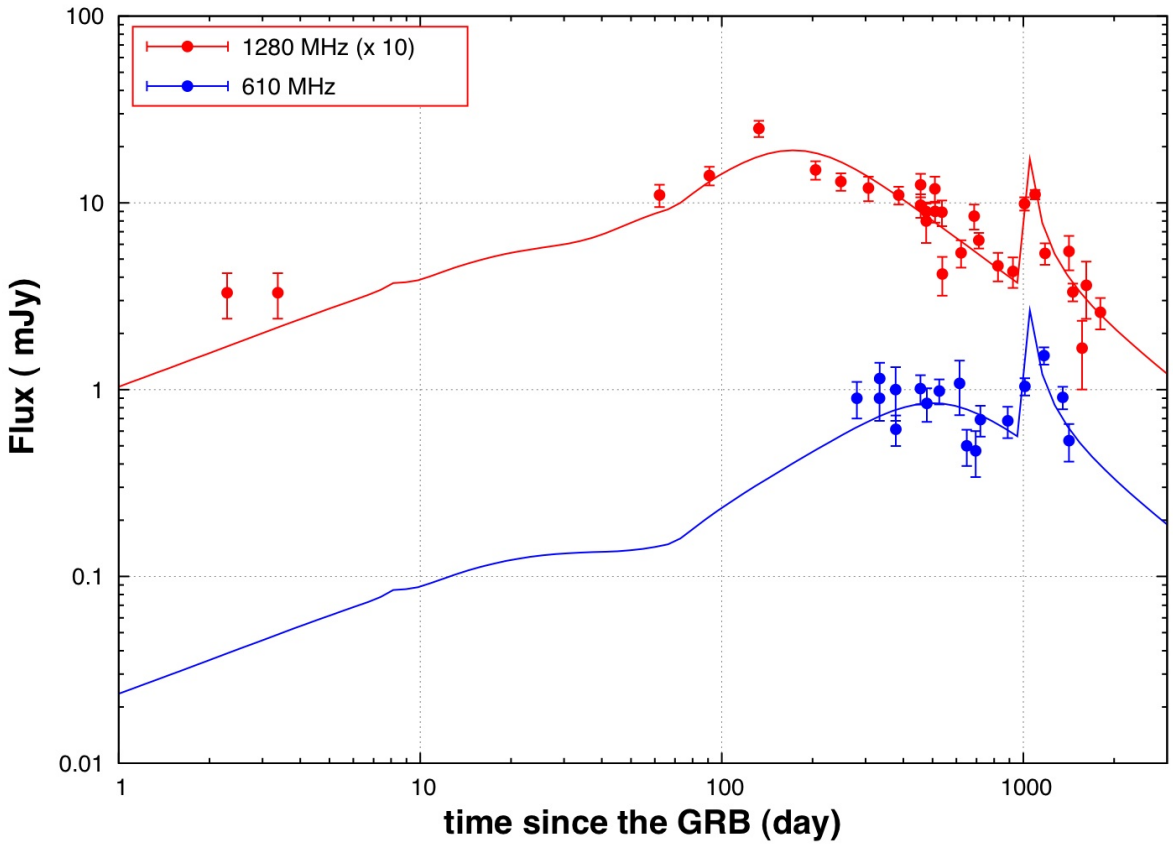
- Angular size ~μas after month, so v>0.8c



Size - Blackbody

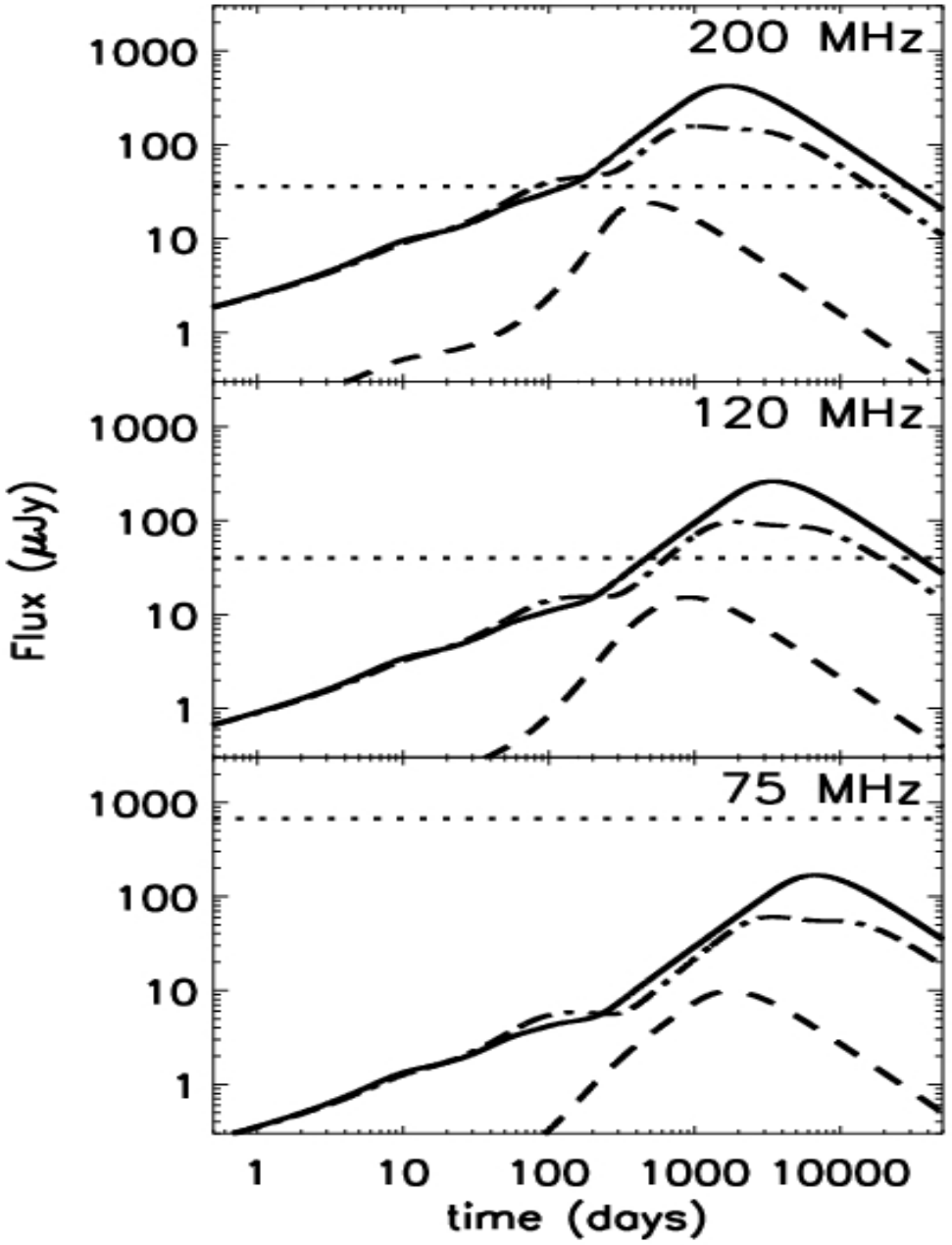
- Reverse-shock flares: measure R_{dec}

Non-relativ: Isotropic?



Kamble et al. in prep: receding jet?

- At late times, non-relativistic, isotropic: measure all energy, count all GRBs
- but only radio is left

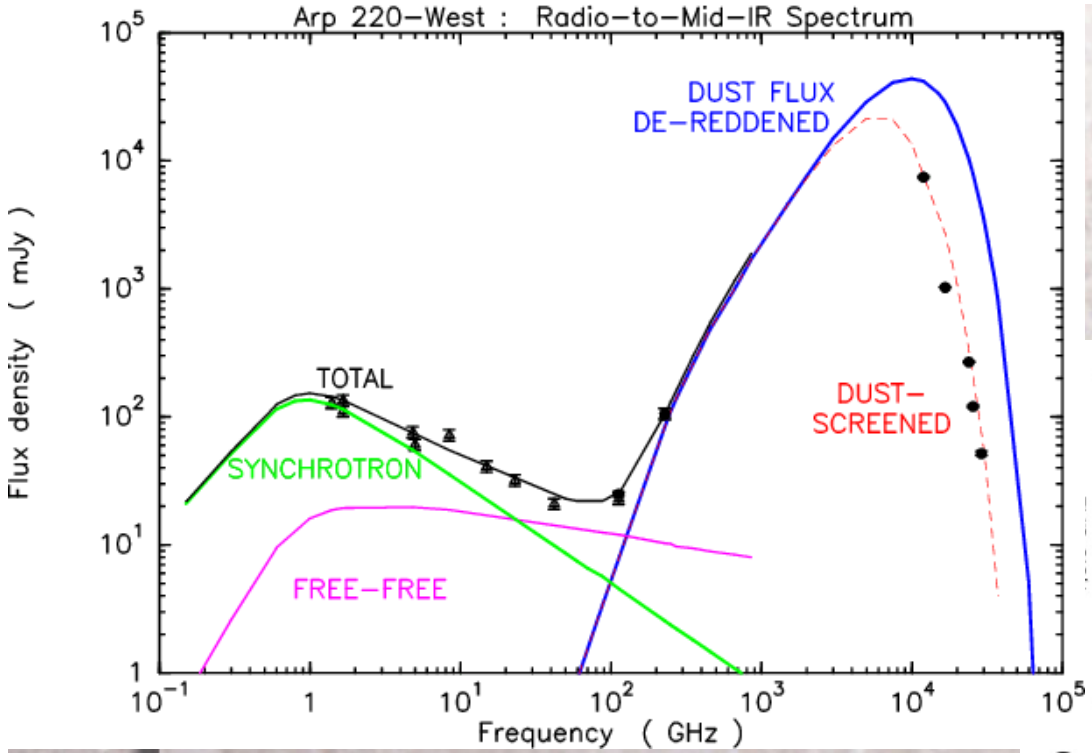


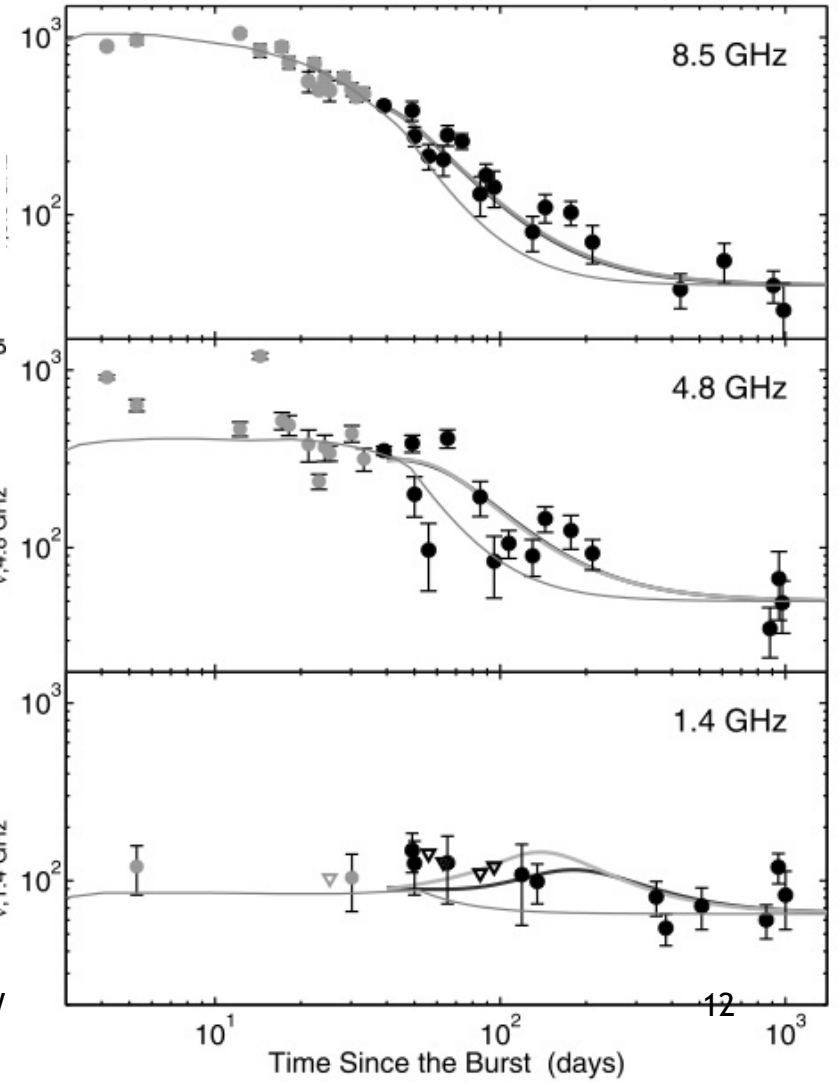
Population census

- At late times, isotropic radio, so can count all GRBs
- Problem: how to recognise them?
  - Timescales of years
  - 'Generic' expanding synchrotron sources

LOFAR prediction, Van der Horst

Star Formation Rate





- Are GRB hosts SFR-high? (MeerKAT)

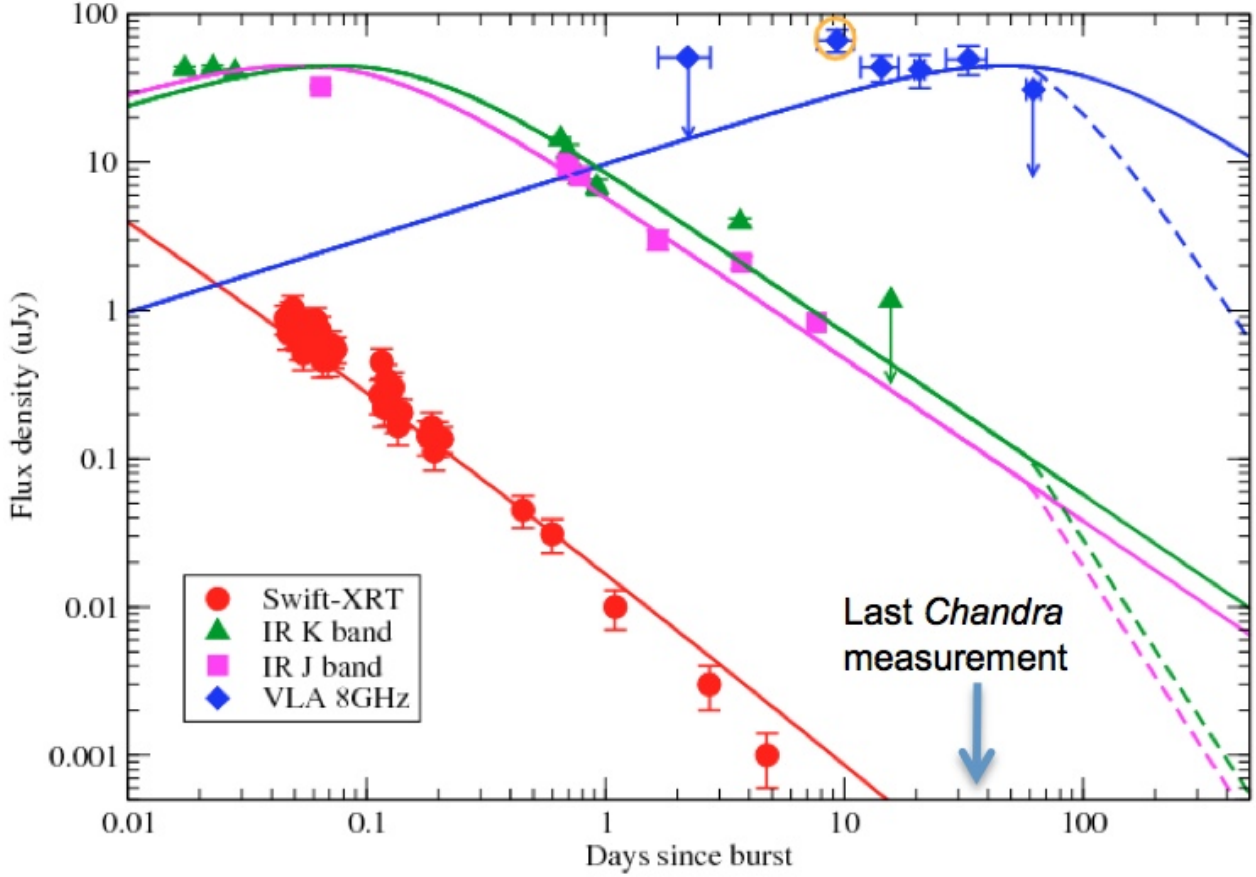
GRB980703 – Frail et al

Open physics questions for/with GRBs

- How do jets form?
- Are BH jets magnetic-dominated?
- How do magnetic fields form [in shocks]?
- How are particles/CRs accelerated?

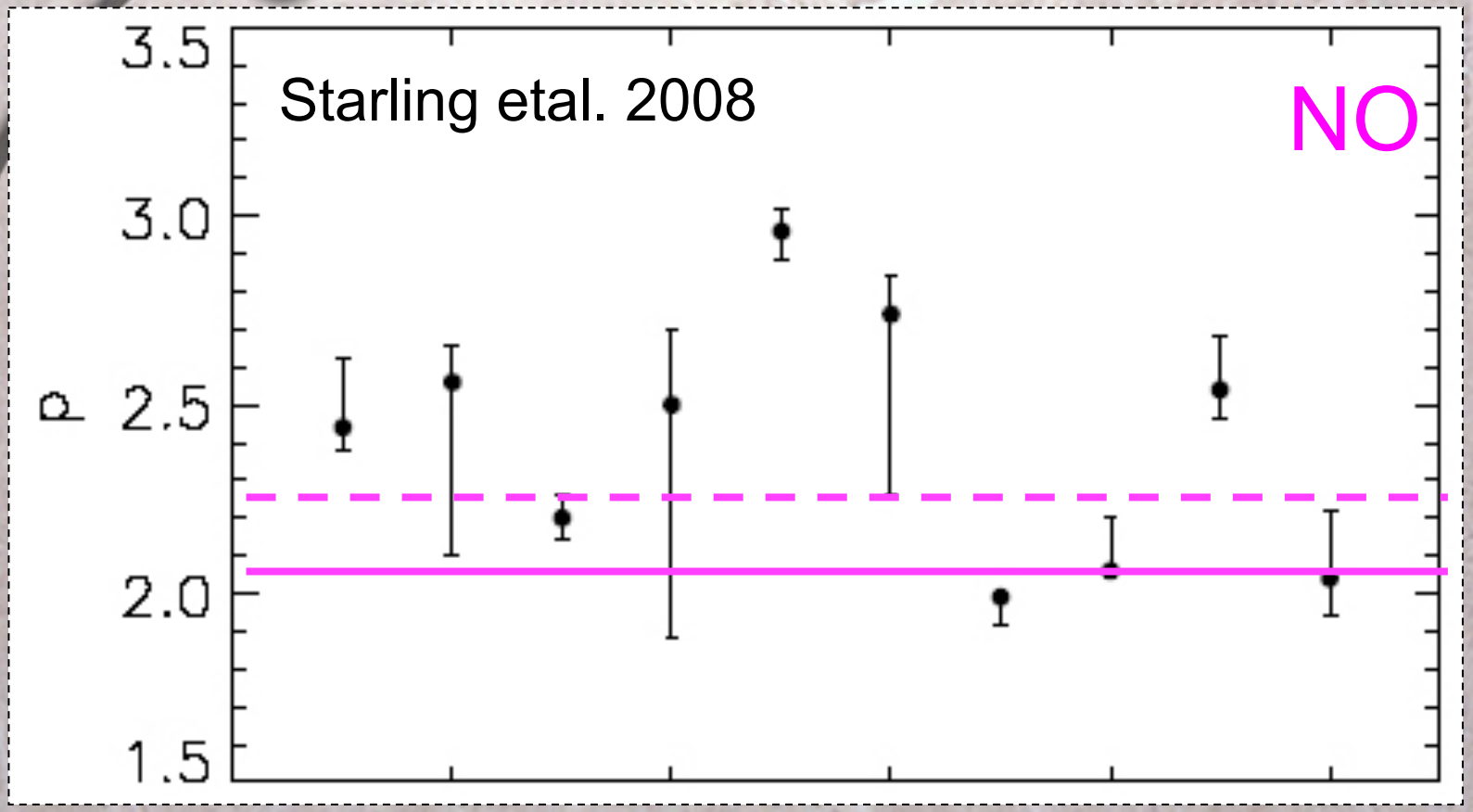
- How do massive stars die?
- What is the [S]SFR in GRB hosts?

Precision Physics



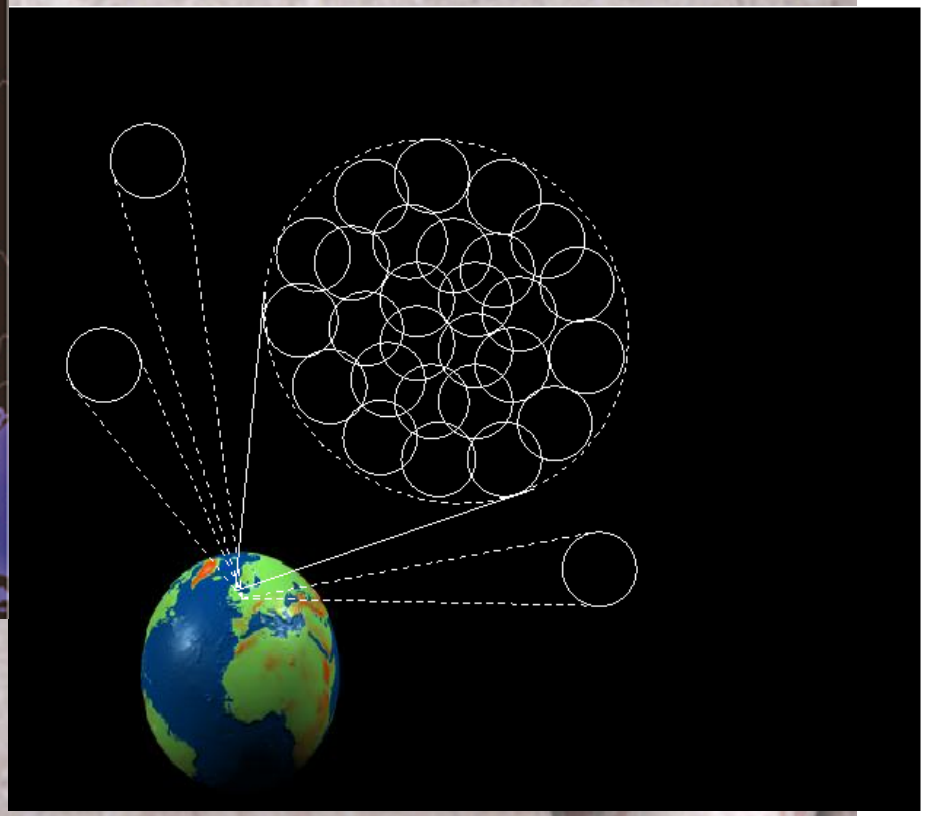
- GRB090423 at z=8.2
- GOOD multi-wavelength coverage needed
- Even simplest model has E, n, θ, ε_e, ε_B, so 5 measurements needed to constrain it

Particle spectrum n~γ^{-p}: Universal p?



- Accelerator varies!
- In Swift, also only 10 good AG (!!), p varies (Curran et al 2008)

The future: Radio monitoring



- LOFAR Digital telescope

AARTFAAC

- All-sky, all the time
- 1-sec and up time resolution
- Few-Jy rms noise in 1 sec

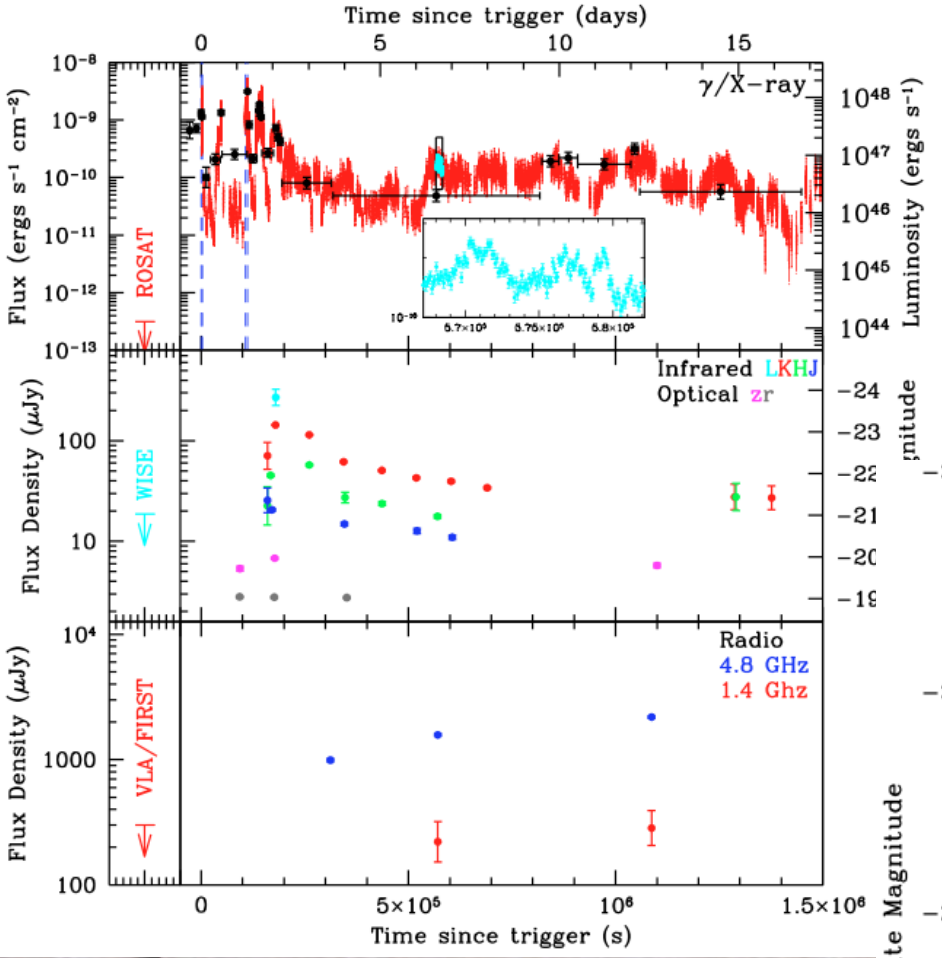
- Find all the funny things in the sky, e.g. GRB prompt radio!

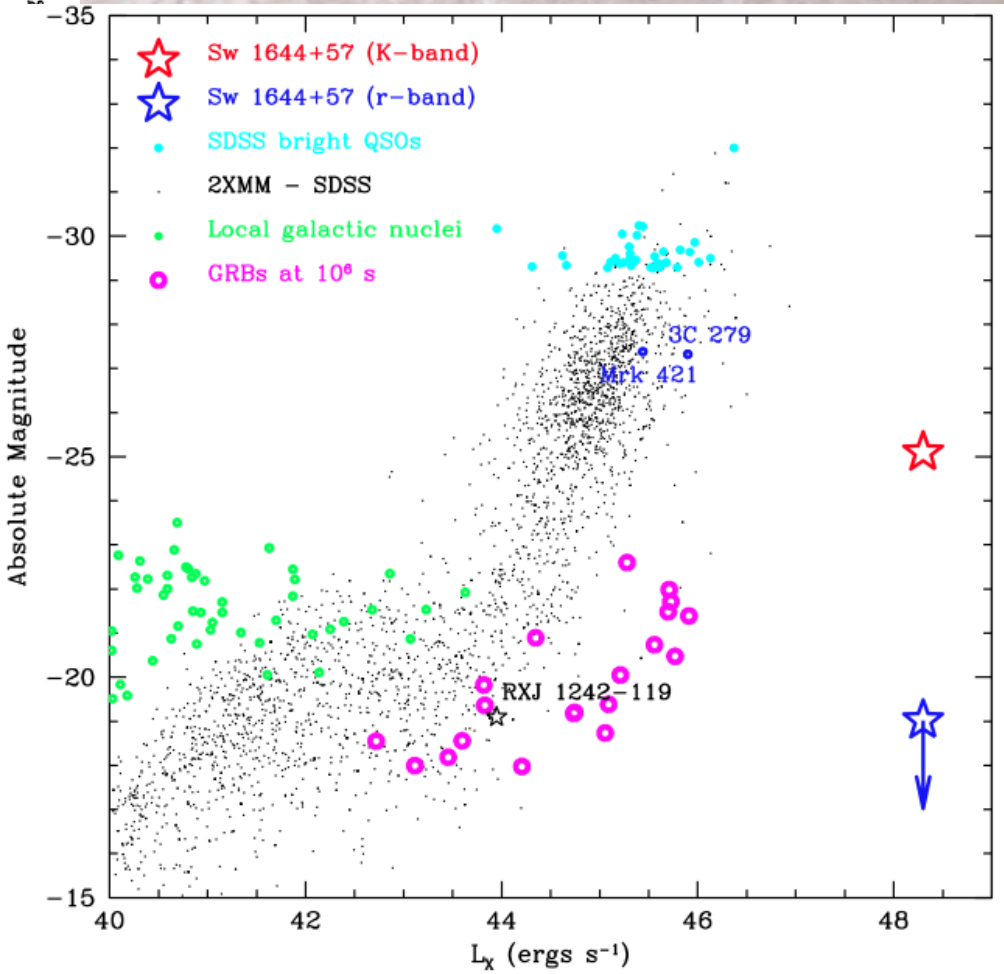
Expectations/wishes from radio

- mJy fluxes:

  KAT-7 just possible, MeerKAT marvelous
- At GHz:
  - Reverse shock in days
  - Forward relativistic shock in weeks
  - Non-relativistic transition to SNR [and host] in years
- Main goals:
  - Get the physics (e.g., energy, dynamics) nailed
  - Tell difference between GRB AG, radio SN, …
  - Study the true weirdo's
  - Get SFR and GRB-host relation

‘GRB’ 110328A





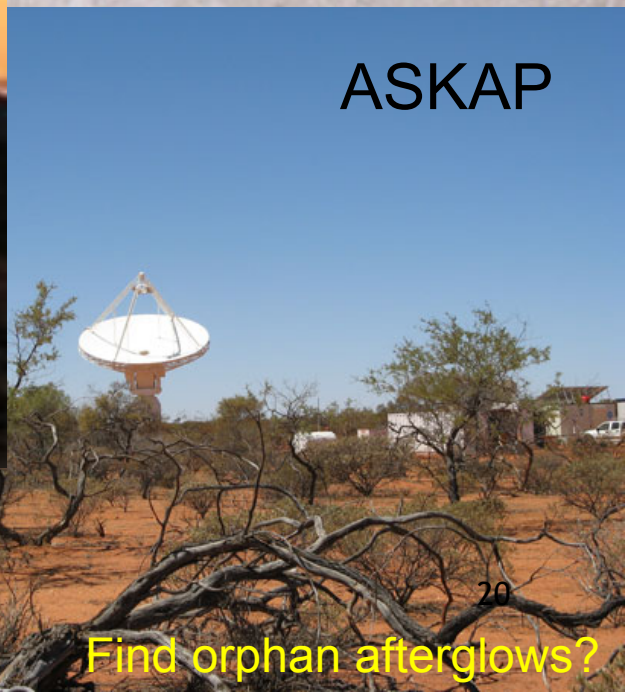
Levan etal, Science, subm.

In core of z=0.35 galaxy

21-Apr-2011
Arniston, SA

MeerKAT:Very sensitive followup

Get a good sample of precision radio light curves down to ~ 10μJy



Conclusions

- Radio has its unique contributions to GRB science
- All wavelengths remain needed
- Future:
  - all-sky monitoring in radio: LOFAR, gamma/X, perhaps ASKAP
  - Sensitive followup with MeerKAT