# Two years of GW170817

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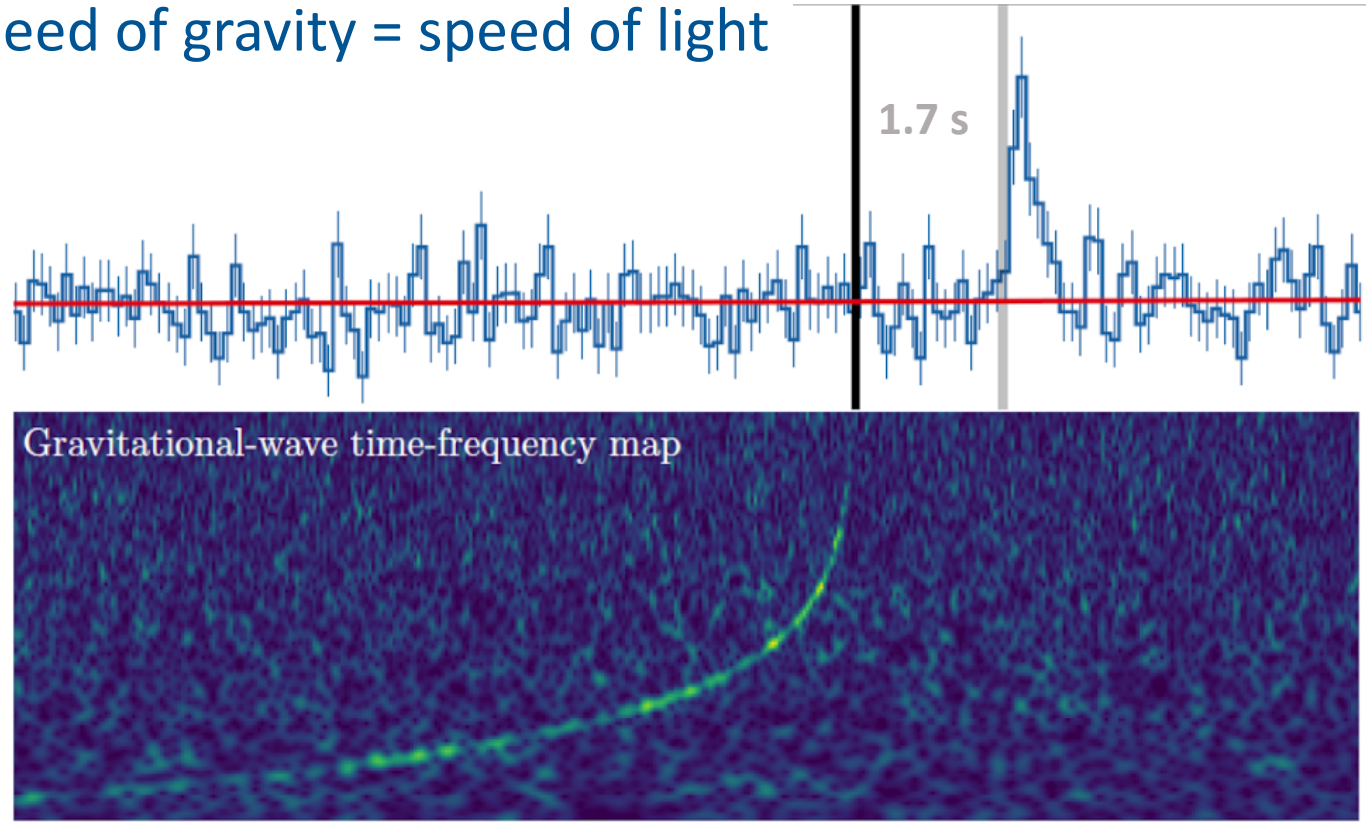
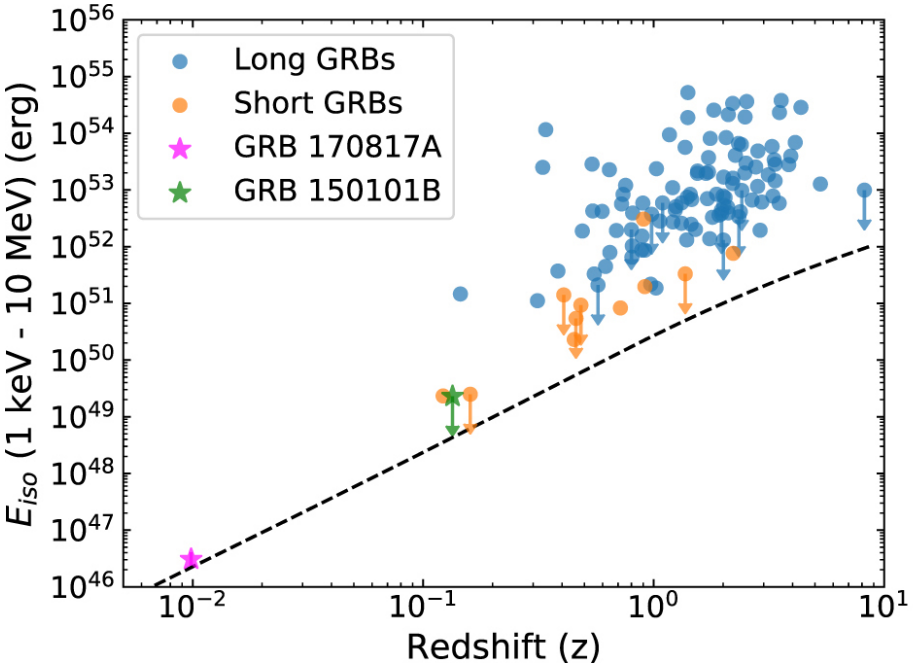
# A short GRB following GW170817

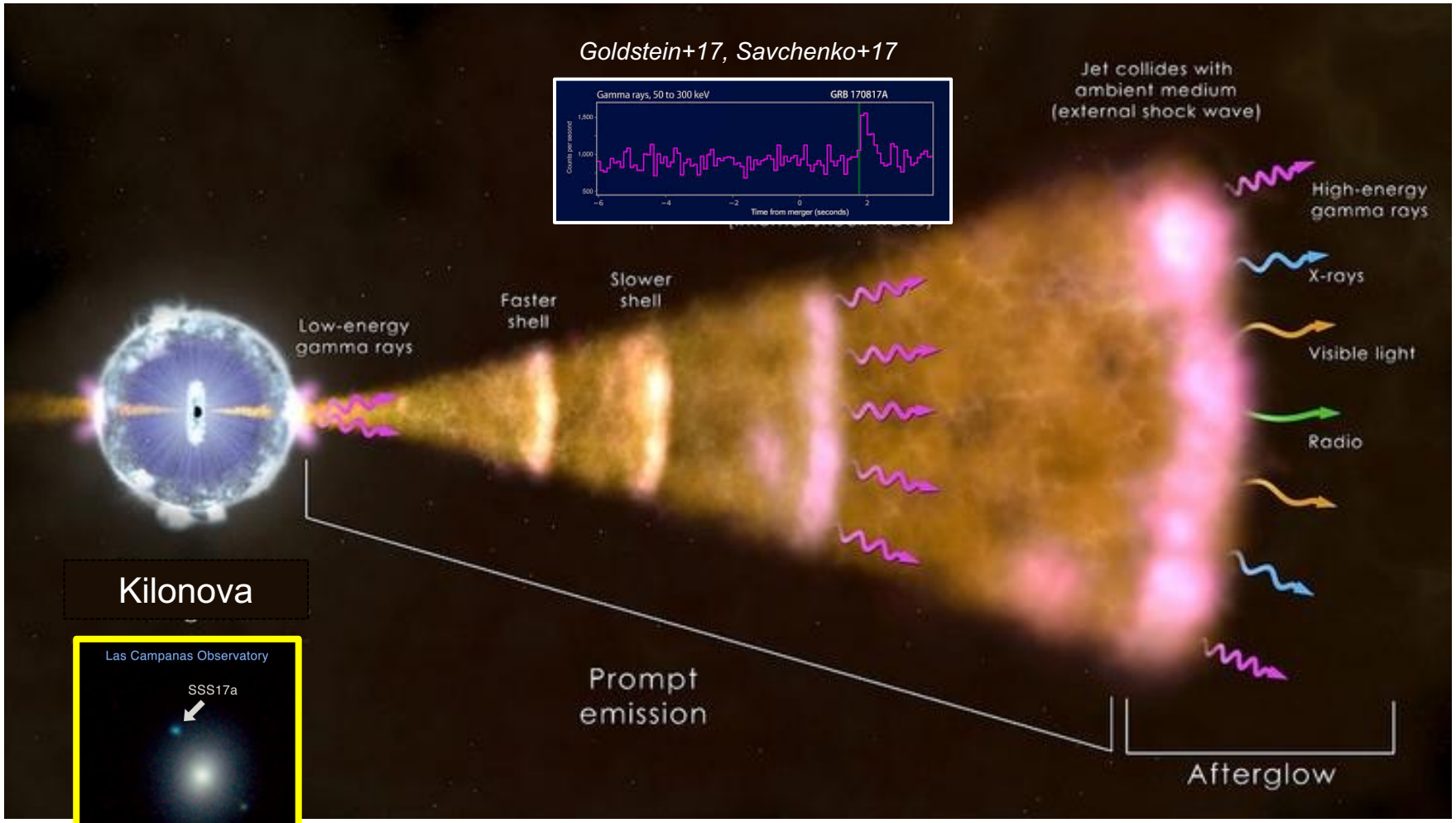
speed of gravity = speed of light




Abbott *et al.* (LIGO Scientific Collaboration and Virgo Collaboration) 2017, Phys. Rev. Lett. **119**, 161101

# The aftermath of a NS merger

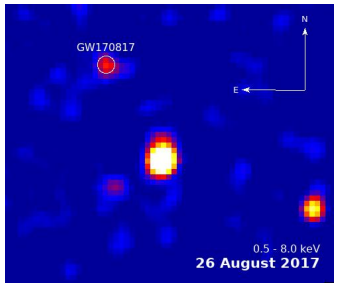




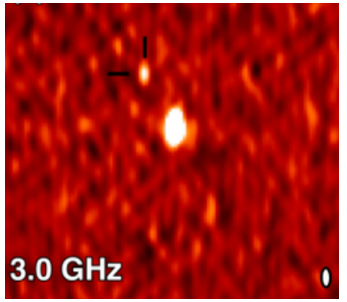


***Coulter+17***
*Arcavi+17, Lipunov+17, Soares-Santos+17, Tanvir+17, Valenti+17*

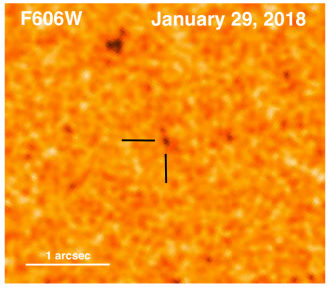
*Troja+17*



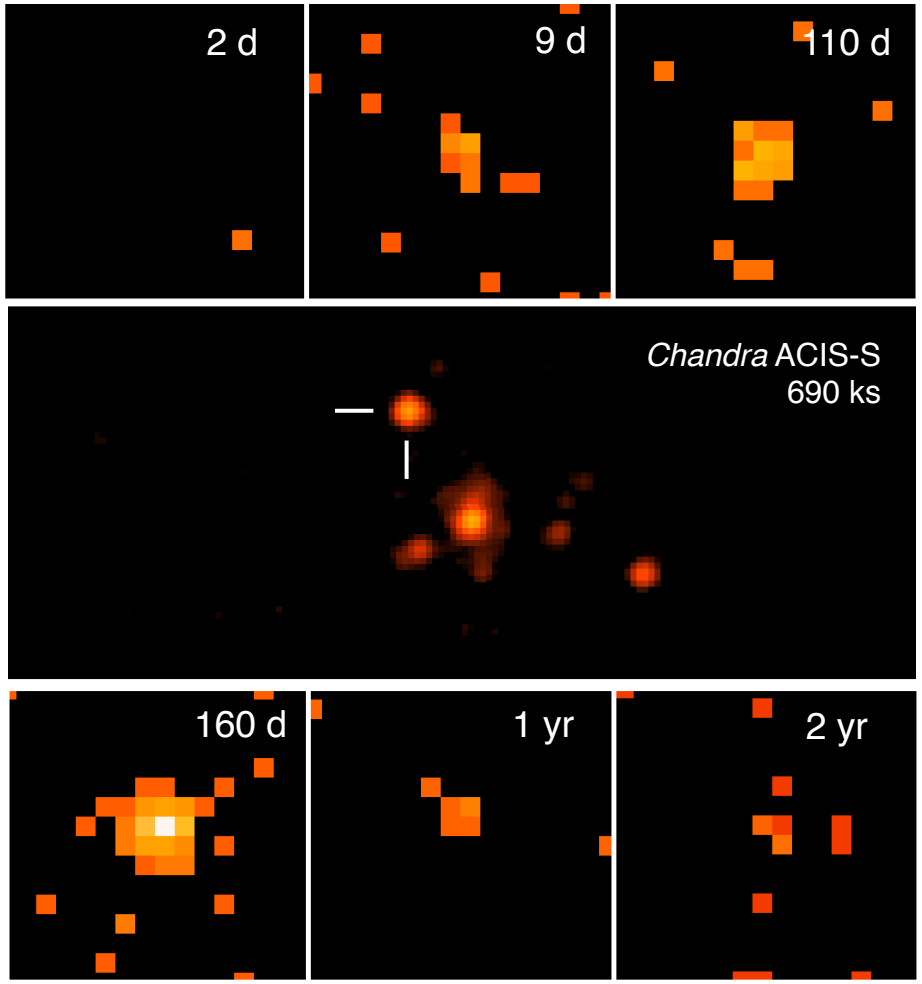

*Hallinan,Corsi+17*




*Lyman+18*



# The X-ray afterglow

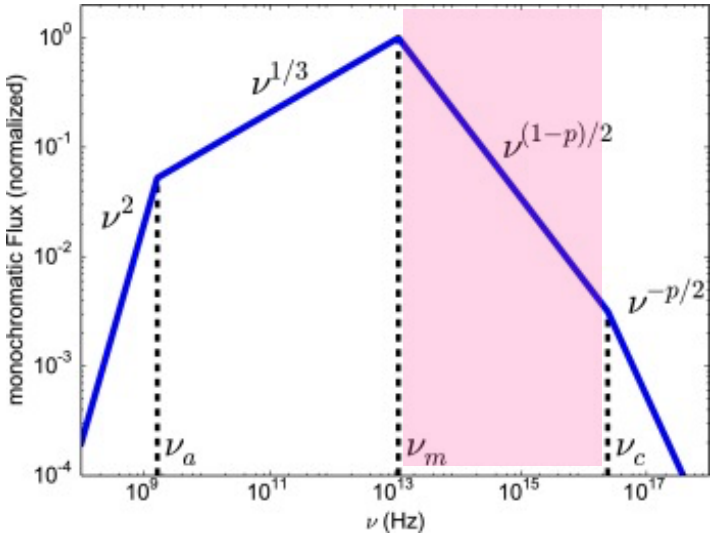


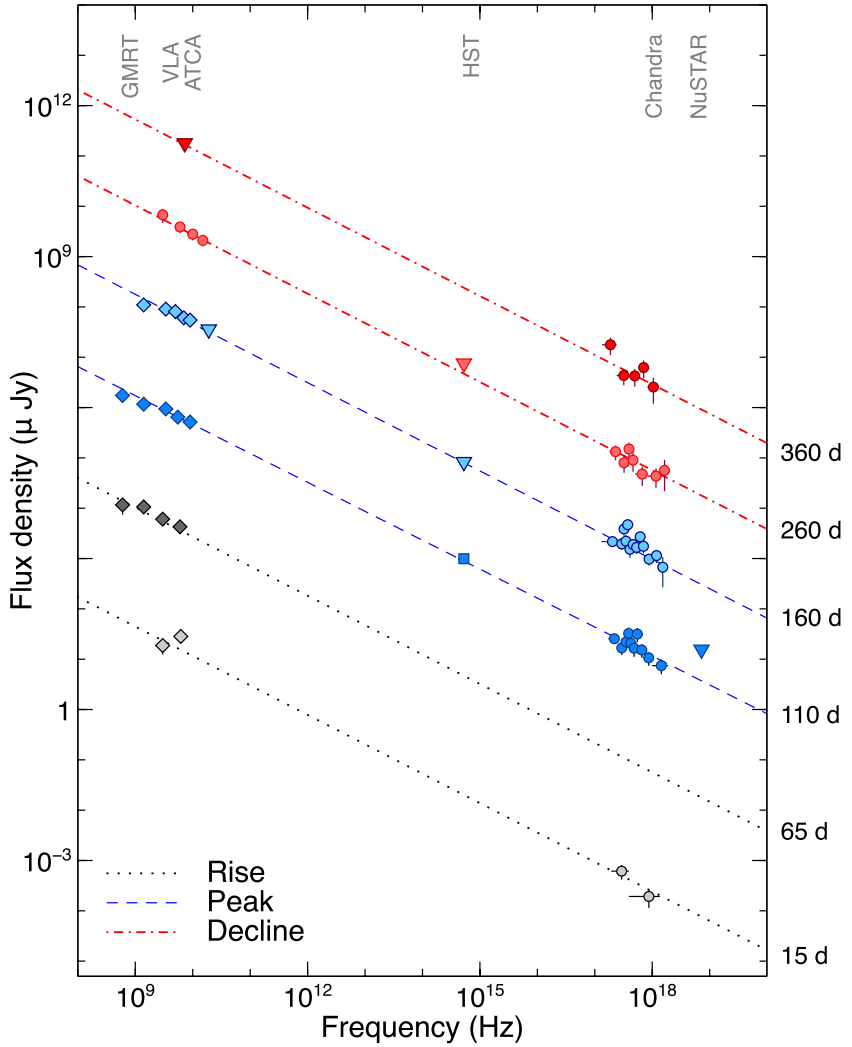

***Troja+17***
*Haggard+17*
*Margutti+17*
***Troja+18***
***Piro+19***
*Nynka+18*
*Pooley+18*
*Alexander+18*
***Troja+19***

# No Spectral Evolution

Simple power-law spectrum
over 10 decades in energy

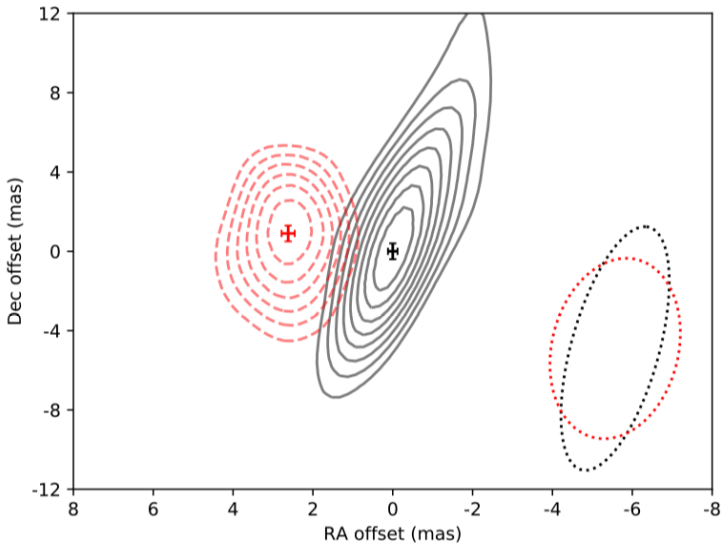
Consistent with synchrotron emission
regime $\nu_m < \nu_r < \nu_X < \nu_c$



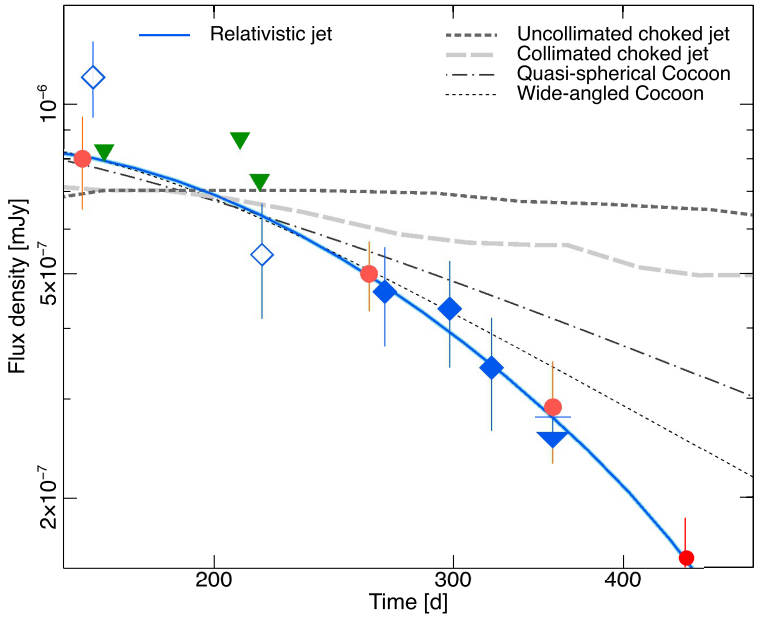




***Troja, van Eerten et al., MNRAS, 2019, arXiv:1808.06617***

# Evidence for a successful relativistic jet



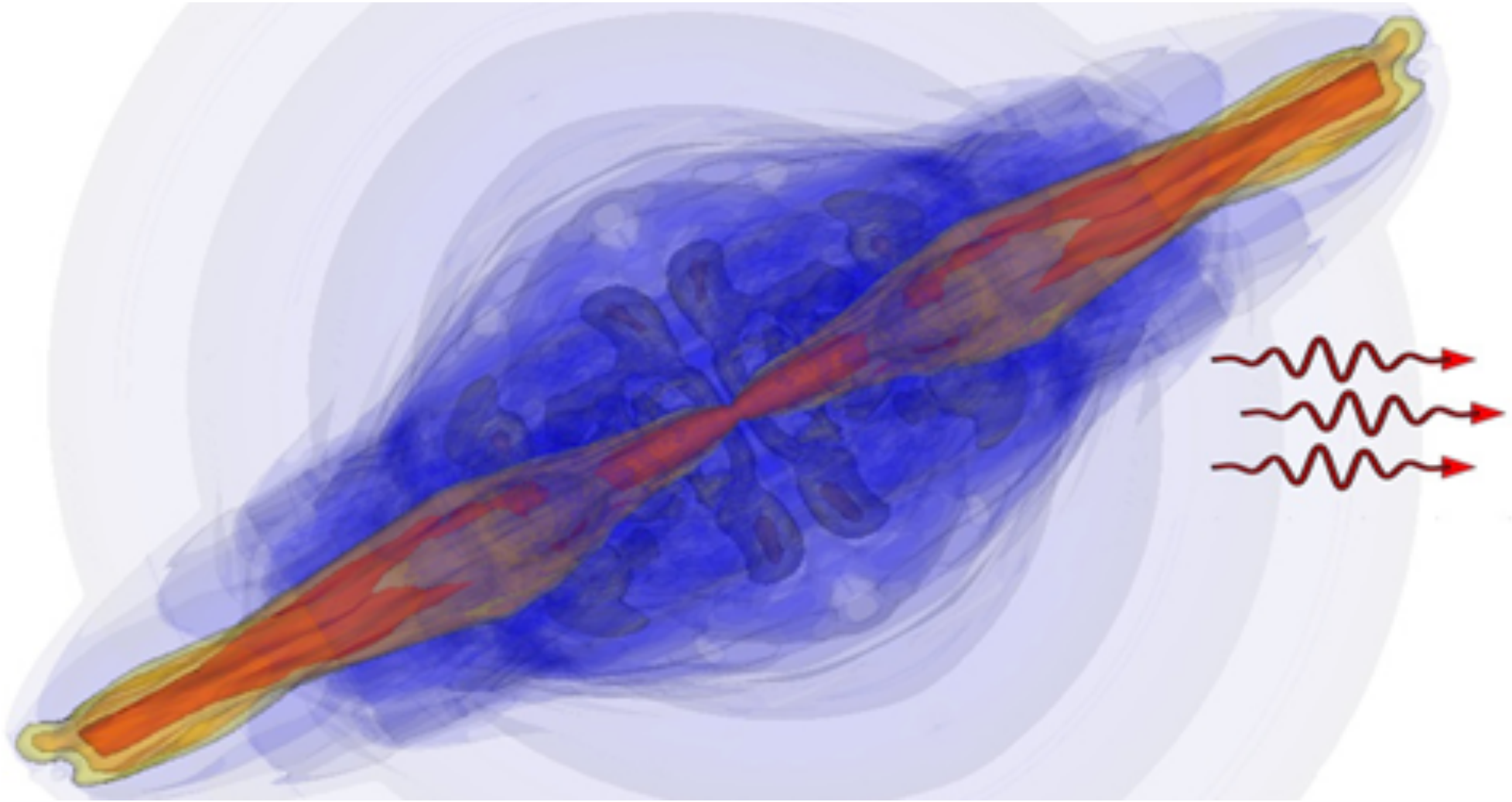

*Mooley et al., 2018*
*Ghirlanda et al., 2019*




***Troja, van Eerten et al., 2019***

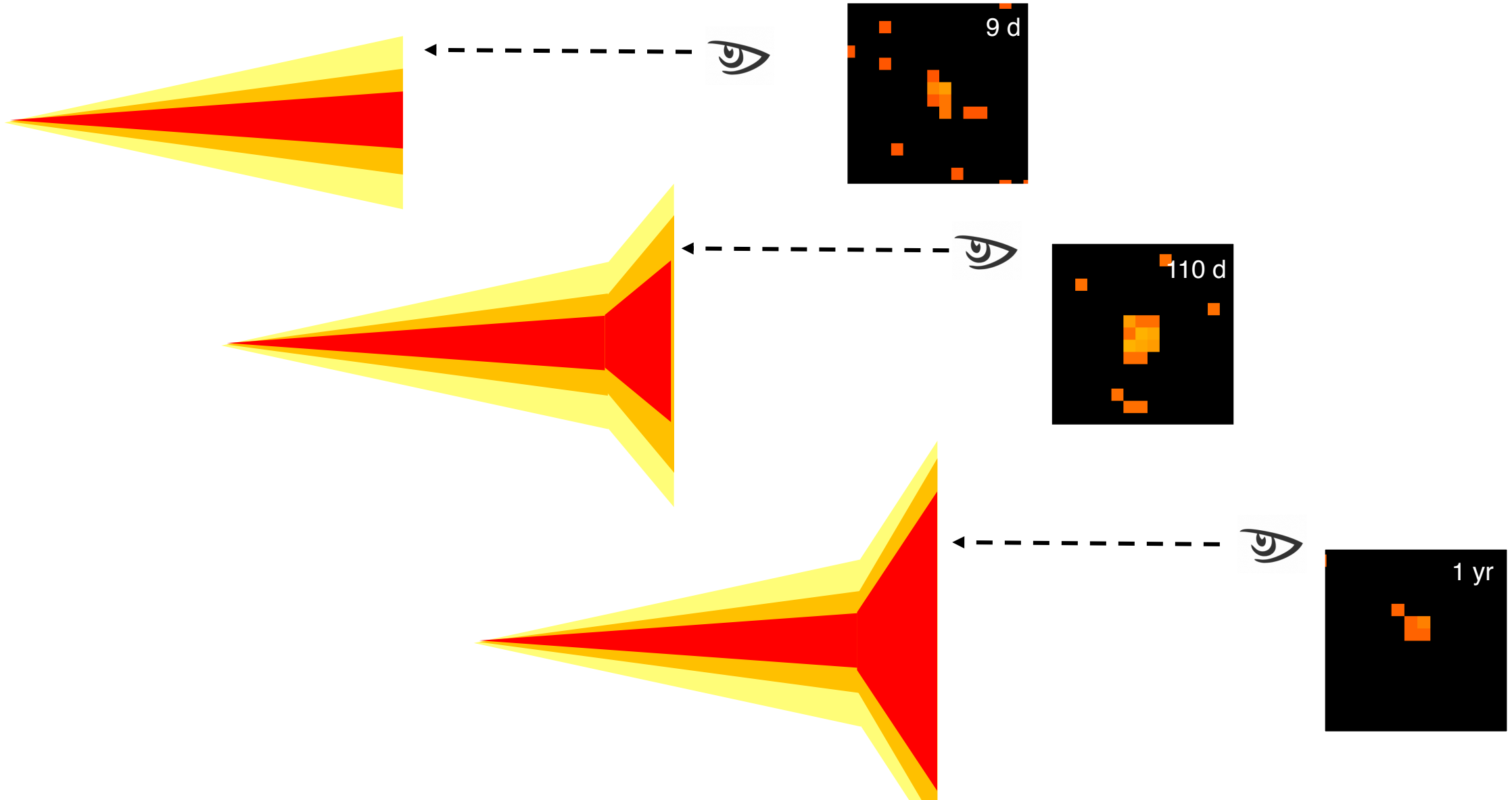
- **High-resolution radio imaging**: compact unresolved radio source superluminal motion
- **Temporal monitoring**: rapid afterglow decline

# A structured jet seen off-axis

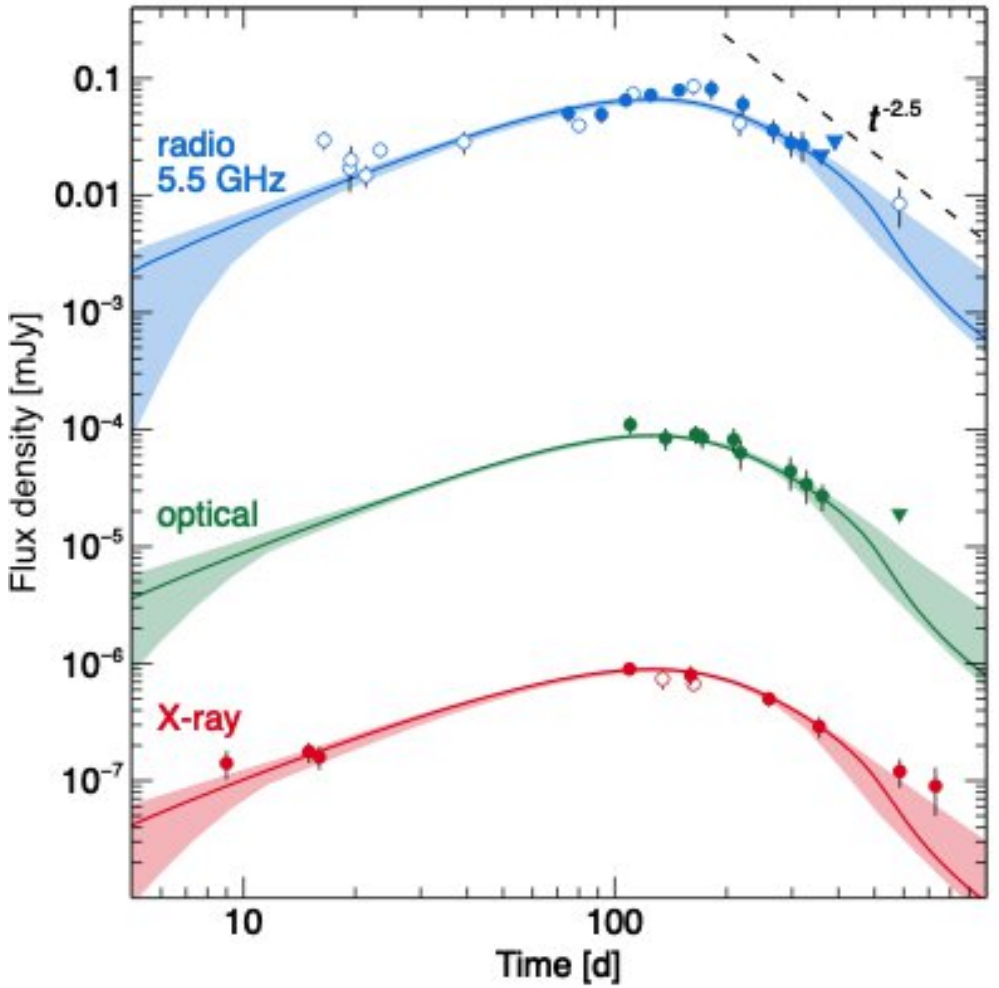


*Zhang & Meszaros 02*
*Rossi+02*
*Aloy+05*
*Janka+05*
***Lazzati+18***
*Xu+18*
*Kathirmagaraju+18*
***Ryan+19***

# The afterglow in the off-axis structured jet model



# Broadband afterglow modeling



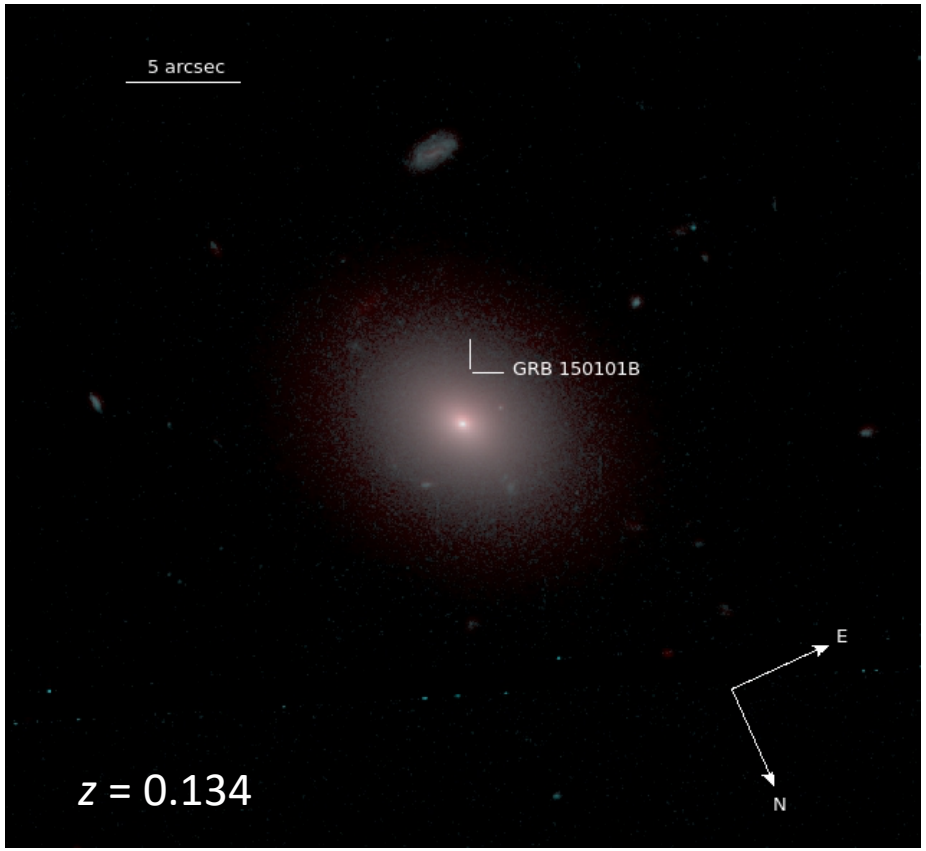

$\theta_{jet}$ ~ 5 deg
$\theta_{view}$ ~ 25 deg
$n$ ~ $10^{-2}$ – $10^{-4}$ cm$^{-3}$
$E$ ~ $10^{50}$ erg

Typical of short GRB afterglows

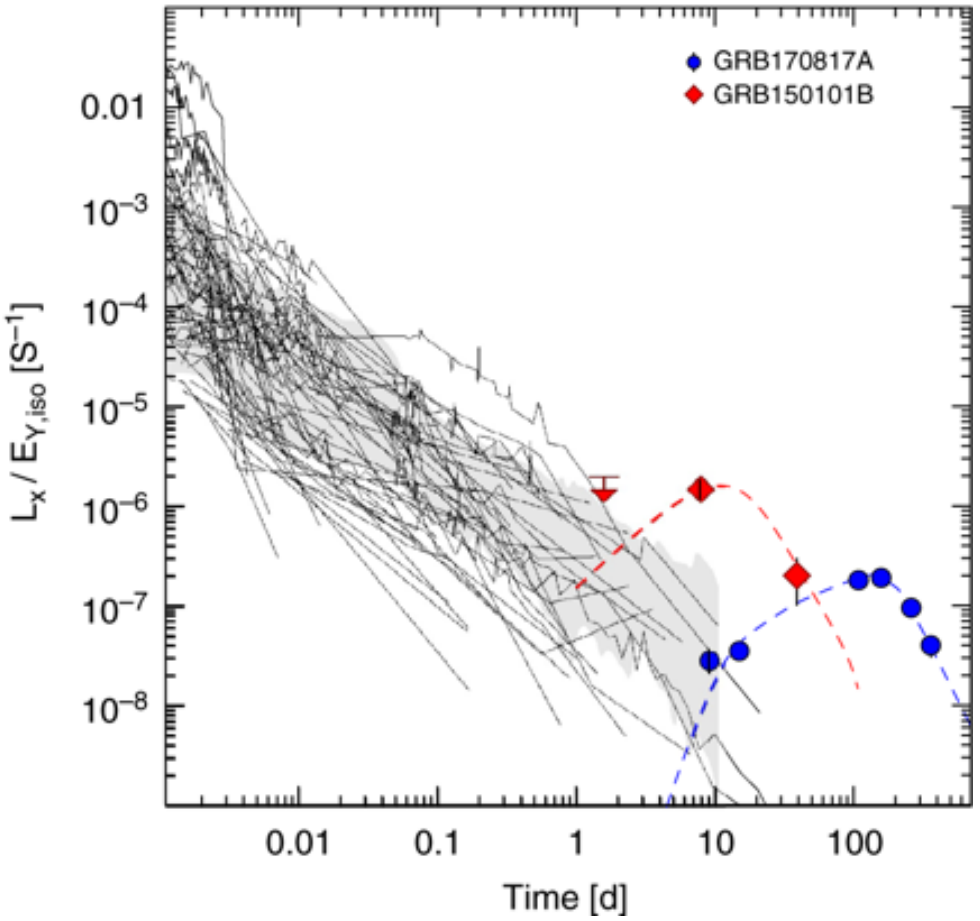
EM viewing angle consistent with the binary inclination from GW data

***Updated from***
***Troja, van Eerten et al., MNRAS, 2019, arXiv:1808.06617***

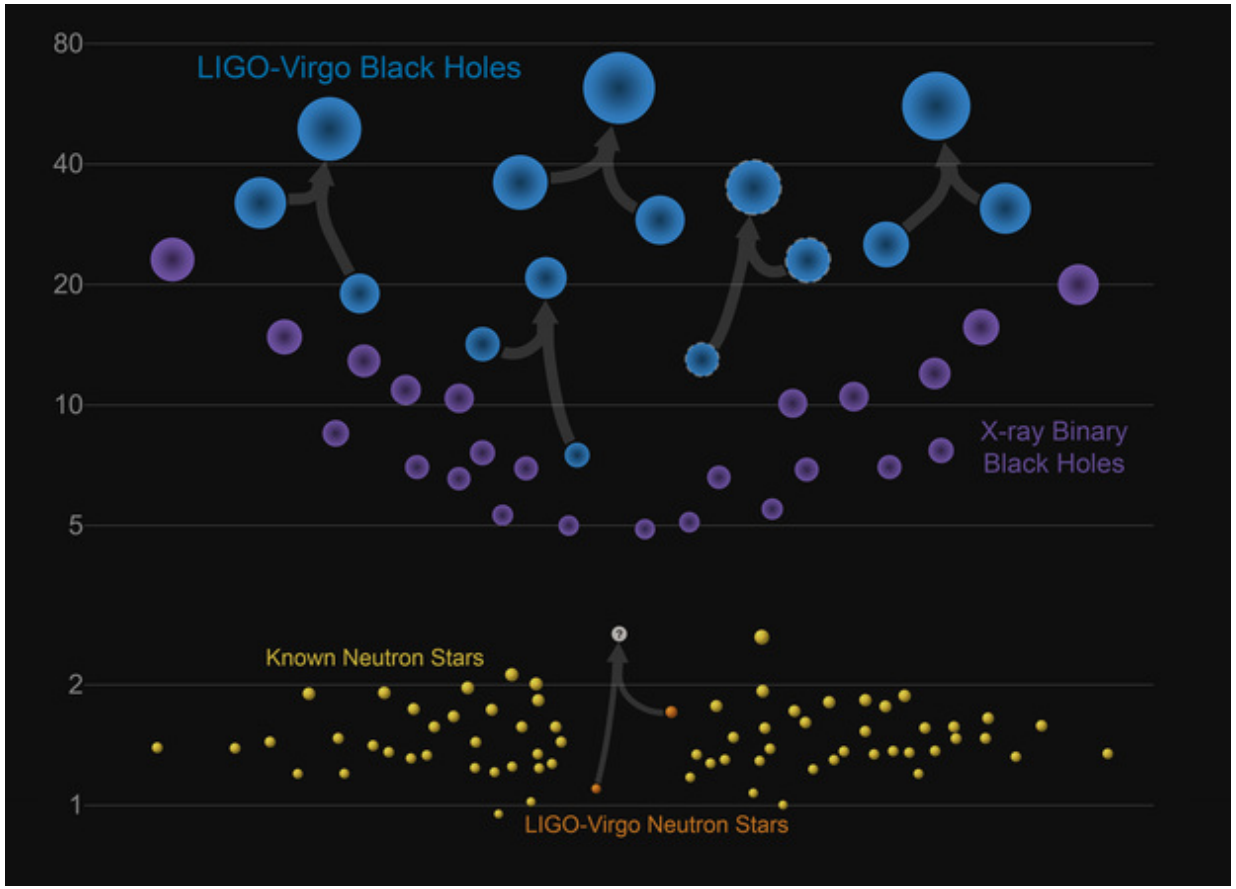
# Analogues in the GRB sample: GRB 150101B




*Troja, Ryan et al. 18*



# Constraints on the remnant: NS or BH?



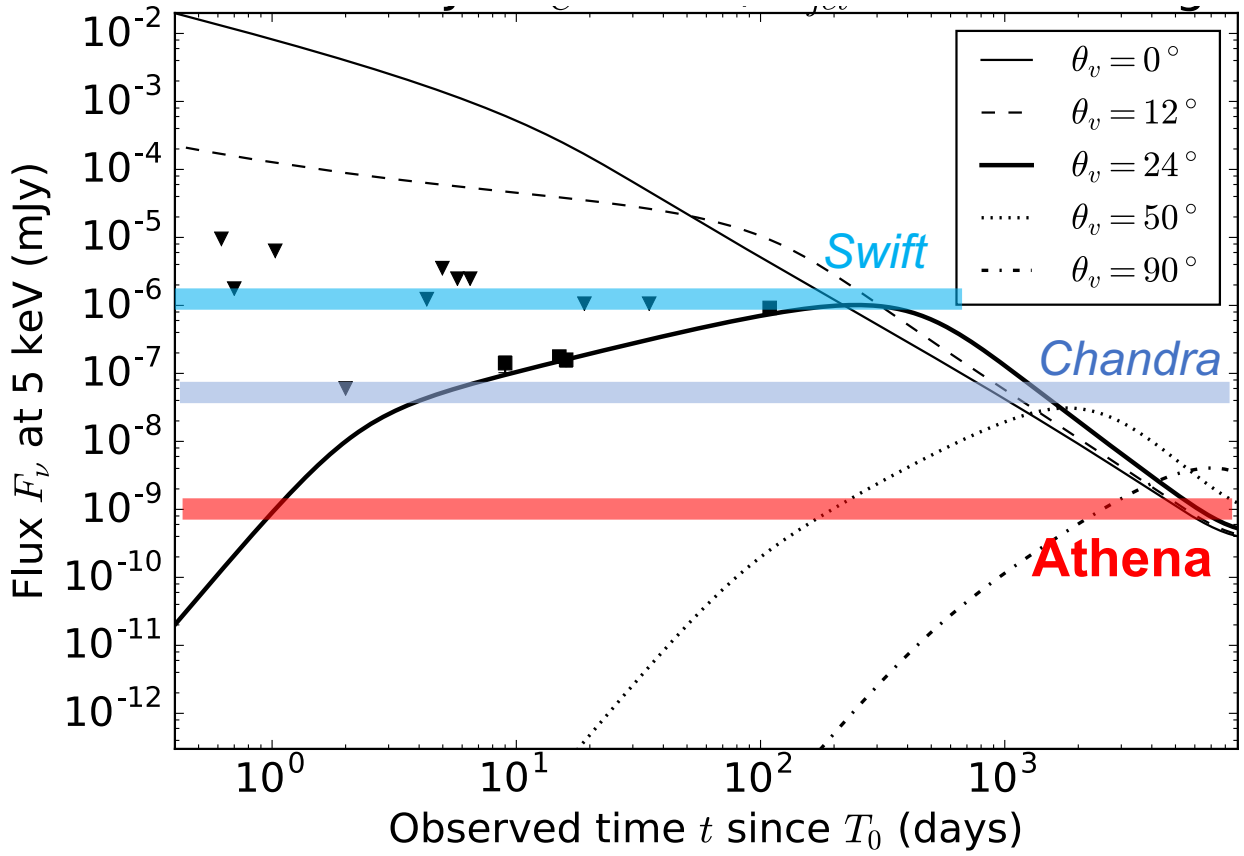

X-ray emission is very sensitive to the GRB central engine: sporadic emission of energy (flares) or continuous spin-down energy injection (plateaus).

$$B < 10^{12}\ G$$

BH *Pooley+18*

or stable low-B NS *Piro+19*

# Future perspectives



# Summary

- NS mergers can launch collimated relativistic outflows (jets) powering GRBs

- Viewing angles play an important role:
  Similar explosions might look very different

- GW170817: an extraordinary ordinary short GRB
  A few similar events might have been seen before

- ATHENA will probe a wider range of explosions