THE NON-THERMAL COUNTERPARTS OF GW170817

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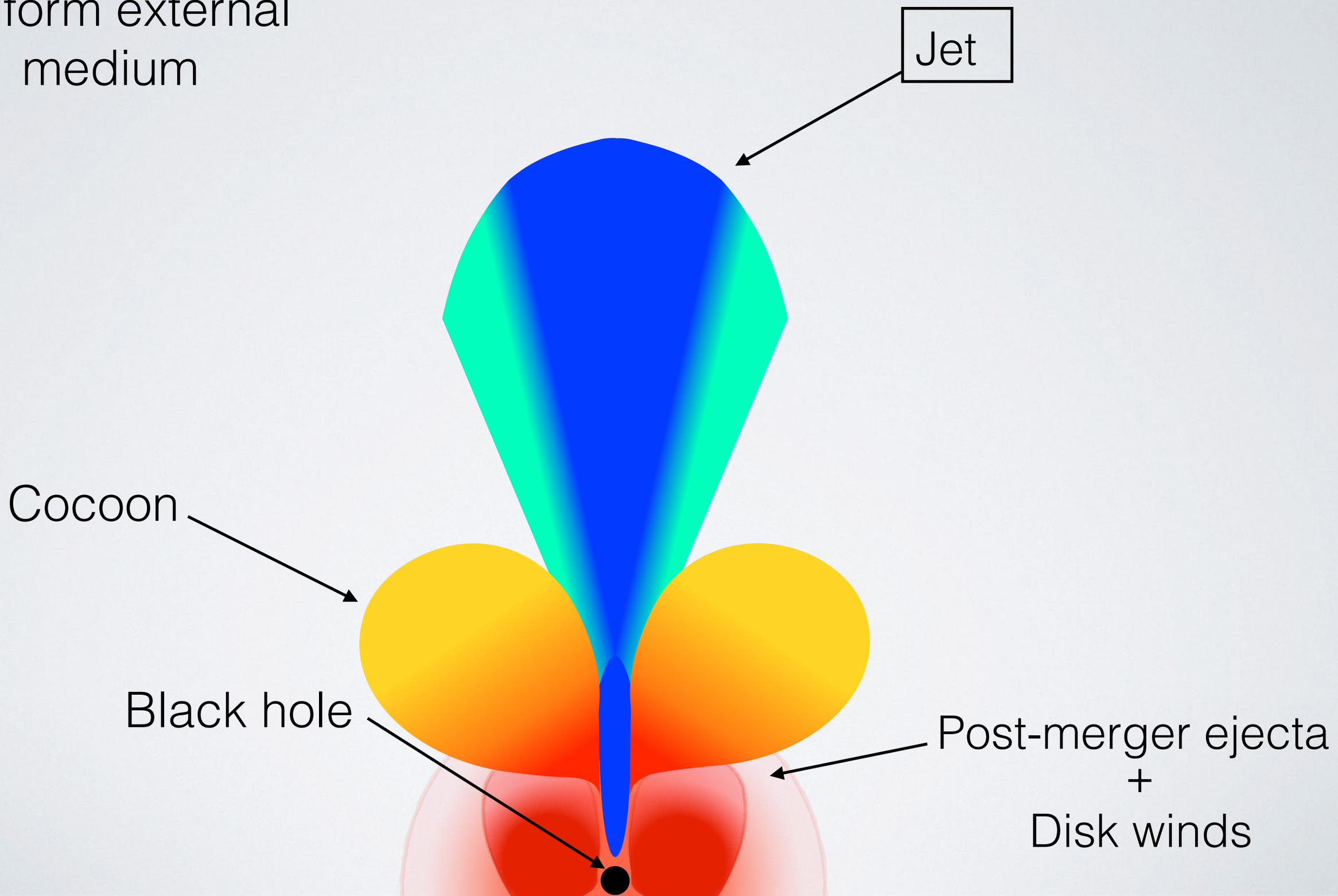
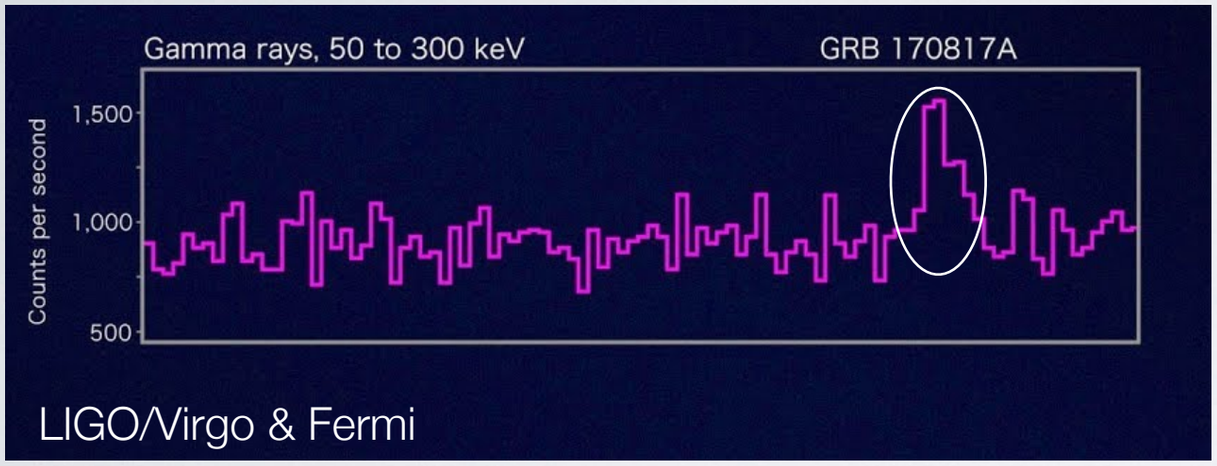
The Post-Merger System

Uniform external medium



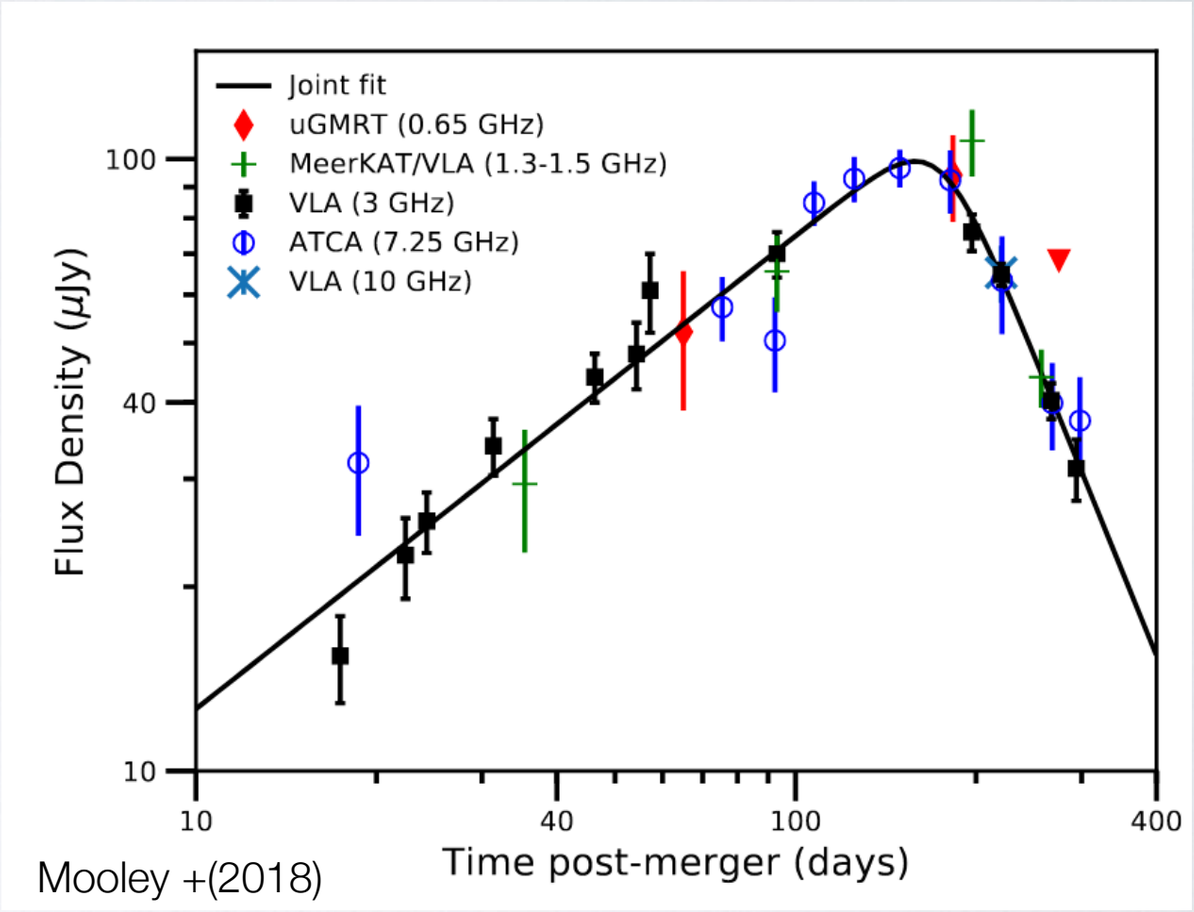
GRB 170817A

Prompt



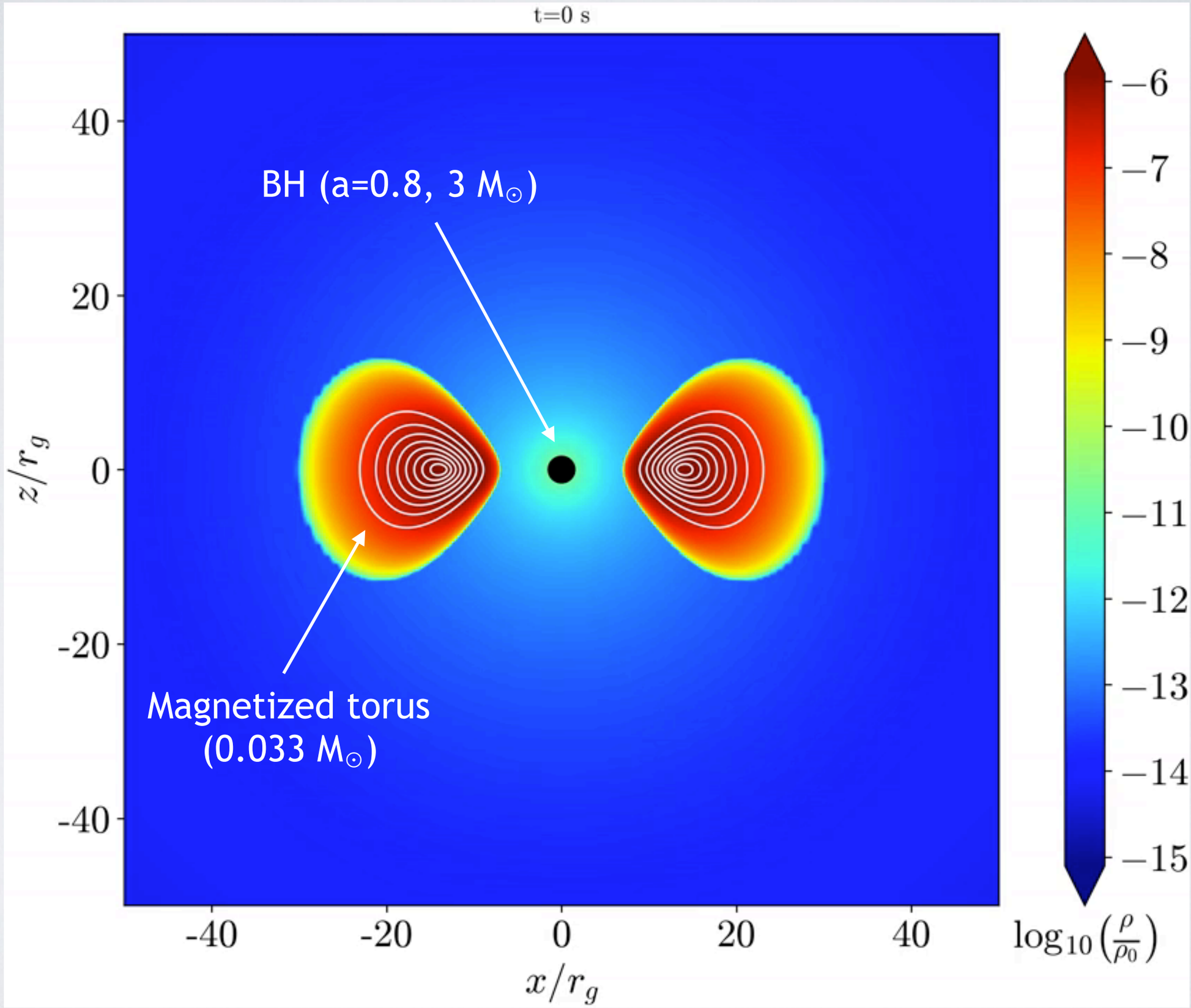
under-luminous GRB

Afterglow



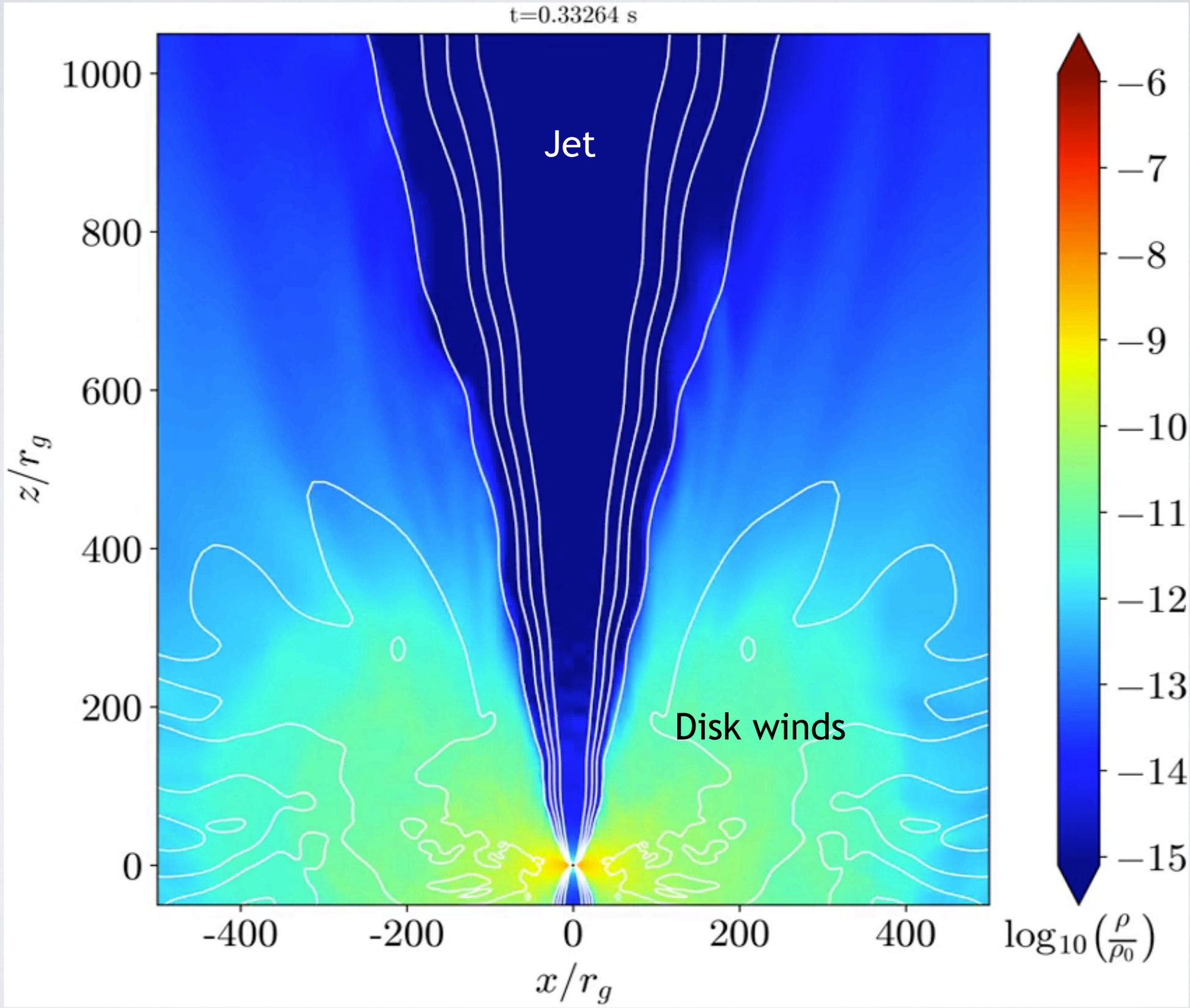
shallow rise and steep decline

Initial Setup of Post-Merger System



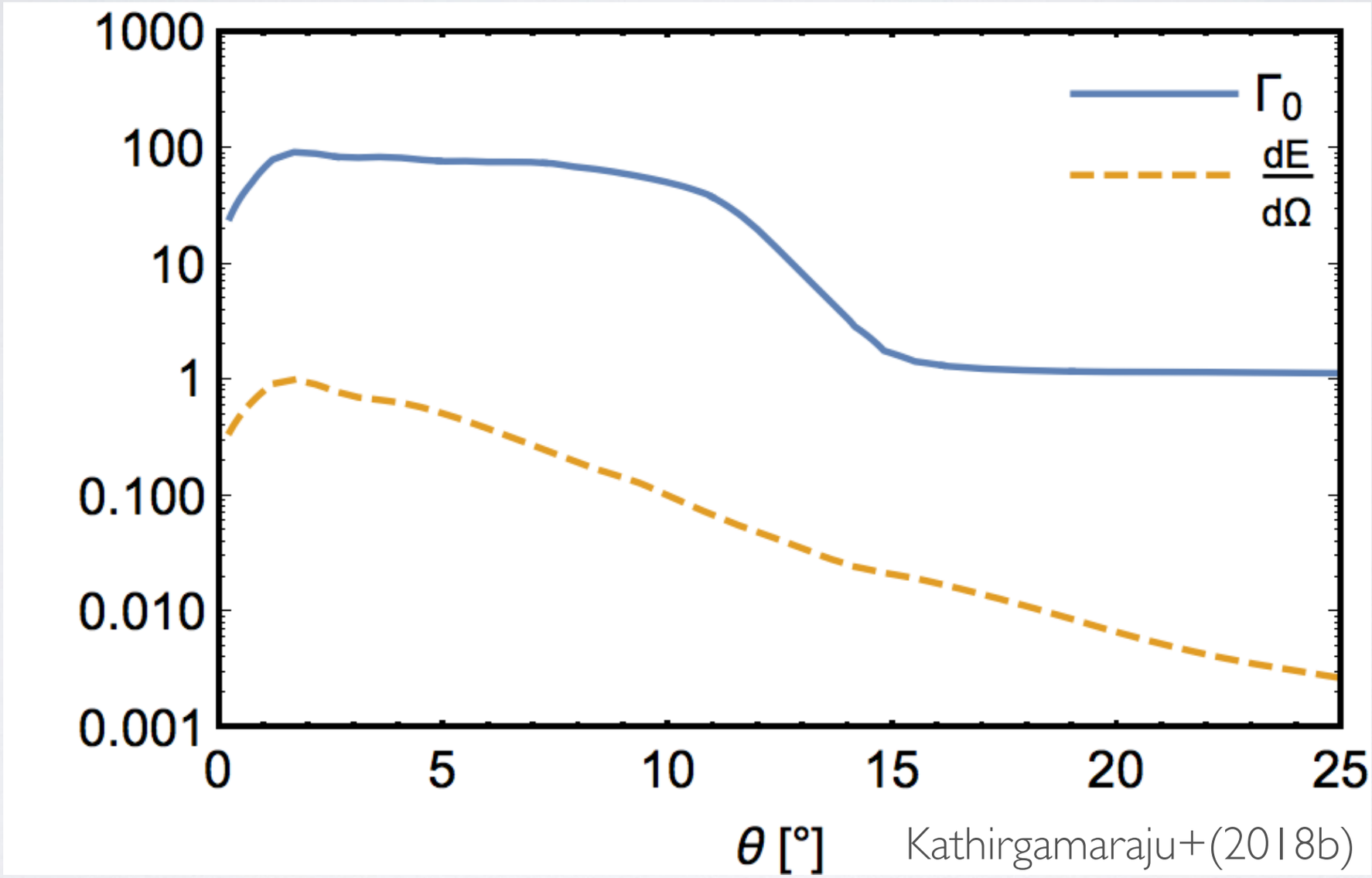
Kathirgamaraju+(2018b), Fernández+(2018),

Simulations of the Post-Merger System



Extracting Jet Structure

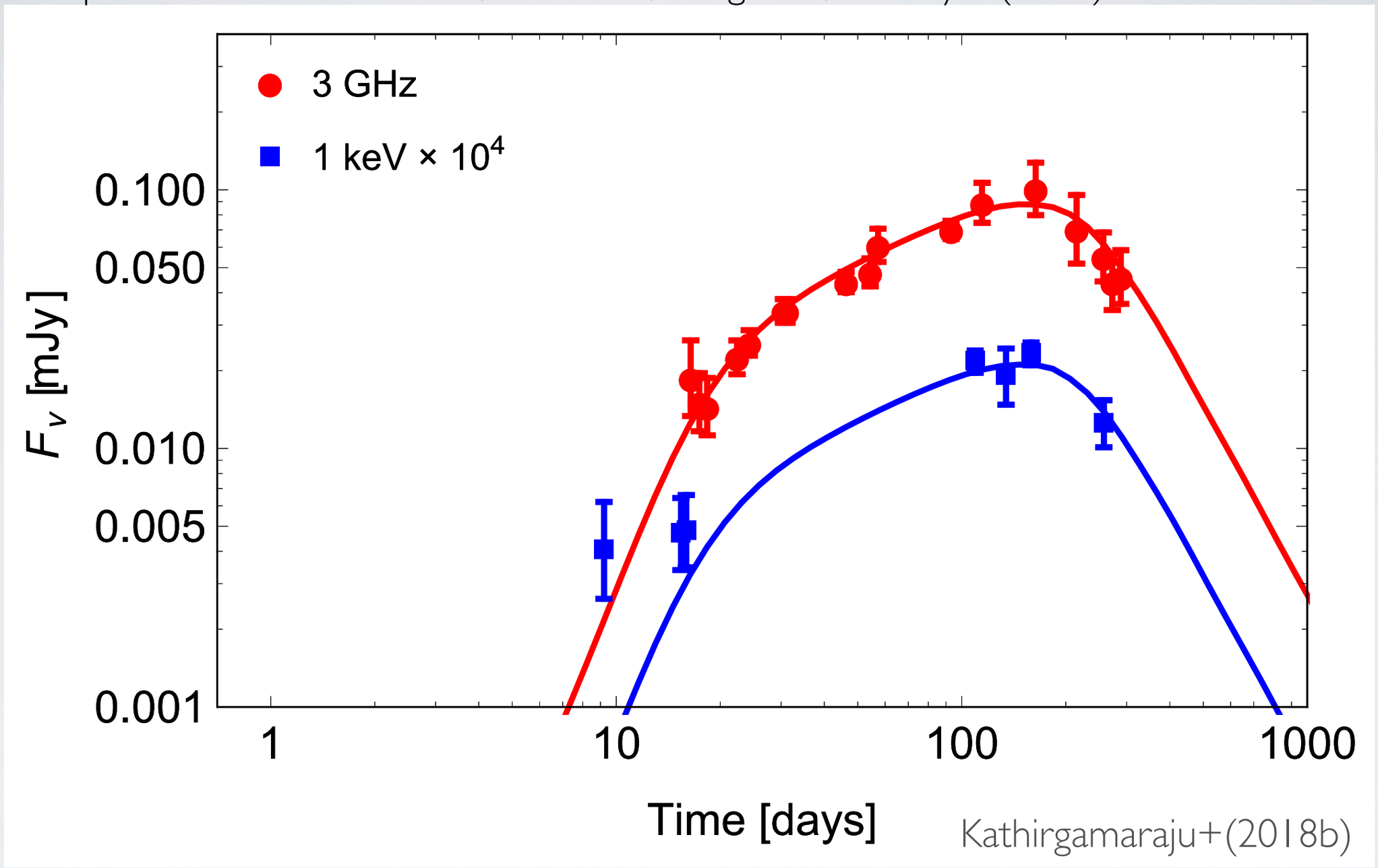
- Measure the average Lorentz factor and energy of the jet (averaged over azimuthal angle) flowing through a surface of fixed radius.



Energy includes the EM, kinetic and thermal components.

Afterglow of GRB 170817A

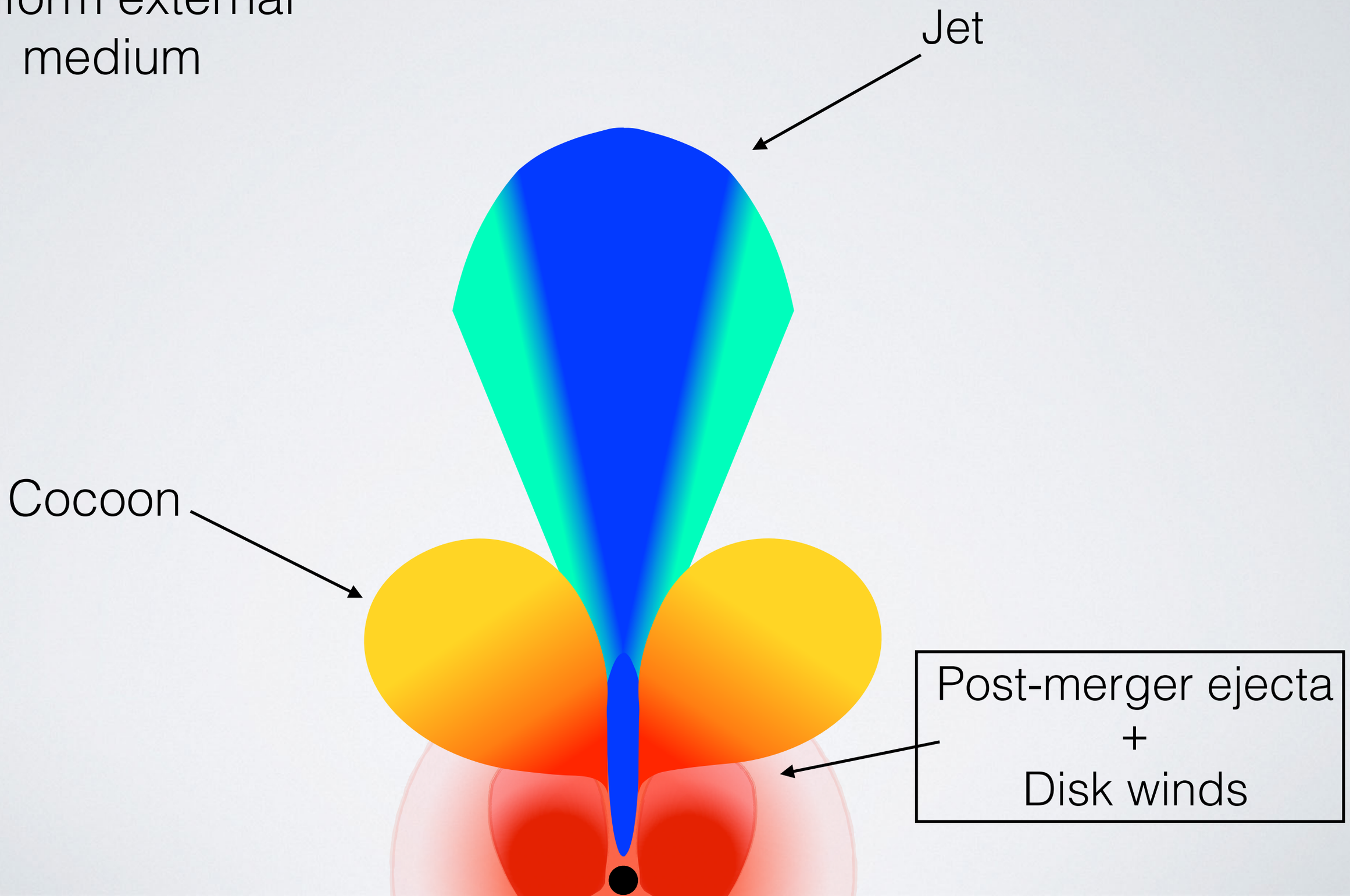
Data points from Alexander+, Hallinan+, Margutti+, Mooley+ (2018)



$E_j \approx 5 \times 10^{50}$ erg, $n_{ism} \approx 0.01$ cm^{-3}, $\theta_{obs} = 30°$

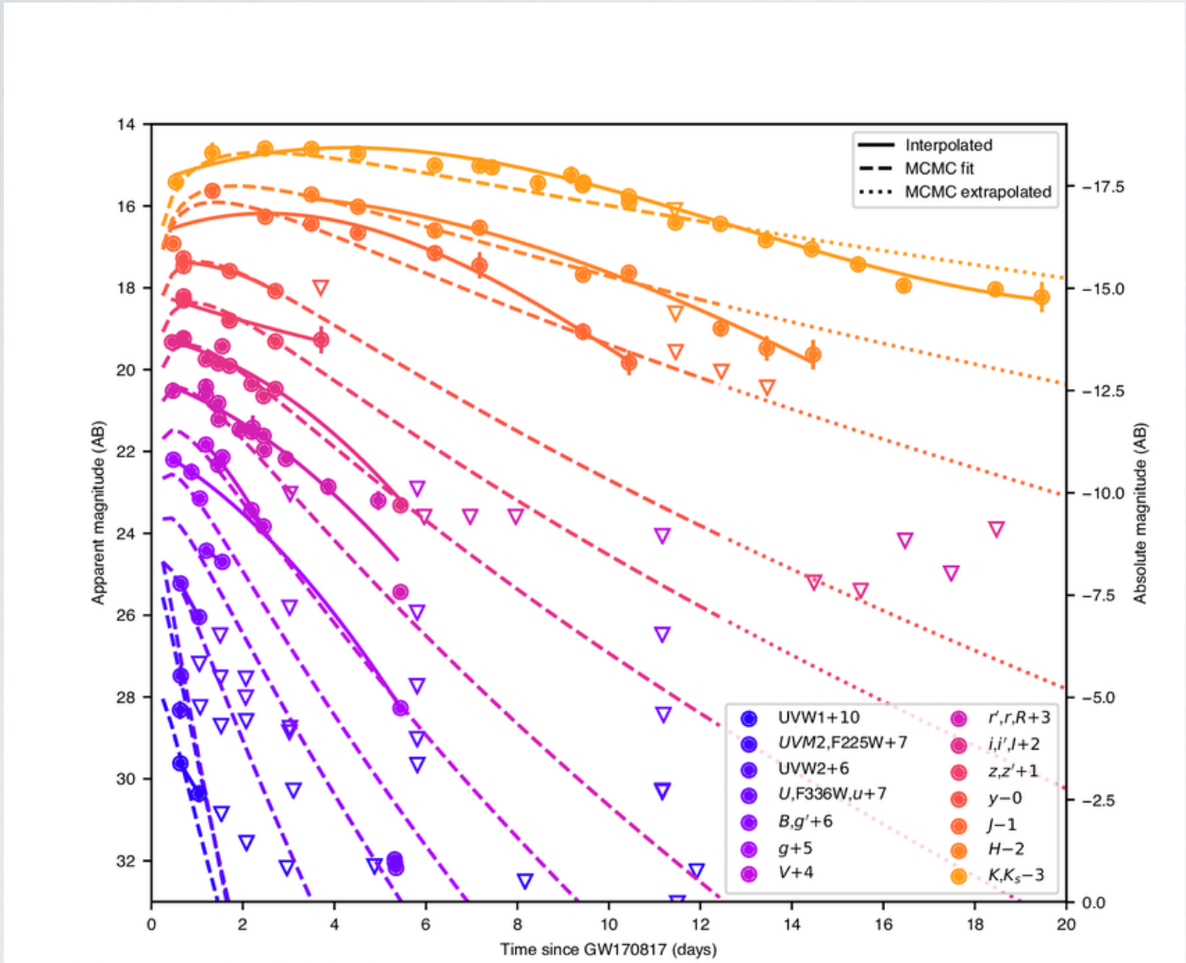
The Post-Merger System

Uniform external medium



The Kilonova AT2017gfo

Thermal: powered by radioactive decay



(Kasliwal +2017)

Non-thermal: kilonova afterglow?

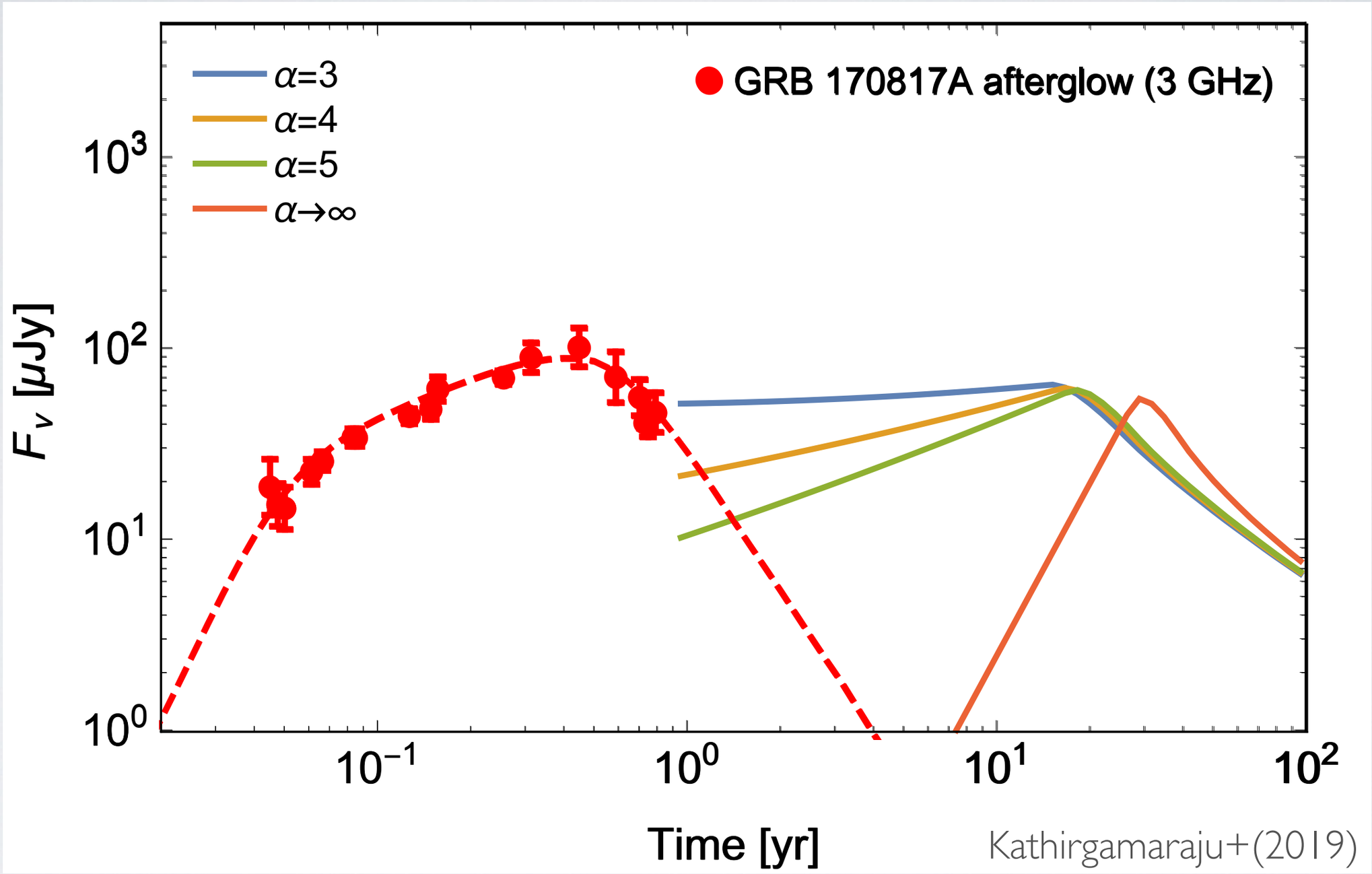
Modeling the kilonova afterglow

- The afterglow associated with KN ejecta can produce late time flares (e.g., Nakar & Piran 2011)

- KN observations imply $E \approx 10^{51}$ erg, $\beta \approx 0.3$ (e.g., Cowperthwaite+ 2018), leading to peak in the afterglow at ~10 yrs (e.g., Alexander+ 2018)

- Assume a power law distribution of energy $E(> \beta\Gamma) \propto (\beta\Gamma)^{-\alpha}$ for the KN ejecta (e.g., Hotokezaka+ 2018, Radice+ 2018)

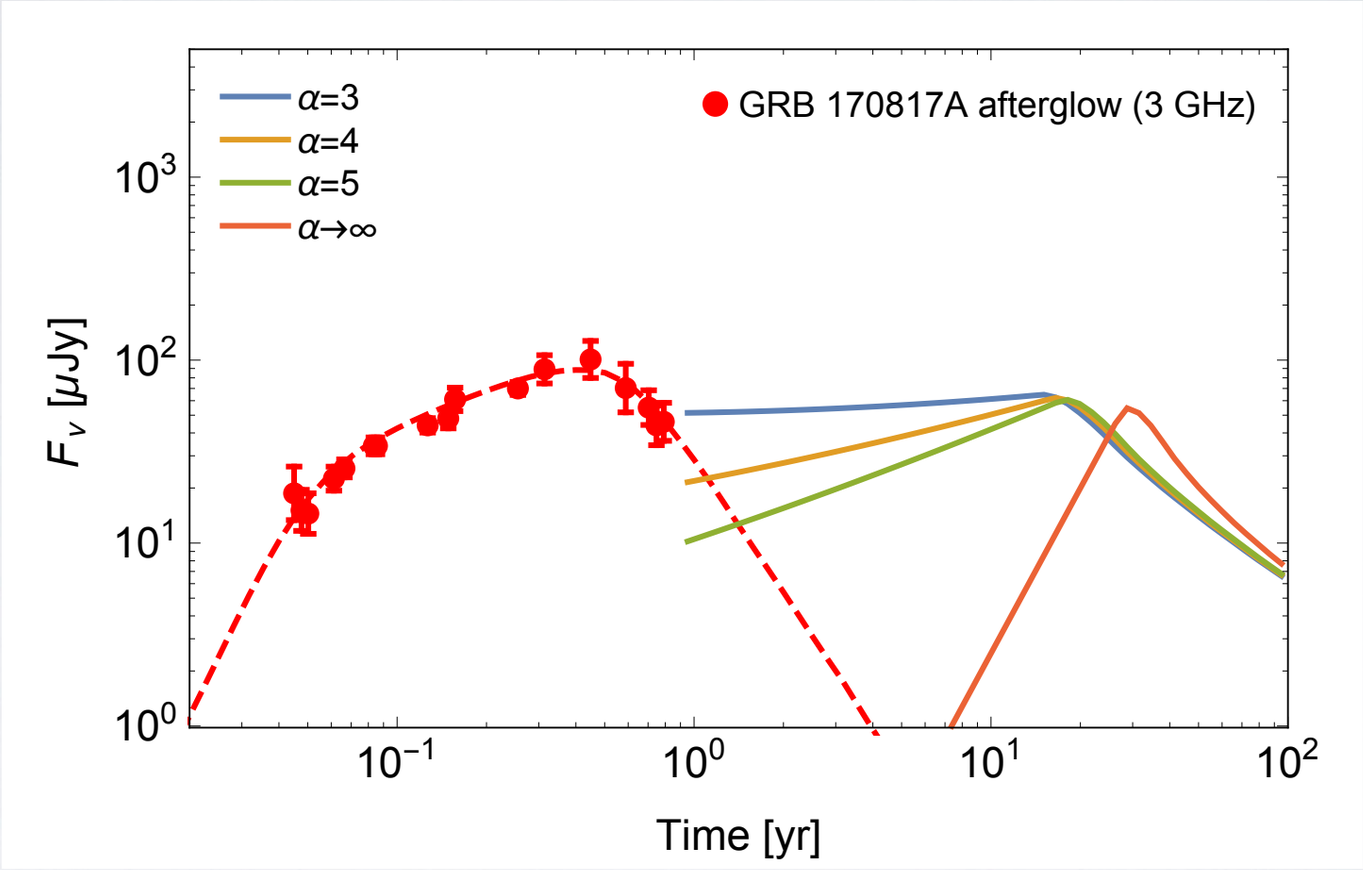
The afterglows of GW170817



Kathirgamaraju+(2019)

$$E(>\beta\Gamma) \propto (\beta\Gamma)^{-\alpha}$$

Inferences from the KN afterglow



- Peak flux and time can constrain the external density and energy of the outflow

- Larger values of α leads to a steeper rise in the afterglow.

Summary

- Using 3D GRMHD simulations, studied the formation and emission of a jet from a post-merger system, without making any assumptions on the initial jet structure.
- A structured jet develops naturally, its emission profile can reproduce the observed properties of GRB 170817A.
- Follow up observations of GW170817 may catch the emergence of the KN afterglow.
- Constraining α can provide insight on quantities such as EoS
- Parameters inferred from its observation can be checked for consistency with GRB and KN models (e.g., external density and β)

Kathirgamaraju A., Barniol Duran R., Giannios D., 2018, MNRAS, 473, L121 (arXiv:1708.07488)

Kathirgamaraju A., Tchekhovskoy A., Giannios D., Barniol Duran R., 2018, MNRAS 484, L98 (arXiv:1809.05099)

Kathirgamaraju A., Giannios D., Beniamini P., 2019, (arXiv:1901.00868)