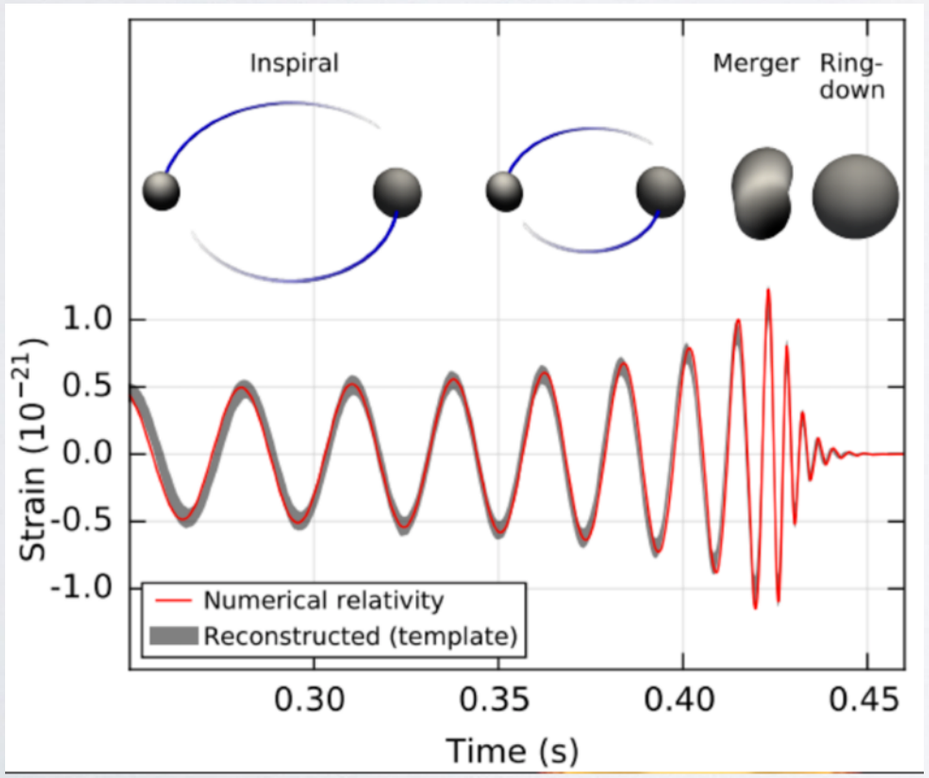
SHORT GRBS FROM STRUCTURED JETS AS EM COUNTERPARTS

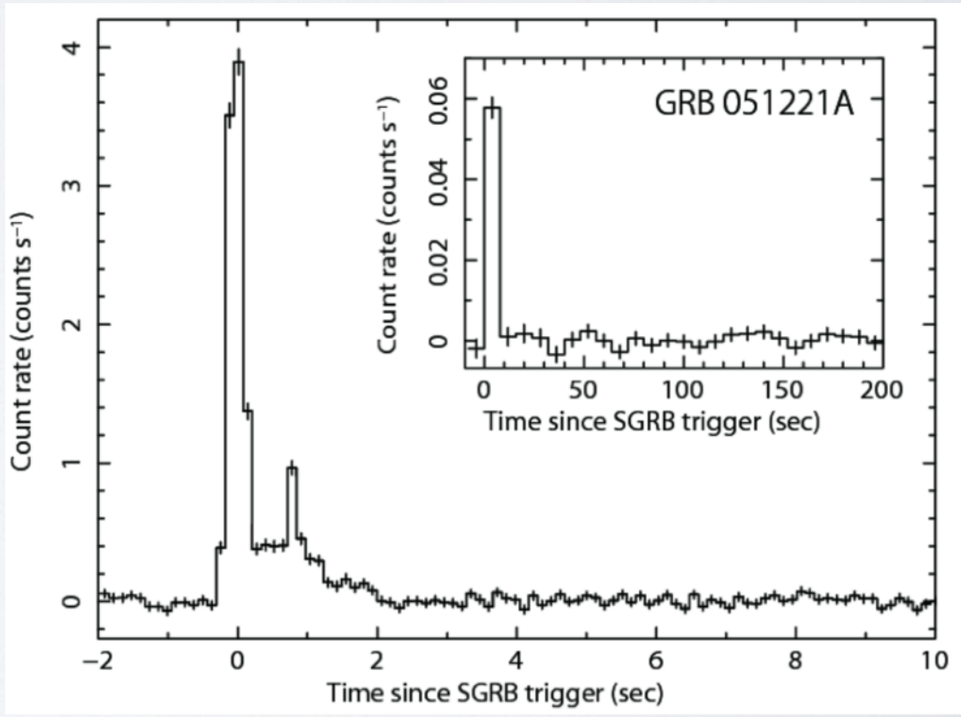
Adithan Kathirgamaraju (Purdue)

In collaboration with:
Rodolfo Barniol Duran (California state Sacramento)
Dimitrios Giannios (Purdue)

Binary NS merger

Gravitational waves + Short GRBs





Prospects of detecting a sGRB associated with GWs

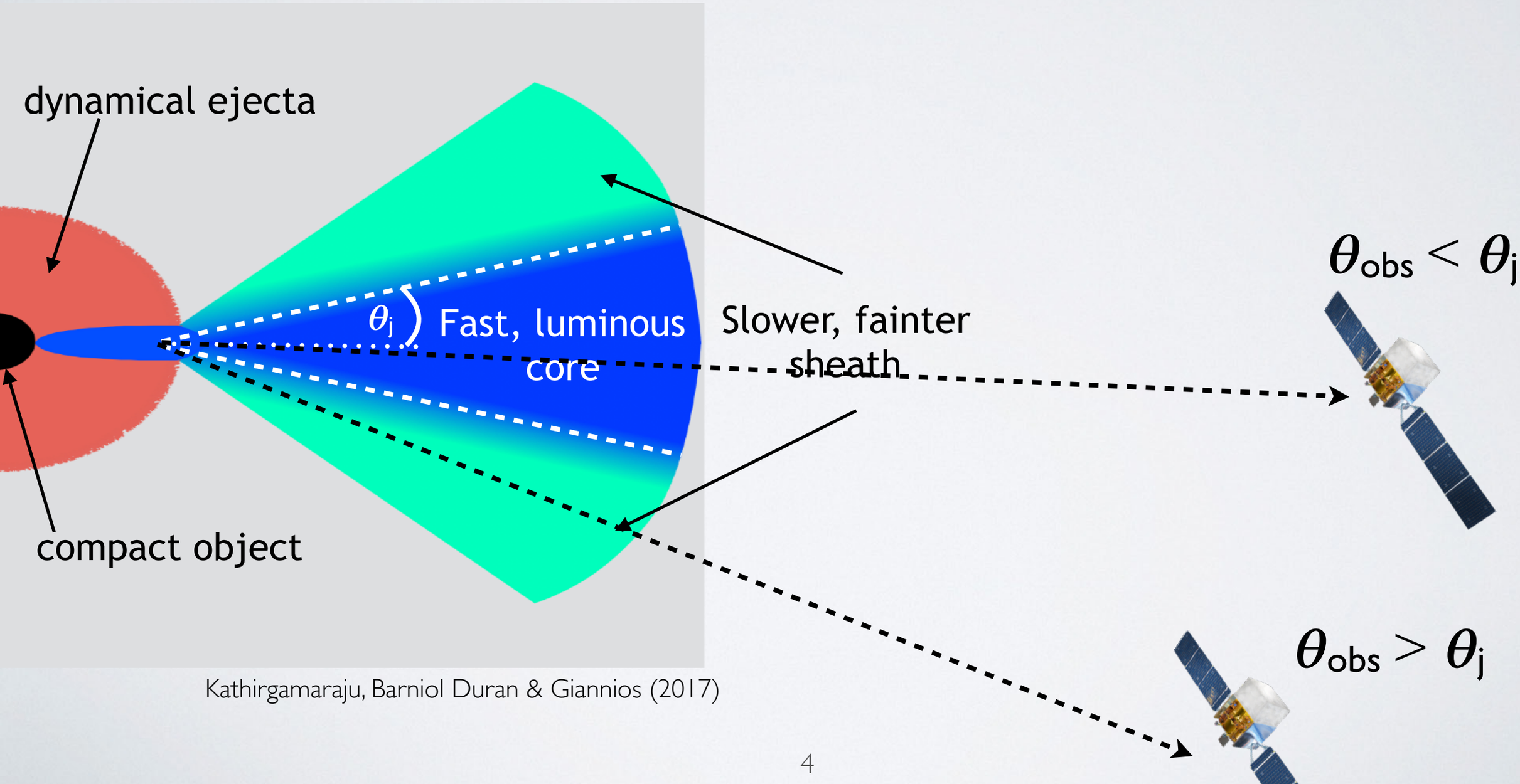
- Rate of observing an on-axis sGRB within LIGO detectability volume (~ 200 Mpc) is ~1 per decade (Wanderman & Piran 2015, Fong et al. 2015).

- sGRB within LIGO volume will be extremely bright (~10^6 cts/s!).

- At these distances, we are more sensitive to off-axis emission and structure of the jet.

A structured jet

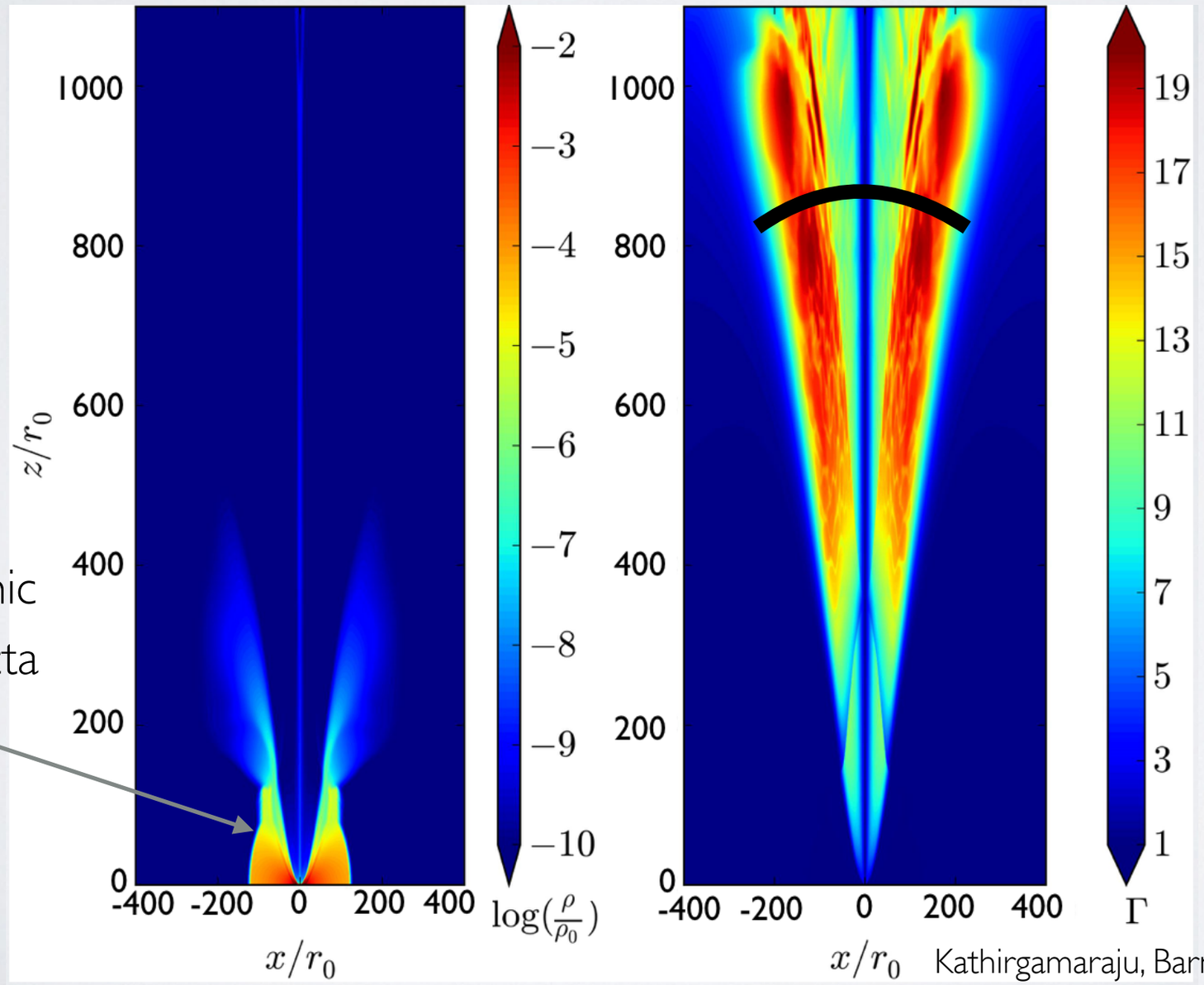
- Numerical and theoretical studies find that a jet develops structure once it breaks out of the collimating medium. (Tchekhovskoy et al. 2010; Komissarov et al. 2010; Sapountzis et al. 2014)



Kathirgamaraju, Barniol Duran & Giannios (2017)

Simulating the jet

- We perform relativistic MHD simulations using the HARM code (Gammie et al. 2003).
- Simulations are run in 2D (1024x384), axisymmetric, initiated by rotating compact object with magnetization ~ 25.

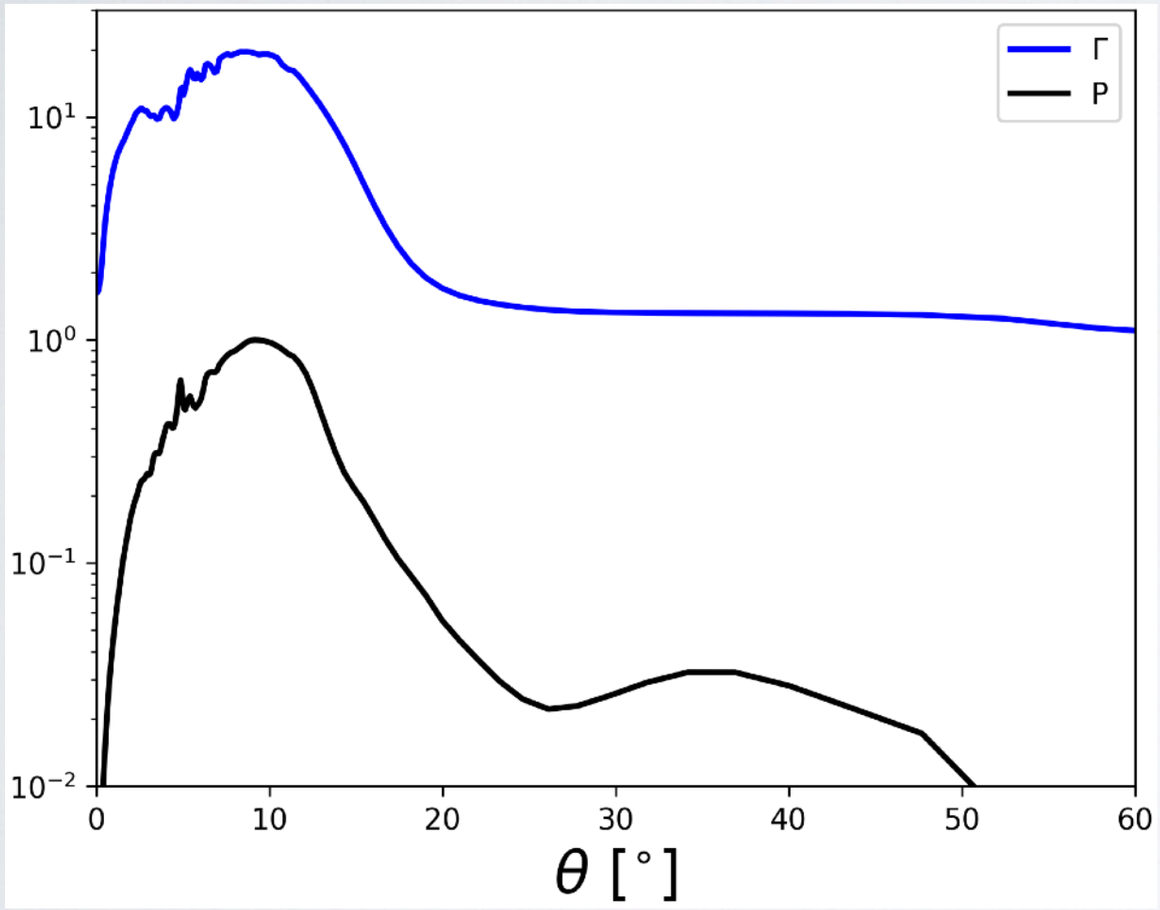


High $\boldsymbol{\rho}$ to mimic dynamical ejecta

Kathirgamaraju, Barniol Duran & Giannios (2017)

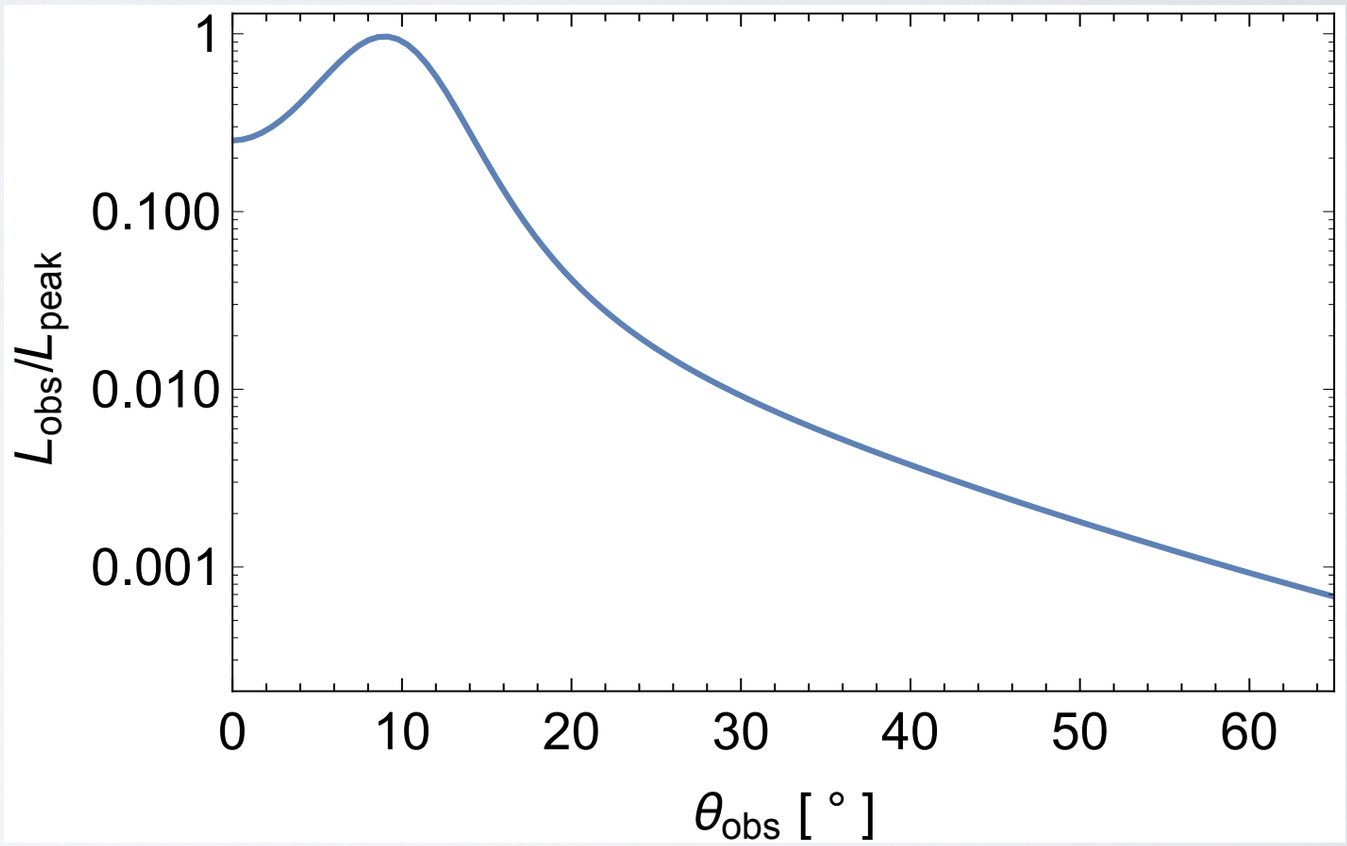
Emission profile of structured jet

Extracting Lorentz factor and power profile



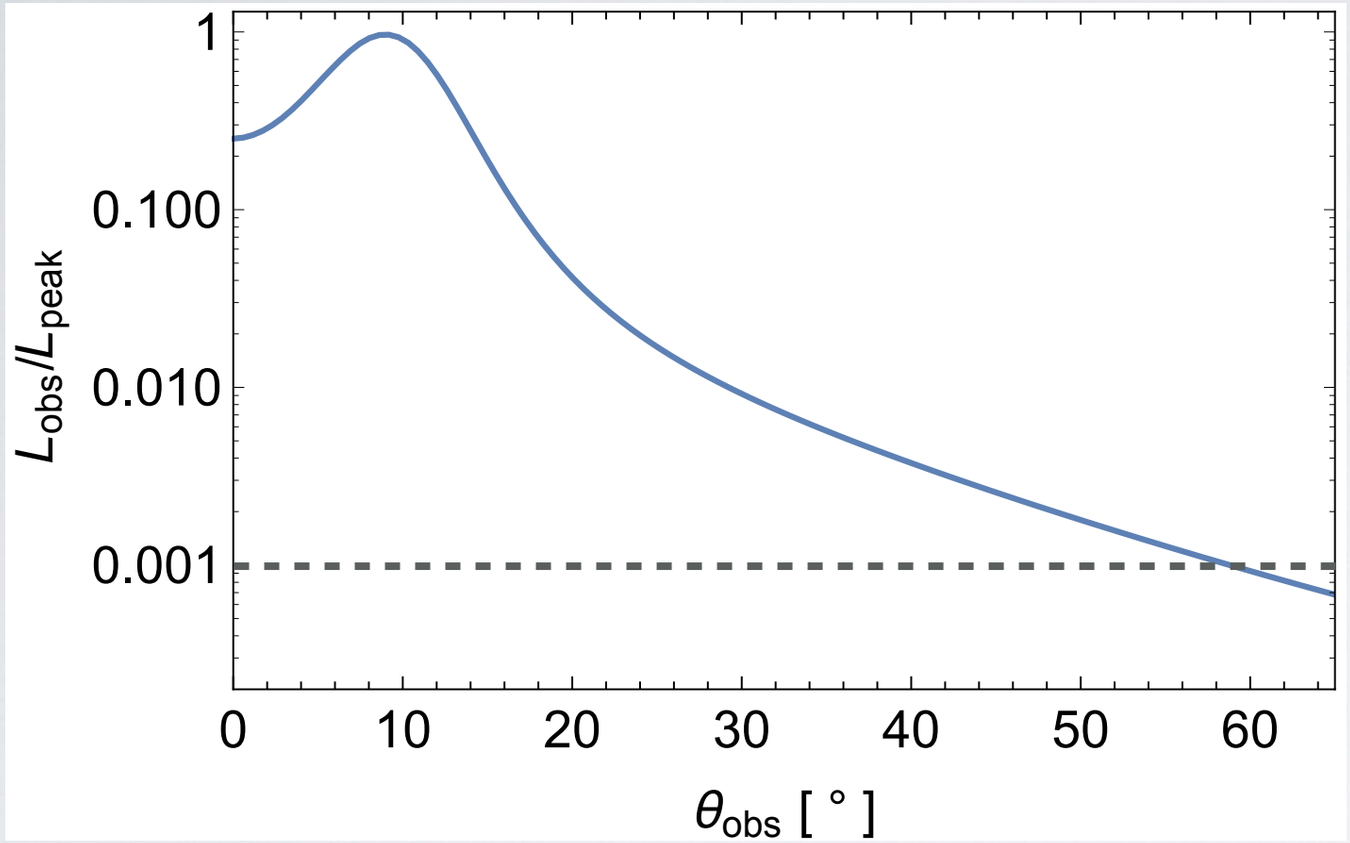
Kathirgamaraju, Barniol Duran & Giannios 2017

Calculate observed (radiated) luminosity from jet



Kathirgamaraju, Barniol Duran & Giannios 2017

Emission profile of structured jet



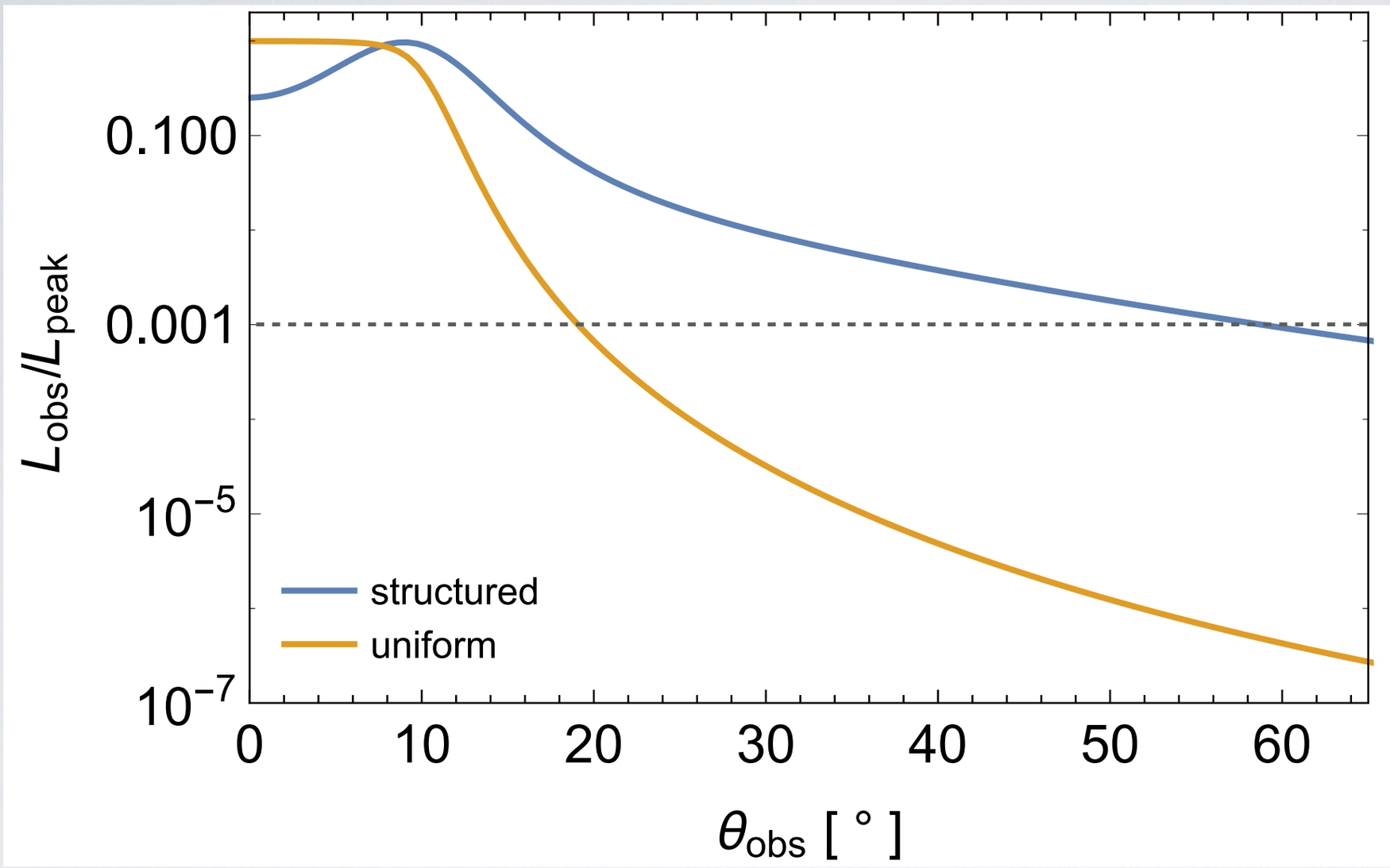
$\sim 10^3$ cts/s

Kathirgamaraju, Barniol Duran & Giannios 2017

- From the range of Γ and P, can estimate a delay of a few to few tens of seconds (for substantially misaligned $\boldsymbol{\theta}_{\mathbf{obs}}$).

- With a coincident LIGO trigger, the count rate required for robust detection $\sim 10^3$ cts/s (Connaughton et al. 2016)

Structured vs. uniform jet



Uniform jet with
$\boldsymbol{\theta}_j = 10°$, $\boldsymbol{\Gamma} = 20$

- When compared to a uniform jet, emission from structured jet detectable for much larger range of $\boldsymbol{\theta}_{obs}$.

Conclusions

- Prompt emission from structured jet detectable by substantially misaligned observers, with the aid of a coincident LIGO trigger.

- Consequently, rates of observing sGRB within LIGO volume can be ~ few per year.

- Prompt detection can localize the source and aid in the follow-up detection of delayed signals.

Kathirgamaraju, Barniol Duran & Giannios - **arXiv:1708.07488**