Controparti Elettromagnetiche di Coalescenza di Binarie Compatte

Stefano Ascenzi

Merger Dynamics

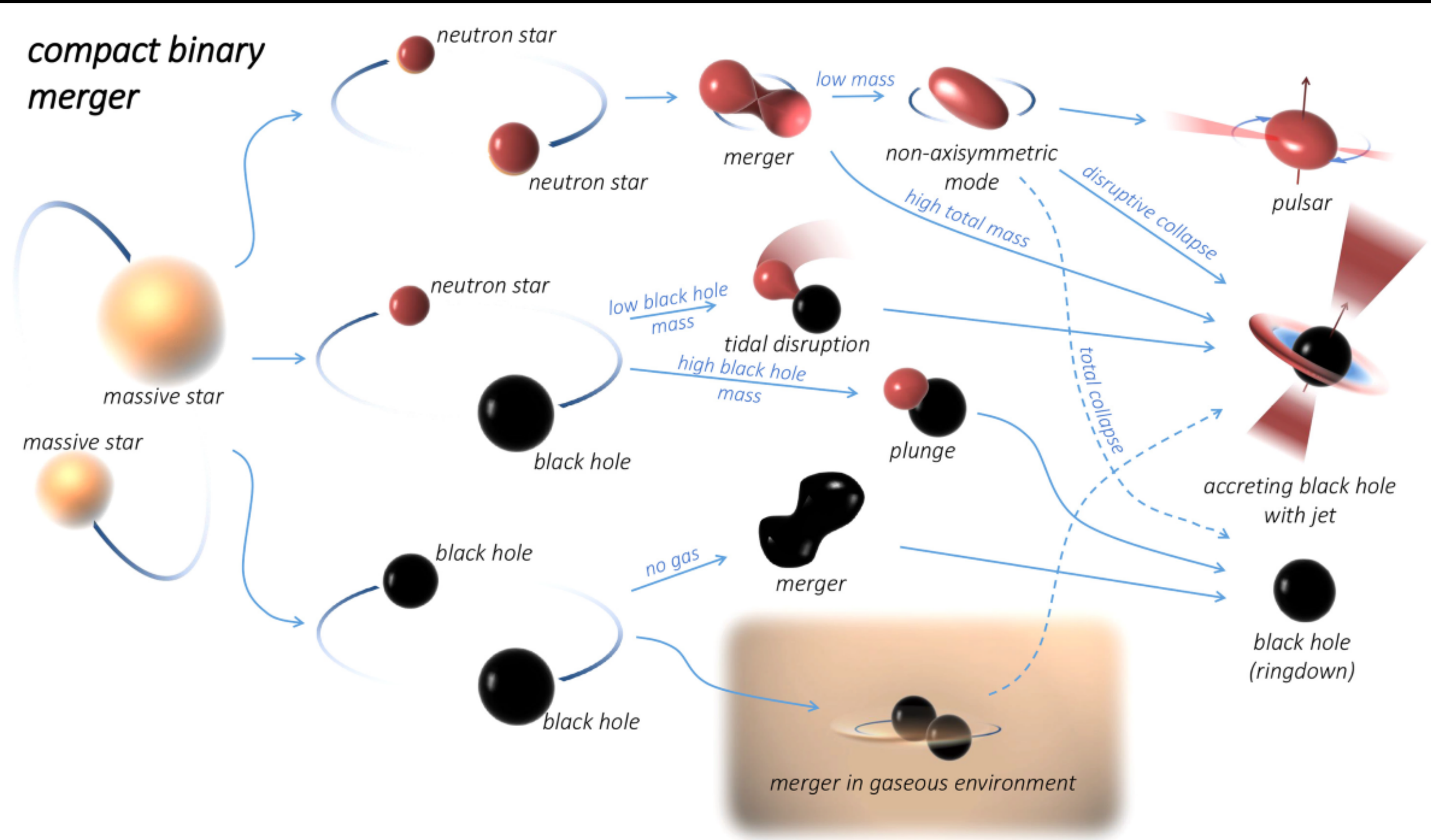


Image credits: I. Bartos & M. Kowalski

Merger Dynamics

MERGER

Accretion Disk

Dynamical Ejecta

Wind-Ejecta

Hydro-Ejecta (NS-NS only)

Tidal-Ejecta

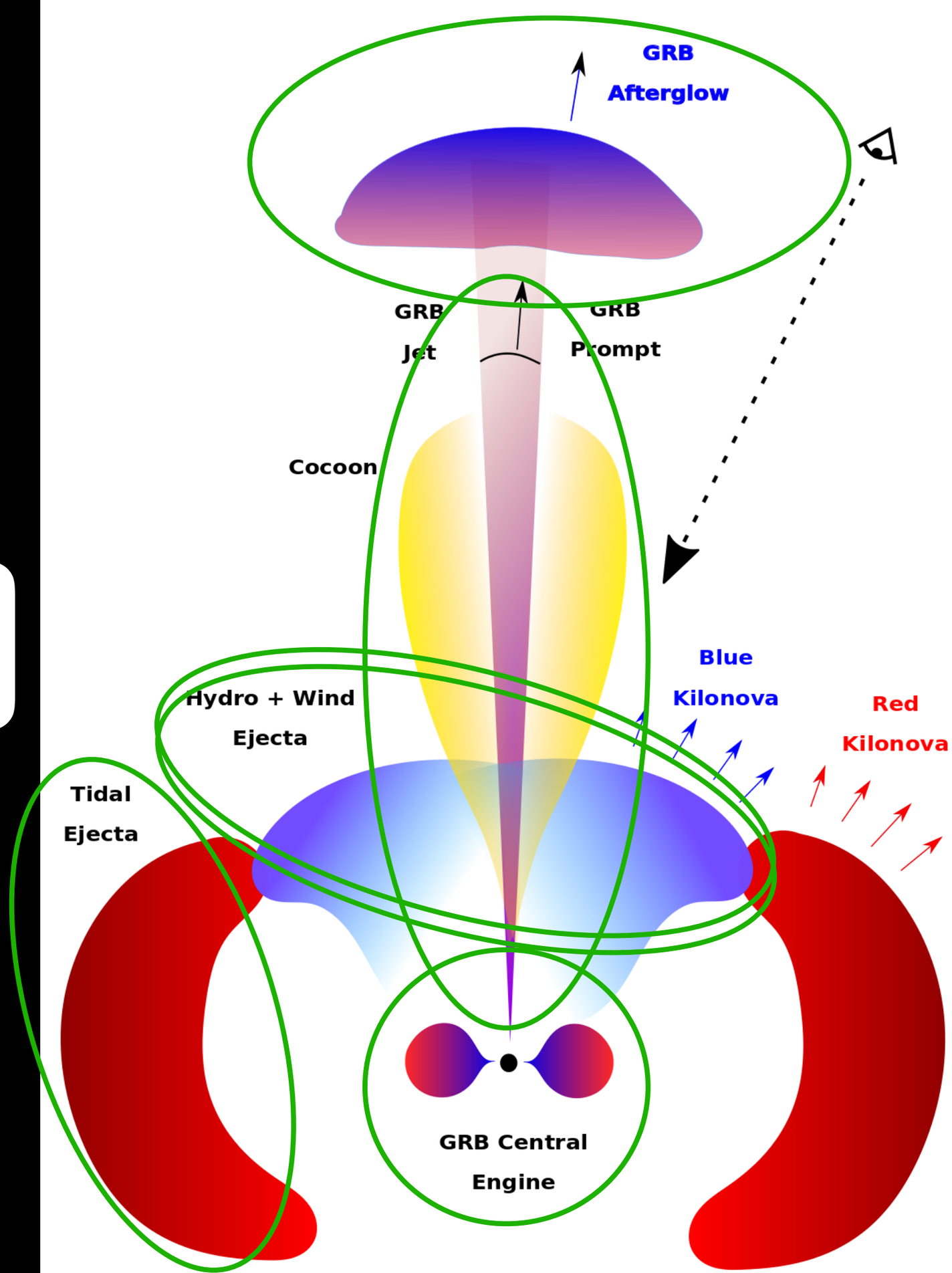
Blue Kilonova (UV, Opt)

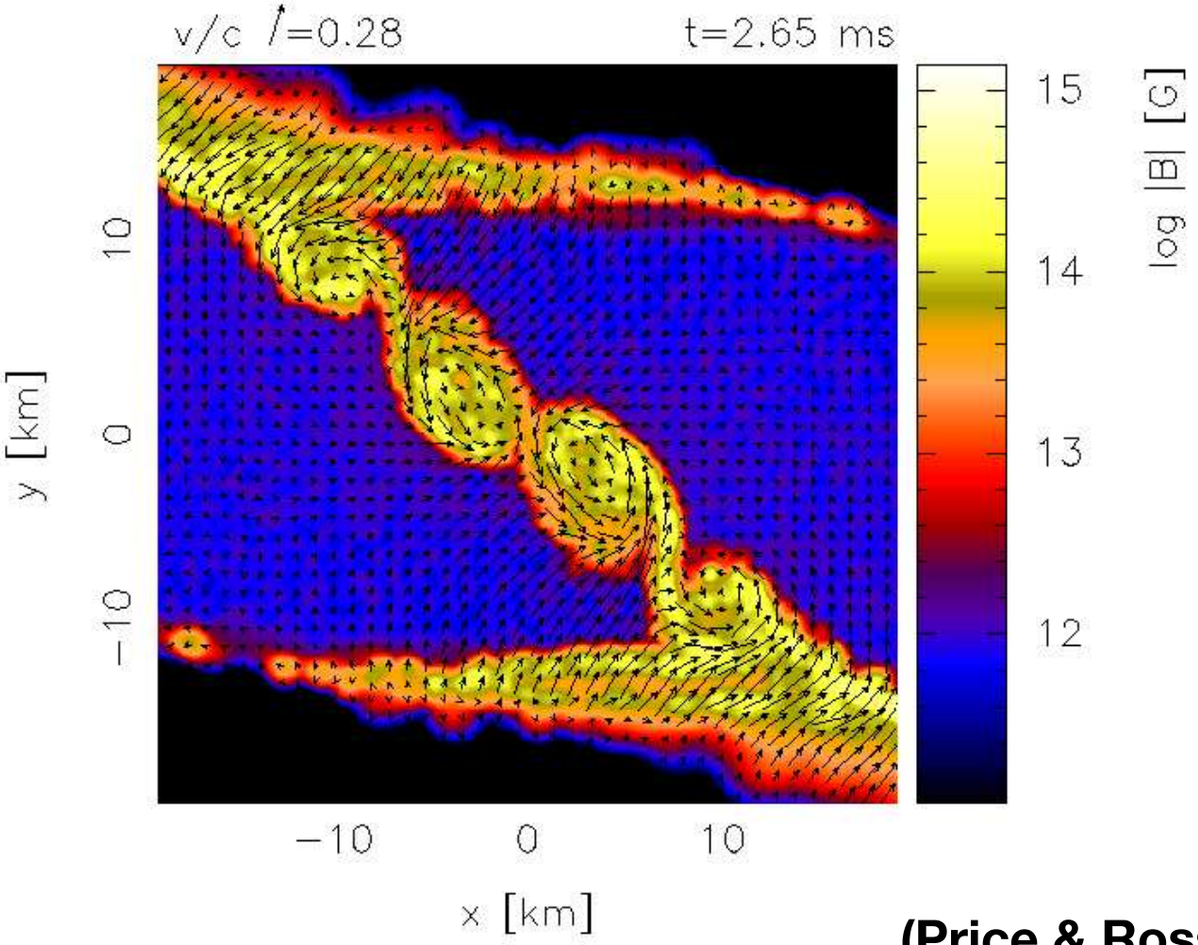
Red Kilonova (Opt, NIR)

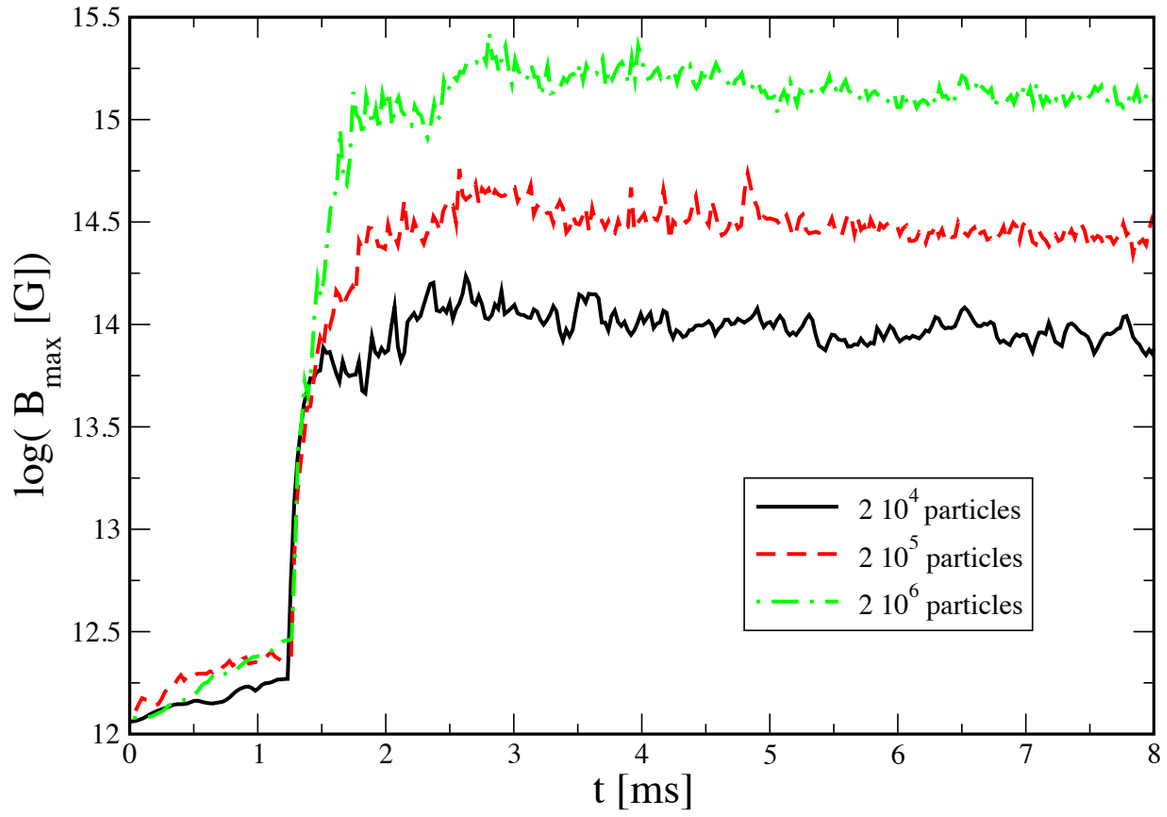
Jet + Cocoon

Short Gamma-Ray Burst Prompt (gamma-rays)

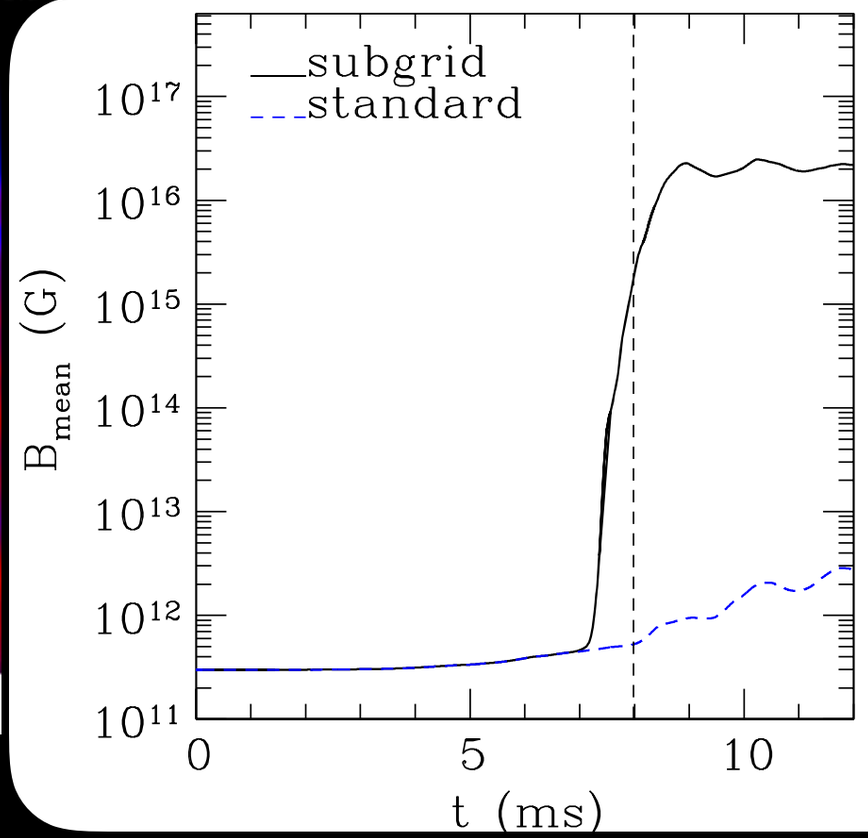
SGRB Afterglow (X-rays, Opt/NIR, Radio)





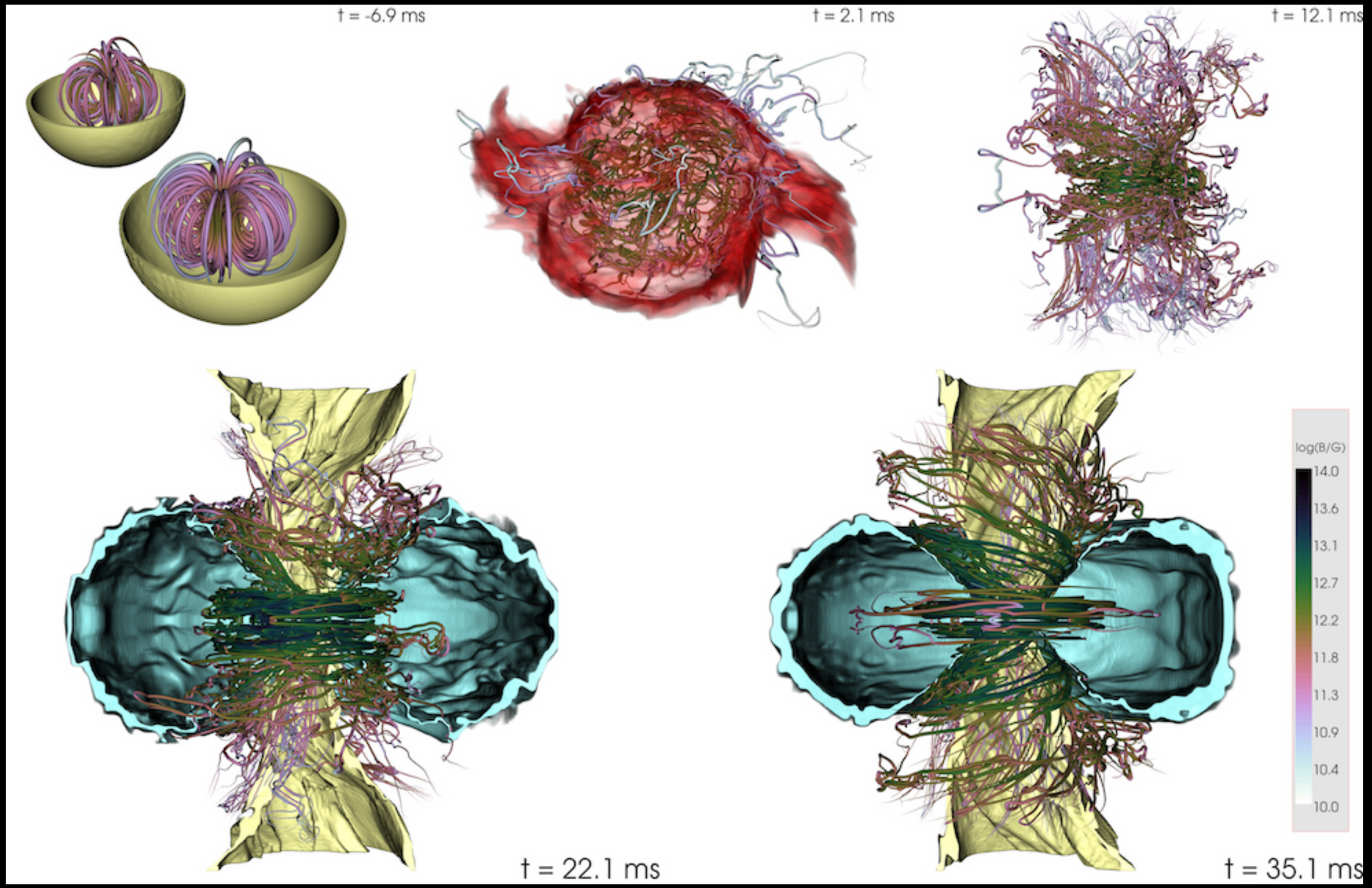


(Price & Rosswog 2006)



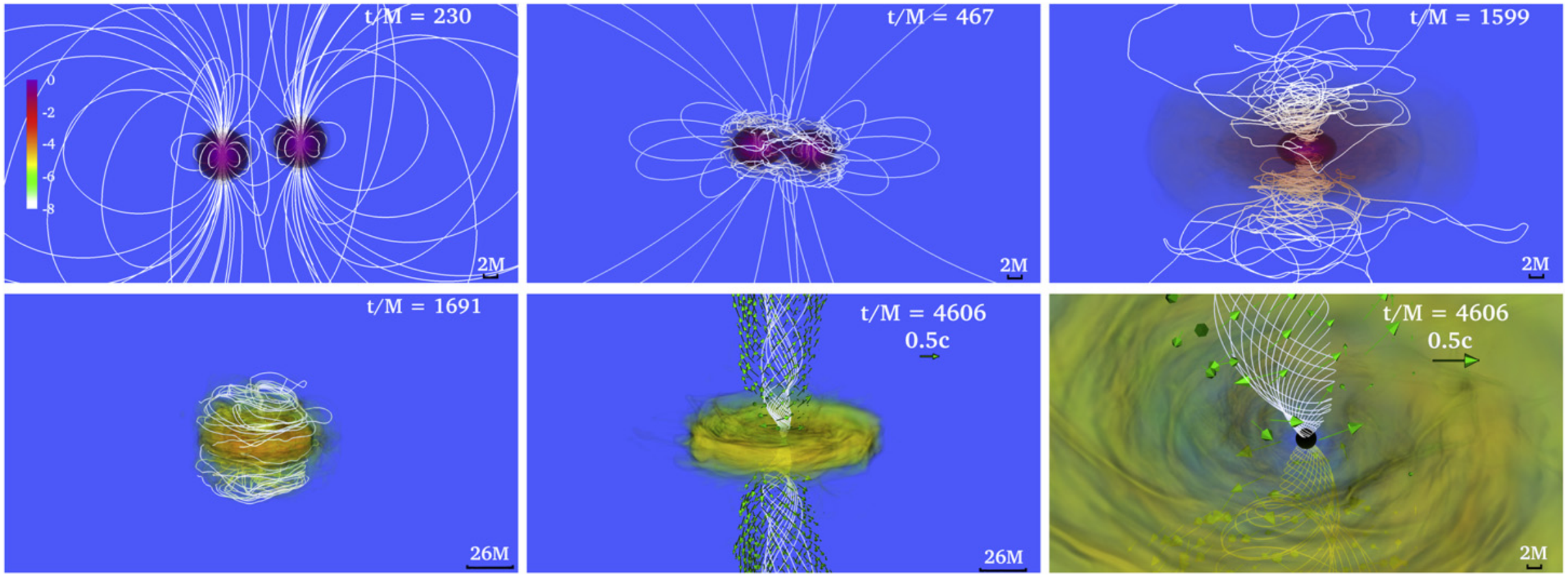
(Giacomazzo+ 2015)

Magnetic-Field Reorganization



(Kawamura + 2016)

Jet Launching Mechanism



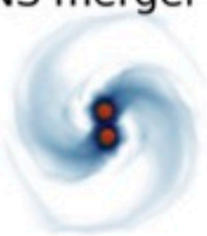
(Ruiz+ 2016)

Spindown-Powered Transients

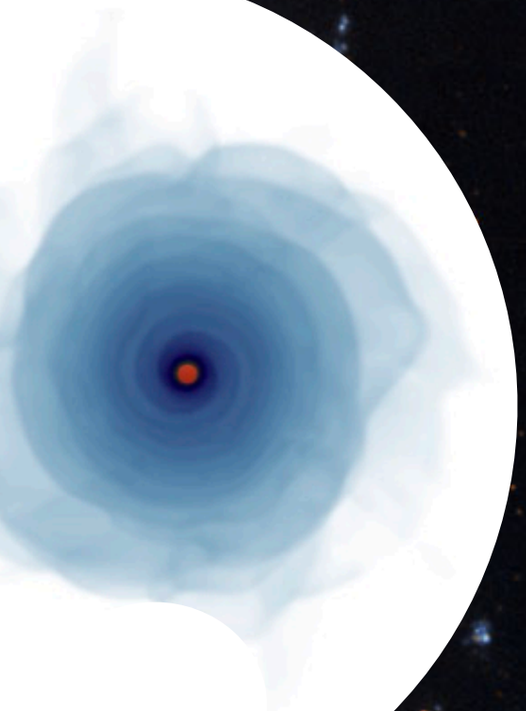
In Collaboration with Riccardo **Ciolfi** (INAF-Osservatorio Astronomico di Padova)

Scenario

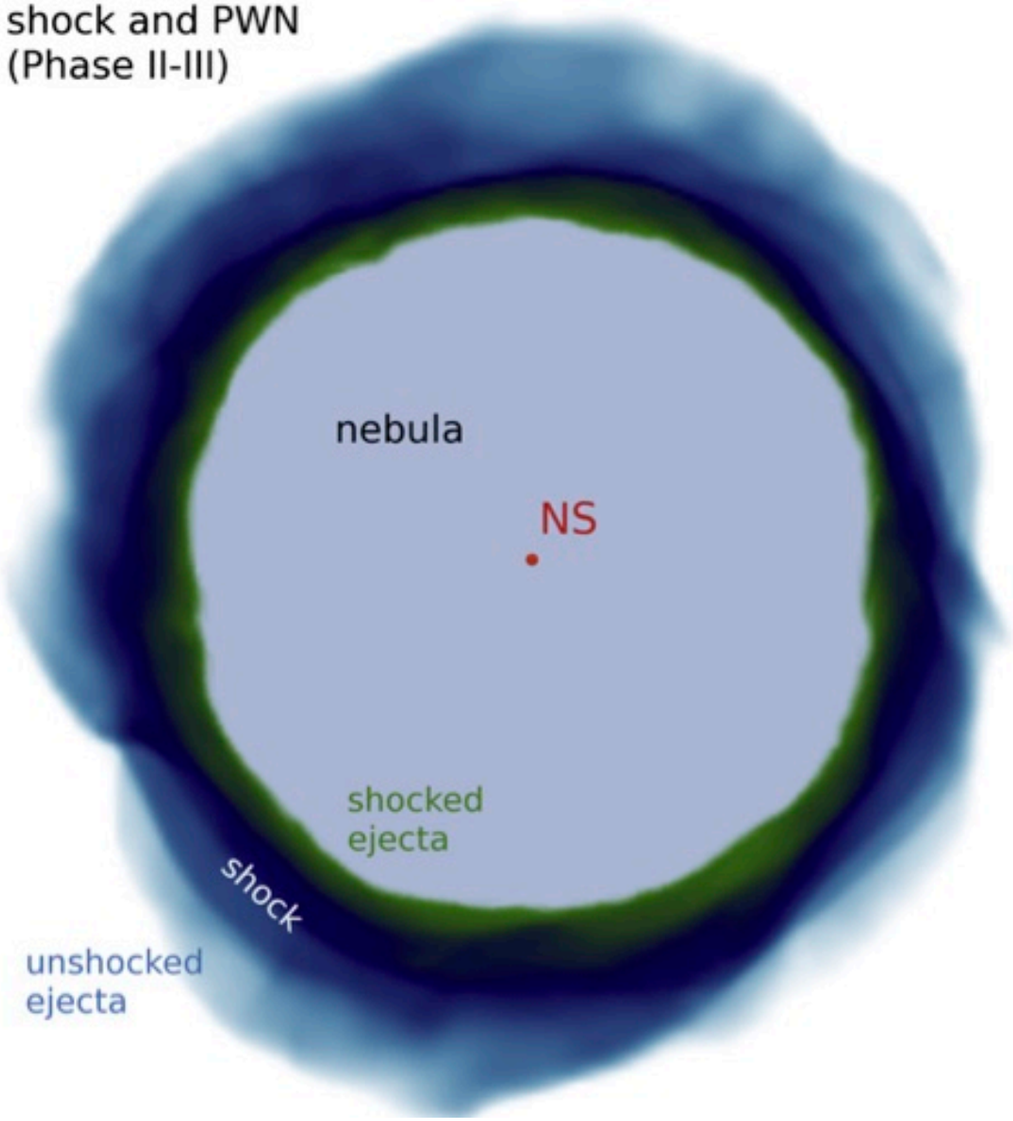
BNS merger



differentially rotating
NS remnant (Phase I)



shock and PWN
(Phase II-III)



Why are they interesting?

- Promising EM counterpart of GW in optical and X-ray bands
- They are isotropic
- They are expected to peak within minutes to hours after the merger
- Possible association with SGRB, FRB and Kilonovae
- They are the only EM transients which are smoking guns for the formation of a long lived NS

Original Contribution of the present work

New approach: first study of these kind of transients with RHD numerical simulations

Final Goal

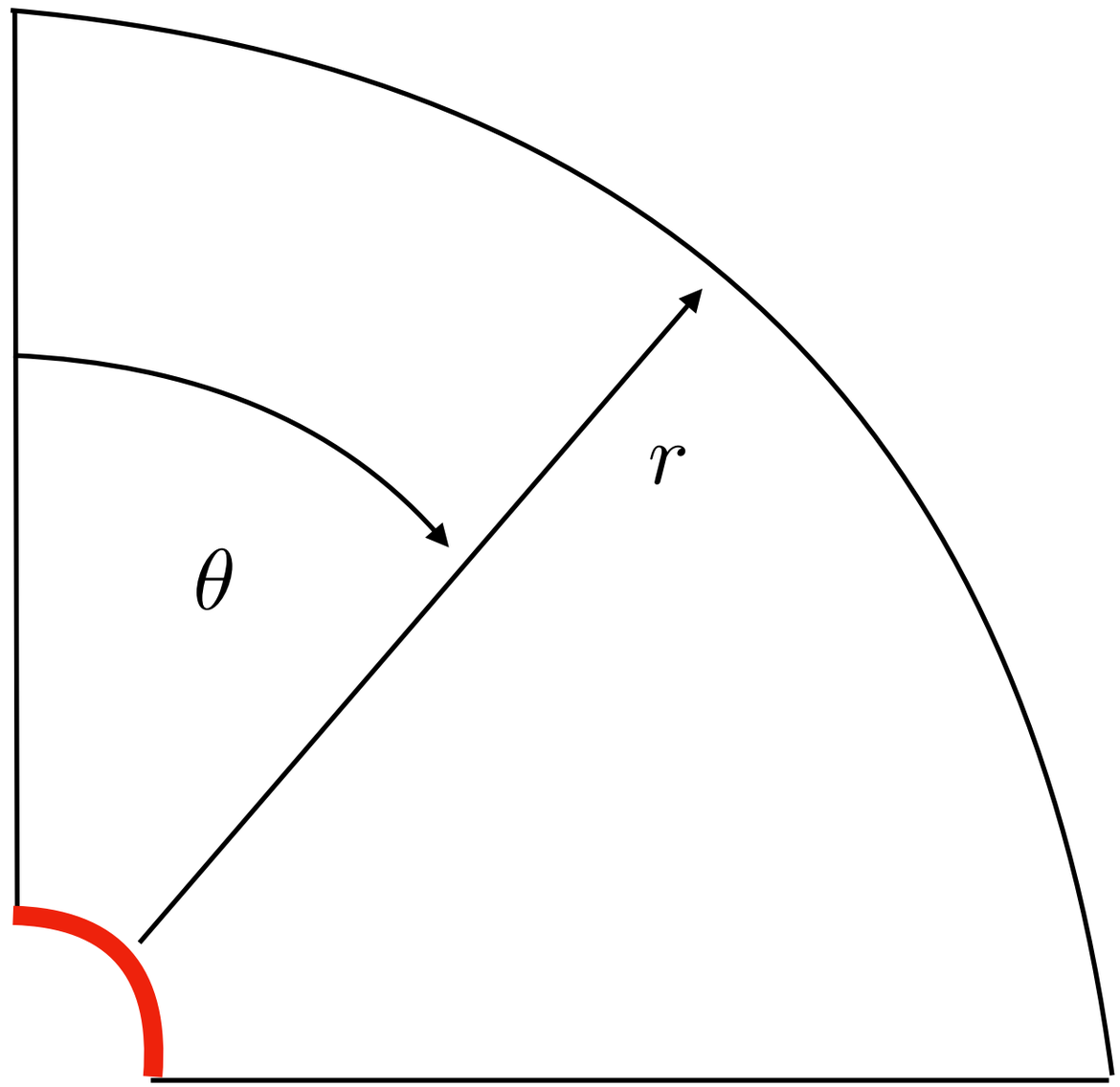
Obtain prediction for observable quantities: time of the peak, peak luminosity, spectral range.

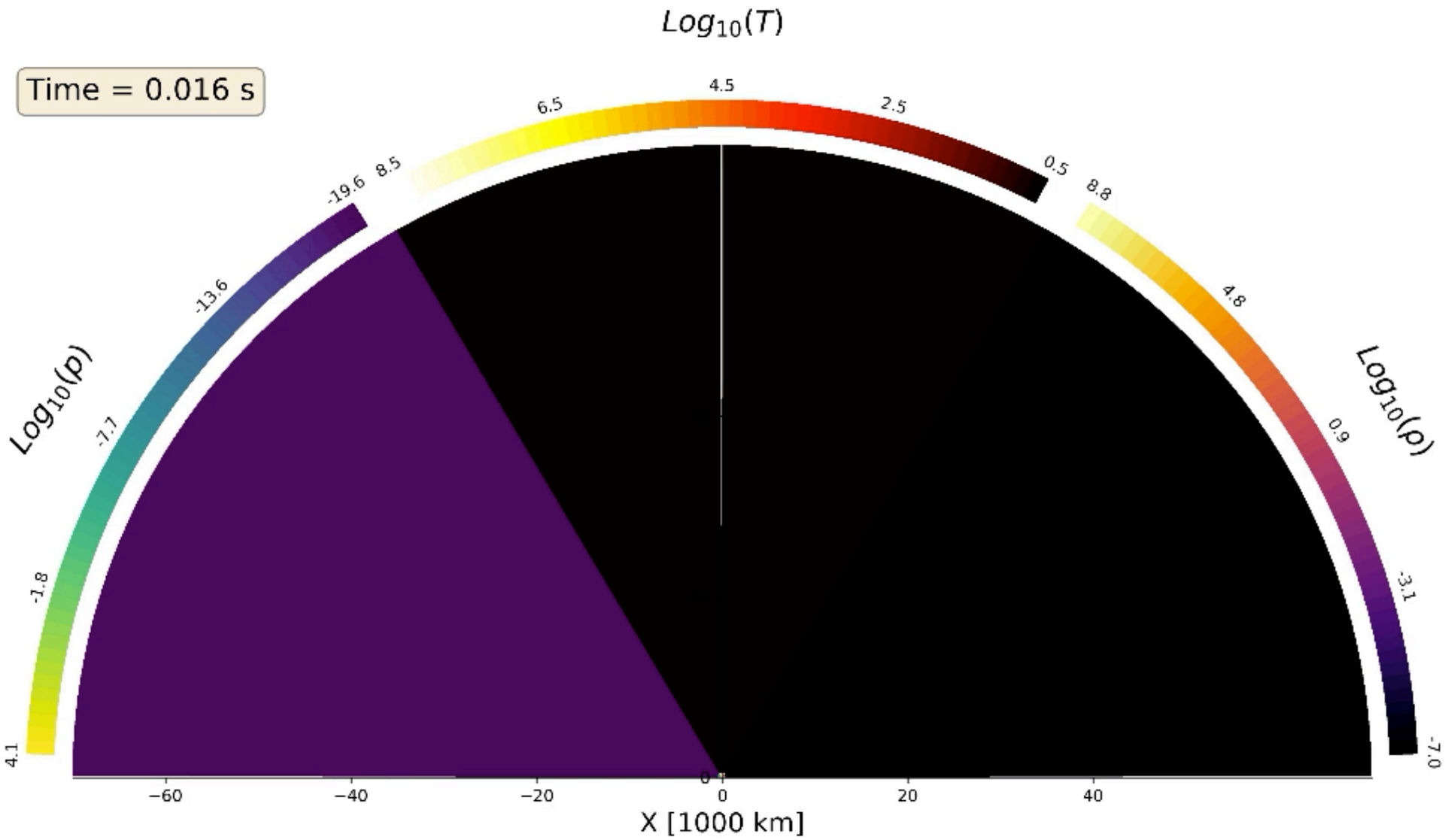
Theoretical Framework

Baryo

Pulsa
Wind

Computational Domain



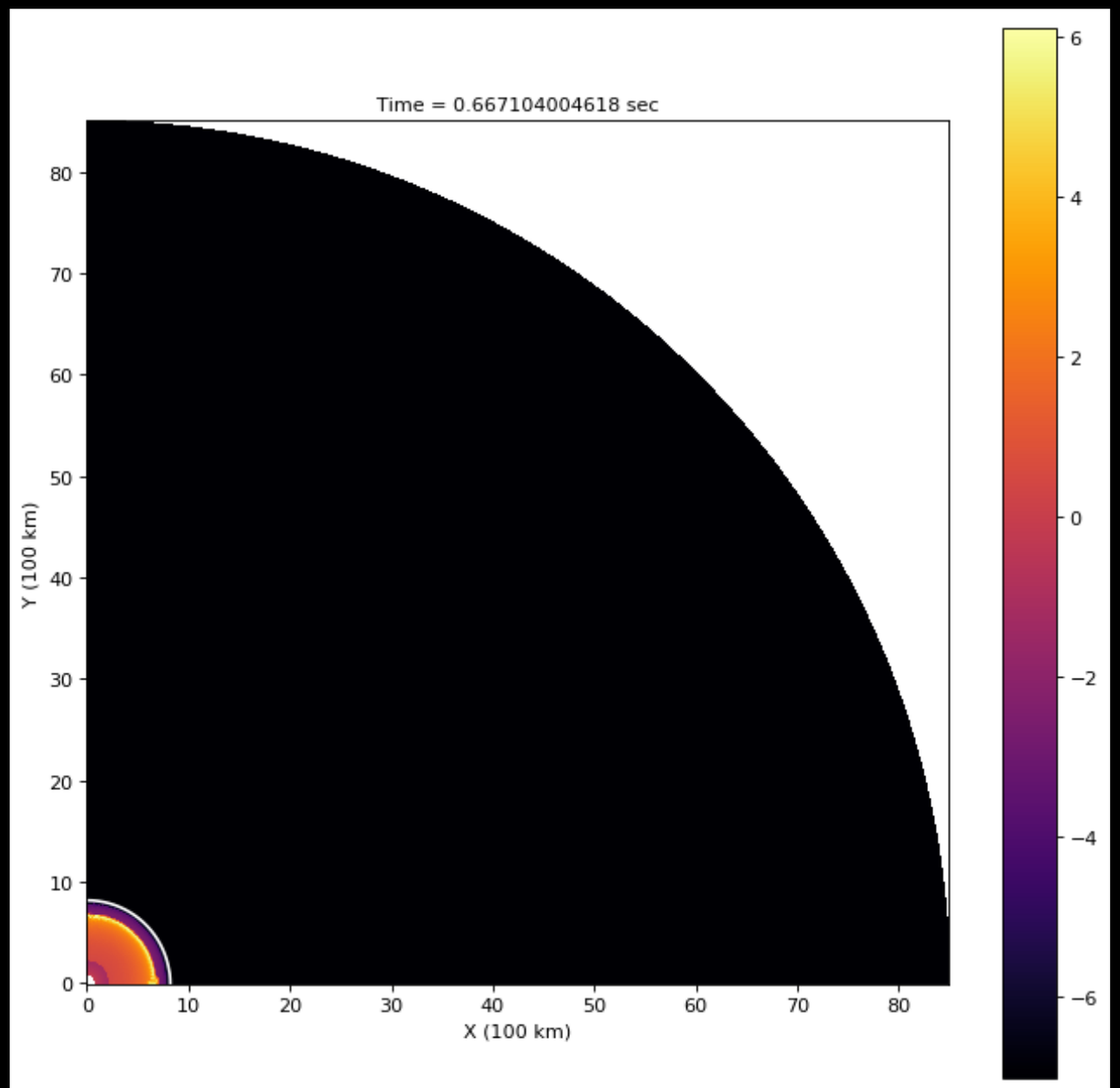


(Ascenzi & Ciolfi in prep.)

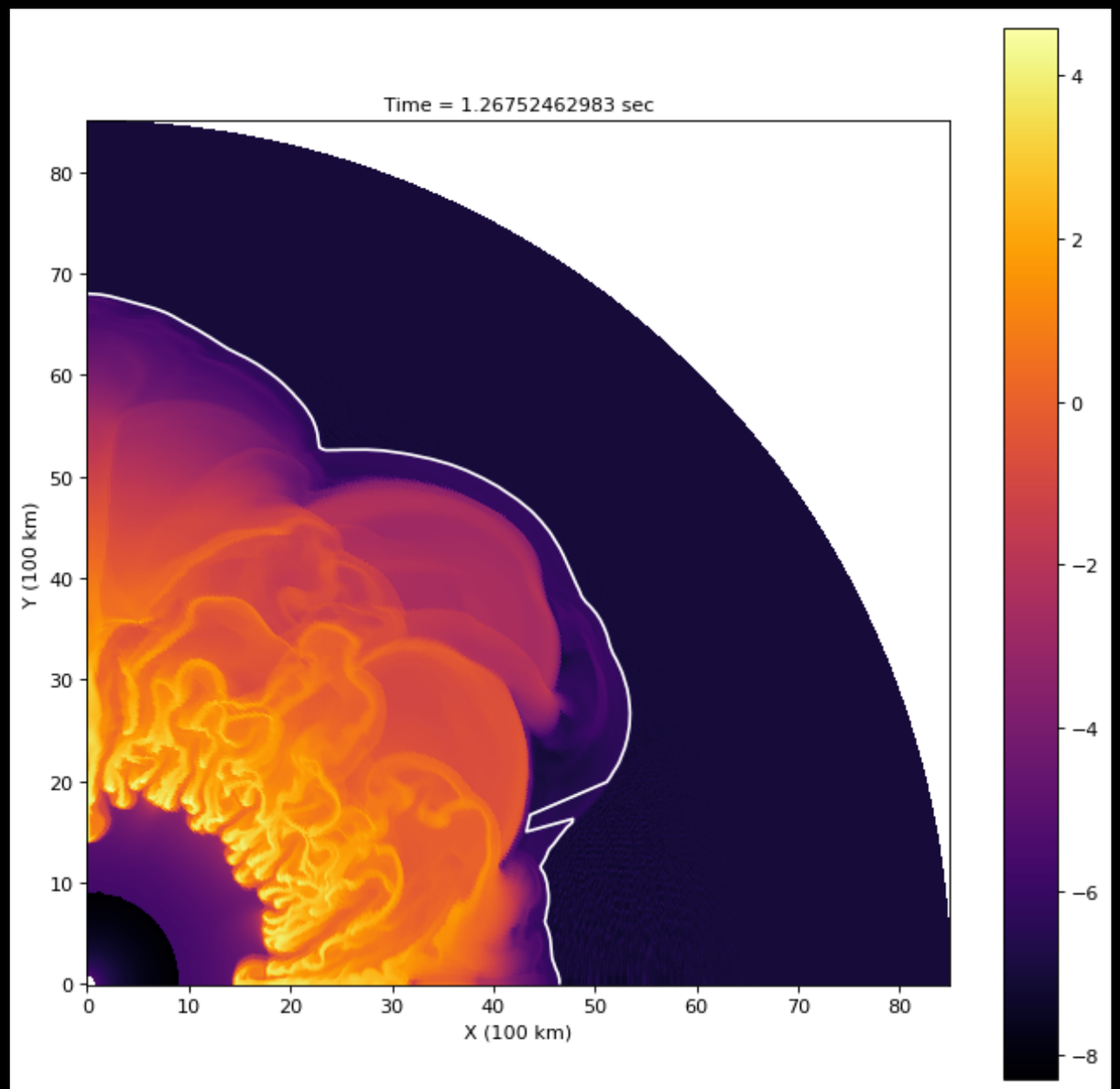
Photosphere

$$\tau = \int_{R_{phot}}^{\infty} \rho\kappa \, dr \equiv \frac{2}{3}$$

t = 0.67 sec

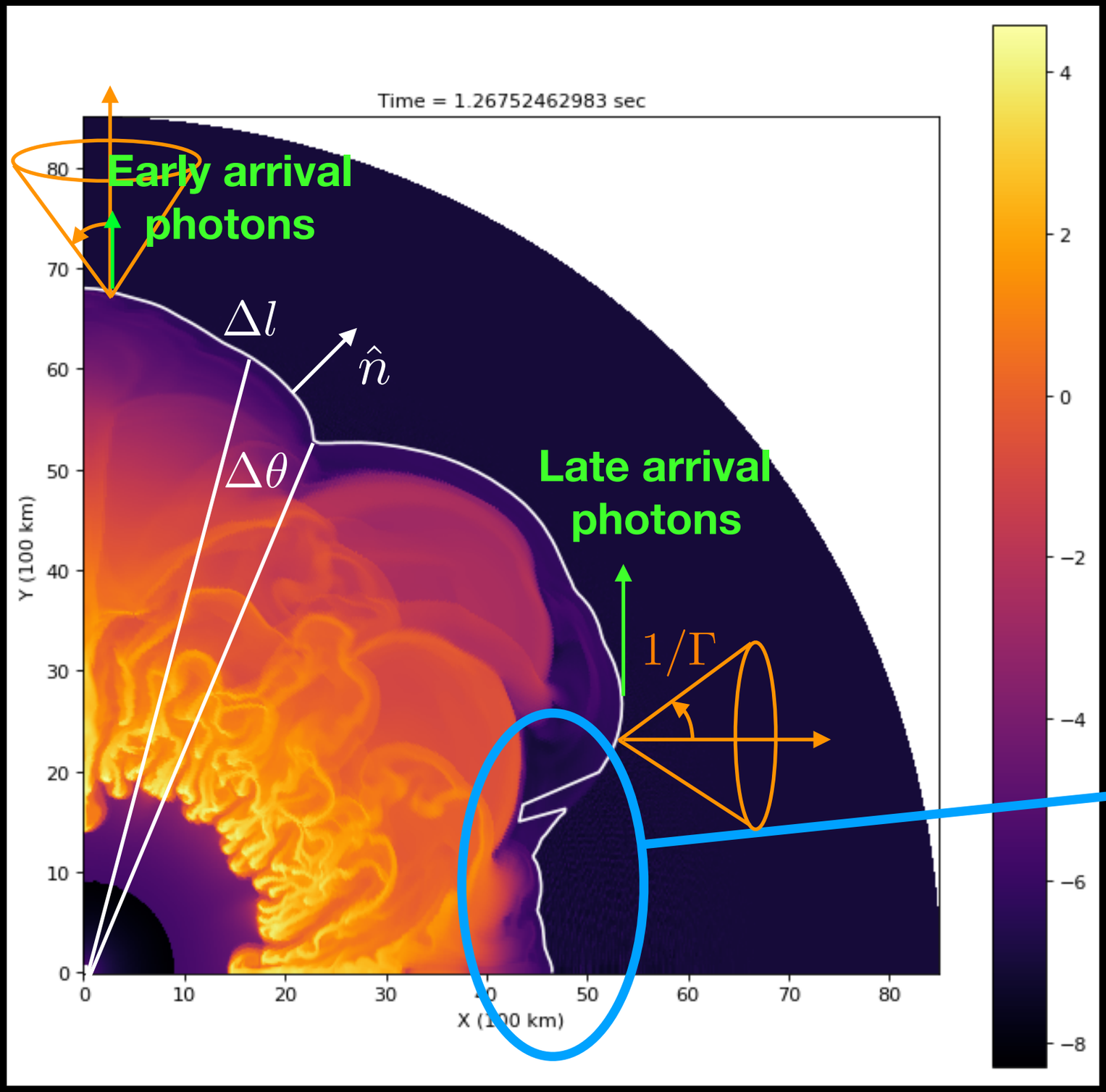


t = 1.27 sec



Observer

Computing the observed Fluxes :



1. Calculate the effective area of the photosphere element at a given angle θ

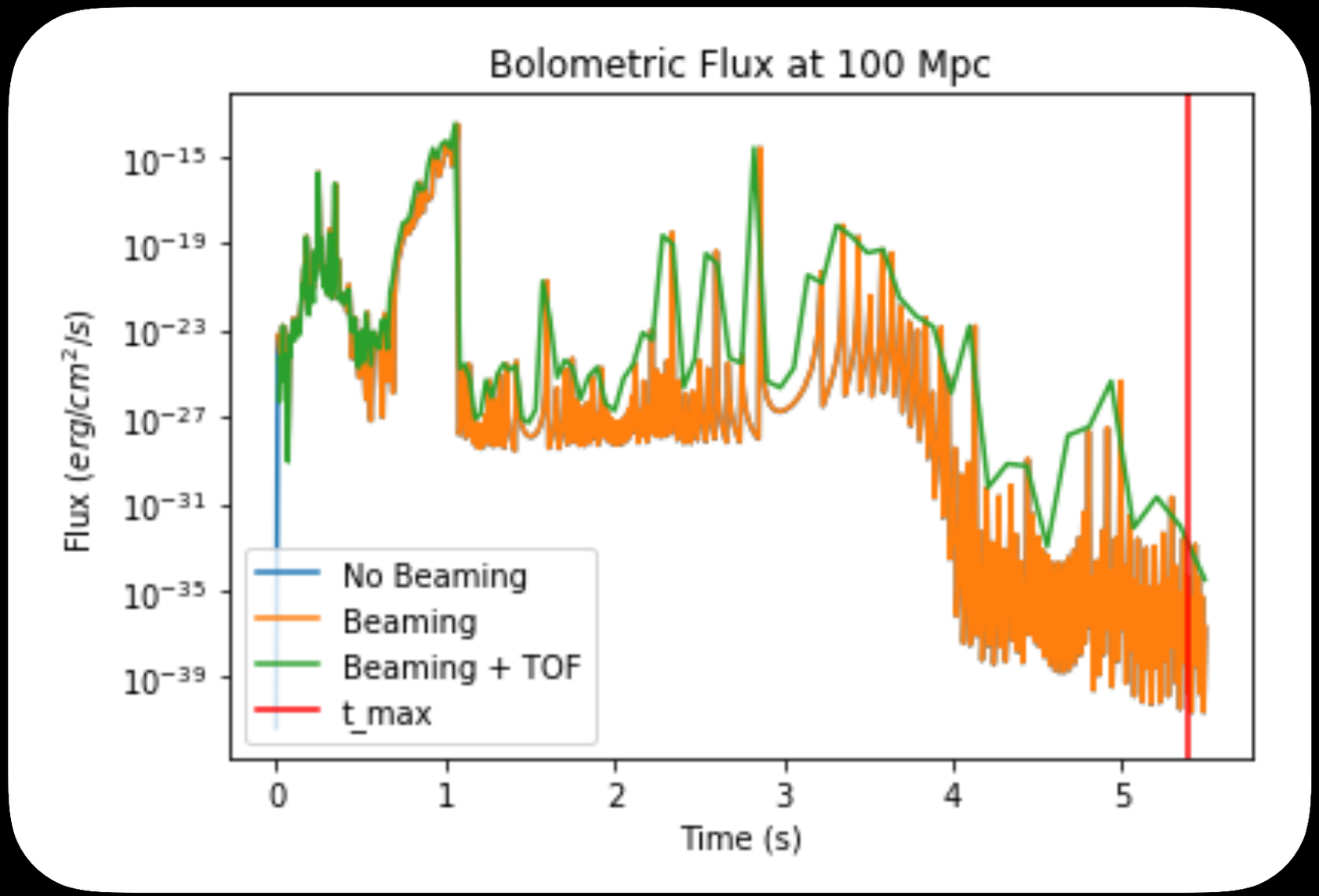
2. Exclude the Shadow zones

3. Add Doppler effect and beaming

4. Consider the different arrival time of photons

Shadow zone

Preliminary Results



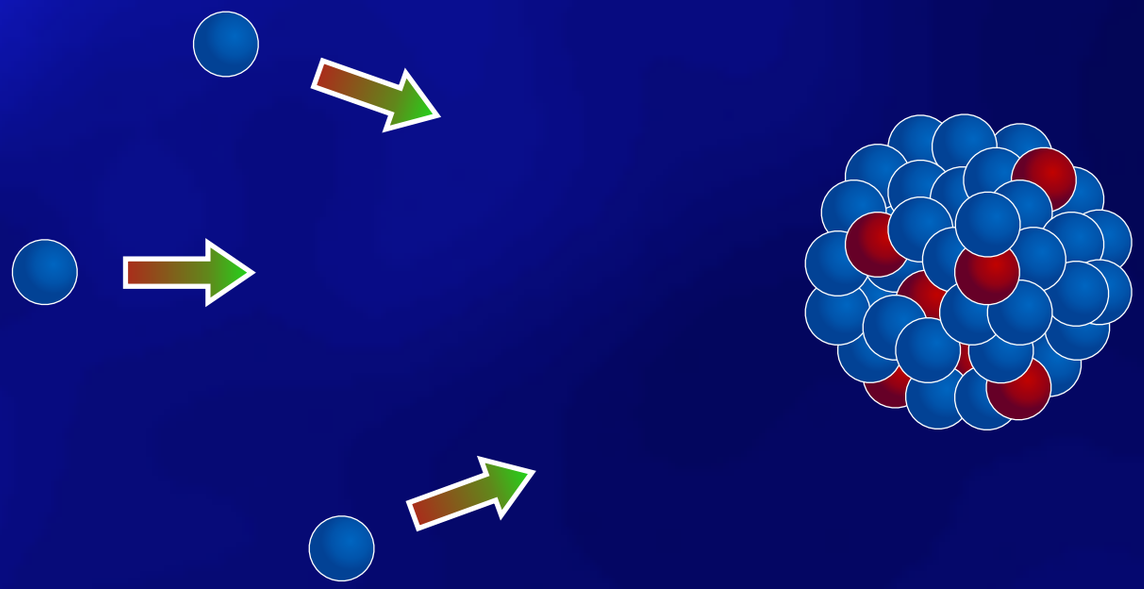
Ascenzi, S. & Ciolfi, R. in prep.

Work in progress…

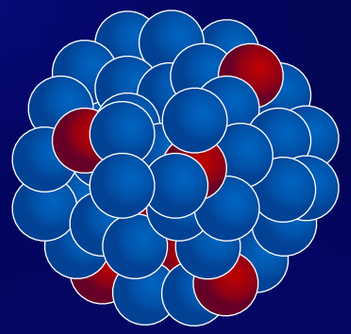
- Arbitrary observer (only for 2D models)
- Multicolored light curves
- Increase the simulation max time

Kilonova

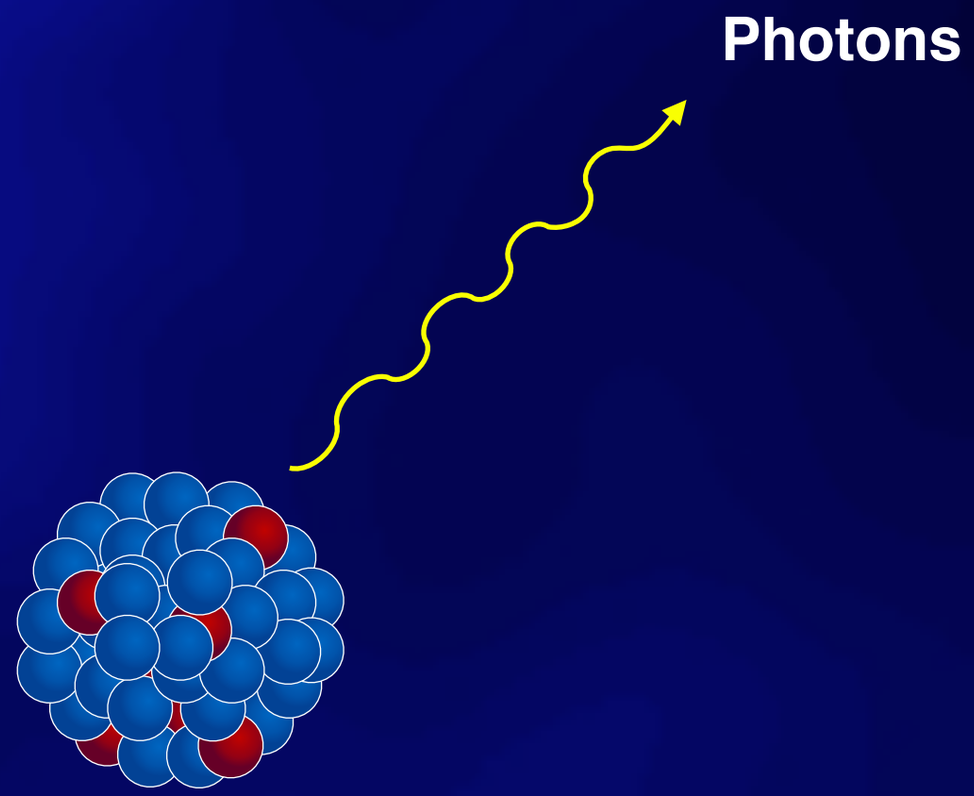
R-Process Nucleosynthesis



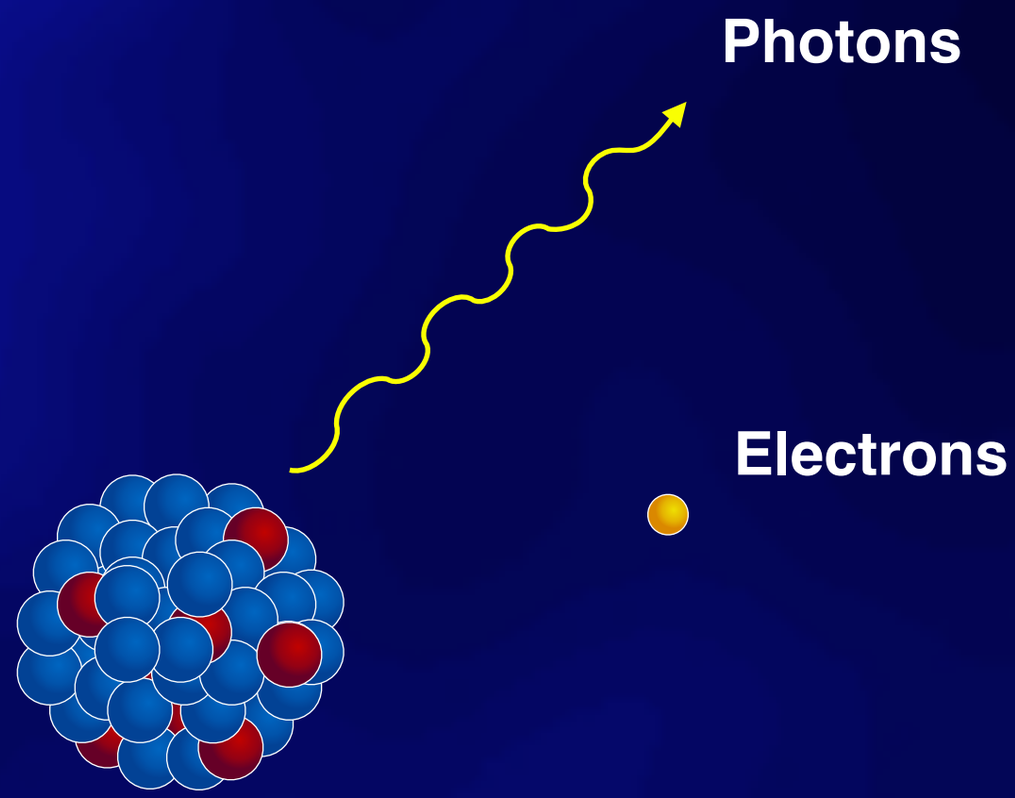
R-Process Nucleosynthesis



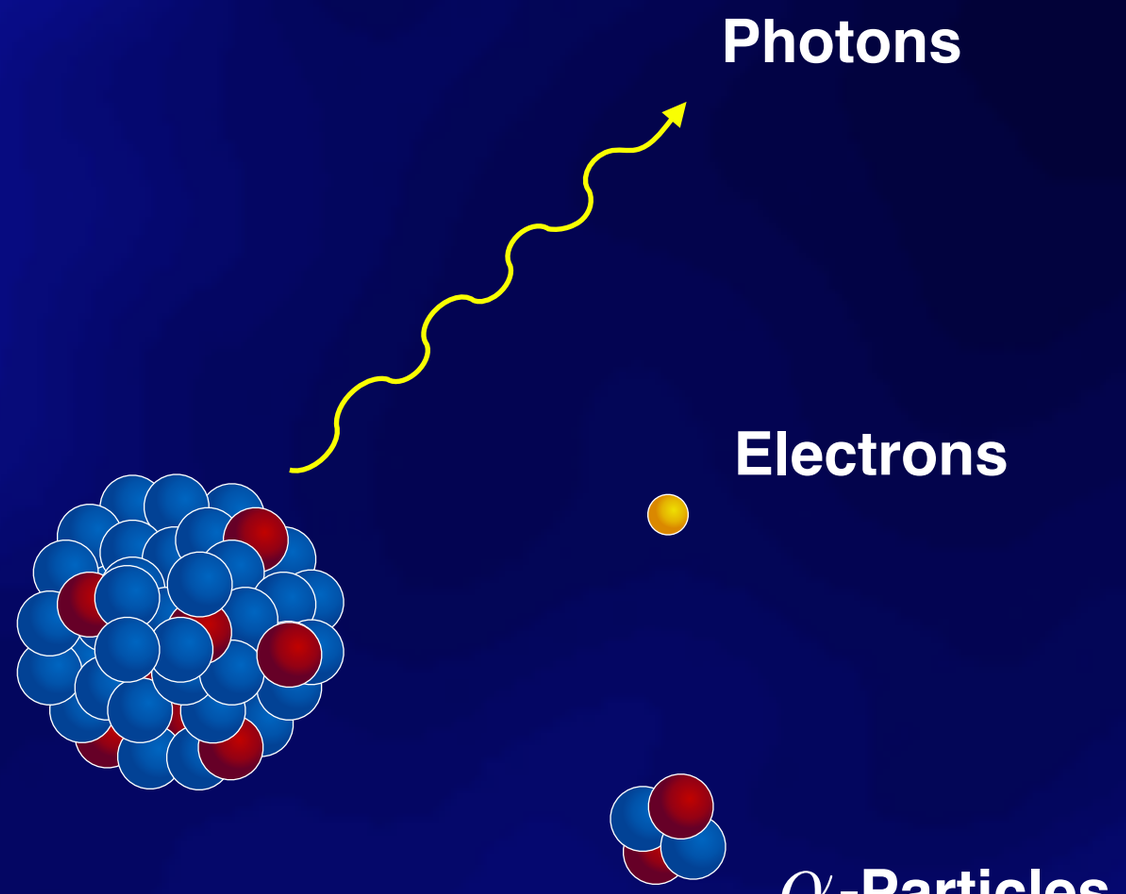
R-Process Nucleosynthesis



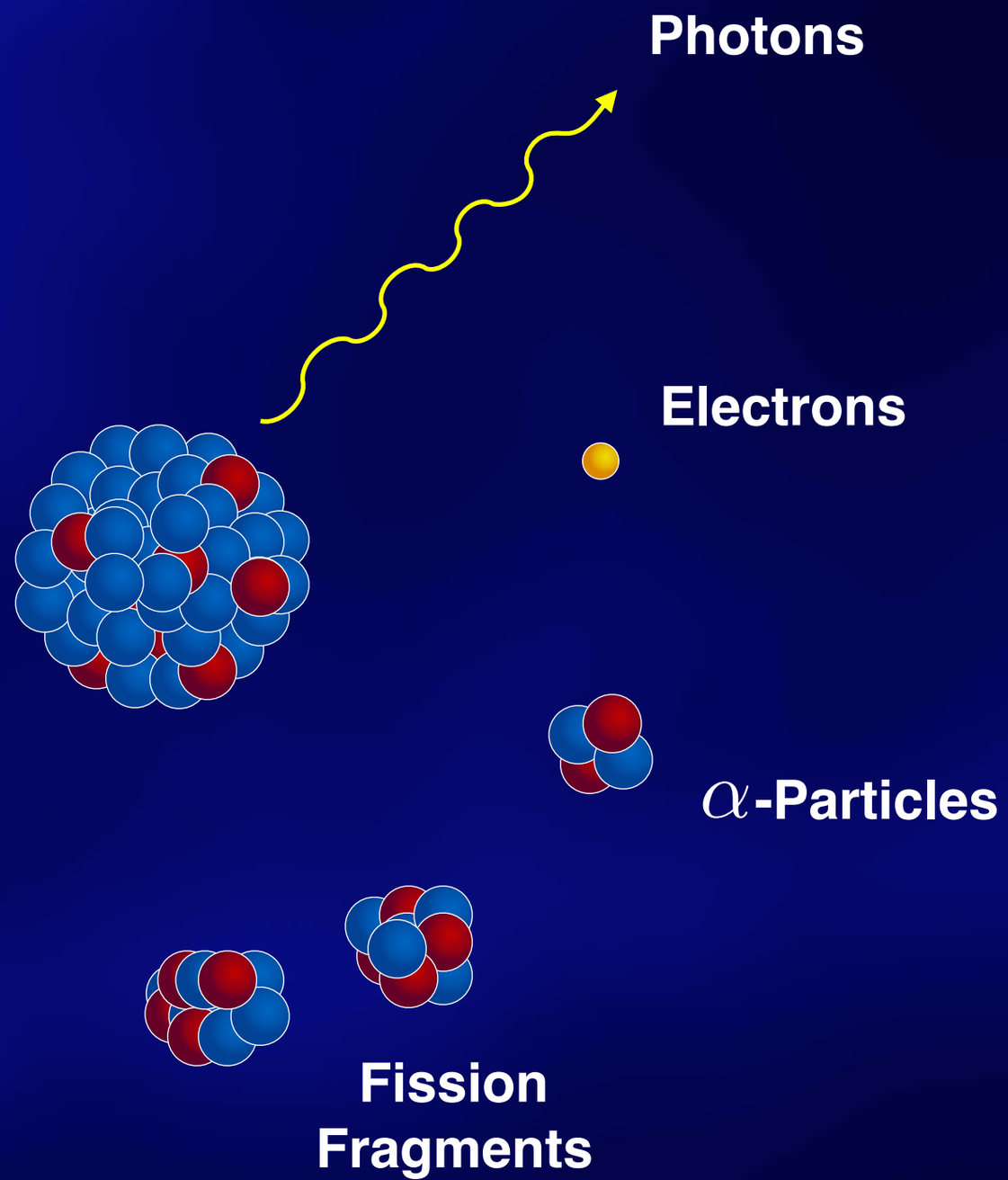
R-Process Nucleosynthesis



R-Process Nucleosynthesis

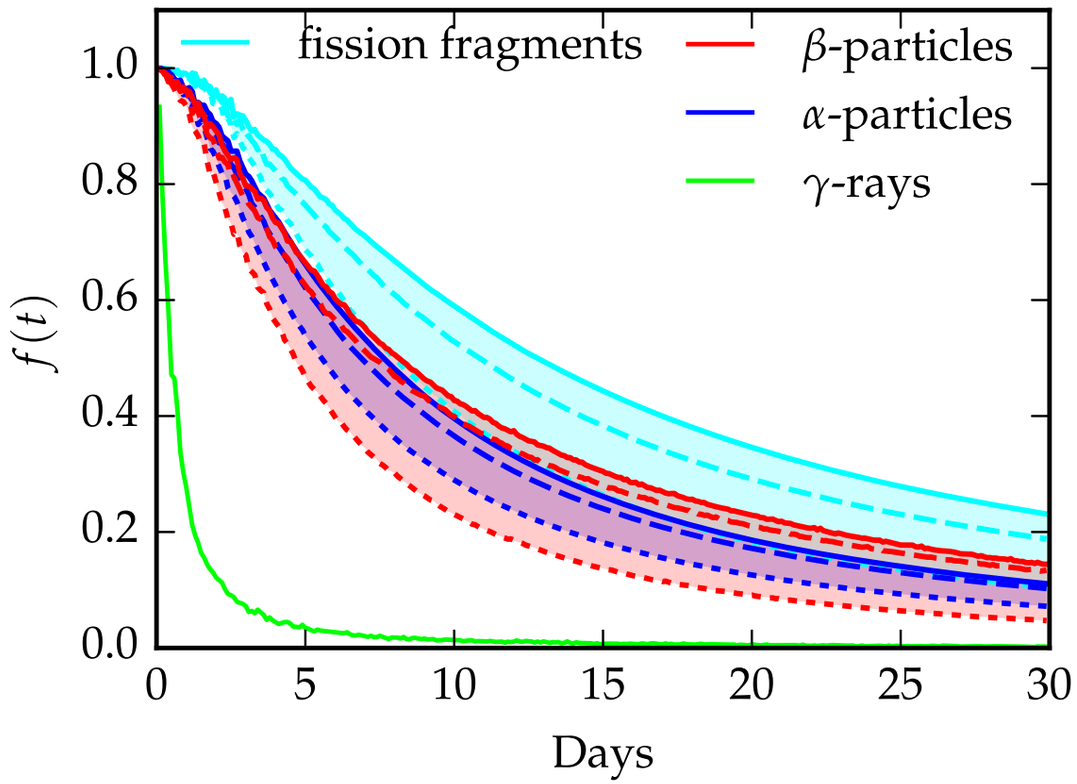


R-Process Nucleosynthesis



Kilonovae

Thermalization Efficiency

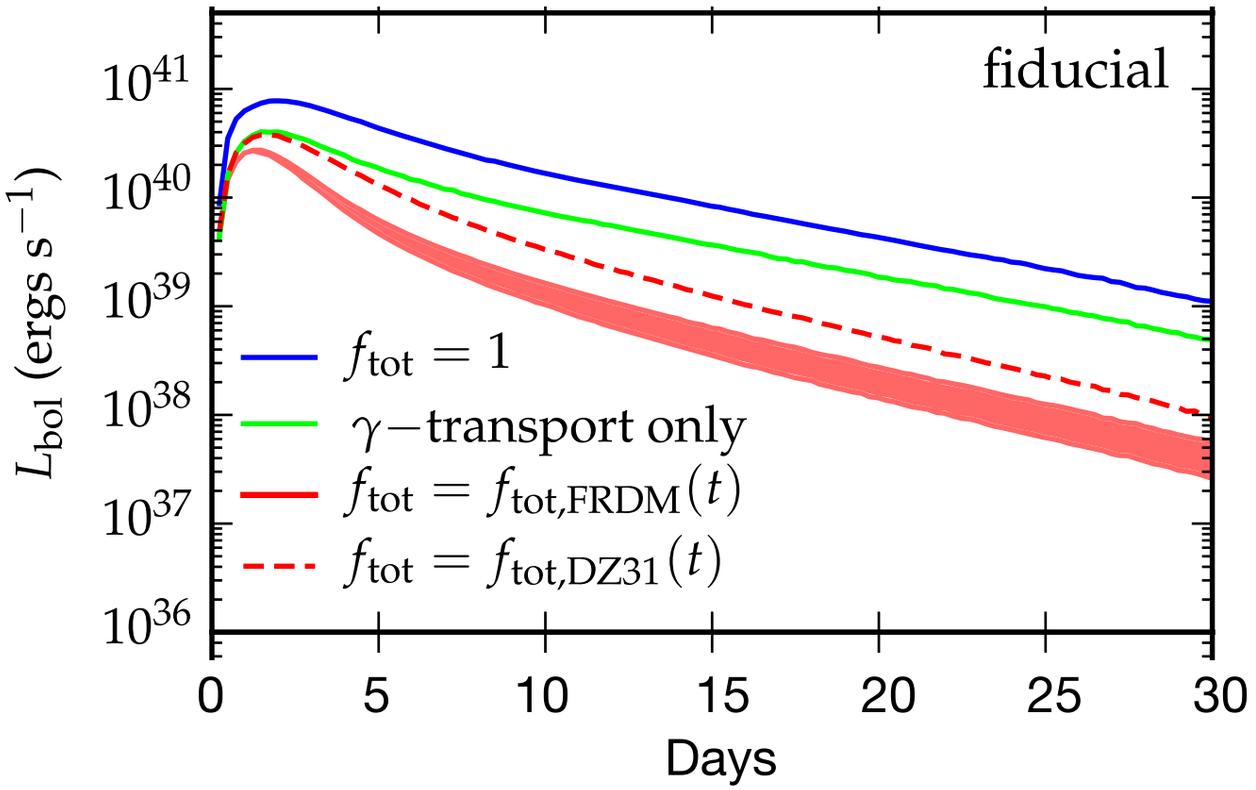


Radial field ⋯⋯

Toroidal field ——

Random field - - - - -

Lightcurve



(Barnes+ 2016)

Conclusion: Open Questions

1. **Magnetic Field Amplification**
2. **Jet Launching Mechanism**
3. **Energy Dissipation within the Jet**
4. **Thermalization of Energy in Kilonovae**
5. **Any Spindown-powered Transient out there?**