Decelerated sub-relativistic material with energy Injection

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37th International Cosmic Ray Conference 2021 Berlin, Germany

July 24th 2021

Motivation

- Kilonovae (KNe) are produced due the coalescence of binary compact objects (NS-NS or BH-NS).
- Short duration gamma-ray bursts (sGRBs) are also linked with this phenomenon.

$\therefore$ Kilonovae may be studied from the formalism of a GRB

Model: Considerations

- Afterglow consisting of two components:
  - One produced by the non-relativistic ejecta mass $(\Gamma \sim 1)$. Energy distributed as a power law $E \propto (\Gamma\beta)^{-\alpha}$. Tan, J. C., Matzner, C. D. and McKee, C. F., 2001.
  - The other taking into account energy injection $E \propto \tilde{E}t^{1-q}$. Zhang, B., *et al.*, 2006.
- Non-relativistic, adiabatic evolution of the forward shock described by the Sedov-Taylor solution. Sironi, L. and Giannios, D., 2013.
- Evolution of the shock front in a stratified medium $(n = A_k R^{-k})$. Electrons of the medium cool by synchrotron process. Dai, Z. G. and Lu, T., 1998.

Model

The velocity of the shock front and blast wave radius for both components may be expressed by the same equations:

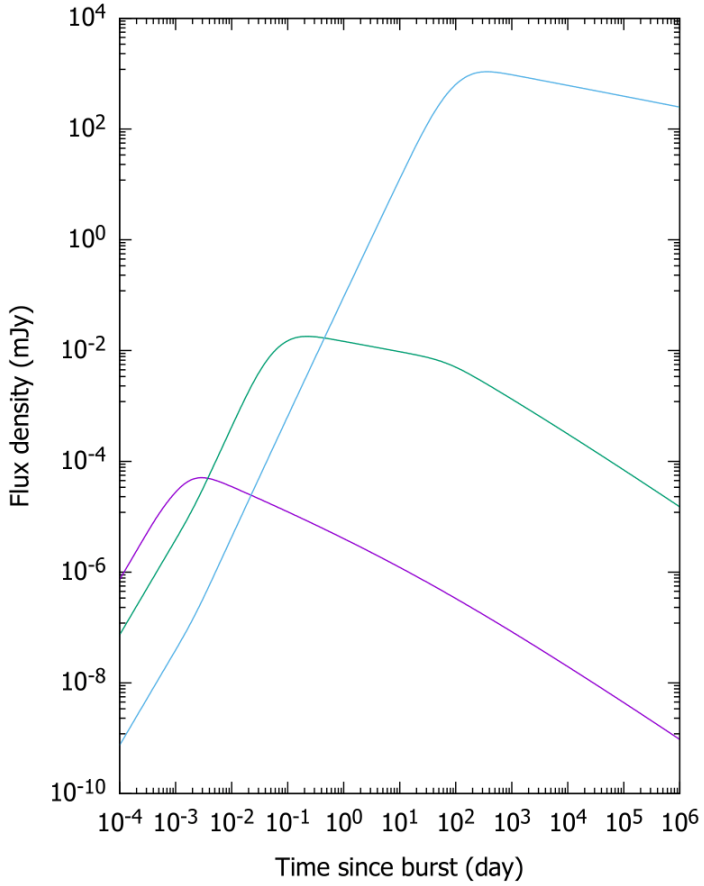
$$\beta = \beta^0 \left(\frac{1+z}{1.022}\right)^{-\frac{k-3}{\alpha+5-k}} A_{\mathrm{k}}^{-\frac{1}{\alpha+5-k}} \tilde{E}^{\frac{1}{\alpha+5-k}} t^{\frac{k-(q+2)}{\alpha+5-k}}$$

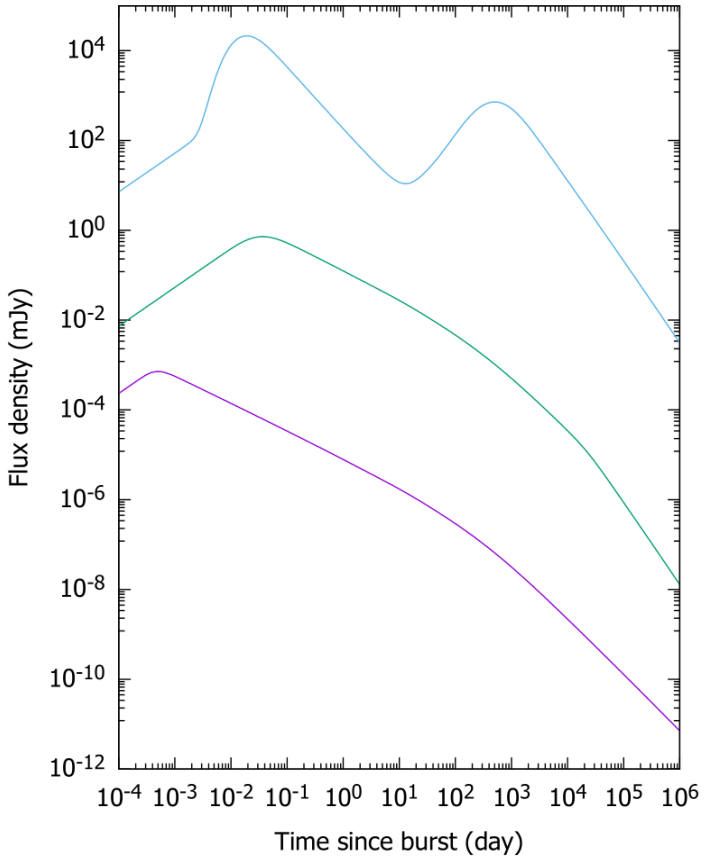
$$r = r^0 \left(\frac{1+z}{1.022}\right)^{-\frac{\alpha+2}{\alpha+5-k}} A_{\mathrm{k}}^{-\frac{1}{\alpha+5-k}} \tilde{E}^{\frac{1}{\alpha+5-k}} t^{\frac{\alpha+3-q}{\alpha+5-k}}$$

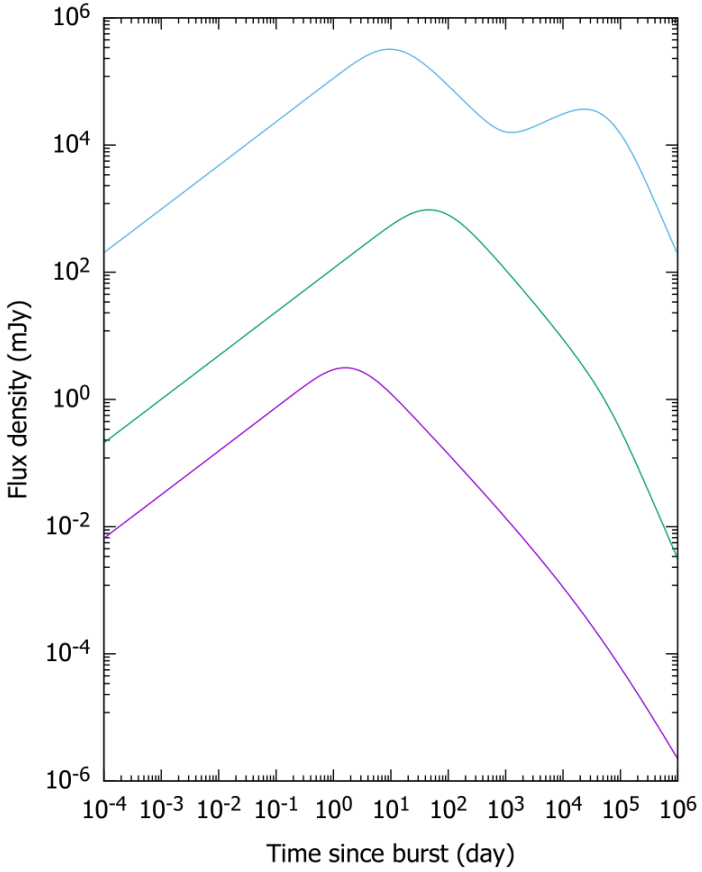
- For the **energy injection component:** $\alpha = 0$
- For the component **without energy injection:** $q = 1$

Fraija, N., Betancourt Kamenetskaia, B., *et al.*, 2021.

Results







Synchrotron light curves

- Purple X-ray (1 keV).
- Green optical (1 eV).
- Blue radio (1.6 GHz).

Left and middle panels: no energy injection.

- Left: ISM $(k = 0)$.
- Right: Wind-like $(k = 2)$.

Right panel:

Energy injection in wind-like medium.

Conclusion and summary

- A model to describe the afterglow emission of non-relativistic ejecta has been derived.
- It considers a stratified medium $n \propto R^{-k}$ and a phase with energy injection $E \propto \tilde{E} t^{1-q}$.
- Synchrotron light curves in the fast- and slow-cooling regimes have been obtained.