Probing the particle acceleration at trans-relativistic shocks with GRB afterglows

K. Takahashi, K. Ioka, Y. Ohira, H. van Eerten

We consider **the observability of the time evolution of the electron power-law index *p*** that is inferred from the spectral evolution of off-axis GRB afterglows. We assume a particle acceleration model that is consistent with the observed afterglow of GRB 170817A, in which **the electron power-law index *p* changes with the shock speed**. As an example, we use the particle acceleration model of **Keshet & Waxman (2005)**.

We calculated the time evolution of afterglow spectra by using **an off-axis afterglow model**. The luminosity distance to the source is set to **200 Mpc**. The number density of the ambient medium is set to $n_0 = 1\ \mathrm{cm}^{-3}$. The viewing angle is changed in the range of $0.25 \leq \theta_\mathrm{v} \leq 0.5$. The model is applied to three kinds of jet structures (**Gaussian jet, hollow-cone jet, and spindle jet**) that are consistent the observed afterglow of GRB 170817A for an assumed ISM density of GRB 170817A, $n_0 = 10^{-2}\ \mathrm{cm}^{-3}$.

Our results show that the time evolution of the electron power-law index is inferred from the evolution of the afterglow spectral slope **around the optical band**. The evolution of *p* displays **a rapid transition from relativistic to non-relativistic regimes in days or several tens of days at the observer frame**. The transition time depends on the viewing angle but is insensitive to the jet structure. In a part of the transition phase, **the optical afterglow flux becomes more luminous than that for GRB 170817A and also dominates the expected kilonova flux. Thus, the transition of *p* will be more accurately observed than in GRB 170817A.**