Research

Gamma-Ray Bursts (GRB) were first detected in 1967 by the American NASA vela satellites. They consist in a short and bright flash of gamma rays (energy from 100 keV to several MeV), lasting from under a to a few tens of seconds. They are the result of the most luminous explosions in the Universe, launching jetted ultra-relativistic blast waves into their environment.

Today, is is known that these explosions are triggered by the collapse of a supermassive star (long GRB) or by the merger of two neutron stars (short GRB), with the recent detection of gravitational waves spectacularly confirming the latter connection. The accretion phenomenon onto the remnant is able to power ultra-relativisitic collimated outflows (jets) that collide with the circumburst medium, eventually emitting synchrotron radiation. This radiation, observed after the prompt gamma-ray emission, is called the afterglow, and it’s features carry the imprint of the complex dynamics of the explosion.

The basic phenomenology of these events is quite well understood and some analytical and numerical modeling of the dynamical and emission processes of both the prompt emission and the afterglow have been carried out. However, some questions regarding the nature of the progenitor and the remnant remain unanswered and require much more precise simulation of the afterglow.

However, the dynamics and radiative transfer processes involved in the afterglow phenomenon harbor complex features that, though they carry a lot of information about the burster, are extremely challenging to model both analytically and numerically.