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# Basics of Gamma Ray Burst and Its Afterglow

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**Abstract :** Gamma-ray bursts (GRB's), short and intense pulses of low-energy γ rays, have fascinated astronomers and astrophysicists since their unexpected discovery in the late sixties. GRB'sare accompanied by long-lasting afterglows, and they are associated with core-collapse supernovae. The detection of delayed emission in X-ray, optical, and radio wavelength, or "afterglow," following a γ-ray burst can be described as the emission of a relativistic shell decelerating upon collision with the interstellar medium. While it is fair to say that there is strong diversity amongst the afterglow population, probably reflecting diversity in the energy, luminosity, shock efficiency, baryon loading, progenitor properties, circumstellar medium, and more, the afterglows of GRBs do appear more similar than the bursts themselves, and it is possible to identify common features within afterglows that lead to some canonical expectations. After an initial flash of gamma rays, a longer-lived "afterglow" is usually emitted at longer wavelengths (X-ray, ultraviolet, optical, infrared, microwave, and radio). It is a slowly fading emission at longer wavelengths created by collisions between the burst ejecta and interstellar gas. In X-ray wavelengths, the GRB afterglow fades quickly at first, then transitions to a less-steep drop-off (it does other stuff after that, but we'll ignore that for now). During these early phases, the X-ray afterglow has a spectrum that looks like a power law: flux F∝ E^β, where E is energy and beta is some number called the spectral index. This kind of spectrum is characteristic of synchrotron emission, which is produced when charged particles spiral around magnetic field lines at close to the speed of light. In addition to the outgoing forward shock that ploughs into the interstellar medium, there is also a so-called reverse shock, which propagates backward through the ejecta. In many ways," reverse" shock can be misleading; this shock is still moving outward from the restframe of the star at relativistic velocity but is ploughing backward through the ejecta in their frame and is slowing the expansion. This reverse shock can be dynamically important, as it can carry comparable energy to the forward shock. The early phases of the GRB afterglow still provide a good description even if the GRB is highly collimated since the individual emitting regions of the outflow are not in causal contact at large angles and so behave as though they are expanding isotropically. The majority of afterglows, at times typically observed, fall in the slow cooling regime, and the cooling break lies between the optical and the X-ray. Numerous observations support this broad picture for afterglows in the spectral energy distribution of the afterglow of the very bright GRB. The bluer light (optical and X-ray) appears to follow a typical synchrotron forward shock expectation (note that the apparent features in the X-ray and optical spectrum are due to the presence of dust within the host galaxy). We need more research in GRB and Particle Physics in order to unfold the mysteries of afterglow.

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