# Cosmic blasts powered by a hot glow

**Spectral sensitivity of Fermi satellite reveals physics of gamma-ray generation.**

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NASA/General Dynamics

The Fermi Gamma-ray Space Telescope has gathered data on hundreds of gamma-ray bursts.

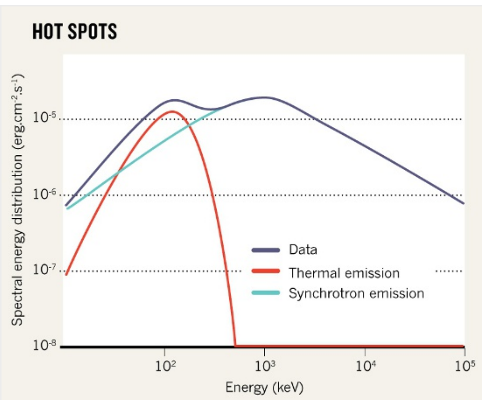
Since its launch in 2008, the Fermi space telescope has recorded hundreds of gamma-ray bursts (GRBs), flashes of light that, for just a few seconds or minutes, are the brightest objects in the Universe. And now the telescope is yielding data that is starting to explain the mechanisms that unleash these beam-like jets of light, which are thought to emanate from the poles of a spinning star as it collapses to form a black hole and explode in a supernova.

On 7 May, at the 2012 meeting of the Fermi/Swift GRB conference in Munich, Germany, members of the Fermi team showed evidence that the gamma rays were not being generated through the commonly invoked process of synchrotron radiation, where electrons emit light as they are accelerated in shockwaves rippling out from the explosion. Instead, most of the light is coming from a seemingly more obvious place: originating in thermal emissions at the surface of the fireball. Just as the Sun's yellow light emanates from its photosphere (the surface region from which the externally perceived light of a star originates), so too are the GRBs arising mostly as thermal emissions from the photosphere of a fireball expanding at nearly the speed of light.

"It's a big paradigm shift because everyone thought it was synchrotron radiation for 20 years," says Jochen Greiner, an astronomer at the Max Planck Institute for Extraterrestrial Physics in Garching, Germany, and one of the leaders of the team in charge of the GRB monitor on Fermi.

The reason the synchrotron-emission mechanism held such sway was because nothing else seemed to be able to create the broad GRB spectra that earlier satellites had detected. The spectra from individual bursts come in many shapes and sizes, but taken together, there seemed to be a distinct shape: a broad rising power law at lower frequencies, and then another decreasing power law as the the intensity of the light fell off at higher frequencies. Synchrotron radiation seemed like a good first approximation. "That's the curse of the field — that this model had fitted so well," says Felix Ryde, a gamma-ray astronomer at the Royal Institute of Technology in Stockholm.

### New light




Sylvain Guiriec, GSFC

A preliminary model for the energy spectrum of gamma-ray burst 120323A, discovered in March by the Fermi telescope, shows a bump that is likely to come from thermal emissions — casting

But at the GRB meeting, Sylvain Guiriec, a Fermi team member at the Goddard Spaceflight Center in Greenbelt, Maryland, said that within Fermi's cache of data he had found about a dozen GRBs that were bright enough to be teased apart into high-resolution spectra. And in the middle of each of these spectra, Guiriec says, there is a tiny extra hump on top of the broad power-law arms — the tell-tale sign of thermal emission (see Hot spots).

The field has also been helped along by an important theoretical breakthrough. For many years, the potential contributions of a thermally emitting photosphere of the expanding fireball were dismissed because it was assumed that it would have the narrow spectral shape of a perfect black body, like that of a static, spherical body such as the Sun, and unlike the broad shape of the GRB spectra. But Ryde points out that the fast-moving cone of a GRB is decidedly neither smooth nor static. He says that recent theoretical calculations show how thermal emissions can account for the bulk of the overall GRB spectrum, even if the broad shape initially favoured the doubt on a long-held view that synchrotron emissions alone could explain the bursts.

idea of synchrotron emission.

Davide Lazzati, a theorist at North Carolina State University in Raleigh, says that there will still be room for synchrotron radiation to contribute to the total gamma-ray flux, particularly at lower frequencies. And at the highest frequencies, Lazzati would invoke an altogether different emission mechanism: inverse Compton scattering, where energetic electrons knock into a photon and bump it up to higher energies. But at least, he says, the field is getting over its long-held dogma and is starting to glimpse the wildly different ingredients that go into the making of a gamma-ray burst. "It's like a minestrone," he says.

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