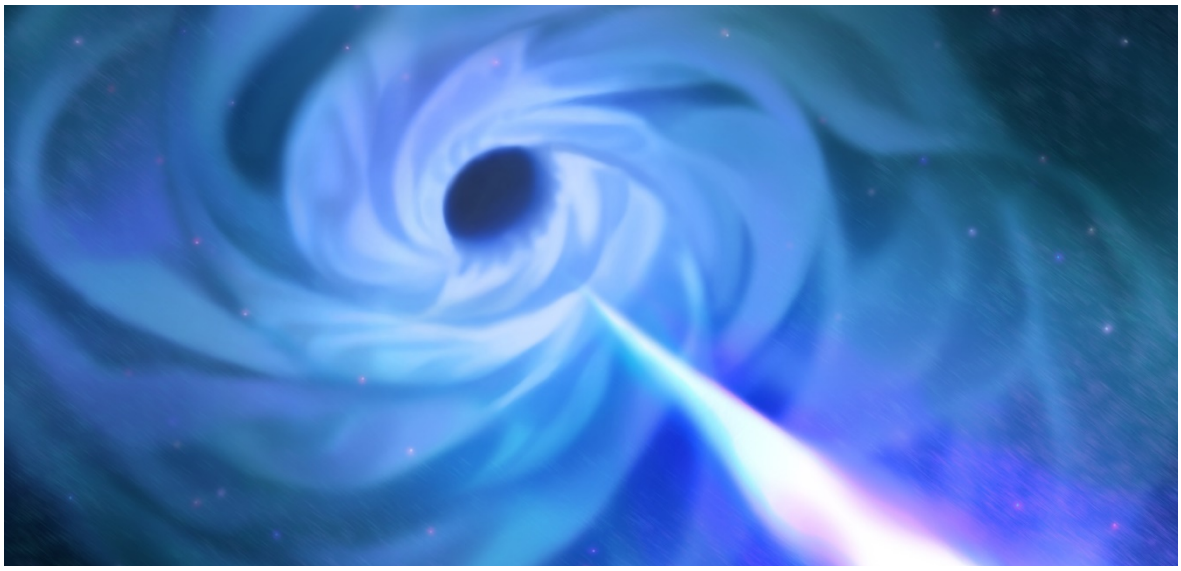
Max-Planck-Institut für Physik

What are gamma-ray bursts?

Gamma-ray bursts (GRBs) are the most violent explosions in the universe. They last from only a few seconds to a maximum of a few minutes. They presumably occur when heavy stars collapse (supernovae) or when neutron stars or black holes fuse together.

In only 10 seconds, gamma-ray bursts release more energy than the sun does in billions of years. Gamma-ray bursts occur almost daily. So far, they have only been observed in distant galaxies. However, such an explosion could also occur at any time in our Milky Way. Because gamma-ray bursts emit extremely strong and aggressive radiation, a burst would have fatal consequences for our solar system and life on Earth.



Artistic representation of a gamma-ray burst (©ICRR UTokyo/Naho Wakabayashi)

In the first phase of a burst, the actual flash, the most energy-rich light particles (photons) are emitted: The initial phase is characterized by a massive emission of gamma and X-rays.

Physical processes in the afterglow

This is usually followed by an afterglow phase of up to a few weeks. During this phase, the energy of the gamma-ray flash gradually weakens. During the afterglow, radiation in all energy ranges – from radio waves to visible light to the gamma spectrum – can be observed.

These emissions can be traced back to synchrotron radiation in which electrons are accelerated to an energy in the two-digit gigaelectron range. MAGIC measured a thousandfold higher energy level during the discovery of gamma-ray burst GRB 190114C. This proves that a completely different emission process has to take place during the afterglow. A possible candidate for this is the inverse Compton process in which high-energy electrons collide with low-energy photons and transfer energy.