Shedding light on the highest energy emission from GRBs with MAGIC observations

MAGIC

MAX-PLANCK-INSTITUT FÜR PHYSIK

The people involved

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WHAT IS THIS CONTRIBUTION ABOUT?

This contribution focuses on a long bright gamma-ray burst, GRB 190114C. This GRB was detected by the MAGIC telescopes at TeV energies, starting observations ~1 minute after the onset of the burst. This was the first time a GRB was reported to have significant detection in the sub-TeV energy range. This was a long awaited result in the very-high-energy community for at least 15 years. The strong signal gave the possibility to study in detail the emission detected by MAGIC, comparing it with the one at lower energies (X-ray, GeV) to understand its origin.

WHY IS IT INTERESTING?

The detection of very-high-energy emission from a GRB can give important information about the emission processes ongoing and acceleration mechanisms. The presence of a very high energy component in GRBs was predicted theoretically, but it could not be proven experimentally. The strong detection of GRB 190114C by MAGIC marks the first time that a GRB was detected in such energy range, opening a new era in GRB studies. It provided a unique data set to study this emission component in detail, and also understand why it was not observed in the past. In this sense, GRB 190114C can be considered the Rosetta stone of gamma-ray bursts, because it helped in discriminating between different emission models.

WHAT HAVE WE DONE?

We compared the very-high-energy emission with the one at lower energies, especially in the X-ray range. With spectral and temporal analyses, we could associate the TeV emission with the afterglow phase of the GRB. The similar temporal decay of the X-ray and TeV light curves suggests a link between the processes producing photons in those energy ranges. By comparing the energies of the gamma rays detected by MAGIC and the maximum energy that can be reached by photons via the synchrotron process, which produces X-rays, we concluded that the MAGIC emission is not due to synchrotron.

WHAT IS THE RESULT?

Detailed studies of the very-high-energy data led to the conclusion that a new emission process in the afterglow is needed in addition to the synchrotron. By modeling the broadband MWL data, the emission detected by MAGIC can be explained with the synchrotron self-Compton process, producing a second peak in the spectral energy distribution of the GRB. The parameters used in the modeling are compatible with those inferred from previous studies of GRB afterglows, implying that such emission can be detected if the observing conditions are suitable and the GRB redshift is low enough.