Gamma-rays with energies of up to 13 teraelectronvolts measured for brightest burst of all time

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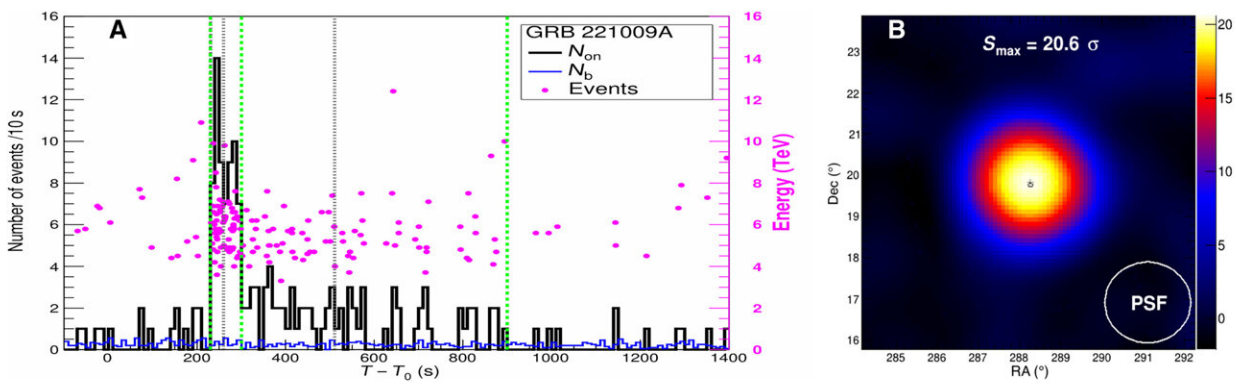

The light curve and significance map of GRB 221009A obtained by KM2A.(**A**) The gamma-ray–count light curve obtained by KM2A with each time bin of 10 s. The black curve indicates the events from the angular cone centered on the GRB, and the blue curve indicates the number of events due to cosmic ray background estimated from 20 similar angular cones at off-source directions with the same zenith angle. The gray dashed lines indicate the peak times of the multipulsed emission observed by GECAM-C in the MeV band. The green dashed lines indicate the times of T_0 + 230 s, T_0 + 300 s, and T_0 + 900 s. The pink points indicate the energy marked by the right label and the arrival time of each event. (**B**) The significance map around GRB 221009A as observed by KM2A. The plus sign and corresponding length denote the position and error determined by KM2A. The black circle denotes the position of the GRB reported by Fermi-LAT. The white circle shows the size of the PSF that contains 68% of the events. Credit: *Science Advances* (2023). DOI: 10.1126/sciadv.adj2778

Astronomers with The LHAASO Collaboration have found that last year's GRB 221009A gamma-ray burst, subsequently nicknamed the Brightest of All Time (BOAT), carried with it 13 teraelectronvolts of energy. In their study, reported in the journal *Science Advances*, the group analyzed data from the LHAASO-KM2A detector located in in Sichuan, China, to learn more about the burst.

Gamma ray bursts result in the brightest explosions seen from Earth and there are many theories regarding their source. Some suggest they're caused by neutron star collisions; others suggest they are due to mergers between neutron stars and black holes or the collapse of a massive star into a black hole.

In any case, theories regarding their brightness center on their afterglow radiation. Rapidly moving material collides, generating shock waves that speed up electrons, which further collide, resulting in high-energy gamma rays. The results are the brightest explosions detected.

Prior research has suggested that prior to GRB 221009A, energy levels from gamma ray bursts have been in the neighborhood of half a teraelectronvolt or less. Thus, when GRB 221009A was detected on October 9, 2022, by the Gemini South telescope in Chile, the star gazing community took notice. The burst was found shortly thereafter to have occurred approximately 2.4 billion light years from Earth, and lasted 70 times as long as any other recorded gamma-ray burst. Researchers around the world have described it as a 1 in 10,000-year event.

Over the past year, the team with The LHAASO Collaboration has been studying the BOAT. They have thus far found that the star involved in its creation was approximately 20 times larger than the sun—and it had a burst that lasted for several hundred seconds. They have also found that more than 140 of the gamma rays in the burst had energies over 3 teraelectronvolts.

They have also found evidence that the afterglow of the burst lasted longer than can be explained by theories describing how gamma ray bursts are supposed to behave. The team plans to continue study of the BOAT, hoping to learn more about the causes of gamma ray bursts and how they behave afterward.

More information: Very high-energy gamma-ray emission beyond 10 TeV from GRB 221009A, *Science Advances* (2023). DOI: 10.1126/sciadv.adj2778

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