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Scientists Have Detected a 'Completely Unprecedented' Burst of Energy in Space

The gamma ray burst is the brightest ever detected in X-rays, according to scientists, and could shed light on the most energetic phenomena in space.

By Becky Ferreira

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Scientists have spotted an "unprecedented" explosion of energy in space, known as a gamma ray burst (GRB), which appears brighter at some wavelengths than any event of this kind observed so far.

Gamma ray bursts are enormous eruptions fueled by intense cosmic phenomena, such as the deaths of huge stars, and they produce some of the brightest spectacles in the universe. News of this particular burst began rippling across social media following its detection on Sunday by the Fermi Gamma-ray Space Telescope and the Neil Gehrels Swift Observatory, both NASA missions, with some astronomers describing it as "an extraordinary event" and potentially "the brightest GRB ever."

Phil Evans, an astronomer at the University of Leicester who works on Swift's X-ray telescope, colorfully described the burst, known as GRB 221009A, as "stupidly really bright" in a tweet on Monday.

In an email to Motherboard, Evans emphasized that the discovery is so fresh that it will take a while to unpack its significance, but he noted that the burst is "clearly the brightest GRB we've seen in X-rays, at least at the time after the initial explosion that we've observed it."

"The new GRB 221009A is something around 1,000 times brighter than the typical GRB and a few hundred times brighter than the brightest ones seen before—but this is only true in X-rays," Evans said. "In gamma-rays it is one of the brightest seen (according to the report from the Fermi telescope team)."

Marcos Santander, an astronomer at the University of Alabama, noted in an email that the Fermi satellite's Gamma-ray Burst Monitor (GBM) was the first to detect the event, and immediately flagged it as exceptional.

"GBM is the most prolific GRB detector and on average it detects a GRB roughly every day, and it has collected thousands of GRBs in more than 14 years of operation since the launch of Fermi in 2008," Santander told Motherboard. "Of those thousands, the one on Oct 9th was by far the brightest"—so bright, in fact, that it "blinded the instruments for a bit given how many gamma rays were arriving over a very short time."

"GRBs are also the most luminous events in the Universe," he continued. "This one could have an intrinsic brightness of 10^22 times that of the Sun, or around a trillion times the entire energy output of all the stars in the Milky Way combined over that short period that the GRB was on if I have the numbers right."

The cosmic light show probably marks the energetic death of a massive star and its subsequent transformation into a black hole. It is unparalleled at some wavelengths in part because it took place about two billion light years from Earth. This is objectively a huge distance, but it is relatively close for a GRB.

"Bear in mind of course that this event is very new, and it will take time before we have the full picture, so this is somewhat preliminary," Evans said. "However…it appears to be a 'long GRB,' and these are fairly well understood. What happens is that a very massive, rapidly rotating star, reaches the point where its nuclear reactions can no longer produce enough energy to support the weight of the star. The center of it collapses and forms a new black hole, and this releases lots of energy."

"This causes some of the material making up the star to be fired out in narrow 'jets' from the top and bottom of the star—jets of material moving at nearly the speed of light," he continued. "If one of these jets is pointed towards the Earth, we see the GRB. So that is what has happened here. Why this one is so bright compared to others is not yet clear" though "part of it is just that it's nearby."

Swift, which has been in orbit around Earth since 2004, didn't spot the initial eruption of GRB 221009A because our planet was blocking that part of the sky. But the observatory's Burst Alert Telescope (BAT) picked up the brilliant aftermath of the blast nearly an hour later, when its fallout came into view.

"This is completely unprecedented—the explosion itself only lasted about 5 minutes (which is fairly typical for a GRB), but GRB explosions are followed by an 'afterglow' that usually fades relatively quickly," Evans said. "We've never before had a GRB where the afterglow was so bright that it triggered BAT."

The GRB did not appear to be very bright at optical wavelengths, but this could be a result of its location in the sky as well as a lack of immediate observations with optical instruments.

"Because of where this GRB is, we have to look right through the disc of our Galaxy to see it," Evans said. "That disc absorbs a *lot* of the optical light, so if it had been in a 'better' bit of sky it would have been a lot brighter."

"The other thing is that, as far as I can tell, no-one observed it with an optical telescope until after Swift had detected it, so 55 minutes after the GRB (this is because Fermi does not give very good positions of where a GRB is; Swift does). If people had observed it when it first occurred, I would not personally be surprised if it had broken all optical records… But as they didn't, we can't say that it did."

Given its impressive luminosity and mind-boggling possible origin, Evans and many other scientists will be keeping tabs on the evolution of GRB 221009A as it fades into lower-energy forms of light.

"I think the first step is to piece together all the data collected by all the instruments that observed the burst and start to look at the details of how this event actually happened," Santander said. "These are in the end the most energetic explosions in the Universe so you want to understand what kind of object could produce such an event, what powered this extreme emission, the types of particles that are accelerated and so on."

"Not only that, being so distant these GRBs can be used as a probe to study the properties of the intervening space, from the amount of light left over from earlier generations of stars, to studying dust clouds in our galaxy and even tests of fundamental physics," he added. "There will be many papers written about this burst, the first step is to put together all the information and different observatories provide different perspectives so there will be more information as analyses are performed and published."

All of this new research will help to explain why the birth of this distant black hole produced such blinding cosmic fireworks, a question that can open a window into the most energetic phenomena in the cosmos.

"The key science here is that we are looking at really extreme physics—very strong gravity, large masses moving at very high velocity while extremely hot—conditions you can never create in a lab, so the only way we can start to understand this is through studying extreme astronomical objects like GRBs," Evans concluded. "A lot of the open questions are pretty detailed physics (and I don't claim to understand all of them!), particularly about what goes on inside those jets—how particles are accelerated, interact, radiate energy and so on. And because this event is so bright, it really represents an awesome dataset with which to probe that physics."

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