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MAGIC OPENS A NEW ERA IN GAMMA ASTRONOMY

On 14 January 2019, perfect teamwork, involving space and Earth telescopes as well as hundreds of researchers worldwide, made it possible to record, for the first time, high-energy photons emitted by a Gamma Ray Burst (GRB): short but powerful cosmic explosions that suddenly appear in the sky about once a day, the result of a very powerful cosmic explosion. These photons, which reached energies of the order of the tera electron volt, thousands of times greater than those of visible light, were captured by the twin MAGIC (Major Atmospheric Gamma Imaging Cherenkov Telescope) telescopes on the island of Las Palmas, in the Canary Islands (Spain). The Italian scientific contribution, with the INAF National Institute of Astrophysics, the INFN, the ASI Italian Space Agency and various universities was fundamental to the discovery. The results were published in Nature at the end of November.

The gamma-ray burst as a whole was discovered independently by two satellite instruments, the Neil Gehrels Swift Observatory and the Fermi Gamma-ray Space Telescope. On the ground, the INAF robotic telescope, REM, located in Chile, which captured the optical emission, and the two Cherenkov MAGIC light telescopes, in the Canary Islands, equipped with mirrors with a diameter of 17m and designed to detect very high-energy gamma photons (25 GeV-50 TeV), emitted from galactic and extragalactic sources, were ready to receive the alert. The MAGIC telescopes, in particular, were designed to rapidly respond to GRB alerts and work on a dedicated follow-up strategy. After pointing in the direction of the GRB 190114C, the two telescopes captured the highest energy photons ever measured for this type of celestial event, detecting its presence up to half an hour after the GRB explosion. Thanks to the intensity of the signal received and to the particular real time data analysis procedure, it was possible to communicate the discovery to the international astronomical community within a few hours of its observation: an unprecedented result, which provides new information essential for understanding the physical processes in progress in GRBs.

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Discovered in the late 1960s, the origin of GRBs remained mysterious until the late 1990s when, thanks to the Italian astronomy satellite X BeppoSAX, it was possible to precisely identify and subsequently observe the region of the sky in which they occur with the most powerful telescopes. Today we know that they are the result of the explosion of very massive stars or the fusion of neutron stars in distant galaxies. Nevertheless, although the origin of these phenomena has been identified, more than 50 years after their discovery, many aspects of them still remain mysterious: the observations with very high-energy gamma-ray telescopes are fundamental to give an answer, because they let us directly observe the core of the phenomenon.

MAGIC owes its observational capability to the Cherenkov radiation detection technique, radiation emitted when high-energy gamma rays penetrate the Earth's atmosphere giving rise to showers of secondary particles. Given the very high energy of the photons from which they originate, the particles produced propagate at a speed higher than that of light in the atmosphere, giving rise to clouds of weak bluish light lasting only a few fractions of a second: Cherenkov radiation, an effect comparable to the sonic boom produced by the shock wave of a supersonic jet. Working in a coordinated manner, the two MAGIC telescopes are able to capture this radiation, thanks to the size of their mirrors and their ultra-sensitive detectors.

MAGIC was built by a largely European collaboration that includes approx. 160 researchers from Germany, Spain, Italy, Switzerland, Poland, Finland, Bulgaria, Croatia, India and Japan. Italy participates through INFN, which is one of the founding institutes, together with the Universities of Padua, Udine and Siena, and the INAF, which joined the experiment in 2006. ■