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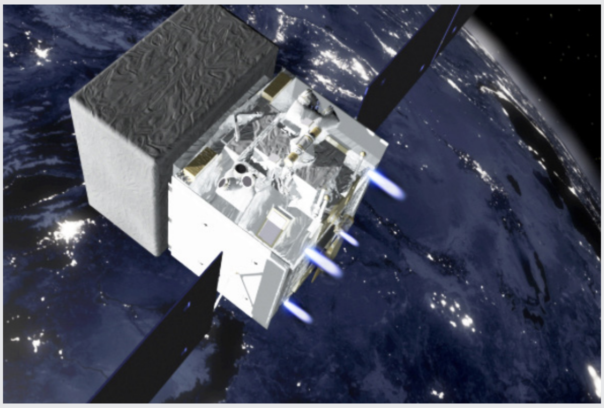

A SPACE EYE ON THE HIGH ENERGY UNIVERSE

In October, Science magazine reported the first detection of an intense flux of gamma rays coming from a pulsar, a neutron star in rapid rotation, outside of the Galaxy. The bright gamma source is located within the Large Magellanic Cloud, a satellite galaxy of the Milky Way. The result was achieved by the international collaboration of the NASA Fermi satellite, in which Italy is participating with the Italian Space Agency (ASI), the INFN and the National Institute for Astrophysics (INAF). Since 11 June 2008, when it was launched with a Delta II rocket from the Kennedy Space Center in Cape Canaveral, Florida, the Fermi satellite has been orbiting the Earth at an altitude of 550 km. Since then, it has continued to provide highly detailed photographs of the sky, seen under a particular radiation – the gamma radiation – constituted by high and very high energy photons. In particular, Fermi has two instruments: the LAT (Large Area Telescope) sensitive to very high energy gamma radiation (from 20 MeV to the TeV), and the GBM (Gamma-ray Burst Monitor), for the study of relatively lower energy phenomena (between 8 keV and 40 MeV).
The satellite, originally called GLAST, was then renamed by NASA, in August 2008, the Fermi Gamma-ray Space Telescope in honour of Enrico Fermi. The great Italian scientist was in fact a multifaceted figure, pioneer in the study of high-energy particles and among other things, was the first to postulate the physical mechanism of acceleration of cosmic rays that pervade our Galaxy, reaching even us. The data that Fermi satellite has provided us over the years has proved invaluable for the study of our universe. Some of the most catastrophic astrophysical phenomena, such as binary systems of neutron stars, black holes, pulsars and active galactic nuclei, in fact, cause intense emissions of gamma rays, which arrive directly as far as us, bringing us information on the sources that generated them and on the interstellar space they passed through. Very high energy photons, unlike the photons that constitute visible light, when interacting with matter, produce electron-positron (antielectron) pairs. Reconstruction of the tracks of these particles therefore allows the direction of the primary

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photon that produced them to be identified and thus their characteristics to be studied. This process is the basis, in particular, of the structure of the LAT instrument - a structure similar to the detectors used in high energy physics, for particle accelerators - for the implementation of which INFN made a significant contribution.

Among the most interesting results published by Fermi is the first evidence of an excess of very high energy electrons and positrons recorded in 2009. This result, together with the excess of cosmic positrons measured by the Pamela and AMS (Alpha Magnetic Spectrometer) satellites, can be explained by two alternative mechanisms, both of considerable interest. The firts one is the emission by an astrophysical source of particularly high energy particles, such as a pulsar, close to us, but still unknown, the second is a signal of dark matter, which in the process of annihilation or decay produces ordinary matter, including electrons and positrons. Fermi has collected millions of electron events, and ongoing studies on the angular distribution of these particles will help us to understand the dominant scenario.

Today the activity of the Fermi satellite is projected towards the completion of its tenth year, in 2018, with a significant improvement in its observational capabilities, thanks to a new software, called Pass 8, providing researchers with a more accurate reconstruction of the events detected and a significant increase in the sensitivity of the telescope, also beyond the energies so far explored. The new generation of algorithms, in fact, allows the energy and direction of each gamma photon passing through the telescope to be measured with high accuracy, allowing the most complex structures of extensive gamma sources to be optimally identified and weak sources thus far not detectable with the previous generation of algorithms to be seen.

It is therefore now possible to isolate sources with exceptional characteristics, such as the pulsar recently observed, and to verify, therefore, our understanding of cosmic ray acceleration and propagation mechanisms, observing a galaxy which, although close to us, is nevertheless different from ours. ■