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MESSENGERS FROM DISTANT GALAXIES

A result published in September in Science by the Pierre Auger Observatory situated in Argentina, in Mendoza Province, answers questions that scientists have been asking for half a century. Where do high energy cosmic rays come from? Are they produced in our galaxy or do they come from distant galaxies? Auger's recent results clearly indicate an extragalactic origin of these particles, an important first step that will be followed by many others in order to identify the sources that emitted them.

Cosmic Rays are high energy atomic particles and nuclei that, moving almost at the speed of light, hit the Earth from every direction and possess different energies. The experiment obtained this important result by observing very high energy cosmic particles (of the order of tens of exaelectron volts). At these energies, cosmic rays do not arrive uniformly from all directions in the sky. In fact, the frequency with which they arrive shows an excess in an area located about 120° from the centre of our galaxy, from a direction distant, therefore, from the galactic centre.

The Pierre Auger Observatory is the largest cosmic ray observatory ever built by man, an international collaboration with over 400 scientists from 18 countries. Situated in the heart of the Argentine Pampas, it is named after the French physicist Pierre Auger, the discoverer of extended air showers. The observatory is a hybrid system that includes surface detectors and fluorescence telescopes situated in proximity to the Andes Mountains at a height of 1400 metres. The surface detectors (approximately 1600) cover an area of 3000 km^2, spaced 1.5 km apart, and are able to observe swarms of cosmic rays when they hit the Earth's surface. The fluorescence telescopes (27 in total), on the other hand, observe the weak light produced by the swarms while they form in the atmosphere (Cherenkov radiation). The joint activity of the two detection systems allows the energy and direction of the cosmic rays to be identified and the fundamental information on the location and type of sources to be traced. INFN has contributed to the

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implementation of the Pierre Auger Observatory and is actively participating in its upgrade program. About 15% of the scientists of the Auger collaboration are Italian and their participation in the research activities of the Observatory is possible thanks to the contribution of the Italian Institute for Nuclear Physics, the Italian Institute for Astrophysics and the Universities of L'Aquila, Catania, Milan, Federico II of Naples, Rome Tor Vergata, Salento and Turin, of the Politecnico of Milan and of GSSI.
Auger is part of a global multi-messenger astronomy program that sees INFN engaged in the Fermi, MAGIC, CTA, KM3NeT, DAMPE and VIRGO experiments. With the development of new detectors and experimental methods, multi-messenger astronomy, engaged in the coordinated detection of electromagnetic signals, cosmic rays, gamma rays, high energy neutrons and gravitational waves will allow us to observe the universe in its variety, integrating the results obtained in particle physics, theoretical physics and astronomy in a unitary framework. ■