

Nobel prize winning research

The Higgs boson

Predicted theoretically in 1964 by Robert Brout, François Englert and, independently, by Peter Higgs, the Higgs boson is a fundamental ingredient of the universe because it is the particle that provides mass to all other elementary particles. For decades it was the missing piece of the mosaic of the Standard Model, the theory that describes the elementary particles and the fundamental forces regulating their interactions. In 2012, the ATLAS and CMS experiments at the CERN's LHC accelerator announced the discovery of the Higgs boson, observed in the collision between high-energy proton beams occurring in the 27 km long LHC superconducting ring. In 2013, Englert and Higgs were awarded the Nobel Prize for their theory. INFN coordinates the Italian contribution at CERN and participates with a community of over 800 researchers and technicians, working on experiments at CERN and often holding positions of responsibility in the large international collaboration.

Gravitational waves

Predicted by Albert Einstein's theory of General Relativity in 1916, gravitational waves are ripples in the spacetime permeating our universe.

They are generated by all accelerated moving masses, and they propagate at the speed of light. But, since the deformations that they produce are infinitesimal, our instruments are able to detect only those produced by large cosmic cataclysms, like the fusion of black holes or neutron stars. That is why it took a century of scientific and technological innovation for their discovery, announced in 2016 by the physicists of the LIGO and Virgo Scientific Collaborations. In 2017, Kip Thorne, Rainer Weiss and Barry Barish, researchers received the Nobel Prize for their contribution to the experimental project. LIGO (in the United States) and Virgo (in Italy, near Pisa, at the European Gravitational Observatory, EGO) are gigantic laser interferometers, consisting of two perpendicular arms a few kilometres long. INFN co-founded the VIRGO project, and now is engaged in the design of the European next generation interferometer that Italy is candidate to host in Sardinia, in the area of the Sos Enattos mine.

From elementary particles to complexity

This is the path taken by Giorgio Parisi, a young INFN researcher in the late 1970s, when he elaborated the physical-mathematical theory of a class of magnetic systems characterized by a high degree of disorder, spin glasses. For these pioneering works, which have paved the way for countless applications, and for his fundamental contributions to the physics of complex systems, which offer us a surprising new point of view on the natural world, Parisi received the Nobel Prize in 2021.

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