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REMEMBERING NICOLA CABIBBO 10 YEARS AFTER HIS DEATH

Interview with Luciano Maiani, Professor Emeritus of Theoretical Physics at the Sapienza University of Rome, national member of the Accademia dei Lincei.

On 16 August 2010, Nicola Cabibbo passed away at 75 years old. Cabibbo was a leading figure of one of the most exciting and prolific periods in the history of particle physics: the period between the post-WWI years and the end of last century. These were the years in which the Standard Model took shape: the great theory that is still today the reference for studying the ultimate constituents of matter. The Standard Model is the result of joining and summarising hypotheses aimed at describing the behaviour of three of the four fundamental interactions existing in nature (electromagnetic, nuclear, and weak forces) and of the particles associated with these. In 1963, Cabibbo inextricably linked his name to the Standard Model when he provided a universal explanation for the weak decay of particles, with and without strangeness (strange particles contain a strange quark). He hypothesised that the weak decays of all particles are determined by the transition of a single quark, which is the overlap of the down and strange quarks, determined by a new universal constant, later named "Cabibbo angle". Cabibbo's theory satisfyingly explained the data then available, an agreement that, with the improvements in data accuracy, has become increasingly precise.

Right from its publication, Cabibbo's theory was seen as a crucial development in particle physics. Abraham Pais, in his book "Inward Bound", cites Cabibbo's theory as one of the most important developments in particle physics since the war. In "History of CERN", John Iliopoulos writes: "With this work (Cabibbo) consolidated his position as one of the main theorists in the area of weak interactions". Cabibbo's mixing idea was then applied to neutrinos by Bruno Pontecorvo, who hypothesised a new phenomenon, neutrino oscillation.

Cabibbo's happy intuition allowed scientists in the following years to first hypothesise and then prove the existence of other types of quarks (charm, top and bottom) and to develop a flavour theory that could include the new particles. Several Nobel Prizes were awarded to those involved in developing the Standard Model, with the exclusion of Cabibbo in 2008; his death in 2010 made this exclusion definitive.

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This is still a living disappointment for Italian physics.
10 years after his death, on 15 December, the INFN Frascati National Laboratories, the place where this giant of physics started his career, paid homage to Nicola Cabibbo with a symposium dedicated to his memory. Apart from his indisputable scientific merits, Cabibbo's successes in his role as science manager were also re-traced during the event. He held this role, alongside his commitment to training new generations of physicists, as president of INFN (from 1983 until 1992) and of ENEA (from 1993 to 1998). Thus, he became a reference figure for planning Italian strategic research activities. The testimonies that followed one another in the course of the symposium included that of Luciano Maiani, who was a friend and colleague of Cabibbo, as well as his successor in leading INFN.

Professor, can you share one of your personal memories of Nicola Cabibbo with us?
It would be impossible to choose just one. Having worked with Nicola for so many years, the memories I accumulated are practically infinite. Of course, the best ones relate to the beginning of our collaboration, when he was already a very famous figure within the physics community, while I was a young researcher who had only graduated a few years before. In particular, I remember that, in 1965, I, and many other young Italian researchers, went to Brandeis University, near Boston, where Cabibbo was running his course on Weak Interactions. He was one of the school's stars. Finding a colleague of our own country there as a teacher, one who was only a little older than we were but already famous, was very exciting. It was then that, in the course of some private chats with Nicola and his wife Paola, we developed a great liking for each other, based on many shared points of view. The relationship then continued and turned into a genuine friendship. In 1967, Nicola moved definitively to Rome, where we began to collaborate, to participate in conferences together and to see each other with our respective families outside of work. It was a sincere friendship that, over the years, was never interrupted, despite the fact that, at a certain point in our lives, science management began to overlap with physics. The former first brought Nicola and then, immediately afterwards, myself to hold the role of President of INFN, which I left shortly before the end of my mandate to assume the role of director of CERN. In this period too, however, our relationship was uninterrupted, even if Cabibbo's research interests shifted towards ambitious national research projects in fields other than my own research.

What were the most important results that Nicola Cabibbo achieved in physics?
Of all the research that Nicola conducted, that which led him to hypothesise the so-called "Cabibbo angle" obviously stands out. This result allowed him to resolve a question that Feynman had pointed out to him as one of physics' crucial problems. It's worth remembering, however, that in his youth Cabibbo

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was also occupied with other questions, beginning with his work on storage rings that he undertook with Raul Gatto. They were the first to grasp the enormous potential of this technology for studying fundamental particles. In addition, Nicola was certainly one of the most important figures in constructing the Standard Model. In the 1970s, the group of Roman physicists that he led, and of which I was a part along with Guido Altarelli, Massimo Testa, Giorgio Parisi, and others, was one of the best theoretical physics schools at a European and international level. We explored the phenomenological consequences of the theory in all its aspects. The work translated into important contributions. Another great merit for which Nicola deserves to be recognised is that of having been among the first to support the idea for CERN's proton-antiproton collider. This step proved to be essential for discovering the bosons that mediate the electroweak force, thanks to Carlo Rubbia and his group.

On the other hand, what, do you think, is the legacy of Nicola Cabibbo, science manager and president of INFN?

Nicola was a great president because he succeeded in his intention to maintain the prestige and good reputation of INFN, which was already, at the time recognised and highly regarded at an international level thanks to the work of physicists like Edoardo Amaldi, Giorgio Salvini, Antonino Zichichi, the latter being the direct predecessor of Cabibbo as leader of the institute, under whose presidency the process for the realization of the National Laboratories of Gran Sasso began. As well as having known how to manage the organisation well, taking care of recruitment and staying away from favouritism and friendships, the most important contributions that Cabibbo made as INFN president were, in my opinion, two. The first concerns his commitment in the field of neutrino research. Thanks to his overall scientific vision, the Gran Sasso National Laboratories became, in fact, the meeting point for researchers - both Italian and international - such as Till Kirsten, one of the most important figures in the laboratories' creation, Ettore Fiorini, Puccio Bellotti, Gian Paolo Bellini, and others. One of the first results was the Gallex experiment observation of the neutrinos produced by the proton-proton cycle in the sun and the proof of their oscillation. The result was announced at an INFN meeting by Cabibbo himself, who was very proud of this success, just a few months before I took over. The second contribution that I'd like to recall relates, on the other hand, to the interest that Cabibbo had regarding gravitational waves. This interest led him to work hard for the INFN approval of the construction of the VIRGO observatory. The attempt, unfortunately, didn't succeed during his mandate. In any case, Nicola conveyed the necessary enthusiasm to me to take up the project again - this time with a positive outcome. The decision laid the foundations for VIRGO's construction in collaboration with the French CNRS, with the results that we have all witnessed in recent years. Italy, with VIRGO, is at the forefront in research on gravitational waves, one of the most promising frontiers in

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physics today.

Nicola Cabibbo was also one of the first to understand the importance of computing for the future of science. Can you tell us something about this?

The creation of the ambitious APE Array Processor Experiment is owed to Nicola Cabibbo. The project proposed to provide INFN with the computing resources necessary to physics research thanks to the creation of a supercomputer. Together with Giorgio Parisi, Nicola was the promoter of this big project, which paved the way for supercomputing from a perspective that didn't involve buying machine time from organisations like CINECA, but directly producing the hardware suitable for INFN's computing needs. It was a completely exceptional undertaking for Italy, made possible by the enlightened scientific leadership of Nicola and Giorgio and by an organisational base, that of INFN, that, on that occasion too, demonstrated its capacity to complete complex projects on time. Italy, unfortunately, hasn't developed the necessary resources to completely support the development of a similar project. In addition, at the time, Europe also hadn't understood the potentials of super computing, believing it to be a sector that was the exclusive privilege of the U.S. This attitude conditioned the future of APE, which couldn't find the necessary funding outside of Italy, and it still makes it difficult, even today, for Europe to keep up in this sector. ■