JULY 2019

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Istituto Nazionale di Fisica Nucleare

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INTERVIEW WITH ANTONIO ZOCCOLI, NEWLY ELECTED PRESIDENT OF INFN

Antonio Zoccoli, Professor of Physics at the University of Bologna, former member of INFN's Executive Board, from July 1 is the new President of INFN

Antonio Zoccoli took over as President of INFN from July 1, following INFN Board of Directors presidential nomination, last 30 May, and the nomination decree of Italy's Ministry of Education, Universities and Research (MIUR). Zoccoli succeeds Fernando Ferroni, who presided over the institute for two terms beginning in 2011. Born in Bologna in 1961, Antonio Zoccoli graduated in physics at the University of Bologna where he is now Professor of Experimental Physics. Zoccoli was an associate researcher with the Bologna INFN division, of which he was the director from 2006 to 2011, and a member of the INFN Executive Board since 2011, of which he was also Vice President.
Throughout his scientific career, Zoccoli has been active in the field of experimental fundamental, nuclear and subnuclear physics. He first held the role of member of the Muon Catalysed Fusion Collaboration at the Rutherford Appleton Laboratory (UK) and of OBELIX at CERN in Geneva. Later, he participated in the HERA-B experiment at the DESY laboratory in Hamburg. Since 2005, he has been a member of the ATLAS collaboration at CERN that, together with the CMS collaboration, announced the first observation of the Higgs boson in July 2012. Zoccoli is co-author of more than 700 scientific and technical publications in international journals. He is actively involved in the popularisation of science and, since 2008, has led the Fondazione Giuseppe Occhialini for the popularisation of physics.
We asked the new president about his vision of INFN's future.

Your election as president is recent, but you have followed INFN research policy for many years, first as director, then as a member of the Executive Board. What is the state of INFN's health? What are its strong points, and what elements need strengthening?
INFN is the only Italian research organisation engaged in the field of nuclear and elementary particle physics, as well as in the more recent field of astroparticle physics. It enjoys the privilege of relying on its own big research facilities, which it won with its capacity for vision and its determination. These facilities include the

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Frascati National Laboratories, which are INFN's cradle, and the place where the first electron-positron collider in the history of physics was constructed - an idea and a technology that were then exported throughout the world. INFN also has the largest underground research centre in the world, the Gran Sasso National Laboratories. This is a unique facility due to its environmental and instrumental purity, and because of the expertise and technologies it developed in the field of research of rare events, such as those linked to the study of dark matter and neutrinos. The National Laboratories of the South (LNS) and the Legnaro National Laboratories (LNL) are two more big national laboratories. These are principally dedicated to nuclear physics and nuclear astrophysics, as well as to the development of medical applications in fundamental physics, such as the production of radiopharmaceuticals and particle beam cancer therapies. The repercussions of basic research are obvious in these cases, which also involve other INFN facilities such as the different INFN division laboratories and the TIFPA Trento Institute. To cite just a couple of examples, these are at work on the applications of technological innovations developed for particle accelerators and detectors and the cryogenic techniques developed through experiments at Gran Sasso. Other INFN facilities, such as the CNAF Computing Centre in Bologna, and the computing facilities that are diffused throughout the country, shouldn't be forgotten. Furthermore, INFN manages the EGO consortium, together with the French CNRS, that is located in Italy, close to Pisa. This hosts the Virgo interferometer, one of the three big instruments in the world that are capable of detecting gravitational waves.

In addition to the national facilities, it shouldn't be forgotten that INFN is a "shareholder" in CERN, the biggest laboratory in the world and the only one of its kind - it is the site of the most powerful particle accelerator ever created, LHC. The close relationship with CERN allows INFN to develop cutting-edge research and to promote and launch frontier research for the near future, at both a national and international level.

One sector where we will have to do some work in the next few years is that of fundings, in order to guarantee a level of adequate funds to continue research that is already under way and to launch what is part of the future strategy. At the same time, we will have to work on strengthening recruitment of young people for the future, defining an appropriate and stable channel for hiring new researchers, so as not to let the best talents trained in Italy leave and to be attractive to those trained overseas.

INFN's excellence is recognised around the world and its reputation rests on its capacity for vision and on a high degree of expertise. Such recognition is proven, for example, by the fact that numerous Italian physicists coming from INFN have always held roles with a high degree of responsibility in international collaborations. How do you plan on maintaining this excellence at an international level?

INFN has always had important positions in almost all the international initiatives in which it participates. This is also owed to the fact that international research is in INFN's very DNA and has distinguished the organisation

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right from the start. Our overseas researchers are excellent. This also goes for young people who trained within INFN, who were prepared right from the beginning of their careers for international collaborations, so that, when they had finished their training, they had developed the necessary capacity to take on high-level roles. The challenge for the next few years will be to maintain this excellence by spurring students finishing their degrees, doctoral students, and post-docs to develop creative and innovative capacities, a proactive bent, and the right attitude for taking on responsibility.
The effort that we will have to make is, therefore, in training young people to have a wider vision not limited by specific national research objectives and by the national context in general. We will have to spur them to propose new and innovative ideas, to compete at an international level, participating in European funding competitions or the ERC Grant competitions, which are structured so as to award creativity and the capacity for innovation, just to make an example.

INFN is the fusion of historical traditions that have their roots in the first half of last century: subnuclear physics research and the study of cosmic rays. Traditions that have maintained their autonomy, by integrating methodologies, technologies, results, and discoveries in an increasingly effective way. What, today, is the most promising challenge for these research strands that, along with theoretical physics, nuclear physics and applied physics, defines INFN's research strategy?
There are two challenges in both of INFN's founding fields that are completely open. The two research share a common aim, that is to study the fundamental laws that govern the universe and that characterised the first moments of its life. And to study this, we use the widest possible range of tools located even in the most disparate places, from underground laboratories, to the depths of the sea, to artificial satellites in orbit. INFN holds a leading role in both these fields, participating in all the big physics, subnuclear physics, and astroparticle physics endeavours at an international level.
In the field of subnuclear physics, so-called high-energy physics, the European strategy for the next few years, to which INFN is making a fundamental contribution, is still being defined. Above all, we will need to establish how to develop the research facilities and what will be the right machine, after the LHC, for producing particle beam collisions. INFN has a primary role in this endeavour, both in terms of strategic vision, and in terms of contributing technology and physics expertise.
On the other hand, in the field of astroparticle physics, the challenge is that of research into dark matter and that encompassed by so-called multimessenger astronomy. The latter explores the mysteries of the universe by using several cosmic messengers and, therefore, various tools for their detection: from electromagnetic observers, to cosmic ray satellites, from gravitational wave interferometers, to underwater telescopes for detecting neutrinos. INFN has, beyond its wide-ranging participation in the whole of international research

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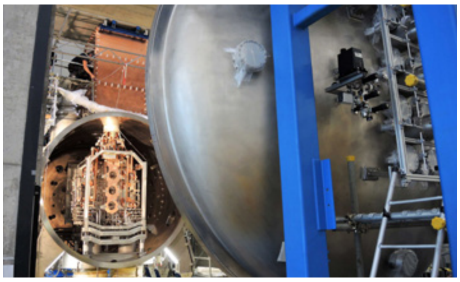
initiatives in this field, its own facilities, which are capable of attracting and gathering researchers from around the world. Among those facilities dedicated to multi-messenger physics, the Gran Sasso National Laboratories and the Italian-French Virgo interferometer are a point of reference for the international community.

In the last few years, INFN has paid particular attention to the transfer of expertise and of technologies developed for basic research in different fields, with an important socio-economic impact. How do you imagine to strengthen this aspect?
Technology transfer is one of the most pressing challenges related to our organisation's strategy. In recent years, it's one we have engaged with in a direct and systematic way with excellent results. We have dedicated a lot of energy to strengthening the societal impact of our research activities, working on two aspects in particular. On the one hand, the transfer of technologies and methods to the Italian industrial system and, on the other hand, the transfer of expertise thanks to the excellent training that young people acquire through research activities in our facilities and alongside our researchers. One of INFN's resources is its ability to give young people suitable preparation for the requirements of the Italian industrial system. And undertaking research with INFN continues to be one of the most profitable channels for the training of young people entering the industrial planning sector.

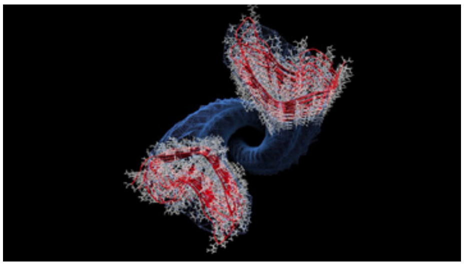
Let's talk about the INFN community, which comprises around 2,000 researchers, technologists, technicians, and administrative staff as well as 3,000 university employee research associates. Choosing one aspect as a priority on which to focus, how do you imagine ensuring this rich community's satisfaction and productivity?
Our researchers' productivity has always been excellent. The passion that motivates them is an excellent engine not only for their capacity for work, but also for their personal initiative and for the proactiveness they demonstrate in their research activities and in establishing programmes. At the same time, the contribution of technologists, technicians, and administrative staff must be recognised since it is their commitment, their professionality, and their dedication that allow us to attain these results. We certainly have some work to do in terms of recognising this commitment. We have to find a way to offer the most talented young people the possibility of a career within the organisation, and this goes for the career progression of all types of employees, whether administrative, research, technical, or technological - and at any level. The chance to progress in the course of your career and to evolve your roles and responsibilities, must be guaranteed, along with the right recognition for your work. We also need to lighten the bureaucratic machinery, and simplify procedures, with the introduction of greater agility and autonomy in the management of administrative files, to facilitate work in the whole community. ■



INTERNATIONAL COLLABORATIONS

AGREEMENT SIGNED BY ITER AND RFX CONSORTIUM

ITER, a project for the construction of the first nuclear fusion reactor in Cadarache, France, and the Padua-based RFX Consortium, consisting of CNR, ENEA, INFN, University of Padua and Acciaierie Venete SpA, have signed a collaboration agreement for the experimentation, in Italy, on the most powerful neutral particle acceleration system ever made. The main ignition system of the future reactor requires the construction and operation of a trial and the development of prototypes which will be tested at the Neutral Beam Test Facility (NBTF) of Padua, under the responsibility of the Italian RFX consortium. The two prototypes are named SPIDER and MITICA. The Italian Ministry of Education, Universities ad Research (MIUR) confirmed the financial support which, added to the contribution of the Consortium Members, leads, in the decade 2020-2030, to a total Italian investment of 55 M €, along with an international commitment to be paid by ITER of 99 M €. ■



APPLIED RESEARCH

A MODEL EXPLAINS HOW PRION, THE PROTEIN THAT CAUSES MAD-COW DISEASE, REPRODUCES

For the first time, a realistic computational model has been created to explain the reproduction mechanism of prion, a toxic protein that, in the middle of the 1990s, became famous throughout the world as the protein that causes the "mad-cow disease." The study, which has been published in the *journal PLOS Pathogens*, was funded by the Telethon Foundation and conducted by the Istituto Telethon Dulbecco and the University of Trento, in collaboration with the INFN, the University of Santiago de Compostela (Spain), and the University of Alberta (Canada).

Prions are anomalous versions of proteins that are normally found in the brains of mammals, and in other species. They are capable of reproducing and spreading themselves in a similar way to viruses and bacteria. We know that they can induce the change of their normal form to the anomalous one, although the precise mechanism is still unknown. Over time, the anomalous form takes over and forms aggregates that kill nerve cells, provoking extremely serious neurodegenerative conditions called transmissible spongiform encephalopathies. Those we know of that strike humans are Creutzfeldt-Jakob disease, fatal familial insomnia, and Gerstmann-Straussler-Scheinker disease. Bovine spongiform encephalopathy is also very well known, having caused a genuine epidemic among cows beginning halfway through the 1980s, first in England and then in the rest of Europe. Several rare cases of transmission to humans, as a result of ingesting infected meat, have also been recorded.

Researchers have revisited the structure of prions and proposed a new structural model in line with the most up-to-date experimental data. Using a new computational method, derived from mathematical methods that were developed in particle physics, they have, thus, reconstructed the reproduction mechanism. The model will allow researchers to conduct a focused search for drugs that are capable of counteracting serious neurodegenerative diseases that are currently incurable. ■

INTERNATIONAL CENTERS

EUCAPT, THE EUROPEAN CENTER FOR ASTROPARTICLE THEORY, IS LAUNCHED

This center is called EuCAPT (the European Center for AstroParticle Theory) and it will coordinate all the activities and proposals of European centres and groups that are active in the field of theoretical astroparticle physics. Its launch was ratified by the signing of an agreement between CERN and APPEC (the AstroParticle Physics European Consortium) during a ceremony that was held at CERN on 10 July 2019. CERN will host the EuCAPT hub in its theoretical physics department for at least five years, and APPEC is the promoter of the new center. A number of people took part in the signing event, including CERN's Eckart Elsen, Director for Research and Computing, and Gian Francesco Giudice, Head of the Theoretical Physics Department; APPEC's Chair, Teresa Montaruli, and General Secretary, Job de Kleuver; INFN's Vice President Antonio Masiero, EGO-Virgo's President Stavros Katsanevas; and the new center's founding Director, Gianfranco Bertone, as well as the steering committee.

EuCAPT was strongly promoted by APPEC's research agencies and institutions with the conviction that the already intense and significant theoretical activity spread throughout various European research centers – both small and large – would greatly benefit from the presence of a European centre that coordinated and supported new proposals. At the moment, around ten big European theoretical astroparticle physics centres have joined EuCAPT; these include Italy's IFPU (Institute for Fundamental Physics of the Universe), but other groups have already expressed their interest in joining.

COMPUTING

A JOINT STRATEGY TOWARDS THE EUROPEAN OPEN SCIENCE CLOUD

Officially kicked off on 5 July 2019 in Rome during an event at the Ministry of Education, University and Research (MIUR), for the next 3 years, EOSC-Pillar will coordinate national Open Science efforts across Austria, Belgium, France, Germany and Italy, and ensure their contribution and readiness for the implementation of the European Open Science Cloud (EOSC). Promoted by the European Commission, EOSC will provide a virtual environment with open and seamless services for storage, management, analysis and re-use of research data, across borders and scientific disciplines. The project is part of a series of similar initiatives including EOSC-Nordic, NI4OS-Europe, EOSC Synergy and ExPaNDS.
The project is coordinated by GARR and sees the participation, besides the INFN that receives a contribution of over 500 thousand euros, many institutions: CINECA, CMCC, CNR, INFN and Trust-IT from Italy, University of Vienna from Austria, Ghent University from Belgium, CINES, CNRS, IFREMER, INRA, INRIA and INSERM from France, DKRZ, Fraunhofer, GFZ and KIT from Germany.
The first months of the project will be concentrated on a multi-dimensional study of national and European contexts. The results of this study will be the basis of the project coordination activities.
This project is a further step forward in the strategy of INFN that sees the computing infrastructure created and maintained for LHC experiments to be one of the founding elements of the EOSC at the national level. ■

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EPS-HEP 2019: A PRIZE FOR THE DISCOVERY OF THE TOP QUARK AND FOR MEASURING ITS PROPERTIES

The European Physical Society (EPS) has awarded the High Energy and Particle Physics Prize 2019 to the CDF and D0 scientific collaborations at the Fermi National Accelerator Laboratory (Fermilab) for the discovery of the top quark and the detailed measurements of its properties. The prize was awarded during the EPS conference that was held in Ghent, Belgium, from 10 to 17 July. It is a recognition that is awarded every two years to one or more people, or to collaborations, that have distinguished themselves for having made an exceptional contribution to high energy and particle physics in the technological, theoretical, or experimental fields.

The discovery of the top quark was jointly announced by the CDF and D0 collaborations in 1995. The two scientific collaborations, in which hundreds of scientists from all over the world participated, managed to measure the mass of the top quark - the last of the six quarks described by particle theory to have escaped observation. They could do so with a high degree of precision thanks to data collected by Fermilab's Tevatron particle accelerator, and they subsequently studied the quark's properties in detail.

CDF is the acronym for the Collider Detector at Fermilab, the laboratory that, at the time, hosted the most powerful particle accelerator in the world, the Tevatron. The latter was a ring in which protons and antiprotons were accelerated up to speeds almost equal to the speed of light in order to make them frontally collide in the detectors.

The first stone of the CDF experiment was laid in April 1982, after having obtained the approval and support of the Department of Energy (DOE) and the National Science Foundation (NSF) in the United States, as well as of the Ministry of Culture and Sport in Japan and INFN in Italy. INFN initially participated alongside the Frascati National Laboratories (LNF) and the Pisa INFN division, later being joined by the Bologna and Padua divisions.

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The collaborations began to collect data in 1985, under competitive pressure from the UA1 and UA2 experiments at CERN, but the first truly interesting data didn't arrive until 1988-89. It was during these years that researchers began to do precision physics. The real shift occurred in the 1990s, when the silicon vertex detector (SVX) was introduced. This was created, in part, thanks to the effective cooperation of INFN and Lawrence Berkeley National Laboratory (LBL) expertise in, respectively, microstrip detectors and integrated electronics. Thanks to the new detector, it was, at that point, possible to measure with very high precision the trajectory of traces of charged particles.

At the same time as the creation of the CDF silicon vertex detector, the construction of a new experiment, D0, began at Tevatron.

Starting from 1992-1993 a period full of CDF measures began. The properties of particles containing bottom quarks and the mass of the W boson were measured with great precision. The W boson was discovered together with the Z boson by the UA1 and UA2 experiments at CERN, a discovery that led to Carlo Rubbia and Simon van Der Meer's winning the Nobel prize. Moreover, the first evidence of the existence of the top quark was obtained in these years, although it had a much higher mass than what was initially hypothesised on the base of indirect measures. The first evidence of the top quark was published by CDF in 1994, and its definitive discovery, with a mass of 175 GeV/c^2, was announced in the spring of 1995.

It took a long time to arrive at this observation because this quark is very heavy and, therefore, a very powerful accelerator was needed to produce it. This particle weighs more than 180 times the mass of the proton. The top quark decays fairly rapidly and, to observe it, you need to study the traces of particles that it leaves behind: these allow researchers to identify it; they are its signature. Furthermore, since the top quark appears just once out of every billion or so collisions, millions of billions of collisions were required to identify it definitively. Its mass, precisely measured, is linked to the mass of the Higgs boson and that of the W boson, and constitutes a milestone in the Standard Model of elementary particles.

As well as the discovery of the top quark, CDF also achieved many important results and recognitions. In 2006, there was another important discovery: the measurement of the oscillations of the strange B meson. In 2008, the prestigious Panofsky prize of the American Physical Society (APS) went to the Italians Aldo Menzione and Luciano Ristori, leaders of projects that were vital for the previous discoveries: the silicon vertex detector (SVX) and the SVT super-processor.

Finally, in 2012, evidence of the existence of the Higgs boson also appears in the data of CDF and D0, after those of ATLAS and CMS.

The data collected by the CDF still continue to be analysed, to take advantage of decades of constant and tenacious work by hundreds of scientists, students, engineers and technicians, who have produced over seven hundred articles and almost as many doctoral theses. ■

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