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INTERVIEW

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THE NEW APPEC ROADMAP LAYS OUT THE FUTURE OF ASTROPARTICLE PHYSICS IN EUROPE

Interview with Antonio Masiero, INFN vice-president and chairman of ApPEC (Astroparticle Physics European Consortium) since January 2017

Astroparticle physicists from all over Europe met in Brussels on 9 January, together with colleagues from other worldwide institutions and laboratories and representatives of the European Commission, for the official launch of the new roadmap set out by the Astroparticle Physics European Consortium (ApPEC). This document gives an indication to the European scientific community for the priorities for research and the recommended strategies for the next ten years. Top of the list are gravitational waves, neutrinos, dark matter and gamma rays, plus the encouragement to act in concert in these areas of research, because that is the only way for Europe to exploit to the full the promising potential for future progress and discoveries. We asked Antonio Masiero, INFN vice-president and chairman of ApPEC since January 2017, to tell us how European astroparticle physics will face nowadays frontiers of our knowledge about the universe and which major directions will be followed after the new roadmap launch.

Which are the main recommendations that the new ApPEC roadmap is based on for the future of astroparticle physics in Europe?
The new ApPEC roadmap identifies three main areas for future research into astroparticle physics: the newly-born multi-messenger astronomy, i.e. simultaneous study of different cosmic messengers (cosmic rays, electromagnetic radiation, neutrinos and gravitational waves) emitted by the high energy cosmic sources in the universe; neutrino physics, which is the detailed study of the most mysterious and elusive elementary particle, which could open the door to new physics; and the exploration of the dark side of the universe, dark matter and dark energy, together with the study of its evolution, from the moment of Big Bang (cosmology, study of cosmic microwave background radiation or CMB).

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How should research institutions act to define their own research strategy in an effective and synergic way? And how can they establish a strong relation among research and society?
In the roadmap, ApPEC invites European institutions to make a constant and consistent effort in active experimentation and financial support in these scientific areas, especially through major infrastructural research projects, either already approved or still in the R&D stage for early presentation. Apart from the scientific issues, the ApPEC report also deals with important organisational aspects and social questions, such as gender balance, education, communication and public involvement, as well as relationships with industry. Concerning this last point, in particular, the roadmap underlines how the demand for studying and developing new technologies to face the formidable experimental challenges of astroparticle physics leads to an important, virtuous operation of technology transfer with the European industries of the highest technological vocation. These are all aspects to be taken into consideration and treated with vision by the communities and by scientific Institutions.
Moreover, there's an aspect with an immediate impact on society, which has been evaluated, for the present and in the next future, as strategic by ApPEC: that's the cultural involvement of the public opinion. Astroparticle physics is a perfect example of curiosity-driven research. A combination of excitement about the mysteries of the universe and spectacular discoveries easily spark public interest. For that reason, ApPEC encourages outreach activities, the exchange of experiences and the sharing of outreach best practices among the institutions.

Many infrastructures of new generation are today based on the shared effort of a large number of European countries. Which are the projects that ApPEC is mainly focussing on?
Among the great infrastructures being considered relevant by ApPEC, the ones which are indicated as of special importance for the commitment of INFN are: KM3NeT, the undersea telescope for neutrinos, measuring one cubic kilometre, with the twin location of the coast of Capo Passero (in Sicily) and Toulon (France); CTA (Cherenkov Telescope Array), the land observatory for gamma rays, the next generation telescope to study the universe of very high energies; an important update of the Virgo gravitational interferometer in Cascina (Pisa) and the study of the innovative future underground interferometer, ET (Einstein Telescope); and substantial updating of our underground research infrastructures, especially the National Laboratories of Gran Sasso (LNGS) of INFN, which is the major underground infrastructure in the world for the research on dark matter and neutrinos.
Among the three knowledge frontiers indicated as prioritises by ApPEC – multimessangers physics, neutrino physics and the physics of the dark side of the universe – the research on dark matter and dark energy is probably the most challenging. In particular, dark energy, the hypothetical form of

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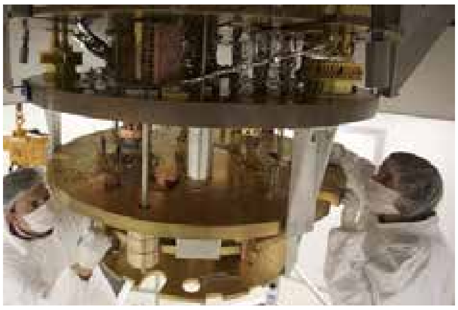
energy behind the universe's accelerated expansion, is studied via large galaxy-survey campaigns (both satellite-based and ground-based) that aim at reconstructing the growth of cosmic structures. In this frame, ApPEC supports the forthcoming ESA Euclid satellite mission, which will establish clear European leadership in space-based dark energy research. Because of their complementarities to Euclid, ApPEC encourages continued European participation in the US-led DEDI and LSST ground-based research projects.

European research policy for astroparticle physics research is so increasingly synergic and aims at favouring shared efforts rather than the institutions' own initiatives.

The future of astroparticle physics therefore calls for a major effort of cooperation and one of the tasks for ApPEC will be to encourage collaboration and synergy between the various leaders in this challenge of knowledge, with the prospects of the new multi-messenger astronomy, as well as ensuring that the scientific community and European experimental activities are at the forefront in all these areas of research worldwide. ■



TECHNOLOGY TRANSFER

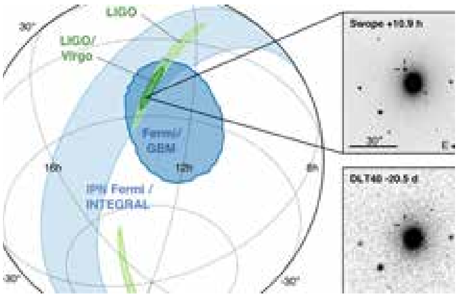
SET UP OF THE R4I PROGRAM, THE INFN FUND FOR INNOVATION

Basic research produces new knowledge and technology. That means innovative, leading edge technology, which can often provide useful applications in society. It may occur, though, that when the research reaches its scientific objective and concludes its programme, the developed technology is not sufficiently mature to leave the scientific laboratories and become innovations that are of interest to the market and make an impact on society. The INFN has therefore decided to provide an opportunity for these technologies: this is why the R4I (Research for Innovation) program has been set up. The INFN has introduced, within its new regulatory system for safeguarding, developing and improving INFN knowledge, the opportunity to use part of the proceeds deriving from the activities of technological transfer to build up a fund of incentives for selected technologies, in order to bring them up to market readiness. The INFN National Committee for Technology Transfer has recently completed its first selection, identifying four projects from the nine that made applications. The four selected projects will be granted €106,000 overall and they include two projects from the medical sector, one from mechanics of accelerators and one from the cryogenics sector. Three of them have already aroused interest from industry in their various sectors. ■

APPOINTMENTS

CHANGES AT THE HEAD OF THE EUROPEAN GRAVITATIONAL OBSERVATORY

Stavros Katsanevas and Antonio Masiero have been appointed, respectively, as the new director of the European Gravitational Observatory (EGO) and the new chairman of the EGO Council. After seven years as director of the EGO consortium, set up by the INFN and its French counterpart CNRS to operate the Virgo interferometer for detecting gravitational waves, Federico Ferrini's mandate has come to an end. Ferrini guided the EGO through a period that saw the development of the Advanced configuration of the interferometer and reached its basic scientific objective of the first detection of gravitational waves and he now passes the helm to Stavros Katsanevas. At the same time, Berrie Giebels makes way for Antonio Masiero, vice-president of the INFN, to take the post of chairman of the EGO Council, which is the decision-making body of the consortium. ■



AWARDS

FOR THE FOURTH TIME BRUNO ROSSI PRIZE GOES TO THE FERMI MISSION

The NASA satellite dedicated to studying high energy radiation in the universe and relying on fundamental Italian participation, with the involvement of the National Institute for Nuclear Physics (INFN), the Italian Space Agency (ASI) and the National Institute of Astrophysics (INAF), has been awarded, for the fourth time, the Bruno Rossi Prize of the High Energy Astrophysics Division. The announcement was made during the annual congress of the American Astronomical Society (AAS), which has just ended. The Bruno Rossi Prize is the highest award in the field of high energy astrophysics and is given as acknowledgement of an achieved result of great importance, with special reference to the latest and most original research. The 2018 edition of the Prize went to Colleen Wilson-Hodge of the Fermi-GBM team, for “the discovery of gamma ray emission coinciding with the gravitational waves produced by coalescence of neutron stars. This means that the phenomenon can be confirmed, but also that a worldwide multi-messenger observational campaign can be launched”. This award for the Fermi mission, which also celebrates its tenth anniversary this year, brings its collection to four Bruno Rossi prizes. The three previous prizes were acknowledgements of results achieved using data from the LAT (Large Area Telescope, the other instrument on board of the satellite, together with the Gamma-ray Burst Monitor, GBM): two of them earned by the LAT team and the other by researchers outside the team. ■

MEDICAL APPLICATIONS

PROTONS AND BORON, A POSSIBLE ALLIANCE IN THERAPY

There are positive results from experiments on cells using boron in proton therapy. The experiments, which were conducted by an international team of Italian and Czech researchers, seem to demonstrate for the first time that a reaction from a fusion of proton and boron 11 (^{11}B) can be effectively achieved in cancerous cells. This result would make the reaction potentially useful for the treatment of tumours with proton therapy, by increasing the biological efficacy of the “shells” (the protons) used to “bombard” and destroy the tumour cells. The experimental method, called Proton Boron Capture Therapy (PBCT), involves administering molecules containing nuclei of ^{11}B inside the tumour mass, which is then bombarded with a proton beam. The latter interacts with the nuclei of ^{11}B giving a very high probability of producing three low energy alpha particles (around 4 MeV). These three alpha particles that are emitted stop immediately and release all of their energy inside the single cell, causing enormous biological damage to add to that generated by the proton incidence. The presence of the substance containing the ^{11}B nuclei in the tumour cells has been shown to increase by up to 30% the biological efficacy of cell deaths. The research is based on irradiating various tumour cells in differing conditions over the course of two years of intense experimental activity, carried out in the Southern National Laboratories (LNS) of INFN. ■

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STUDYING THE STARS UNDER A MOUNTAIN: THE LABORATORIES OF GRAN SASSO, A STORY OF THIRTY YEARS OF EXCELLENCE

15 January was a special day for the National Laboratories of Gran Sasso (LNGS) of INFN. It was the 30th anniversary of the world's most important underground laboratory dedicated to astroparticle physics. The guest of honour for the celebration of this major anniversary was the President of the Italian Republic, Sergio Mattarella, who visited the experimental rooms inside the Gran Sasso mountain massif before meeting the INFN community and leaving a message of thanks and congratulations for the work already completed, as well as best wishes for the future.

In terms of dimensions and worth of the scientific instrumentation, the INFN National Laboratories of Gran Sasso are the biggest and most important underground research centre in the world, where internationally known scientists and Nobel Prize winners conducted their research and continue to operate, names such as Carlo Rubbia and Barry Barish who was awarded a 2017 Nobel Prize for the discovery of gravitational waves. The LNGS were designed and built beneath 1400 metres of rock, to the purpose of exploiting the protection of the mountain against cosmic radiation, which constantly hits the Earth. The Laboratories are therefore immersed in what physicists call 'cosmic silence', which is a necessary condition for carrying out scientific activity involving the study of extremely rare phenomena that are difficult to detect.

In 1979 Antonino Zichichi, then president of INFN, had the remarkable idea of equipping the Institute with a large underground laboratory with leading edge technological structures, to study the new frontiers of physics. This research infrastructure meant that Italy could, for the first time, carry out a scientific enterprise that was unique in the world and would therefore be able to attract physicists from every continent. The excavation works for constructing the underground rooms started in 1982 and in 1987 the laboratories were able to start their scientific activities and host the first experiments.

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The LNGS are around 120 km away from Rome, in the region of Abruzzo, inside the motorway tunnel between the towns of L'Aquila and Teramo, which passes for 10 km inside the Gran Sasso massif. They are equipped with three large rooms for experiments, each one is about 100 m long, 20 m wide and 18 m high, together with service tunnels, making up a total volume of 180,000 cubic metres. The laboratories are used today as a structure on a worldwide level by scientists from around thirty different countries: currently there are around one thousand people engaged in around fifteen experiments at various stages of completion.

The main areas of research of the current scientific programme of the LNGS are the physics of neutrinos, those produced naturally, either by nuclear reactions in the Sun or by supernova explosions; direct research of dark matter; and the study of nuclear reactions of interest for astrophysics and for the understanding of rare decays.

Because of their structural characteristics, their leading edge experimental equipment and the competencies of the researchers that have worked here over these thirty years, the INFN National Laboratories of Gran Sasso represent a leading international infrastructure on a worldwide level in fundamental physics research and a priceless resource for the area and the whole country, as a centre of production of science and knowledge that is unique in the world, with a history of excellence, part of the tradition of Italian physics. ■

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Cover
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