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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 prioritised by ApPEC – multimessengers 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. ■