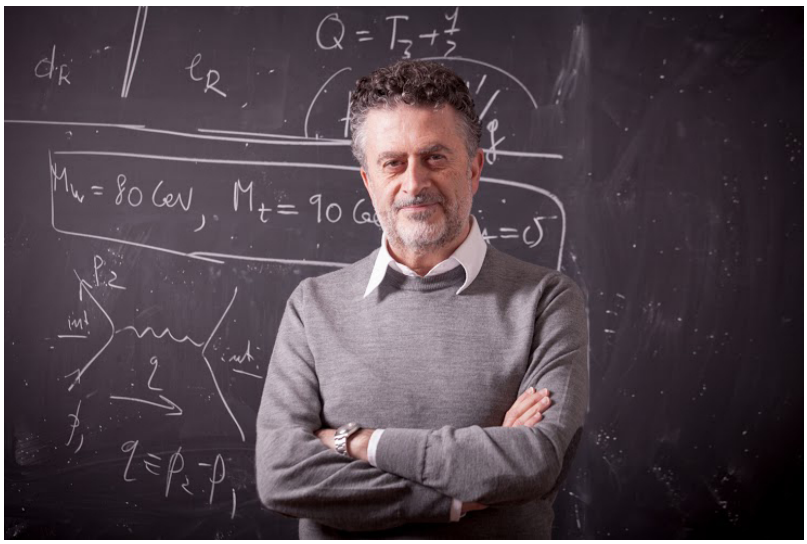
Newsletter Interview

BIG PHYSICS FROM BARCELONA TO EUROPE



Interview with Eugenio Coccia, director of IFAE, the Institut de Fisica d'Altes Energies, in Spain

IFAE, the Institut de Fisica d'Altes Energies, is a fundamental physics research centre, set up in 1991. Its headquarters are in Barcelona on the campus of the Universitat Autonoma de Barcelona (UAB), one of the largest and best Spanish universities. Since November 2022, it has been directed by Eugenio Coccia, INFN researcher, professor at the Gran Sasso Science Institute in L'Aquila, of which he was a supporter and rector right from its foundation, and former director of INFN Gran Sasso National Laboratories. On the European scene, IFAE is one of the leading institutes of many of the main fundamental physics projects. Thus, we asked Coccia to tell us how the institute approaches new challenges, from future particle accelerators to studying gravitational waves, and to introduce us to the scientific line that the institute he directs will follow in upcoming years.

Can you introduce us to the Institut de Fisica d'Altes Energies and its main scientific activities?
From particles to the Cosmos: IFAE's mission is to conduct top theoretical and experimental research on the most important topics in particle physics, astrophysics, and cosmology and, at the same time, to apply this knowledge and the technologies thus acquired to strategic sectors for society, such as medical physics and quantum technologies.
From a legal standpoint, IFAE is a public consortium between the Generalitat de Catalunya and the UAB. It has complete autonomy, answering only to the Government Council headed by the Catalan Minister for Research and Universities.
We are not a large institute but we are very well equipped to participate in the activities we consider at the forefront and in which we're involved in leadership positions or as a major partner. I'm talking, in particular, about activities conducted in international collaborations, like ATLAS, T2K, MAGIC, CTA, Virgo, Einstein Telescope, DES, PAU, DESI, Euclid, and LSST. For this, IFAE involves more than one hundred international researchers and around thirty engineers and technicians who perform their work using state-of-the-art laboratories and mechanical and electronic workshops. The projects that require strong computing resources are supported by one of the best computing centres in Europe, the PIC (Port d'Informacion Cientifica), which hosts one of the Tier-1 of LHC, among other things. Managed by IFAE, the PIC is a joint venture between IFAE and CIEMAT, the Spanish national centre for research and technology. IFAE's scientific staff participates in Universitat Autonoma de Barcelona (UAB) programmes, in particular teaching in the master's courses in High-energy physics, Astrophysics, and Cosmology. In turn, various teachers of the UAB are associated with IFAE. This positive relationship, well known to INFN, enables, among other things, to call many PhD students in our

field.
I should also add that IFAE's scientific activities are evaluated by an international scientific committee, headed by Nobel laureate Barry Barish from this year.

The main scientific projects that Europe is focusing on include, of course, the Einstein Telescope (ET), the large future research infrastructure for detecting gravitational waves. What role does IFAE have in this project?
In 2019, after reflecting on the most promising future activities, the institute decided to participate in research into gravitational waves, attracted precisely by the fascinating prospects of the Einstein Telescope project. An experimental group immediately, successfully joined the Virgo experiment, looking after the study and monitoring of diffuse light that propagates in the interferometer in particular. This topic exploits IFAE's experience in developing detectors and, in particular, light sensors. From then, the group grew, under the leadership of Mario Martinez, and became part of the ET collaboration right from the set-up of the scientific collaboration, in May of last year. IFAE considers ET a flagship project and is committed to making this new observatory possible alongside INFN and the other European bodies participating in it. IFAE's commitment can also be seen in the role held by Martinez who is the leader of the ET-Preliminary Phase European project and is a member of the ET directorate. With regard to the visibility of IFAE in the ET, I should also add that, in November of last year, right when I was becoming director of IFAE, I was elected Chair of the ET Collaboration Board. The work organising ET is just at the start but it's clear that we want to participate in the R&D work on some key aspects of the experiment, including precision optics, the vacuum, and monitoring diffuse light.
We've been discussing precisely this in recent months with our colleagues, first of all with our INFN colleagues.
We are also very interested in data analysis, especially for information that the signals will give us in terms of fundamental physics.

Another ambitious European project is the Future Circular Collider at CERN. How is IFAE involved in this project?
In 2016, a collaboration was set up between CERN, IFAE and other Spanish centres (ICMAB, UPC, ALBA Synchrotron) to study the behaviour of high-temperature superconductor-coated conductors (HTS-CCs) for the screens of the Future Circular Collider (FCC-hh) beam. IFAE has designed and constructed a machine dedicated to studying its properties under mechanical stress. The work, funded by CERN, was extended to build a proof-of-concept device for the screen of the FCC-hh beam based on HTS-CC.

What does IFAE believe it's important to aim for?
In addition to the commitment to gravitational waves, we want to consolidate our role in particle physics in LHC developments, high-energy astrophysics with CTA, and observational cosmology. A fundamental aspect of this consolidation lies in the capacity to select and train young leaders - I would say that this is truly the priority.
IFAE can leverage the excellence and great freedom of research that characterise its environment and the attractiveness that Barcelona's cultural vivacity presents to young people from around the world.
But there are other two sectors in which I'd like to keep investing: applied physics and outreach.
We have extraordinary activities in terms of applied physics. Since 1999, IFAE has used its experience with radiation detectors to develop advanced medical imaging devices. IFAE has joined the Medipix collaboration, with its headquarters at CERN, led European projects, and generated several patents and a spin-off company.
In addition, IFAE has been very engaged in quantum technologies since 2019. The special implementation developed at IFAE, quantum annealing, is one of the most promising paths for obtaining an advantage over

conventional computers. The IFAE group has already demonstrated the first manipulation of coherent qubits and, in Spain, has established itself as the main experimental group in quantum computing, coordinating two H2020 projects and creating the Qilimanjaro Quantum Technologies S.L. (QQT) spin-off, which represents our bridge with industry for quantum applications.
In terms of outreach, I have a plan for strengthening IFAE activities, already intense, with more dedicated staff and a wider range of public initiatives.

We've spoken, in particular, about two big projects that represent the possibility of Europe's preserving its leadership in the gravitational wave and high-energy physics research sectors. Considering the great big science projects, but not just these, and the big challenges for our society, how do you see the future of physics in Europe?
I have faith, if Europe doesn't forget itself in this complex historic period. Europe has a long tradition of excellence in physics and in its capacity to train young people in research. This tradition mustn't be lost and so we need to continue investing in basic research, the engine of all applied research, to stubbornly promote international collaborations, and with maximum openness, and to courageously develop research infrastructure and ecosystems for technological innovation. I don't see signs of decline in this respect, just a few creaks.
I want, though, to broaden the discourse. The future of physics in Europe, and, more generally, the future of European science, will surely depend on how strongly it continues to believe in the importance of fundamental research. It will, however, especially depend on how much Europe wishes to defend its founding values in a world studded by social conflicts and authoritarian tensions. Science is done by people, and these people are attracted by places and communities not just where the recognition of merit is in force, but where fundamental freedoms and social solidarity are considered as non-negotiable values. These are the values of Europe envisioned by the founding fathers after two world wars. In the 1900s, when Europe fell into authoritarian oblivion, it lost incomparable talent, as we well know.

As you already mentioned beforehand, the dissemination of culture and scientific knowledge is a value to invest in, and you've always been very dedicated to this. Why do you think it's important to share scientific knowledge with society?
First of all, because our research is funded by the taxes that citizens pay. Therefore, I believe that we have a duty to communicate the results of our work to people in the most comprehensible way possible. Beyond the duty, there's also the pleasure: describing the motivations for our research, sharing the fascination of studying the universe with everyone, especially young people, its fundamental components and forces, research into our place in the cosmos. The satisfaction you feel when, by communicating, you manage to stimulate new interests in young people, interests that then determine their life choices, is priceless. I also like to experiment with forms of communication and exchange in which science and art prove to be two complementary forms of research, united by the fascination for the mystery of existence and making the invisible visible.

What is your recipe for doing good scientific research?
There are three fundamental ingredients: the first is curiosity, the passion for research. The second, the spirit of collaboration, with colleagues from different countries. The third, the sense of responsibility, in relation to society in general, students, and young researchers in particular. I would add, as you sometimes do with cocktails, two drops of another ingredient: optimism.