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Europe sets priorities for hunting cosmic particles

Club of physics funding agencies pushes for projects including a neutrino observatory in the Mediterranean Sea.

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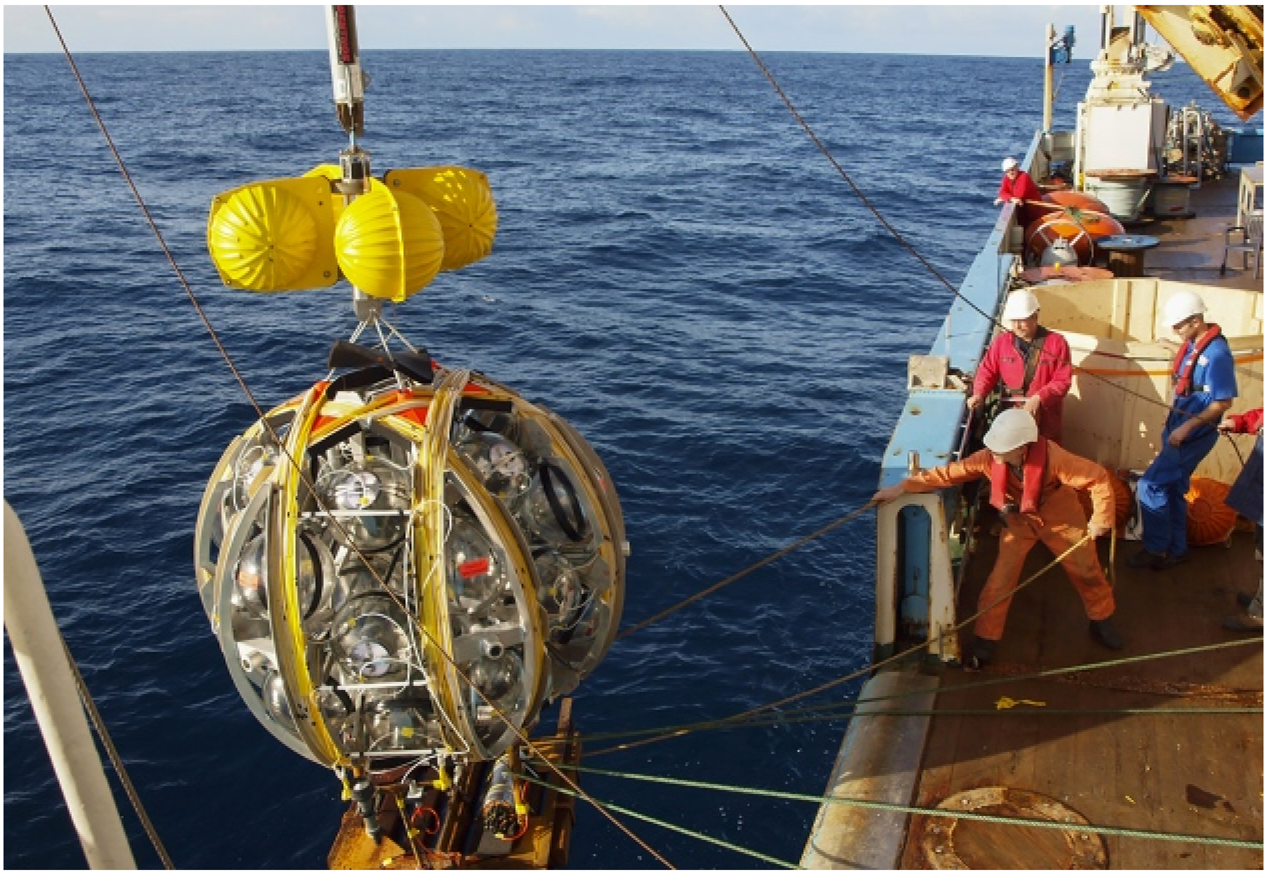

KM3NeT

The KM3NeT neutrino telescope is deploying arrays of light sensors deep in the Mediterranean Sea.

Neutrinos, dark matter and γ-rays top European physicists' wish list for the next decade of efforts to catch high-energy particles from space. The priorities are laid out in a roadmap for 2017–26, posted online last month by a group of funding agencies from fourteen European countries, ahead of being officially unveiled in January.

Twenty years ago, the field of astroparticle physics barely existed. But some of the major discoveries in particle physics — including neutrino research that earned Nobel prizes in 2002 and 2015 — are now coming from space-focused detectors, rather than through the more conventional venue of atom smashers. It's a field that ties together the largest and smallest scales of physics, says Antonio Masiero, a physicist at the University of Padua, Italy, from the expansion of the Universe to exotic types of nuclear decay: “The beauty of astroparticle physics is that it has no borders.”

The roadmap is the second such exercise by the Astroparticle Physics European Consortium (APPEC), which aims to coordinate funding plans for this fast-growing field. (CERN — Europe’s physics lab near Geneva, Switzerland — the European Southern Observatory and the European Space Agency do this for the continent’s particle-physics, astronomy and space-based facilities, respectively.) APPEC requested input from across the community, and held an open ‘town meeting’ in Paris in April 2016 before a panel of experts, chaired by Masiero, compiled the final document.

Infrastructure ideals

The resulting strategy covers huge observatories all the way down to tabletop experiments. At smaller scales, it urges funding agencies to be open to innovative proposals. But when it comes to the largest facilities, the strategy is to be “resource aware”, says Masiero: focusing on only a few projects and requiring only a modest increase over current funding levels. It’s not a “Santa Claus list”, agrees Frank Linde, a particle physicist at the Dutch National Institute for Subatomic Physics in Amsterdam and former APPEC chair.

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Among the big projects endorsed by APPEC is the Cubic Kilometre Neutrino Telescope (KM3NeT), a double array of deep-sea light sensors being built by a primarily Dutch, French and Italian collaboration. One site, off the coast of Toulon, France, is designed to detect relatively low-energy neutrinos produced by cosmic rays hitting the atmosphere, whereas the other, off the southern tip of Sicily, Italy, will aim to catch the signature of the highest-energy neutrinos coming from outer space, after they have travelled through Earth. Researchers hope to figure out where these particles come from.

So far, KM3NeT has received one third of the approximately €150 million (US$177 million) in funding it would need for building the full-size detector, says spokesperson Mauro Taiuti, a physicist at the University of Genoa, Italy. The APPEC stamp of approval could help it to win the rest.

Another major piece of infrastructure that garnered support was the Cherenkov Array Telescope, a €300-million γ-ray observatory to be split between Spain's La Palma Island and Paranal, in Chile's Atacama Desert. The two arrays of optical telescopes will seek flashes of blue light produced in the atmosphere when a high-energy photon collides with a molecule of air, creating a cascade of secondary particles across the sky.

In the nascent field of gravitational-wave astronomy, which APPEC also covers, the big priority is the Einstein Telescope (ET), a next-generation triple interferometer that will have light beams running along three 10-kilometre arms in an equilateral triangle, instead of the two perpendicular arms that current detectors use. Like the Japanese interferometer KAGRA — now under construction — the proposed ET would be built underground, to protect it from vibrations ranging from footsteps to falling leaves, says B. S. Sathyaprakash, a physicist at Pennsylvania State University in University Park, who helped to design it.

Dark-matter dash

APPEC also wants Europe to double-down on existing efforts to spot dark matter, calling for a dramatic scale-up of experiments that use tanks of liquid argon and xenon, to look for traces of collisions between these mysterious particles and atoms of ordinary matter. The largest such detectors now contain more than three tonnes of the noble gases, but according to the roadmap they need to be ten times larger.

These searches bet on the theory that dark matter is composed of weakly interacting massive particles, or WIMPs. Some physicists have called for more investment in 'alternative' searches for dark matter, for example, looking for particles known as axions. The road map is a "vanilla document, clearly redacted not to ruffle any feathers", says Juan Collar, a physicist at the University of Chicago in Illinois. "If European programme managers follow this roadmap to the letter, they will turn the dark-matter field into a desert of ideas."

But Mario Livio, an astrophysicist at the University of Nevada in Las Vegas who has also called for broadening the search for dark matter, counters that concentrating efforts on WIMPs will allow Europe "to build on existing experience and facilities". Overall, the roadmap is "very reasonable", he adds. "The programme, if executed as envisioned, will address some of the most exciting questions in astroparticle physics."

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