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Image of just one of the detector modules equipping Antares CEA/Irfu

Antares, First Neutrino Telescope to Go Underwater

New neutrino detector begins operation... in the Mediterranean sea

The construction of the 12 observation lines of the first underwater neutrino telescope, Antares, is now complete and for more than a month now, two of the observation lines have been operational, continuously looking for any sign of neutrino particles coming from out of space. Antares is part of the European Antares collaboration, involving CEA-Irfu, IN2P3-CNRS, INSU-CNRS and Ifremer, but not only. Neutrinos are amongst the most mysterious elementary particles known to man. They are part of the fermion family, the group of leptons (the electron is part of it as well), bear no electrical charge and have an extremely low mass (no yet calculated). They also present extremely weak interactions towards normal matter, meaning that they pass through very massive objects without being absorbed and are not affected by magnetic fields, since their electrical charge is zero. Because neutrinos are weakly interacting particles, they are also extremely hard to detect, this usually translating into very big detectors in order to enhance as much as possible the chance of detecting a particle. The European Antares collaboration began in 1996; however, the true work began only in early 2006 with the installation of the first detection line, sitting some 400 meters above the Mediterranean sea floor, under 2,500 meters of water. Currently, all observation lines are in place and ready to monitor an area up to four times that of a standard football pitch. Because it sits beneath a column of water more than two kilometers high, Antares is both shielded from the cosmic rays coming from space and is provided with the total darkness required to detect neutrino particles. As neutrinos pass through the whole mass of the Earth, some of them are being absorbed and produce muon particles while others exit the other side. Eventually, some of these muon particles will interact with the atoms in the water, producing photon that can be then observed by the Antares neutrino telescope. This means that although the Antares telescope is located in the northern hemisphere of the planet, it is actually making observations on a patch of sky facing exactly the opposite side of the planet, which also includes the galactic nucleus of the Milky Way. Neutrinos coming from space are believed to be the key unlocking the secrets behind high-energy astronomy, because they can be produced during ultra-high-energy proton interactions in objects such as super massive black hole or supernova remnants. Most of the protons and photons resulting from such violent processes are eventually absorbed into interstellar matter, making observations extremely difficult. Neutrinos, presenting weak interactions towards normal matter have a much better chance of reaching our position, and relay the information regarding the violent phenomena taking place half way across the universe. Alternatively, Antares is set to look for possible confirmation of the theory that the center of the Sun or the Milky Way is mostly populated by dark matter accumulations. Dark matter and dark energy have been in the center of cosmological debates for more than seven decades, as it seems that as much as 95 percent of the mass of the universe is invisible to our instruments. The Antares telescope has been operating for little over a month (with only two lines); however, this doesn't appear to have stopped it in detecting several hundreds of neutrino particles created in the Earth's atmosphere by interacting with cosmic rays, tunneling all the way from the other side of the planet. Some of them could just as well come from the visible edge of the universe, but until more data is collected, they remain hidden.