IL NUOVO CIMENTO **39 C** (2016) 251
DOI 10.1393/ncc/i2016-16251-8

Colloquia: IFAE 2015

Search for cosmic neutrinos from point-like sources with the ANTARES Neutrino Telescope

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received 7 January 2016

Summary. — One of the main questions in Physics is the origin of high-energy cosmic rays. In the last decades great progress has been made related to their energy spectrum and composition but their origin remains uncertain. The observation of cosmic neutrinos can enlarge the information, as they can emerge from dense media and travel across cosmological distances without being deflected by magnetic fields nor absorbed by ambient matter and radiation. ANTARES is the first undersea neutrino telescope and the only one currently operating. Its location in the Northern Hemisphere allows for surveying a large part of the Galactic Plane, including the Galactic Centre, thus complementing the sky coverage of the IceCube detector installed at the South Pole. In this contribution the search for cosmic neutrino point-like sources using six years of data is described, no signal has been found and upper limits on the flux normalization for an energy spectrum $\propto E_\nu^{-2}$ have been set.

1. – Introduction

ANTARES (Astronomy with a Neutrino Telescope and Abyss environmental RESearch) consists in a matrix of 885 photomultiplier tubes arranged into 12 lines anchored to the sea bed at a depth of $\sim$ 2.5 km in the Mediterranean Sea, $\sim$ 40 km south-east from the coast of Toulon (France). The main purpose of ANTARES is the search for cosmic neutrino sources by detecting the Cherenkov radiation induced by the path in water of superluminal charged particles produced by the interactions of cosmic neutrinos near the detector. For detailed information about the detector, refer to [1].

2. – Search for point-like neutrino sources

The observation of point-like sources is possible by identifying a significant excess of events from particular spots (or small regions) of the sky. The analysis presented here [2], performed on the 2007–2012 data sample (livetime = 1338 days), uses muon tracks only, by charged current interactions of muon neutrinos, which offer a better angular resolution

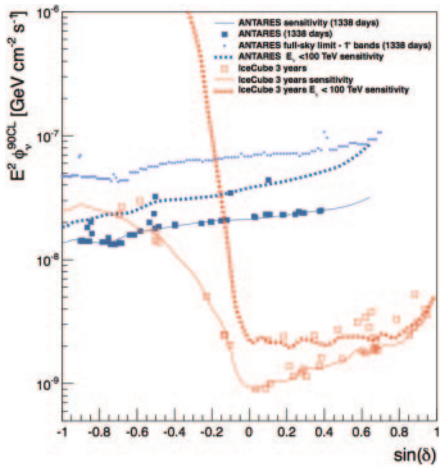

Fig. 1. – 90% CL flux upper limits and sensitivities for a point-like source with a spectrum $\propto E_\nu^{-2}$ as a function of the source declination for six years of ANTARES data. IceCube results are also shown for comparison. The dashed dark blue (red) line indicates the ANTARES (IceCube) sensitivity for neutrino energies lower than 100 TeV, showing that the IceCube sensitivity for sources in the Southern Hemisphere is mostly due to events of higher energy (taken from [2]).

than shower events. The median angular resolution achieved for a muon track, assuming an energy spectrum $\propto E_\nu^{-2}$, is $< 0.4°$ allowing good performance in the searches for neutrino point-like sources. The final neutrino sample has been obtained after tight cuts on the reconstruction quality parameter, called Λ, the estimated angular resolution ($< 1°$) and the zenith angle ($\cos\theta < 0.1$). Two different searches have been performed: a time-integrated full-sky search looking for an excess of events over the atmospheric neutrino background in the declination range $[-90°, +48°]$ and a candidate-list driven search looking for events in the directions of a predefined list of 50 candidate sources of interest which are known gamma-ray emitters and potential sites for hadronic acceleration. In both searches no significant excess over the background has been found and upper limits have been derived (fig. 1).

3. – Conclusions

The ANTARES neutrino telescope is in its eighth year of operation. Thanks to its location and to the excellent angular resolution it has set the best limits in the world for many (galactic) sources in the Southern Hemisphere, especially for $E_\nu < 100$ TeV. More competitive results are expected in the future as ANTARES will continue taking data at least until the end of 2016, when it will give way to the KM3NeT detector.

REFERENCES

[1] Ageron M. *et al.*, *Nucl. Instrum. Methods A*, **656** (2011) 11 (arXiv:1104.1607 [astro-ph.IM]).
[2] Adrian-Martinez S. *et al.*, *Astrophys. J.*, **786** (2014) L5 (arXiv:1402.6182 [hep-ex]).