Model-Dependent and Independent Stacking search for Seyfert neutrino emission with the KM3NeT/ARCA and ANTARES detectors

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MOTIVATION

Seyfert galaxies are not-jetted Active Galactic Nuclei (AGNi) powered by a super massive black hole (SMBH) positioned in their core. Accretion disk and magnetic dissipation processes form a hot magnetised corona which can be a source of high-energy neutrinos [1]. The recent evidence of neutrino emission from NGC 1068 found by IceCube [2] has sparked much interest in neutrino emission from these sources. In this contribution, following [3,4], we perform a stacking search over a catalogue of Seyfert galaxies using both the KM3NeT/ARCA and the ANTARES telescope. We search both for power-law spectra and for specific hot-corona models employed by [5,6].

NEUTRINO TELESCOPE

KM3NeT: is three dimensional grid of digital-optical-module (DOMs). Currently is under construction at two different site in Mediterranean sea: ARCA (Sicily, Italy), optimized to detect high-energy neutrino, and ORCA (Toulon, France) designed for low-energy atmospheric neutrino. Nowadays, ARCA consists in 28 lines, ORCA in 22 lines.

ANTARES: consisted in an array of 12 vertical strings of photomultiplier. It was taking data from 2007 to February 2022.

Right: an illustration of the KM3NeT final configuration

ANALYSIS METHOD

In order to evaluate the sensitivity of a source catalogue, a total binned log-likelihood is defined as following:

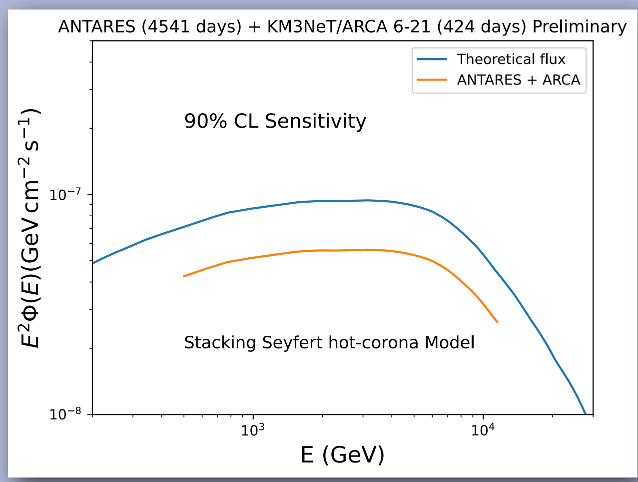
$$\log L_{tot}(ss) = \sum_{n=1}^{N} \log L_n(ss)$$

Where N is the total number of sources. For a given signal strength (ss) the sum is performed for each pseudo-experiment (PE). An unique fit is performed to obtain the global minimum. The test statistic is defined as following:

$$TS = \ log \frac{\mathscr{L}_{tot}(\hat{ss})}{\mathscr{L}_{tot}(0)}$$

HOT-CORONA MODEL

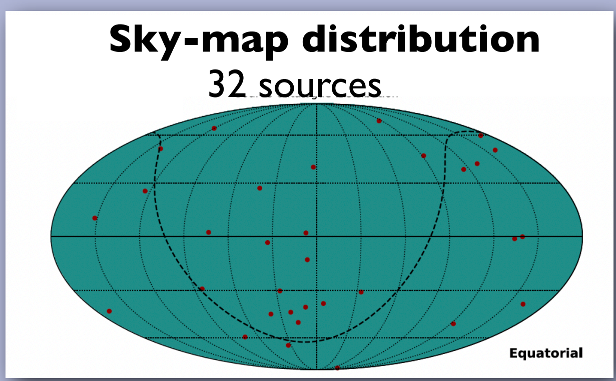
Specifics models have been employed to explain the neutrino of NGC 1068 [5,6]. Here, following [3,4], we performed a stacking analysis for these hot-corona model applied to 9 specific Seyfert. In the figure is reported the final sensitivity at 90 % C.L. considering ANTARES+ARCA detector.

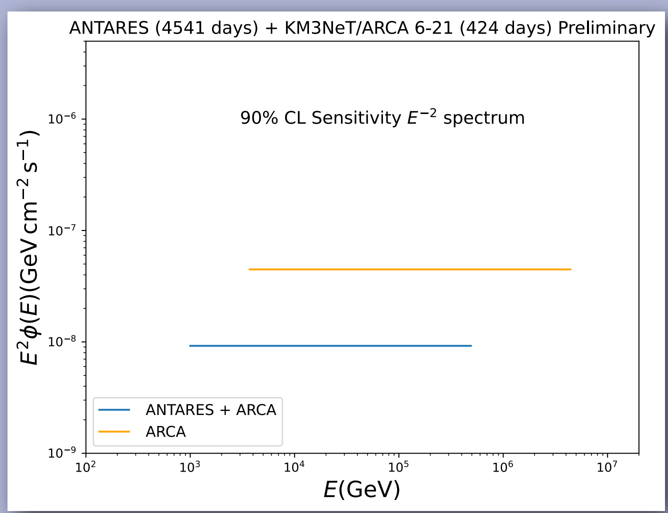


B.A.S.S. CATALOGUE SEARCH

The stacking analysis is performed considering 32 Seyfert galaxies chosen by the most luminous from the B.A.S.S catalogue.

Each source is weighted according to L_X/d^2 , where L_X is the intrinsic X-ray luminosity and d is the distance from the source. The sensitivity at 90% C.L. is calculated considering an energy spectra E^{-2} for each source. The calculation is performed using all track-like events of ANTARES and ARCA6+8+19+21 (blue line) and only ARCA (orange line).





EXTRAPOLATION TO THE WHOLE SKY

We determine the limit of the neutrino luminosity in terms of the X-ray luminosity for each source, in order to extrapolate the limits to the whole source population (see approach employ by the Fermi-LAT collaboration [10]).

Where L_X:

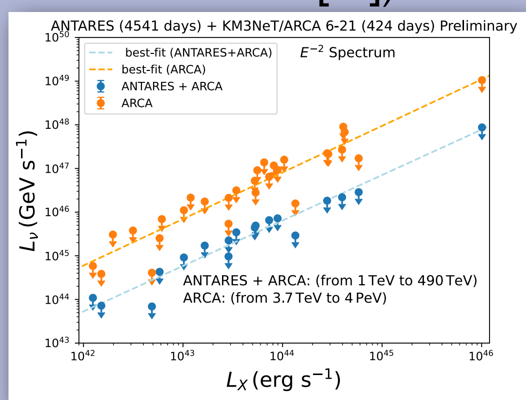
$$L_X = F_X 4\pi D_l^2$$

and L_ν:

$$L_\nu = 4\pi D_l^2 \phi_{1\,\mathrm{GeV}}^{\mathrm{sensi}} \int_{E_{\min}}^{E_{\max}} \left(\frac{E}{1\,\mathrm{GeV}}\right)^{-1} dE$$

Upper-limits fitted with

$$L_\nu \propto L_X^m$$

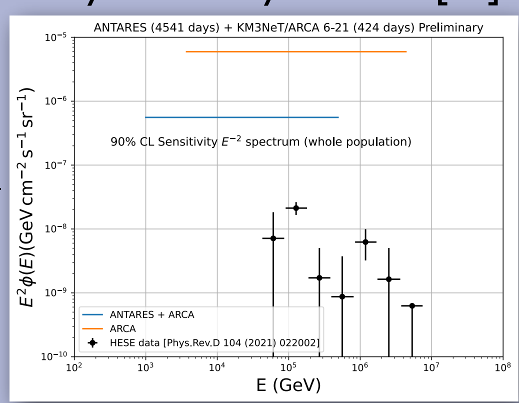


The final extrapolation using the x-ray luminosity function [11]

$$E^2\phi_{\nu+\bar{\nu}} = \frac{c}{4\pi H_0}\int_0^5 \frac{dz}{\sqrt{\Omega_M(1+z)^3+\Omega_\Lambda}} \times$$

$$\times \int_{10^{42}}^{10^{46}} \frac{dL_X}{L_X \ln 10}\,\frac{d\Phi_X(L_X,z)}{d\,\log L_X}\,\frac{L_\nu(L_X)}{\ln(E_{\max}/E_{\min})}$$

In figure are reported the extrapolated limits to the whole sky.



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