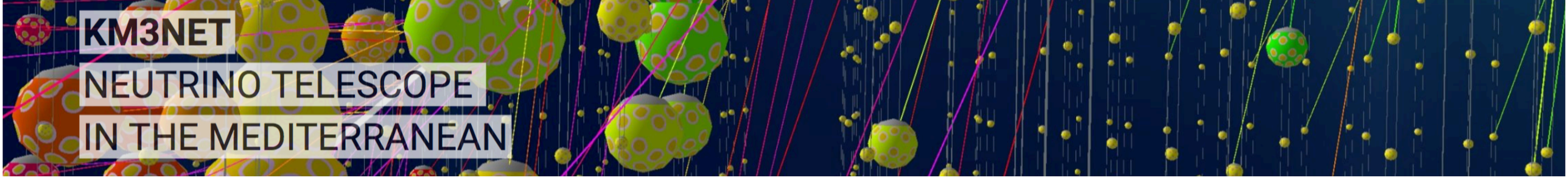
Search for Sterile Neutrinos with KM3NeT/ORCA and ANTARES

A. Domi„ Joao A.B. Coelho



Search for Sterile Neutrinos with KM3NeT/ORCA and ANTARES

A. Domi[1,2,3], J. Coelho[4]

For the **ANTARES** and **KM3NeT** Collaborations

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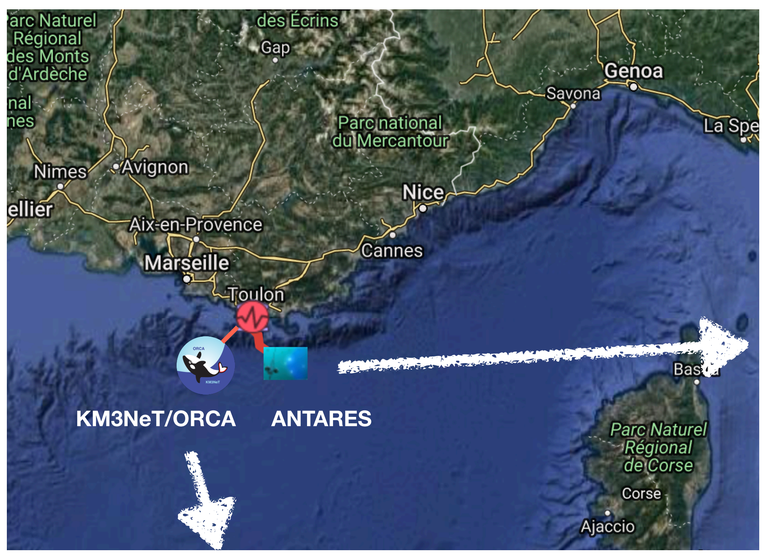
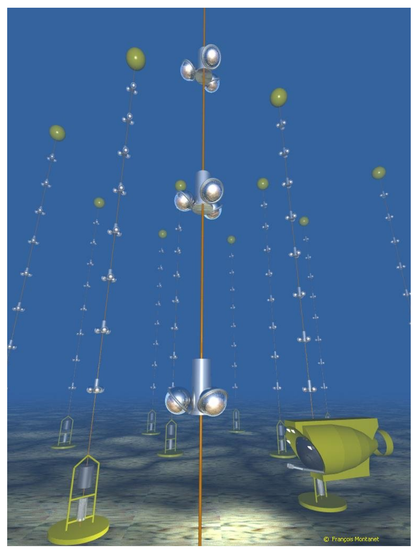
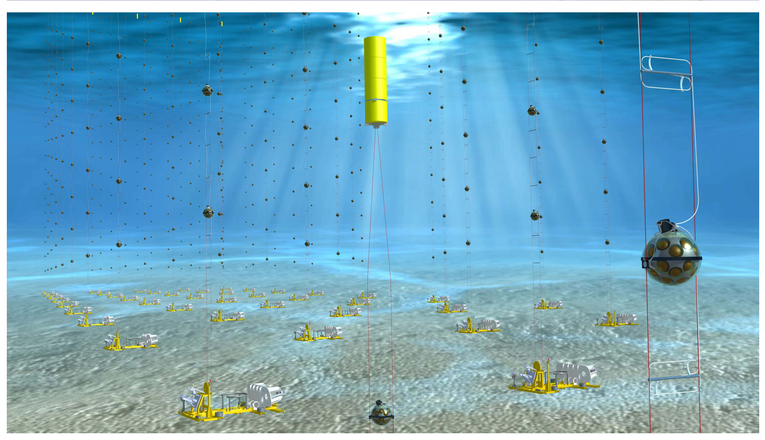
Anomalies in few reactors and short/long baseline experiments could be a hint of the presence of a light sterile neutrino (with mass ~1 eV).
The investigation of these anomalies is a top priority in neutrino physics ⟶ we can exploit the multi-potential of neutrino telescopes for this purpose!



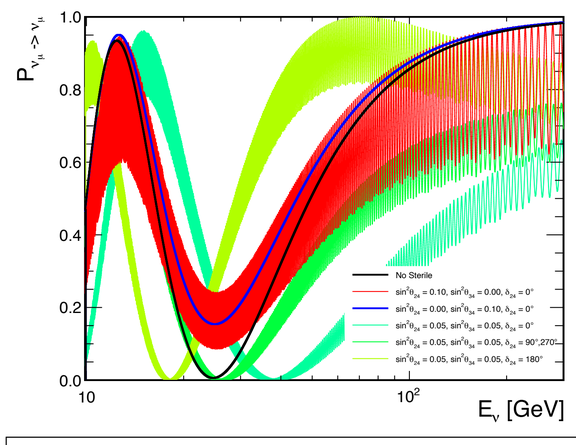


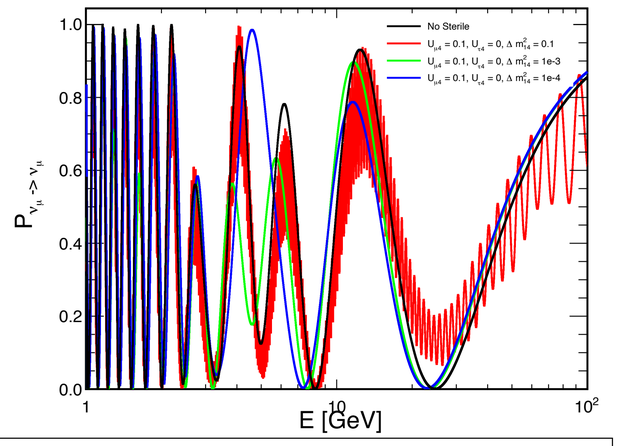


ANTARES [1] and KM3NeT/ORCA [2]: deep sea neutrino telescopes in the abysses of the Mediterranean Sea. Neutrino detection possible by detecting the Cherenkov light emitted from the charged particles produced in neutrino interactions in the water. Use of PMTs (17” for ANTARES, 3” for ORCA).

Atmospheric Neutrino Flux (HKKM 2014 - Gran Sasso site [3]**) used as input for this analysis.**

Oscillation pattern distorted by Earth’s Matter effects, the **PREM Model** [4], with 42 layers and realistic Z/A values is used for this analysis. ⟶ The possible presence of a light sterile neutrino changes the ν oscillation probablity.



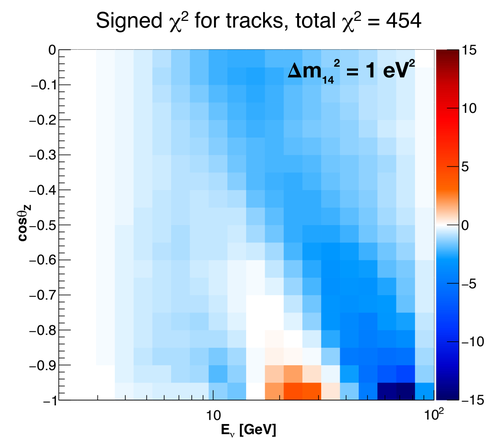


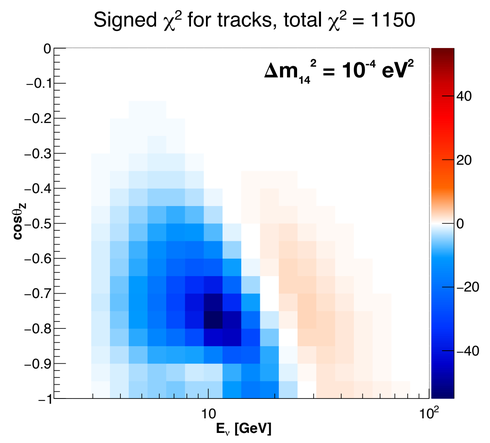
[1] The ANTARES Collaboration, ANTARES: the first undersea neutrino telescope. Nucl. Instrum. Meth. A 656 (2011) 11.
[2] The KM3NeT Collaboration, *Letter of Intent for KM3NeT 2.0*, Journal of Physics G: Nuclear and Particle Physics, 43 (8), 084001, 2016.
[3] M. Honda et al., Atmospheric neutrino flux calculation using the NRLMSISE-00 atmospheric model. Phys. Rev., D92(2):023004, 2015.
[4] Adam M. Dziewonski and Don L. Anderson. Preliminary reference Earth model. Physics of the Earth and Planetary Interiors, 25(4):297–356, 1981.
[5] The ANTARES Collaboration, Measuring the atmospheric,neutrino oscillation parameters and constraining the 3+1 neutrino,model with ten years of ANTARES data. J. High Energ. Phys. (2019) 2019: 113.

ANTARES Data Sample: from 2007 to 2016 (2830 days of livetime) [5].

ORCA Detector Response: a multi-dimensional response matrix is built from MC, taking into account triggering, reconstructions and particle identification and uncorrelated smearing of reconstructed energy and zenith angle..

$$\text{signed-}\chi^2 = \frac{(HP_{Sterile} - HP_{Standard})|HP_{Sterile} - HP_{Standard}|}{\sqrt{HP_{Standard}}}$$





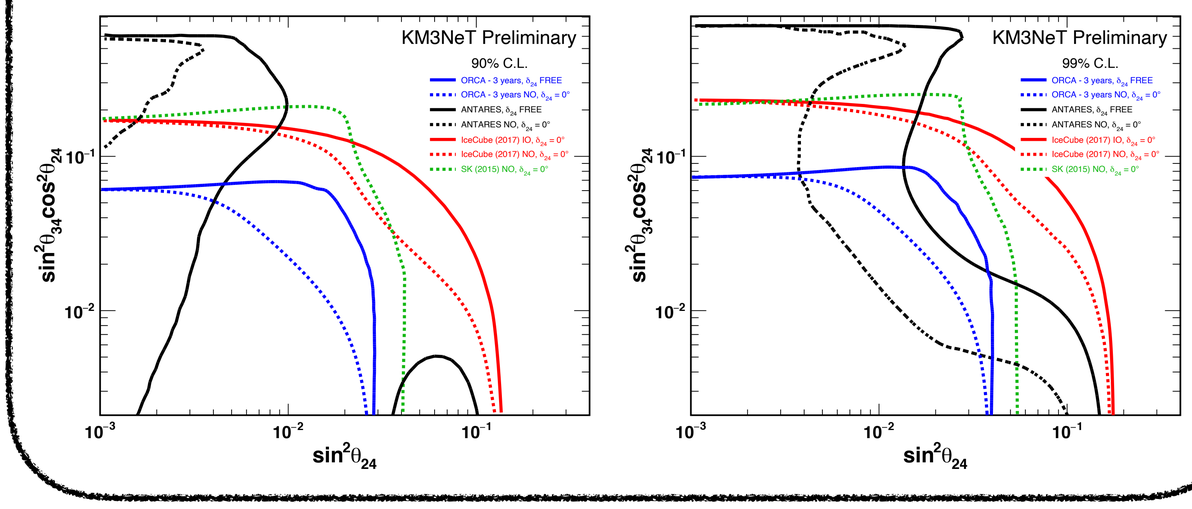
ANTARES Analysis

Parameter	Prior	Fit NH	Fit IH
θ_{24} [°]	none	$1.5^{+2.0}_{-5.0}$	$1.5^{+2.0}_{-5.0}$
θ_{34} [°]	none	$25.9^{+5.1}_{-4.2}$	$25.9^{+5.1}_{-4.2}$
δ_{24} [°]	none	180 ± 71	0 ± 72
n_ν	none	$0.84^{+0.10}_{-0.09}$	$0.84^{+0.10}_{-0.09}$
$\nu/\overline{\nu}$ [σ]	0.0 ± 1.0	$1.07^{+0.63}_{-0.55}$	$1.07^{+0.63}_{-0.55}$
$\Delta\gamma$	0.00 ± 0.05	-0.011 ± 0.036	-0.011 ± 0.036
Δm^2_{32} [10^{-3} eV^2]	none	$3.0^{+0.8}_{-0.6}$	$-3.0^{+0.6}_{-0.8}$
θ_{23} [°]	none	52 ± 8	52 ± 8
θ_{13} [°]	8.41 ± 0.28	8.41 ± 0.28	8.41 ± 0.28
M_A [σ]	0.0 ± 1.0	$0.11^{+0.93}_{-0.97}$	$0.11^{+0.93}_{-0.97}$

ORCA Analysis

Parameter	Prior
θ_{13}	$8.54° \pm 0.15°$
$\frac{\Delta m^2_{31}}{10^{-3}\text{eV}^2}$	2.49 ± 0.5
Flux Norm	1 ± 0.10
NC Scale	1 ± 0.05
ν_μ/ν_e Skew	0 ± 0.05
$\nu/\bar{\nu}$ Skew	0 ± 0.03
Energy Slope	0 ± 0.05
Energy Scale	1 ± 0.03

ORCA Sensitivity and ANTARES Upper Limits to Sterile Mixing Angles



ORCA Sensitivity and ANTARES Upper Limits to Low Sterile Masses