ANTARES SENSITIVITY TO DIFFUSE HIGH ENERGY NEUTRINO FLUXES

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The European collaboration ANTARES aims at operating a large deep-sea neutrino telescope in the Mediterranean sea. The detection of high-energy cosmic neutrino can improve our knowledge on the most powerful astrophysical sources in the Universe and about the origins of cosmic rays. A first Monte-Carlo study for the ANTARES sensitivity to diffuse neutrino fluxes predicted by current models is reported.

The goal of the ANTARES project is to observe Cherenkov light produced by high-energy muons induced by neutrino interactions in the matter surrounding the detector[1]. The neutrinos to be detected can most likely originate from : cosmic-accelerators, cosmic ray showers in the atmosphere or neutralino annihilations. Moreover, neutrinos are the only particles with all the required properties for high energy astronomy : they are neutral (no deflection by magnetic fields), stable and interact weakly (travel through cosmological distances and escape from dense regions of the universe). At high energy, the muon trajectory is closely aligned with the incident neutrino, so it indicates the source position in the sky with a good angular resolution of 0.2^o at high energy. ANTARES can therefore probe the fundamental physics of cosmic ray origins, neutrino oscillations and dark matter in the Universe.

The detector will be installed in the Mediterranean sea, at a depth of 2400 m, 40 km from La Seyne sur Mer (near Toulon, France). It will consists of 10 identical strings, each about 400 m high, supporting 30 storeys. Each storey has 3 downward looking optical modules. Each optical module is essentially a pressure resistant glass sphere containing a 10 inch photomultiplier (PMT). The PMTs detect the times and amplitudes for hits of Cherenkov light emitted by the muons when crossing the sea water. This information allows the reconstruction of the muon track with a good precision. The PMT positions will be determined to the required accuracy

($\sim$10 cm) by an acoustic positioning system composed of hydrophones and emitters and by a system of tiltmeters and compasses along the strings.

The astrophysical mechanisms likely to produce high energy neutrinos in general, are hadronic processes involving pion decay. Potential sources are particle accelerators in the Universe : extra-galactic sources like Active Galactic Nuclei (AGN) and Gamma Ray Bursts (GRB) or galactic sources like supernova remnants and binary stars.

The background comes from the shower development initiated by the interaction of a cosmic ray in the atmosphere. Atmospheric muons and neutrinos are produced by meson decays. The muon flux, which is the dominant component of the background, is suppressed by rejecting downward-going tracks. The atmospheric neutrino flux is composed of : the conventional neutrino flux, due to pion and kaon decays, dominant at low energy, known with an uncertainty of about 20 % ; and prompt neutrinos, due to the decay of heavy flavour particles, can be dominant at high energy. The discrepancy between different prompt neutrino flux predictions can reach two orders of magnitudes [2].

Diffuse neutrino fluxes based on unresolved source distributions are predicted by various models[3,4,5] leading to an event rate between 1 to 100 events per year in the ANTARES detector. The signal can be identified as an excess above the atmospheric neutrino background of high energy events. The muon energy estimator is based on the amount of light detected and leads to an energy measurement within a factor 3 of the true value above 1 TeV [6]. Monte-Carlo simulations show that the signal exceeds the background for energies above 1-10 TeV as illustrated in the Table 1. As an example, two different AGN models of diffuse neutrino fluxes have been

Table 1: Integrated number of events per year above a given Monte-Carlo muon energy threshold.

	Energy threshold		
	1 TeV	10 TeV	100 TeV
atmospheric (conv.)	240	19	0.2
atmospheric (conv. + prompt)	243 - 273	20 - 30	0.2 - 1.1
P96 [3]	29	25	14
SDSS91 [4]	136	129	76

considered : one by Protheroe [3] referred to as P96 where protons interact with radiations produced by the accretion disk, and another one by Stecker et al.[4] referred to as SDSS91 based on X-ray observations (already ruled out by the experimental upper limit given by the AMANDA collaboration[7]). Table 1 shows the expected number of events per year in the detector : above 100 TeV this number is between 0.2 and 1.1 for the atmospheric neutrino background, depending on the prompt neutrino flux used, around 14 (76) for the signal using the P96 (SDSS91) model.

The construction of the ANTARES detector is under way. Deployment of complete strings will start in 2003 and are due to terminate in 2005. After a few years of data taking, the ANTARES experiment will be able to measure the cosmic neutrino fluxes and therefore add new information on possible sources of high energy cosmic neutrinos.

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