# Preface

The ANTARES underwater neutrino telescope was successfully built and now it is operating in the Mediterranean Sea. It has the capability to detect charged particles by Čerenkov light using an array of 875 photomultipliers. Ultra high energetic muon neutrinos interacting with the medium produce muons with almost the same direction and energy as the original neutrinos. The detection of these muons gives information about the astrophysical source that has generated the high energy neutrinos.

The main task of the telescope is the search for cosmic sources of neutrinos. Super Novae Remnants, microquasars and Gamma Ray Bursts are candidates for compact, often point-like neutrino sources, while the Galactic Centre, the Galactic Plane, Fermi bubbles are candidates for extended sources. In particular, the analysis of the Fermi-LAT data has revealed a large structure centred around the Galactic Centre emitting gamma rays—the so-called Fermi bubbles. A promising explanation of this phenomenon is a Galactic wind scenario in which accelerated cosmic rays interact with the interstellar medium in the Fermi bubble regions producing pions. Gamma rays and high-energy neutrinos emission are expected with similar flux from the pion decay.

In this work the ANTARES data during 3.5 years were investigated for a possible emission of the high energetic neutrinos. No statistically significant excess of events was observed. Upper limits on the flux of neutrinos from the Fermi bubbles were derived for various assumed energy cutoffs at the source.

In the first chapter of this manuscript, high energy neutrino astrophysics is introduced. Motivating ideas and evidences of neutrino sources are described in Sect. 1.1. Neutrino detection is described in Sect. 1.2 starting from neutrino interaction with matter and focusing on the optical method of neutrino detection in which the products of interaction are detected by Čerenkov light emitted in the medium. Finally, atmospheric muons and neutrinos are introduced which present the main component of the background noise.

In the second chapter the ANTARES detector is described. Its design overview is done in the first section. The main focus is put on photomuliplier studies since

they have been part of this thesis work. Data acquisition and detector calibration are described in the following sections.

In the third chapter the detector simulation is described. The simulation of the detector response to cosmic neutrinos and the atmospheric background is important for physics data analysis. It is used for detector performance estimation, especially, the neutrino direction resolution and energy reconstruction capability. Also, the simulation is used for data quality control and event selection optimisation. A key ingredient of simulations is the sea water optical properties at the ANTARES site which have been described in detail. Another important part of the simulation is photons detection by optical modules. Detailed GEANT simulation of the optical modules was performed and has been part of this thesis work. Finally, environmental optical background is considered at the end of this chapter.

The fourth chapter describes event reconstruction which determines the neutrino direction and energy estimation. The data quality control and the data selection for the main analysis is described at the end of this chapter.

The fifth chapter is devoted to the main analysis of this thesis—a search for neutrino emission from the Fermi bubbles with the ANTARES telescope. The hypothetical neutrino emission is described in the first sections of the chapter. The background estimation method using the off-zones is done in the following ones. Then, the event selection optimisation is presented. Finally, the observed events are presented and compared with the background noise. Upper limits are evaluated using the likelihood elaborated in this thesis for this measurement following a Bayesian approach and compared with the existing methods.

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