Abstract

Neutrino astronomy plays a vital role in the broader field of multi-messenger astronomy. Neutrinos are ideal particles for investigation of processes happening in deep space. Their attributes allow them to travel tremendous distances in the universe unimpeded and thus providing undistorted information about deep-space phenomena. Conversely, these characteristics make neutrino detection a challenging endeavor.

This doctoral thesis is focused on two of the main neutrino telescopes in the world – Baikal-GVD and KM3NeT. In these telescopes, neutrinos are detected indirectly, through detection of Cherenkov radiation produced by secondary charged particles originating in neutrino interactions. The main aim of the part of the thesis dedicated to the Baikal-GVD neutrino telescope is the development of the double cascade reconstruction algorithm. Double cascade signature can be created in ν_τ interaction. Since the production of high-energy ν_τ in the atmosphere is negligible, detection of high-energy ν_τ provides a promising way of astrophysical neutrinos identification. In this part of the thesis, development as well as the precision and the efficiency of the first double cascade reconstruction algorithm for the Baikal-GVD neutrino telescope are presented. Moreover, the first results from the processing of the experimental data with the double cascade reconstruction algorithm are given. The second topic related to the Baikal-GVD neutrino telescope is the analysis of the ambient light present in Lake Baikal. Ambient light creates unavoidable background to neutrino identification, hence the systematic study of this light is essential. Time and spatial variations of the ambient light at the Baikal-GVD site are presented. The part of the thesis related to the KM3NeT neutrino telescope describes the study of internal noise of the basic detection unit of this detector – digital optical module. Internal noise corresponds to signals which are detected when no external sources are present. In order to suppress a primary source of background – atmospheric muons, the measurements were performed in the Modane underground laboratory. This part of the thesis includes the preparation of the experimental setup for these measurements, subsequent experimental measurements as well as the development of the Monte Carlo simulations corresponding to the Modane underground laboratory setup. Furthermore, the detailed analysis of Monte Carlo simulations and the data collected in the laboratory is presented.

Keywords: astrophysical neutrinos, neutrino telescopes, Baikal-GVD, KM3NeT, double cascades, digital optical module