Starlight beneath the waves : in search of TeV photon emission from Gamma-Ray Bursts with the ANTARES Neutrino Telescope
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Propositions associated with the dissertation

Starlight beneath the waves

In search of TeV photon emission from Gamma-Ray Bursts with the ANTARES Neutrino Telescope

1. Observing very-high energy (VHE) γ-rays from Gamma-Ray Bursts (GRBs) can provide clues on the origin of cosmic rays and the internal mechanism of GRBs.

   Chapters 1 & 2

2. The bulk Lorentz factor Γ of a GRB determines whether VHE γ-rays could escape from the GRB. The attenuation of VHE γ-rays by the cosmic infrared background limits possible observations only to GRBs with redshift $z \lesssim 0.3$.

   Chapter 2

3. Three factors determine the observability of VHE γ-rays from any GRB: Its high-energy spectral index, its distance, and the size of the detector.

   Chapter 4

4. A km^3 neutrino telescope could detect VHE γ-rays from single GRB events of redshift $z \lesssim 0.1$.

   Chapter 4

5. After 5 years of data taking period, said neutrino telescope has a $\sim$50% probability of detecting VHE γ-rays with at least 3σ significance and $\sim$25% probability of making a discovery with at least 5σ significance.

   Chapter 5

6. The photon effective area of the ANTARES neutrino telescope is approximately 1 m^2 at 5 TeV. It is suitable to detect only the nearest GRBs of redshift $z \lesssim 0.01$, but nevertheless complements spaceborne γ-ray detectors at higher energy regime.

   Chapter 7

7. In general, the background rate of a neutrino telescope is so low that detecting only 5 signal events already gives a 90% probability of making a discovery with 3σ significance. The problem lies in the very low probability of the occurrence of nearby GRBs.

   Chapter 9

8. No event associated with VHE γ-ray emission from GRBs was observed with the ANTARES telescope, however two nearby GRBs were within the field of view of IceCube. Considering the size of IceCube, it is important that they observe them

and apply the same analysis performed in this dissertation.

Chapters 11 & 12

9. Spaceborne instruments are still a GRB astronomer's best friend.
10. Future km^3 neutrino telescopes should also consider the prospect of detecting downgoing photon-induced muons in their design and site selection.
11. Astronomy has always been traditionally performed by observing photons of various energy, and hence the science can be classified by the energy of the observed photons. With the advent of multimessenger astronomy, classifying astronomy by the observed particles can become an actuality: photon astronomy, neutrino astronomy, graviton astronomy, etc.
12. Neutrino astronomers still require the electromagnetic informations of a potential neutrino source. A strong collaboration with photon astronomers is thus essential to produce the best analysis.
13. A professional astronomer is publicly imagined as someone who peeps through the eyepiece of a telescope during cold, clear nights. We should all move on beyond this romanticised image and construct a more realistic image.

Leiden, March 26th 2013
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