Search for cosmic neutrinos with ANTARES

Bogazzi, C.

Author: Bogazzi, Claudio
Title: Search for cosmic neutrinos with ANTARES
Issue Date: 2014-05-15

Appendices

A. Spectral functions

Several spectral functions have been introduced in this thesis. This appendix lists the main point source spectral models used to fit gamma-ray data. Typical units are GeV^{-1} cm^{-2} s^{-1}.

- **Power-law.** The power-law function can be expressed as:

$$\frac{dN}{dE} = N_0 \left(\frac{E}{E_0}\right)^{\gamma}. \tag{A.1}$$

where N_0 is the normalization factor, E_0 the energy scale and γ the spectral index. In neutrino astronomy the default spectral index is $\gamma = -2$.

- **Broken power-law.** The broker power-law function has the form:

$$\frac{dN}{dE} = N_0 \times \begin{cases} (E/E_b)^{\gamma_1} & \text{if E} < \text{E}_\text{b} \\ (E/E_b)^{\gamma_2} & \text{otherwise} \end{cases} \tag{A.2}$$

where E_b is the breaking energy, i.e. the energy at which the spectral index changes from γ_1 to γ_2.

- **Smoothly broken power-law.** The function is a low energy power-law with spectral index γ_1 which smoothly changes its spectral index to γ_2 at breaking energy E_b:

$$\frac{dN}{dE} = N_0 \left(\frac{E}{E_0}\right)^{\gamma_1} \left(1 + \left(\frac{E}{E_b}\right)^{\frac{\gamma_1 - \gamma_2}{\beta}}\right)^{-\beta} \tag{A.3}$$

where β is the smoothness of the break.

- **Exponential cut-off.** The function follows a power-law and rapidly decreases up to a maximum energy E_c:

$$\frac{dN}{dE} = N_0 \left(\frac{E}{E_0}\right)^{\gamma} e^{-E/E_c} \tag{A.4}$$

B. Run selection

In Chapter 6 we have briefly discussed the selection of the runs used in the analysis. In this appendix we describe this selection with more details.

Depending on the detector status and the optical background during data taking, physics runs are divided in the following four categories, called also Quality Basic (QB) flags [177]:

- **QB = 1.** Basic selection of runs for physics analyses.
- **QB = 2.** At least 80% of active OMs.
- **QB = 3.** Baseline rate $\leq$ 120 Hz and burst fraction $\leq$ 0.4.
- **QB = 4.** Baseline rate $\leq$ 120 Hz and burst fraction $\leq$ 0.2.

These run sets are cumulative, meaning that runs satisfying the condition QB = i with i = 2,3,4 satisfy the condition QB = i - 1 as well. All runs with QB $\geq$ 1 were chosen for the analysis. Among other criteria, the runs with QB $\geq$ 1 require these conditions:

1. Apparent run duration close to the effective run duration: $0 \leq \mathrm{T_{app}} - \mathrm{T_{eff}} \leq 450\,\mathrm{s}$. The apperent duration of a run is the time window between the start and the end of that run. The efficient duration corresponds to the livetime of the run, i.e. the product of the number of recorded frames and the frame duration (104.858 ms).
2. No runs which present synchronization problems.
3. No runs with double frames.
4. Muon rate between 0.01 Hz and 100 Hz.

Figure B.1 shows the QB flag for these runs.

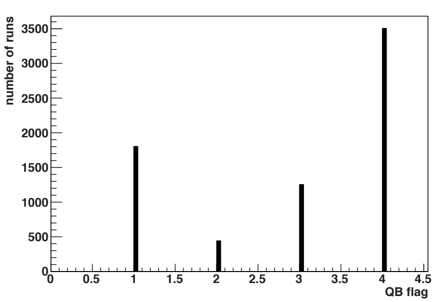

Figure B.1.: Number of selected runs for each of the QB flags.

B.0.1. SCAN runs

For some runs the data taking conditions were not recorded in the database. This makes it very hard to reliably simulate these data. Hence, these runs, flagged as "SCAN", are not included in the final selection. The integrated livetime of the "SCAN" runs is roughly 60 days. It is likely that a large number of these runs were taken under stable conditions, but additional work is required to select such runs. Experts in the ANTARES collaboration are working towards a possible inclusion of "SCAN" runs in all the analyses.

C. Calibration and alignment

Each selected run is calibrated within the SeaTray framework (see for example Chapter five of [178] for a detailed description). The calibration is performed by reading all the necessary parameters from the ANTARES database. In this way for each run the most appropriate calibration set is chosen. Different calibrations were used for different data taking periods as summarised in Table C.1.

The alignment procedure is assigned using a standard calibration software (version 0.994). For a total of 82 runs no valid alignment was found. Hence, the reconstruction of these runs was not possible. However, this is not a big loss since the livetime covered by these runs is roughly few hours.

First run	Last run	Label
25669	26796	2007:L5:v6.0
26770	27658	2007:L5:V6.0-bis
27659	28803	2007:L5:V6.1
28980	29761	2007:L5:V6.1-bis
29762	30427	2007:L5:V6.2
30508	31374	2007:L10:V7.0
31675	32491	2008:L10:V7.1
32529	33756	2008:L10:V7.2
34346	34976	2008:L12:V6.0
35000	36215	2008:L12:V6.1
36218	37475	2008::12:V6.2
37591	38759	2009:L12:V6.3-interlineoffset
38760	39589	2009:L12:V6.4
39590	40809	2009:L12:V6.6
40841	42425	2009:L12:V6.7
42477	42686	2009:L12:V7.1
42756	43282	2009:L12:V7.2
43285	44315	2009:L12:V7.3
45054	45565	2009:L12:V8.1
45459	47263	2010:L12:V2.0
47536	48064	2010:L12:V2.1
48484	49942	2010:L12:V2.2
50225	50955	2010:L12:V2.3
50958	52301	2010:L12:V2.4
52305	52853	2010:L12:V2.5
53074	53483	2010:L12:V2.7
53484	54045	2010:L12:V2.8
54049	54250	2010:L12:V2.9

Table C.1.: Versions of the calibration sets used and the range of runs which they were applied to.

Bibliography

[1] E. C. Krupp, *Echoes of the Ancient Skies: The Astronomy of Lost Civilizations*, Astronomy Series, Courier Dover Publications, 2003.

[2] V. Hess, Observations in low level radiation during seven free balloon flights, *Phys. Zeit*, **12**:1084-1091, 1912.

[3] J. Blümer, R. Engel and J. R. Hörandel, *Cosmic rays from the knee to the highest energies*, Progress in Particle and Nuclear Physics, **63**:293, 2009.

[4] K. Nakamura *et al.*, Review of particle physics, *J. Phys.*, G **37**, 075021 (2010).

[5] D. J. Bird *et al.*, Astrophys. J. *The Cosmic ray Energy Spectrum Observed by the Fly's Eye*, **424**:491, 1993.

[6] V. Berezinsky, A. Gazizov, and S. Grigorieva, *Dip in UHECR spectrum as signature of proton interaction with CMB*, Phys. Rev. D**74**, 043005, 2006.

[7] K. Greisen, *End to the Cosmic-Ray Spectrum?*, Phys. Rev. Lett. **16**:748, 1966.

[8] G. Zatsepin and V. Kuzmin, *Upper limit of the spectrum of cosmic rays*, JETP Lett. **4**:78-80, 1966.

[9] C. Bonifazi, *Angular Resolution of the Pierre Auger Observatory*, Proceedings of 29th ICRC, Pune, 2005.

[10] P. Abreu *et al.*, *Update on the correlation of the highest energy cosmic rays with the nearby extragalactic matter*, Astopart. Phys., **34**: 314-326, 2010.

[11] A. Cuoco and S. Hannestad, *Ultra-high energy Neutrinos from Centaurus A and the Auger hot spot*, Phys. Rev. D, **78**, 023007, 2008.

[12] E. Fermi, *On the Origin of the Cosmic Radiation*, Phys. Rev., **75**:1169-1174, 1949.

[13] G. F. Krymskii, *A regular mechanism for the acceleration of charged particles on the front of a shock wave*, Akademiia Nauk SSSR Doklady, **234**: 1306-1308, 1977.

[14] R. D. Blandford and J. P. Ostriker, *Particle Acceleration by Astrophysical Shocks*, Astrophys. J., **221**: L29-L32, 1978.

[15] J. N. Bahcall, A. Dar and T. Piran, *Neutrinos from the Supernova in the LCM*, Nature, **326**:135-136, 1987.

[16] http://www-sk.icrr.u-tokyo.ac.jp/sk/index-e/html

[17] K. S. Hirata *et al.*, *Observation in the Kamiokande-II detector of the neutrino burst from supernova SN1987A*, Phys. Rev. D, **38**:448-458, 1988.

[18] R. M. Bionta *et al.*, *Observation of a neutrino burst in coincidence with supernova SN1987A in the Large Magellanic Cloud*, Phys. Rev. Lett., **58**:1494, 1987.

[19] E. N. Alekseev *et al.*, *Possible detection of a neutrino signal on 23 February 1987 at the Baksan underground scintillation telescope of the institute of nuclear research*, JETP Lett., **45**:589-592, 1987.

[20] R. Claus *et al.*, *A wave shifter light collector for a water cherenkov detector*, Nucl. Instrum. Meth., **A261**:540-542, 1987.

[21] E. N. Alekseev *et al.*, *The Baksan underground scintillation telescope*, Phys. Part. Nucl., **29**:254-256,1998.

[22] G. Pagliaroli, F. Vissani, M. L. Costantini and A. Ianni, *Improved analysis of SN1987A antineutrino events*, Astropart. Phys., **31**:163-176, 2009.

[23] J. Becker, *High energy neutrinos in the context of multimessenger physics*, Phys. Rep., **458**:173-246, 2008.

[24] J. Alvarez-Muniz and F. Halzen, *Possible High-energy neutrinos from the cosmic accelerator RX J1713.7-3946*, ApJ, **576**:L33-L36, 2002.

[25] A. G. Cocco, G. Mangano and M. Messina, *Capturing Relic Neutrinos with β-decaying Nuclei*, J. Cosm and Astr. Phys., **6**:15, 2007.

[26] B. Pontecorvo, *Inverse β-process*, Report PD-205, Chalk River, Canada, unpublished.

[27] P. Anselmann *et al.*, *Solar neutrinos observed by GALLEX at Gran Sasso*, Phys. Lett. B **285**:376-389, 1992.

[28] http://www.sno.phy.queensu.ca

[29] V. Antonelli, L. Miramonti, C. Pen$\tilde{a}$-Garay and A. M. Serenelli, *Solar Neutrinos*, to be published in Special Issue on Neutrino Physics, Advances in High Energy Physics Hindawy Publishing Corporation 2012.

[30] T. Kashti and E. Waxman, *Flavoring Astrophysical Neutrinos: Flavor Ratios Depend on Energy*, Phys. Rev. Lett., **95**:181101, 2005.

[31] W. Bednarek, G. F. Burgio and T. Montaruli, *Galactic discrete sources of high energy neutrinos*, New. Astron. Rev., **49**:1, 2005.

[32] M. L. Costantini and F. Vissani, *Expected neutrino signal from supernova remnant RX J1713.7-3946 and flavor oscillations*, Astropar. Phys., **23**:477-485, 2005.

[33] K. Bernlor *et al.*, *The optical system of the H.E.S.S. imaging atmospheric Cherenkov telescopes, Par I: layout and components of the system*, Astropart. Phys., **20**:111-128, 2003.

[34] R. Cornils *et al.*, *The optical system of the H.E.S.S. imaging atmospheric Cherenkov telescopes, Par II: mirror alignment and point spread function*, Astropart. Phys., **20**:129-143, 2003.

[35] http://veritas.sao.arizona.edu/

[36] C. Baixeras, *The MAGIC Telescope*, Nucl.Phys.B (Proc.Suppl.), **114**:247-252,2003.

[37] F. Aharonian *et al.*, *Detection of TeV gamma-ray emission from the shell-type supernova remnant RX J0852.0-4622 with H.E.S.S.*, Astron. and Astrophys., **437**:L7, 2005.

[38] F. Aharonian *et al.*, *A detailed spectral and morphological study of the gamma-ray supernova remnant RX J1713.7-3946*, Astron. and Astrophys., **449**:223-242,2006.

[39] A. M. Hillas *et al.*, *The Spectrum of TeV Gamma Rays from the Crab Nebula*, ApJ, **503**:744,1998.

[40] W. B. Atwood *et al.*, *The Large Area Telescope on the Fermi Gamma-Ray Space Telescope*, ApJ, **697**:1071, 2009.

[41] M. Ackermann *et al.*, *Detection of the Characteristic Pion-decay Signature in Supernova Remnants*, Science, **339**:807-811, 2013.

[42] F. Aharonian *et al.*, *First detection of a VHE gamma-ray spectral maximum from a Cosmic source: H.E.S.S. discovery of the Vela X nebula*, Astron. and Astrophys., **448**:L43-L47,2006.

[43] F. Aharonian *et al.*, *3.9 day orbital modulation in the TeV gamma-ray flux and spectrum from the X-ray binary LS 5039*, Astron. and Astrophys., **460**:743-749,2006.

[44] J. Albert *et al.*, *Variable Very-High-Energy Gamma-Ray Emission from the Microquasar LS I +61 303*, Science, **312**:1771-1773,2006.

[45] C. Distefano *et al.*, *Neutrino Flux Predictions for know Galactic Microquasars*, ApJ, **575**:378-383, 2002.

[46] S. Adrián-Martínez *et al.*, *A time dependent search for neutrino emission from microquasars with the ANTARES neutrino telescope*, t.b.s., 2013.

[47] F. Aharonian *et al.*, *Very high energy gamma rays from the direction of Sagittarius A^**, Astron. and Astrophys., **425**:L13-L17,2004.

[48] F. Aharonian *et al.*, *Very high energy gamma rays from the composite SNR G0.9+0.1*, Astron. and Astrophys., **432**:L25-L29,2005.

[49] F. Acero *et al.*, *Localising the VHE gamma-ray source at the Galactic Center*, MNRAS, **402**:1877-1882, Issue 3,2009.

[50] M. D. Kistler and J. F. Beacom, *Guaranteed and Prospective Galactic TeV Neutrino Sources*, Phys. Rev. D., **74**:063007,2006.

[51] C. Lunardini and S. Razzaque, *High Energy Neutrino Emission from the Fermi Bubbles*, Phys. Rev. Lett., **108**:221102, Issue 22, 2012.

[52] F. Halzen and E. Zas, *Neutrino fluxes from active galaxies: a model independent estimate*, Astrophys. J., **488**:669, 1997.

[53] F. W. Stecker, *Note on high-energy neutrinos from active galactic nuclei*, Phys. Rev. D., **72**:107301,2005.

[54] J. K. Becker, P. L. Biermann and W. Rhode, *The diffuse neutrino flux from FR-II radio galaxies and blazars: a source property based estimate*, Astropart. Phys., **23**:355-368, 2005.

[55] V. Agrawal *et al.*, *Atmospheric neutrino flux above 1 GeV*, Phys. Rev. D., **53**:1314-1323, 1996.

[56] R. Abbasi *et al.*, *A Search for a Diffuse Flux of Astrophysical Muon Neutrinos with the IceCube 40-String Detector*, Phys. Rev. D., **84**:082001, 2011.

[57] J. A. Aguilar *et al.*, *Search for a diffuse flux of high-energy ν_μ with the ANTARES neutrino telescope*, Phys. Lett. B., **696**:16-22,2011.

[58] J. Becker, P. L. Biermann, J. Dreyer and T. M. Kneiske, *Cosmic Rays VI: Starburst galaxies at multiwavelengths*, A&A, 2009, arXiv:0901.1775.

[59] R. Abbasi *et al.*, *Time integrated search for Point-like Sources of Neutrinos with the 40-string IceCube Detector*, Ap.J., **732**:18, 2011.

[60] K. Murase, S. Inoue and S. Nagataki, *Cosmic rays above the second knee from clusters of galaxies and associated high-energy neutrino emission*, Ap. J., **689**:L105-L108, 2008.

[61] E. Waxmann and J. N. Bahcall, *High Energy Neutrinos from Astrophysical Sources: An Upper Bound*, Phys. Rev. D., **59**, 023002, 1999.

[62] E. Waxmann and J. N. Bahcall, *High energy astrophysical neutrinos: the upper bound is robust*, Phys. Rev. D., **64**, 023002, 2001.

[63] K. Mannheim, R. J. Protheroe and J. P. Rachen, *On the cosmic ray bound for models of extragalactic neutrino production*, Phys. Rev. D., **64**, 2001.

[64] P. Sreekumar *et al.*, *EGRET Observations of the Extragalactic Gamma-Ray Emission*, Ap.J., **494**:523-534, 2000.

[65] T. J. Galama *et al.*, *An unusual supernova in the error box ot the gamma-ray burst of 25 April 1998*, Nature, **395**:670-672, 2008.

[66] E. Waxmann and J. Bahcall, *High energy neutrinos from cosmological gamma-ray burst fireballs*, Phys. Rev. Lett., **78**:2292-2295, 1997.

[67] D. Guetta *et al.*, *Neutrinos from individual gamma-ray bursts in the BATSE catalog*, Astropart. Phys., **20**:429-455, 2004.

[68] R. Abbasi *et al.*, *An absence of neutrino associated with cosmic-ray acceleration in γ-ray bursts*, Nature, **484**:351, 2012.

[69] R. Abbasi *et al.*, *Search for muon neutrinos from gamma-ray bursts with the IceCube neutrino telescope*, Ap.J., **710**:346-359, 2010.

[70] M. Tavani *et al.*, *The AGILE mission*, Astron. and Astrophys., **502**:995-1013, 2009.

[71] P. Nolat *et al.*, , ApJS, **199**:31-77, 2012.

[72] F. Aharonian *et al.*, *The H.E.S.S. survey of the Inner Galaxy in very high-energy gamma-rays*, Ap.J., **636**:777-797, 2006.

[73] J. A. Hinton and W. Hofman, *Teraelectronvolt Astronomy*, ARA&A, **47**, Issue 1, 523-565, 2009.

[74] D. Ellison *et al.*, *Particle Acceleration in Supernova Remnants and the Production of Thermal and Nonthermal Radiation*, ApJ, **712**:861, 2008.

[75] Z. R. Wang, Q.-Y. Qu and Y. Chen, *Is RX J-1713.7-3946 the remnant of the AD393 guest star?*, Astron. and Astrophys., **318**:L59-L61, 1997.

[76] Y. Fukui *et al.*, PASJ, **55**:L61, 2003.

[77] E. Pfeffermann and B. Aschenbach, *Rosat observation of a new supernova remnant in the constellation scorpius*, Roentgenstrahlung from the Universe, 267-268, 1996.

[78] T. Tanaka *et al.*, *Study of Nonthermal Emission from SNR RX J1713.7-3946 with Suzaku*, ApJ., **685**, 988, 2008.

[79] H. Muraishi *et al.*, *Evidence for TeV gamma-ray emission from the shell type SNR RX J1713.7-3946*, A&A, **354**:L57-L61, 2000.

[80] F. Aharonian *et al.*, *Primary particle acceleration above 100 TeV in the shell-type Supernova Remnant RX J1713.7-3946 with deep H.E.S.S. observations*, Astron. and Astrophys., **464**:235-243, 2007.

[81] A. A. Abdo *et al.*, *Observations of the young Supernova remnant RX J1713.7-3946 with the Fermi Large Area Telescope*, ApJ, **734**:28, 2011.

[82] V. N. Zirakashvili and F. A. Aharonian, *Nonthermal radiation of young supernova remnants: the case of RX J1713.7-3946*, ApJ, **708**:965-980, 2010.

[83] M. A. Malkov, *Asymptotic Particle Spectra and Plasma Flows at Strong Shocks*, ApJL, **511**:53, 1999.

[84] T. Inoue *et al.*, *Toward understanding the cosmic-rays acceleration at young supernova remnants interacting with interstellar clouds: possible applications to RX J1713.7-3946*, ApJ, **744**:71, 2012.

[85] R. Dodson *et al.*, *The Vela Pulsar's Proper Motion and Parallax Derived from VLBI Observations*, ApJ, **596**:1137, 2003.

[86] A. Abramowsky *et al.*, *Probing the extent of the non-thermal emission from the Vela X region at TeV energies with H.E.S.S.*, submitted to Astron. and Astrophys. .

[87] O. C. de Jager, P. O. Slane & S. LaMassa, *Probing the radio to X-ray connection of the Vela X PWN with Fermi LAT and H.E.S.S.*, ApJ, **689**:125, 2008.

[88] T. C. Weekes *et al.*, *Observation of TeV gamma rays from the Crab nebula using the atmospheric Cerenkov imaging technique*, ApJ, **342**: 379, 1989.

[89] P. Goret *et al.*, *Observations of TeV gamma rays from the Crab nebula*, Astron. and Astrophys., **270**:401-406, 1993.

[90] P. Baillon *et al.*, *Gamma ray spectrum of the Crab nebula in the multi TeV region*, Astropart. Phys., **1**: 341-355, 1993.

[91] F. Aharonian *et al.*, *Observations of the Crab Nebula with H.E.S.S.*, Astropart. Phys., **22**:109-125, 2004.

[92] M. Tavani *et al.*, *Discovery of powerful γ-ray flares from the Crab Nebula*, Science, **331**:736-739, 2011.

[93] A. A. Abdo *et al.*, *γ-ray flares from the Crab Nebula*, Science, **331**:739-742, 2011.

[94] R. Zanin *et al.*, *MAGIC measurement of the Crab Nebula spectrum over three decades in eenergy*, Proceedings of the 32nd ICRC, 2011.

[95] A. Kappes *et al.*, *Potential Neutrino Signal from Galactic γ-Ray Sources*, ApJ, **656**:870-878, 2007.

[96] S. R. Kelner, F. A. Aharonian and V. V. Bugayov, *Energy spectra of gamma-rays, electrons and neutrinos produced at proton-proton interactions in the very high energy regime*, Phys. Rev. D., **74**:3, 2006.

[97] G. Morlino, P. Blasi and E. Amato, *Gamma Rays and Neutrinos from SNR RX J1713.7-3946*, Astropart. Phys., **31**:376-382, 2009.

[98] E. Amato and P. Blasi, *A general solution to non-linear particle acceleration at non-relativist shock waves*, MNRAS, **364**:L76-L80, 2005.

[99] E. Amato and P. Blasi, *Non linear particle acceleration at non-relativistic shock waves in the presence of self-generated turbulence*, MNRAS, **371**:1251-1258, 2006.

[100] F. L. Villante and F. Vissani, *How precisely neutrino emission from supernova remnants can be constrained by gamma ray observations?*, Phys. Rev. D,**78**:103007, 2008.

[101] B. Link and F. Burgio, *Flux predictions of high-energy neutrinos from pulsars*, MNRAS, **371**:375-379, 2006.

[102] E. Amato, D. Guetta and P. Blasi, *Signatures of high energy protons in pulsar winds*, Astron. and Astrophys., **402**:827-836, 2003.

[103] Y. Gallant and J. Arons, *Structure of relativistic shocks in pulsar winds: a model of the wisps in the Crab Nebula*, ApJ, **435**:230-260, 1994.

[104] M. A. Markov, *On high energy neutrino physics*, Proceedings of the 10^{th} International Conference on High Energy Physics, 1960.

[105] S. L. Glashow, *Resonant scattering of antineutrinos*, Phys. Rev., **118**:316, 1960.

[106] R. Gandhi *et al.*, *Ultrahigh-energy neutrino interactions*, Astropart. Phys, **5**:81, 1996.

[107] R. Gandhi *et al.*, *Neutrino interactions at ultrahigh energies*, Phys. Rev. D**58**, 093009, 1998.

[108] H. L. Lai *et al.*, *Improved Parton Distributions from Global Analysis of Recent Deep Inelastic Scattering and Inclusive Jet Data* Phys. Rev. D., **55**, 1280, 1997

[109] J. Pumplin *et al.* (CTEQ Collaboration), *New generation of parton distributions with uncertainties from global QCD analysis*, JHEP, **07**:12, 2002.

[110] S. Klimushin, E. Bugaev and I. Sokalsky, *Precise parametrizations of muon energy losses in water*, Proceedings of the 28th ICRC, 2001.

[111] P. A. Cherenkov, *Visible radiation produced by electrons moving in a medium with velocities exceeding that of light*, Phys. Rev., **52**:378, 1937.

[112] J. V. Jelley, *Cherenkov radiation and its application*, Pergamon Press, Oxford, UK.

[113] J. G. Learned and S. Pakvasa, Astropart. Phys., **3**:267, 1995.

[114] T. De Young, S. Razzaque and D. F. Cowen, *Astrophysical tau neutrino detection in kilometer-scale Cherenkov detectors via muonic tau decay*, Astropart. Phys., **27**:238-243, 2007.

[115] H. Hanada et al., *A highly sensitive optical detector for use in deep underwater*, Nucl. Instrum. Meth., **A408**:425-437, 1998.

[116] The Baikal Collaboration, *The Baikal neutrino project: Status report*, Nucl. Phys. B (Proc. Suppl.), **91**:438, 2001.

[117] J. A. Aguilar *et al.*,, *Transmission of light in deep sea water at the site of the ANTARES neutrino telescope*, Astroparticle Physics, **23**:131, 2005.

[118] C. Spiering, *Neutrino astrophysics in the cold: AMANDA, Baikal and IceCube*, Physica Scripta, **T 121**:112, 2005.

[119] P. Coyle, *The ANTARES Deep-Sea Neutrino Telescope: Status and First Results*, Proceedings of the 31^{st} International Cosmic Rays Conference, Lódź, Poland, 2009, e-Print: arXiv:1002.0754 [astro-ph.HE].

[120] P. Amran *et al.*, *The ANTARES optical module*, Nucl. Instrum. Methods, **A484**:369, 2002.

[121] J. A. Aguilar *et al.*, *AMADEUS - The Acoustic Neutrino Detection Test System of the ANTARES Deep-Sea Neutrino Telescope*, NIMA, **626**:128-143, 2011.

[122] J. A. Aguilar *et al.*, *The data acquisation system for the ANTARES neutrino telescope*, Nucl. Instrum. Meth., **A 570**:107-116, 2007.

[123] J. Ageron *et al.*, *The ANTARES optical beacon system*, Nucl. Instrum. Meth., **A 578**: 498, 2007.

[124] J. Aguilar *et al.* (ANTARES Collaboration), *Transmission of light in deep sea water at the site of the ANTARES neutrino telescope*, Astropartile Physics, **23**:131-135, 2005.

[125] A. Brown, *Positioning system of the ANTARES neutrino telescope*, Proceedings of the 31th ICRC, Lódź, 2009, e-Print: arXiv:0908.0814 [astro-ph.HE].

[126] G. Halladjian, *Recherce de neutrinos cosmiques de haute-energie emis par des sources ponctuelles avec ANTARES*, Ph.D. Thesis, 2010.

[127] D. Zaborov, Ph.D. Thesis, 2010.

[128] R. Abbasi *et al.*, *A search for a diffuse flux of astrophysical neutrinos with the IceCube 40-strings detector*, Phys. Rev. D, **84**, 082001, 2011.

[129] E. Zas, F. Halzen and R. A. Vaśquez, *High energy neutrino astronomy: horizontal air showers versus underground detectors*, Astroparticle Physics, **1**:297, 1993.

[130] Y. Becherini, A. Margiotta, M. Sioli and M. Spurio, *A parameterisation of single and multiple muons in deep water and ice*, Astroparticle Physics, **25**:1-13, 2006.

[131] V. Agrawal *et al.*, *Atmospheric neutrino flux above 1 GeV*, Phys. Rev. D, **53**:1314, 1996.

[132] M. de Jong, *The ANTARES Trigger Software*, Antares Internal Note, 2005.

[133] A. J. Heijboer, *Track reconstruction and point source searches with ANTARES*, Ph.D. Thesis, 2004.

[134] D. Bailey, *Monte Carlo tools and analysis methods for understanding the ANTARES experiment and predicting its sensitivity to Dark Matter*, Ph.D. Thesis, 2002.

[135] Parameters of the Preliminary Reference Earth Model are given by Adam Dziewonsky, Earth Structure, Global, in: *The Encyclopedia of Solid Earth Geophysics*, David E. James, ed. (Van Nostrand Reinhold, New York, 1989) p.331.

[136] G. D. Barr, T. K. Gaisser, P. Lipari, S. Robbins and T. Stanev, *Three-dimensional calculation of atmospheric neutrinos*, Phys. Rev. D., **70**:023006, 2004.

[137] P. Antonioli *et al.*, *A three-dimensional code for muon propagation through the rock: MUSIC*, Astropart. Phys., **7**:357-368, 1997.

[138] G. Carminati *et al.*, *Atmospheric MUons from PArametric formulas: A fast GEnerator for neutrino telescopes*, Comp. Phys. Comm., **179**:915-923, 2008.

[139] Y. Becherini *et al.*, *A parameterisation of single and multiple muons in the deep water or ice*, Astropart. Phys., **25**:1-13, 2006.

[140] J. Brunner, *Geasim: User manual*, ANTARES Internal Note.

[141] S. Navas and L. Thompson, *KM-A7 User Guide and Reference Manual*, ANTARES Internal Note, 1999.

[142] GEANT program manual, CERN program library long writeup, W5013, 1993.

[143] A. Heijboer, *TTS Analysis*, Antares Collaboration Meeting, September 2011, Bamberg.

[144] W. H. Press *et al.*, *Numerical recipes in C*, Cambridge University Press, 1993.

[145] Z. Zhang, *Parameter estimation techniques: A tutorial with application to conic fitting*, Image and Vision Computing Journal, **15**:59, 1997.

[146] http://root.cern.ch/root/html/TProfile.html

[147] C. Bogazzi, *Point source search with 2007-2010 data*, Antares Internal Note, 2011.

[148] E. V. Korolkova and L. Thompson, *Monte Carlo simulation of cosmic ray muons at sea level with corsika*, Antares Internal Note, 2003.

[149] E. V. Bugaev *et al.*, *Prompt leptons in cosmic rays*, Nuovo Cimento, **12**:41-73, 1988.

[150] J. A. Aguilar *et al.*, *Zenith distribution and flux of atmospheric muons measured with the 5-line ANTARES detector*, Astropart. Phys., **34**:179, 2010.

[151] C. Riviere, Run-by-run Monte Carlo simulation for ANTARES: v2, Antares Internal Note, 2012.

[152] S. Adrián-Martínez *et al.*, Search For Cosmic Neutrino Point Sources with Four Years of Data from the ANTARES Telescope, ApJ, **760**:53, 2012.

[153] G. J. Feldman and R. D. Cousins, *Unified approach to the classical statistical analysis of small signals*, Phys. Rev. D, **57**:3873-3889, 1997.

[154] S. Adrián-Martínez *et al.*, First Search for Point Sources of High Energy Cosmic Neutrinos with the ANTARES detector, ApJL, **743**:14, 2011.

[155] A. I. Nikishov, Soviet. Phys. JETP, **14**:393, 1962.

[156] R. L. Gould and G. P. Schreder, *Opacity of the Universe to High-Energy Photons*, Phys. Rev. Lett., **16**:252, 1966.

[157] J. V. Jelley, *High-energy gamma-ray absorption in space by 3.5 $^\circ$K microwave field*, Phys. Rev. Lett., **16**:479, 1966.

[158] Fits data from: http://www.mpi-hd.mpg.de/hfm/HESS/pages/publications/auxiliary/VelaX_auxin
.

[159] Fits data from: http://www.mpi-hd.mpg.de/hfm/HESS/pages/publications/auxiliary/auxinfo_rxj1

[160] F. Schussler *et al.*, *Multimessenger analysis of the ANTARES neutrino excess*, Proceedings of the 33$^{\rm rd}$ ICRC, Rio de Janeirio, July 2013.

[161] M. Ambrosio *et al.*, *Neutrino astronomy with the MACRO detector*, ApJ, **546**:1038, 2001.

[162] E. Thrane *et al.*, *Search for astrophysical neutrino point sources at Super-Kamiokande*, ApJ, **704**:503, 2009.

[163] R. Abbasi *et al.*, *Search for point sources of high energy neutrinos with final data from AMANDA-II*, Phys.Rev. D., **79**, 062001, 2009.

[164] T. Montaruli, *IceCube point source results and CR composition sensitivity*, talk at NuSKY, Trieste, 2011.

[165] G. C. Hill and K. Rawlins, *Unbiased cut selection for optimal upper limits in neutrino detectors: the model rejection potential technique*, Astropart. Phys., **19**:393, 2003.

[166] A. Margiotta, *The KM3NeT project: status and perspectives*, Geosci. Instrum. Method. Data Syst., **2**:35-40, 2013.

[167] R. Coniglione, *KM3NeT detection perspective of RX J1713.7-3946*, KM3NeT Collaboration Meeting, Marseille, 2013.

[168] R. Coniglione, *Discovery potential of Galactic sources*, KM3NeT Collaboration Meeting, Marseille, 2013.

[169] S. Schulte, *Update on NIKHEF point sources analysis*, ANTARES Collaboration Meeting, Marseille, June 2013.

[170] A. A. Abdo *et al.*, *FERMI-LAT discovery of GeV gamma-ray emission from the young supernova remnant Cassiopea A*, Apj, **710**:L92-L97, 2010.

[171] G. Morlino and D. Caprioli, *Strong evidence for hadron acceleration in Tycho's supernova remnant*, A&A, **538**:A81, 2012.

[172] Q. Yuan, P-F. Yin and X-J. Bi, *Neutrino emission of Fermi supernova remnants*, Astropart. Phys., **35**:33-38, 2011.

[173] M. Mandelartz and J. Becker-Tjus, *A statistical study of Galactic SNR source spectra detected at $>$ GeV energies*, ArXiv e-print, http://arxiv.org/abs/1301.2437

[174] S. Gkaitatzis, *Point Source Searches Using High-Energy Down-going Neutrinos with the ANTARES Telescope*, University of Amsterdam, 2011.

[175] http://www.aps.org

[176] C. Sutton, *Spaceship Neutrino*, Cambridge University Press, 1992.

[177] V. van Elewyck, *Data quality*, talk at the ANTARES Collaboration Meeting, November 2010, Amsterdam.

[178] E. Presani, *Neutrino induced showers from gamma-ray bursts*, Ph.D. Thesis, 2011.