Search for a small scale anisotropy with 3 years of the IceCube detector

Anna Bernhard TU München

> VLVnT August 2013 Stockholm

Motivation



- Is there a hidden signal coming from various weak sources?
- Search for event clustering at angular scales comparable to detector resolution
- A possible signal scenario: A number of small event clusters
- Complementary to point source (needs strong flux) and diffuse search (needs many sources)
- no prior information about the potential sources is required

Motivation

 Last search was done in 2008 on AMANDA, now we have 3 years of IceCube data (IC40+IC59 and IC79)



AMANDA Max significance: 1.60

IceCube: the largest neutrino detector

- A neutrino detector located at the south pole
- 5160 DOMs (digital optical modules) are installed in a depth of 1450m to 2450m and 162 surface stations (IceTop)
- Goal: observe the universe through high energy neutrinos instead of light



IceCube Configurations

IC79



Search for Event Autocorrelations



- **Method**: Count the number of event pairs given a maximum angular separation
- Compare this to distributions from isotropic data, which comes from scrambled data (with randomized RA)
- The maximum angular separation is varied up to 5°

This autocorrelation study

- Use 3 years of IceCube data (IC40+IC59+IC79)
- Use four different energy bins (all events, 10% highest events, 1% highest, 0.1% highest) for a better background suppression
- Scan an angular scale from 0° to 5° in steps of 0.25°
- Look at north and south seperate

Challenges:

Computationally not trivial since there will be many pairs

Fitting the pseudo experiments

- To get a 5 sigma significance we would need 10⁷ pseudo experiments, which takes too much time to produce
- Instead the background distributions are fitted
- The 2 highest energy bins (1% and 0.1% highest events) are fitted with a gamma distribution
- The 2 lowest energy bins (all and 10% highest events) are fitted with a gaussian
- This is possible because the gamma function converges to a gaussian for high statistics (high shape parameter)



How do we inject signal?







Injected Signal Distribution E⁻²:



Most sensitive bin for the north





- For the E⁻² spectrum the 1% energy bin seems to be the best, while for the cutoff spectrum the 1. energy bin seems to be the best
- The higher the energy the smaller the peak
 → better energy reconstruction at higher energies

Most sensitive bin for the south



 For the south in the E⁻² spectrum the 0.1% energy bin seems to be the best, while for the cutoff spectrum it stays with the 1. energy bin

Galactic plane

- Use the Green catalogue for the distribution of SNRs in the GP
- Distribute the sources following this distribution
- Then the events get weighted again for the acceptance





12

Discovery Potential E-2 for the north



Discovery Potential with exp. Cutoff at 10 TeV



Discovery Potential for random sources for the south



Results



 p-values are obtained from scrambled data

• North:

- Pre-trial p-value: 0.16
 - \rightarrow trial-corrected: <u>0.84</u>
- South:
 - Pre-trial p-value: 0.055

 \rightarrow trial-corrected: <u>0.78</u>

Underfluctuation in both hemispheres! → consistent with Multipole

Results North



Results South



Npairs North



Npairs South





Summary and Outlook

- An autocorrelation test was performed and a underfluctuation was observed in both hemispheres
 - Working on setting limits
- Add more data:
 - Use Spline based reconstruction
 - Extend analysis with data from the complete detector