Implications of neutrino flux limits
by the AMANDA experiment

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III. Interpretation of the diffuse signal
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$p \gamma \rightarrow \Delta \rightarrow \pi \rightarrow \nu \ldots$

$\nu N \rightarrow \ldots \mu, \text{casc}$
677 PMTs on 19 strings
Cherenkov light
Detection strategies

Point source searches - significance map?clustering of neutrinos
identified photon sources

AMANDA/IceCube FoV:
northern hemisphere
Detection strategies

Stacking strategy - sum signal of point sources of same source class

AMANDA/IceCube FoV: northern hemisphere
Detection strategies

Search for a diffuse signal: use complete northern hemisphere

AMANDA/IceCube FoV: northern hemisphere
Other strategies

Cascade analyses

Transient sources:
- Flares of permanent objects
- Gamma Ray Bursts → stacking approach, temporal clustering
- SGR 1860-20

Dark matter searches
- WIMPs
- Magnetic Monopoles

CR composition (IceTop)

Atmospheric muons, charm contribution

Acoustic detection

Talks Doug Cowen, Ty DeYoung
Talk Elisa Resconi
Poster Brennan Hughey
Poster Juande Zornoza
Poster Tom Gaisser
Talks Stephan Hundertmark, Justin Vandenbroucke, Buford Price
Search for single point sources

Event map - 4282 events in 5 years (2000-2004) - effective time: 1001 days

preliminary!
Search for single point sources

Event map - 4282 events in 5 years (2000-2004) - effective time: 1001 days

No significant signal - Limit map

90% confidence level flux upper limits for the northern hemisphere in 0.5 deg bins (15% systematic error included)
Stacking of AGN

- GeV blazars (EGRET) - GeV
- Unidentified EGRET sources - unidGeV
- Infrared sources - IR
- HAEO-A-detected keV sources - keV(H)
- ROSAT-detected keV sources - keV(R)
- TeV blazars - TeV
- Compact Steep Spectrum and Giga-Hertz peaked sources - CSS/GpS
- FR-I galaxies including M87 - FR-I(M)
- FR-I galaxies without M87 - FR-I
- FR-II galaxies - FR-II
- Radio-weak quasars - QSO
Stacking of AGN

preliminary!
Diffuse energy spectrum & limit

Energy spectrum (2000)


\[ E^2 \phi = 8.8 \times 10^{-8} \]

GeV cm\(^{-2}\) s\(^{-1}\) sr\(^{-1}\)

Poster Jessica Hodges

Hill et al., Neutrino 2006
X-ray AGN (I)

Nellen, Mannheim & Biermann

Stecker & Salamon
Space Science Rev. (1996)

Limits & IceCube sensitivity
Hill et al., Neutrino 2006

Limit strongly restrictive
→ Favoring IC scenario

log($E_\nu$/GeV)

$\Phi E_\nu^2$ [GeV sr$^{-1}$ s$^{-1}$ cm$^{-2}$]
Model-dependence of limit

- Not always $E^{-2}$
- Energy range of limits change with spectral index, $E^{-\gamma}$
- Higher energies for flatter spectra
Nellen, Mannheim & Biermann

Stecker & Salamon
Space Science Rev. (1996)

Limits & IceCube sensitivity
Hill et al., Neutrino 2006

Limit adjusted to model → 1 order of magnitude below flux
\[ \star = \nu + \gamma(\text{TeV}) \]
\[ \star = \nu \]
\[ \nu + \gamma(\text{TeV}) = \nu \]

\[ z = \infty \sim 10 \]

\[ z = 0.3 \]
TeV Blazars – ν spectrum

- Total diffuse ν flux:
  \[ E^2 \frac{dN}{dE} = \phi_0 \cdot \int_0^\infty (z+1)^{-2} \cdot \rho(z) \cdot \frac{dV}{dz} := \phi_0 \zeta(\infty) \]

- Neutrino flux up to a certain redshift:
  \[ E^2 \frac{dN}{dE} = \phi_0 \cdot \int_0^{z_{\text{max}}} (z+1)^{-2} \cdot \rho(z) \cdot \frac{dV}{dz} := \phi_0 \zeta(z_{\text{max}}) \]

- Absorption factor:
  \[ \eta(z_{\text{max}}) = \frac{\zeta(\infty)}{\zeta(z_{\text{max}})} \]
Absorption factor

\[ \eta(z_{\text{max}} = 0.3) < 53 \]

conservative estimate:
Maximum contribution

\[ \phi E^{-2}_v [\text{GeV sr}^{-1} \text{s}^{-1} \text{cm}^{-2}] \]

\[ \log (E_v / \text{GeV}) \]

- Atmospheric
- \[ \text{AMANDA-II, unfolded} \]
- \[ \text{diffuse limit (2000)} \]
- \[ \text{diffuse limit (00–03)} \]
- \[ \text{obs. TeV (} z_{\text{max}} \text{=} 1.0) \]
- \[ \text{sens. icecube (3yrs)} \]
- \[ \text{obs. TeV (} z_{\text{max}} \text{=} 0.3) \]
- \[ \text{MPR bound, } \tau_{\nu} < 1 \]

astro-ph/0607427

08/2006 Julia Becker, Universität Dortmund TeV particle astrophysics, Madison
Summary

- **Point source analysis** → no significant signal
- **Source stacking**: increase of sensitivity → limits to flux from source classes
- **Diffuse flux**: strong constraints →
  - **X-ray AGN**: most likely X-rays from Inverse Compton
  - **TeV-sources**: limit to contribution of TeV-photon observable sources
  - Limits adjusted to different flux models
- Very near future (9 strings working already!) →