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(for the AMANDA collaboration)

- The AMANDA detector
- Signal simulation
- Results from AMANDA-B10 (1997 data)
- Something about AMANDA-II (2000 data)
- The (not so far) future: IceCube
The AMANDA collaboration (in short):

The detector:

**AMANDA-B10 (1997):**
- cylinder of 500m. H x 120m. D
- 10 strings
- 302 Oms

**AMANDA-II (2000):**
- cylinder of 500m. H x 200m. D
- 19 strings
- (3 of them instrumented over 1-km. for ice studies)
- 677 OMs
WIMP ($\chi$) CAPTURE

- $\rho_\chi$: Density of WIMPs
- $\sigma_{\text{scatt}}$: Scattering cross-section
- $\Gamma_{\text{capture}}$: Capture cross-section
- $\Gamma_{\text{annihilation}}$: Annihilation cross-section

Earth

- $\nu_{\mu}$: Neutrino
- $\mu$: Muon

Sun

- $\nu_{\text{int}}$: Interaction
- Detector, $\Phi_{\mu}$
One sets limits to what one simulates!

**MSSM with 7 parameters**

- Higgsino mass parameter $m$ $[-50000,50000]$ GeV
- Gaugino mass parameter $M_2$ $[-50000,50000]$ GeV
- Ratio of Higgs VEV, $\tan \beta$ $[1,60]$ 
- Mass of CP-odd Higgs, $m_A$ $[0,10000]$ GeV
- Scalar mass parameter $m_0$ $[100,30000]$ GeV
- SUSY breaking parameters, $A_b$ and $A_t$ $[-3,3]$ on $A_i/m_0$

No restrictions from supergravity

except for gaugino mass unification at GUT scale

Parameter space scanned and models already rejected by accelerator searches discarded
For each model, the neutralino relic density, $\Omega_\chi h^2$, is calculated and only models with $0.025 < \Omega_\chi h^2 < 1$ are kept.

A galactic DM density of $0.3\text{ GeV/cm}^3$ and a DM velocity dispersion of $270\text{ km/s}$ have been assumed.

Annihilations into $\chi\chi$ 1 cc, $b\bar{b}$, $t\bar{t}$, $\tau\bar{\tau}$, $WW$, $ZZ$ were considered for 6 neutralino masses: 100GeV, 250GeV, 500GeV, 1000GeV, 3000GeV and 5000 GeV.

Hadronization and decay of the resulting products simulated with PYTHIA.

The resulting muon is tracked including energy losses until it decays or passes the detector.
Background to this search:
atmospheric neutrinos

Main handle:
angular distribution
**Analysis strategy:**

- Unstable runs, X-talk and noise hit cleaning
- Fast (line) fit and loose zenith angle cut (>70°)
- Likelihood reconstruction with use of photon scattering probabilities in ice

Further cuts based on:

- Sphericity of hit distributions
- Track length
- Number of hits due to unscattered photons
- Number of hit channels
- Summed hit probability of the hit modules
- z-component of the center of gravity of hits
- Event time flow

**Mass-dependent final angular cuts as to contain 90% of a possible WIMP signal**
Challenge
Achieve a rejection factor of \( \sim 10^8 \) due to the presence of a strong atmospheric muon background.
Sensitivity to signal given by

\[ V_{\text{eff}} = \frac{N_{\text{finalcut}}}{N_{\text{gen}}} \times V_{\text{gen}} \]

Observable quantity

\[ \Gamma_{\nu\mu} = \frac{N_{90}}{V_{\text{eff}} t} \]

From \( \Gamma_{\nu\mu} \) to \( \Phi_\mu \) at any threshold and angular region
AMANDA-B10 limit on the muon flux from the center of the Earth compared with current indirect limits (Phys. Rev. D66, 032006)

AMANDA curves include the effects of systematic uncertainties in $N_{90}$
Running since 2000

1.3 x 10^9 events collected in 2000
1.5 x 10^9 events collected in 2001
~1.4 x 10^9 events collected to date 2002

Bigger detector:

x 2 in V_{eff} for WIMP signal from the Earth

Simpler cuts achieve necessary rejection:

NN + 1 track quality cut

Preliminary! 20% of 2000 data. non-optimized cuts!
Bigger detector...

Higher sensitivity to horizontal tracks. Makes it suitable for searches for WIMP signals from the Sun (Sun at most at 22.5° below horizon at the Pole)

Main challenge: rejection of down-going misreconstructed atmospheric muons

Handle: Sun is a point source: background estimated from data with on-source/off-source method

Analysis of 2000-01 data for WIMP signal from the Sun under way

2002 data being filtered on line at the Pole
ICECUBE:

Really big!

80 strings/5000 OMs

1 Km$^3$ instrumented volume between 1450-2450 m depth

Excellent horizontal HE sensitivity (1 Km lever arm)

Competitive with direct searches for some combinations of SUSY parameter space

expected sensitivity of IceCube to WIMP-induced muon flux from the Sun
Large neutrino telescopes can be successfully used for indirect DM searches

Results from searches for a WIMP signal from the Earth with AMANDA-B10 published

Recent results from direct searches make the search using the Sun as source the most promising path for DM searches with neutrino telescopes

AMANDA-II/IceCube will explore the possible signal from the Sun