IceCube, a neutrino telescope in the Antarctic ice.

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Outline

1. Neutrino Astronomy
   - Astrophysical Messengers
   - Neutrino Detection

2. IceCube
   - Detector
   - Data Acquisition
   - South Pole

3. Physics Topics
   - IC-9 Atmospheric Neutrino search
   - IC-9 Point Source search

4. Summary
Neutrino Astronomy
Astrophysical Messengers

- AGN
- GRB
- SN Remnants
- Pulsars
- ...

Candidate neutrino sources:

\[ p: \text{directions scrambled by extragalactic magnetic fields} \]

\[ \gamma: \text{straight-line propagation but reprocessed in sources; extragalactic backgrounds absorb } E_\gamma > \text{TeV} \]

\[ \nu: \text{straight-line propagation; not absorbed, but difficult to detect} \]

Astrophysical beam dump
Neutrino Astronomy

**Neutrino Detection**

- **Interaction with matter**
  
  \[ \nu_l(\bar{\nu}_l) + N \rightarrow l^- (l^+) + X \text{ (charged current)} \]
  \[ \nu_l(\bar{\nu}_l) + N \rightarrow \nu_l(\bar{\nu}_l) + X' \text{ (neutral current)} \]

  where \( l = \mu, e \text{ or } \tau \)

- **Neutrino signatures**

![Diagram showing Muon neutrino, Electron neutrino, and Tau neutrino](image)

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IceCube Neutrino Telescope
IceCube

Detector

Completion by 2011.

Drilling Status
- 2004-2005: 1 string
- 2005-2006: 8 strings
- 2006-2007: 13 strings
- 2007-2008: 18 strings

TOTAL: 40 strings (+ 19 strings for AMANDA)

Outline
Neutrino Astronomy
IceCube
Physics Topics
Summary
IceCube
Data Acquisition

1) Drilling
2) DOMs
3) IceCube Lab

Inside the IceCube Lab:
- DOM Hub
- String Processor
- Event Builder
- DAQ-Dispatch
- Processing and Filtering
- SPADE

4) UW Data Warehouse

TDRSS
IceCube Neutrino Telescope
Physics Topics

Rich astroparticle physics programs connected to:

- Astrophysics
- Cosmology
- Particle Physics
Physics Topics
IC-9 Atmospheric Neutrino search

Goal: separate atmospheric neutrinos from downgoing muons background $\rightarrow$ cuts applied.

Results for 137.4 days of lifetime: $211 \pm 76.1 \pm 14.5$ atmospheric neutrino events expected to survive $\rightarrow 242$ are measured.
Maximum excess of 3.35 $\sigma$ for experimental data.
BUT simulated background maps: after applying cuts and triggers, 60% had a statistical excess of 3.35 $\sigma$ or more.
→ Not significant!
Sensitivity will be greatly improved with IC-22.
Summary

- For the first time, a kilometer cube array is built for neutrino detection.
- With IC-9, tools were developed and first analysis showed expected behaviors.
- Full geometry will improve sensitivity.
- Groups are currently working on extensions of IceCube for low and high energies.