

Antarctic Sciences GPRA Highlights, FY 2005

Antarctic Muon and Neutrino Detector Array

Nugget ID: 11189

Professor Robert Morse and his colleagues from the AMANDA International Collaboration use the Antarctic ice to detect rare neutrino collisions with atom nuclei. The challenge of neutrino astronomy is to build large volume instruments that can identify upward-moving muons (resulting from neutrino collisions) in a background of down-going cosmic ray muons, which penetrate the ice sheet to a depth of 2000 m. Rejection of the background muons by almost 10 billion is demonstrated, leaving events whose rate and properties agree with those of atmospheric neutrinos. Limits are also presented on the high energy neutrino fluxes from gamma ray bursts and from cosmic neutrino sources like those possibly associated with supermassive black holes. The preliminary analysis establishes that, with an effective telescope area of order 104 m² for TeV neutrinos and a pointing accuracy of 2.5° per muon track, the AMANDA detector represents the first of a new generation of high energy neutrino telescopes, reaching a scale envisaged by scientists over 25 years ago.

This work is notable because:

The AMANDA detector represents the first of a new generation of high energy neutrino telescopes, reaching a scale envisaged by scientists over 25 years ago.

Primary Goal Indicator: Contributions

Secondary Goal Indicators:

Other Indicators:

No other indicators apply.

OPP/ANT 2005

Program Officer: Vladimir Papitashvili

NSF Award Numbers:

9980474

Award Title: AMANDA 2000

PI Name: Robert Morse

Institution Name: University of Wisconsin-Madison

PE Code: 5115

Submitted on 03/04/2005 by Elana Khanna

ANT: Approved 03/09/2005 by Altie H. Metcalf

OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf

Blood Falls, Antarctica

Nugget ID: 10064

Blood Falls, a saline discharge from beneath the Taylor Glacier, Antarctica, is thought to be the last remnant of an ancient salt-water lake, formed as much as 5 million years ago when the sea levels

were higher and the ocean reached far inland. This iron-rich, salty seep is subject to episodic releases into permanently ice-covered Lake Bonney. Scientists in the McMurdo Dry Valleys LTER studied the geochemistry of the outflow and showed that Blood Falls provides a source of viable microbes, new nutrients, carbon and energetic mineral weathering products to the Lake Bonney system. The system provides an important site for the study of microbial life in an extreme environment.

This work is notable because:

Geomicrobiological studies of an ancient salt-water lake may lead to important and significant contributions of how life adapts in extreme environments.

Primary Goal Indicator: Contributions

Secondary Goal Indicators:

Other Indicators:

OI-3: This work involves multidisciplinary research.

This research in the project involves chemical studies, microbiology and education.

OPP/ANT 2005

Program Officer: Polly Penhale

NSF Award Numbers:

0096250

Award Title: The Role of Natural Legacy on Ecosystem Structure and Function in a Polar Desert: The McMurdo Dry Valley LTER Program

PI Name: W. Berry Lyons

Institution Name: Ohio State University Research Foundation

PE Code: 5111

Submitted on 02/16/2005 by Elana Khanna

ANT: Approved 03/09/2005 by Altie H. Metcalf

OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf

Image of Lake Vostok Map/"Mass and Energy Fluxes Through Lake Vostok: Observations and Models

Nugget ID: 10036

Dr. Robin Bell of the Lamont-Doherty Earth Observatory of Columbia University and her colleagues are using ocean modeling techniques to explore the circulation patterns within subglacial Lake Vostok. Using a box model, radar data analysis, a study of the melting and freezing patterns over the lake, and other tools, researchers are beginning to understand the lake's origins, history and processes that control how the lake has evolved. Preliminary results suggest that every 13,300 years the ice sheet flowing over Lake Vostok removes the equivalent of the entire volume of the lake, an amount that is comparable to Lake Ontario in the United States.

This work is notable because:

The ideas developed here have the potential to create new ways of studying subglacial lakes.

Primary Goal Indicator: Contributions

Secondary Goal Indicators:
Other Indicators:

No other indicators apply.

OPP/ANT 2005

Program Officer: Julie Palais

NSF Award Numbers:
0088047

Award Title: Mass and Energy Fluxes Through Lake Vostok: Observations and Models

PI Name: Robin Bell

Institution Name: Columbia University

PE Code: 5116

Submitted on 02/15/2005 by Elana Khanna

ANT: Approved 03/14/2005 by Altie H. Metcalf

OPP: Approved for OPP on 03/14/2005 by Altie H. Metcalf

Next Generation CMB Polarization Measurements with the QUEST Experiment on DASI

Nugget ID: 11190

The QUEST telescope has been deployed at the U.S. Amundsen-Scott South Pole Station to operate over two austral winter seasons. It is mounted on the existing DASI platform, covering most of the cost of doing so using existing funds, and re-using large parts of the DASI infrastructure and control system, making this a highly leveraged proposal. QUEST is a 2.6-m Cassegrain telescope equipped with a next generation polarization-sensitive bolometer array, which will be aimed on obtaining maps of the Cosmic Microwave Background (CMB) polarization with unprecedented sensitivity and angular resolution. The polarization of the CMB results from bulk motions of material at the time of the plasma-neutral transition and the polarization measurements are the next frontier of CMB research, offering both the opportunity to make crucial tests of the standard cosmological model, and fresh insights which will lead beyond it. DASI was the first experiment to detect E-mode polarization. More recently WMAP has released results on the T-E cross-correlation providing important new information on the reionization of the Universe. The QUaD experiment (referred as "QUEST and DASI") will go well beyond these and is a true "next generation" instrument.

This work is notable because:

The combination of the QUEST telescope and DASI platform are truly "next generation" instrumentation in astronomy.

Primary Goal Indicator: Contributions

Secondary Goal Indicators:

Other Indicators:

No other indicators apply.

OPP/ANT 2005

Program Officer: Vladimir Papitashvili

NSF Award Numbers:

0338138

Award Title: Collaborative Research: Next Generation CMB Polarization Measurements with the QUEST Experiment on DASI

PI Name: Sarah Church

Institution Name: Stanford University

PE Code: 5115

Submitted on 03/04/2005 by Elana Khanna

ANT: Approved 03/09/2005 by Altie H. Metcalf

OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf

Ocean Tide Modeling using Interferometric SAR and Radar Altimetry

Nugget ID: 10788

Professor Shum of the Ohio State University combined several satellite-based observing systems to investigate the effect of ocean tides in deforming floating antarctic ice shelves, and to study the complex interactions between the ice shelves, the ocean, and the atmosphere. He devised a high-resolution digital elevation model of the Sulzberger Ice Shelf, using differential Interferometric Synthetic Aperture Radar data, and ICESat laser altimetry. These research results have been used to estimate two-dimensional ice stream velocities, to study tidal dynamics, and to determine grounding zone topographies.

This work is notable because:

This study combined several satellite-based observing systems to investigate the effect of ocean tides in deforming floating antarctic ice shelves, and to study the complex interactions between the ice shelves, the ocean, and the atmosphere. A high-resolution digital elevation model of the Sulzberger Ice Shelf was also used.

Primary Goal Indicator: Instrument technology

Secondary Goal Indicators:

Other Indicators:

No other indicators apply.

OPP/ANT 2005

Program Officer: Bernhard Lettau

NSF Award Numbers:

0088029

Award Title: Ocean Tide Modeling in South Ross Sea Using Interferometric SAR and Radar Altimetry

PI Name: C. K. Shum

Institution Name: Ohio State University Research Foundation

PE Code: 5113

Submitted on 02/15/2005 by Elana Khanna

ANT: Approved 03/09/2005 by Altie H. Metcalf

OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf

Optical Logging for Dust and Microbes in Boreholes in Glacial Ice

Nugget ID: 10038

The design and construction of an optical dust logger will assist researchers to determine the distribution and grain size of various types of particles in deep boreholes in glacial ice. Evidence has been accumulating for decades that volcanic eruptions can perturb climate and possibly affect it on long timescales. The dust-logger data can be used to examine the relationship between volcanism and millennial climate change. Another related instrument has been used to measure microbes and other biomolecules in boreholes in glacial ice in Greenland and Antarctica. Eventually these instruments could be used to search for life on Mars and on Europa, the icy moon of Jupiter.

This work is notable because:

Research will advance the instrument technology for the study of glacial ice.

Primary Goal Indicator: Instrument technology

Secondary Goal Indicators:

Other Indicators:

No other indicators apply.

OPP/ANT 2005

Program Officer: Julie Palais

NSF Award Numbers:

0125794

Award Title: Optical Logging for Dust and Microbes in Boreholes in Glacial Ice

PI Name: P. Buford Price

Institution Name: University of California-Berkeley

PE Code: 5116

Submitted on 02/15/2005 by Elana Khanna

ANT: Approved 03/14/2005 by Altie H. Metcalf

OPP: Approved for OPP on 03/14/2005 by Altie H. Metcalf

Percolation in Sea Ice

Nugget ID: 10787

Dr. Kenneth Golden of the University of Utah has consistently integrated undergraduates in cutting edge research projects. Troy Finlayson, a physics major, worked on the quantitative assessment of brine transport. Amy Heaton, a chemistry major, worked on the first comprehensive, predictive theory for the fluid permeability of sea ice [3]. She has given numerous lectures and presentations on these results, including an Undergraduate Mathematics Research Conference at Ohio State, an exhibition for members of the US Congress and White House representatives on Capitol Hill, as well as the Utah State Legislature. From February 2003 through May 2005, six University of Utah undergraduates will have participated in field trips to Barrow to study Arctic sea ice in situ. Their

majors are Mathematics, Physics, Chemistry, Biology, Bioengineering, and Electrical and Computer Engineering.

This work is notable because:

From February 2003 through May 2005, six University of Utah undergraduates will have participated in field trips to Barrow to study Arctic sea ice in situ. Their majors are Mathematics, Physics, Chemistry, Biology, Bioengineering, and Electrical and Computer Engineering. And one student has given numerous lectures and presentations on these results, including an Undergraduate Mathematics Research Conference at Ohio State, an exhibition for members of the US Congress and White House representatives on Capitol Hill, as well as the Utah State Legislature.

Primary Goal Indicator: Public understanding of science

Secondary Goal Indicators:

Other Indicators:

OI-3: This work involves multidisciplinary research.

This study involved scientists with degrees in mathematics, physics, chemistry, biology, bio-engineering and electrical and computer engineering.

OPP/ANT 2005

Program Officer: Bernhard Lettau

NSF Award Numbers:

9725038

Award Title: Percolation in Sea Ice

PI Name: Kenneth Golden

Institution Name: University of Utah

PE Code: 5113

Submitted on 02/15/2005 by Elana Khanna

ANT: Approved 03/09/2005 by Altie H. Metcalf

OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf

ROMEO

Nugget ID: 10255

Dr. Sam Bowser (University of Albany School of Public Health) and manufacturing engineering student Jeff Blair (Worcester Polytechnic Institute) deployed a remotely operable microenvironmental observatory (ROMEO) through a hole in the ice of Explorers Cove near McMurdo Station, Antarctica. ROMEO consists of a video camera with night vision, encased in a custom lexan watertight enclosure and operated by a fiber-optic cable. The camera will be used to observe benthic foraminifera (large protozoans) that are found on the sea floor. Installation of the fiber-optic cable was achieved with the use of a hot water drill usually employed for glaciology studies. The drill hole was made laterally through the ice, which may be the first time that a hot water drill has been used in this fashion.

This work is notable because:

The instrument named ROMEO consists of a video camera with night vision, encased in a custom lexan watertight enclosure and operated by a fiber-optic cable. The camera will be used to observe benthic foraminifera (large protozoans) that are found on the sea floor.

Primary Goal Indicator: Data collection/analysis

Secondary Goal Indicators:
Other Indicators:

No other indicators apply.

OPP/ANT 2005

Program Officer: Polly Penhale

NSF Award Numbers:

0216043

Award Title: Remotely Operable Micro Environmental Observatory for Antarctic Marine Biology Research

PI Name: Samuel Bowser

Institution Name: Health Research Incorporated/New York State Department of Health

PE Code: 1189

Submitted on 02/15/2005 by Elana Khanna

ANT: Approved 03/14/2005 by Altie H. Metcalf

OPP: Approved for OPP on 03/14/2005 by Altie H. Metcalf

Scientists Discover Undersea Volcano Off Antarctica

Nugget ID: 10812

An international team from the United States and Canada, headed by Dr. Eugene Domack of Hamilton College, set out to study the disintegration and collapse of Larsen B, a massive ice sheet. In the process, the research team comprised of scientists from Hamilton College, Colgate College, the Lamont-Doherty Earth Observatory at Columbia University, Montclair State University in New Jersey, Southern Illinois University in Carbondale and Queens University in Canada, discovered a major, previously unknown, active volcano. The volcano exists below the sea on the continental shelf off the Antarctic Sound at the northernmost tip of Antarctica. A bottom-scanning video recorder, sonar mapping and highly sensitive temperature probes were used to collect and examine the evidence that collaborated the finding.

This work is notable because:

This volcano was an accidental discovery after the ship was detoured from its intended route. Active volcanoes were previously unknown this area, and this discovery will likely spur future projects to both study the collected samples and perhaps explore this unique feature and others like it on the Antarctic sea floor.

Primary Goal Indicator: Identifying new opportunities

Secondary Goal Indicators: Instrument technology

Other Indicators:

OI-2: This work involves high risk research.

This project studies an uncharted area of Antarctic waters, recently exposed by the collapse of an

ice shelf. It is high-risk, in that the sea ice conditions are variable and dangerous, and it's not guaranteed that the ship can get into the area of intended study. The project's focus is undersea sediments that will tell us about the history of the Antarctic ice sheet.

OPP/ANT 2005

Program Officer: Thomas Wagner

NSF Award Numbers:

0338142

Award Title: Collaborative Research: Paleohistory of the Larsen Ice Shelf System: Phase II

PI Name: Eugene Domack

Institution Name: Hamilton College

PE Code: 5112

Submitted on 02/15/2005 by Elana Khanna

ANT: Approved 03/09/2005 by Altie H. Metcalf

OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf

Why Does Antarctic Krill Swarm?

Nugget ID: 10784

Professor Glenn Flierl of the Massachusetts Institute of Technology, in a study entitled: "Modeling the Effects of Eddies and Mean Flows on Southern Ocean Biology" is using numerical and analytical modeling techniques to study how zooplankton aggregation behavior might have evolved. In collaboration with marine biologists he has been investigating the characteristics of ocean currents and turbulence in relation to the swarming behavior of antarctic krill. In a turbulent ocean, swarming behavior increases mating success, but depletes the food supply, while in a quiescent ocean, the existing zooplankton distributions are simply moved about without changing their concentration. With the addition of small-scale three-dimensional flow discontinuities such as tidal flows, convective plumes, and mesoscale eddies, however, zooplankton aggregations can exist as a stable component, and appear as an interactive physical-biological process.

This work is notable because:

The opportunity to study life in extreme environments has the potential to lead to new discoveries and significant science contributions. Antarctica and the ocean are two extreme, little known environments.

Primary Goal Indicator: Contributions

Secondary Goal Indicators:

Other Indicators:

No other indicators apply.

OPP/ANT 2005

Program Officer: Bernhard Lettau

NSF Award Numbers:

9910052

Award Title: Modelling the Effects of Eddies and Mean Flows on Southern Ocean Biology

PI Name: Glenn Flierl
Institution Name: Massachusetts Institute of Technology
PE Code: 5113

Submitted on 02/15/2005 by Elana Khanna
ANT: Approved 03/09/2005 by Altie H. Metcalf
OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf

***Under Antarctic Ice* education project**

Nugget ID: 10221

The celebrated underwater naturalist and photographer [Norbert Wu](#) spent three seasons diving in McMurdo Sound, Antarctica, to document the unique life forms and environmental conditions in its below-freezing waters. Results include an extensive web site, a 1-hour high definition television special, *Under Antarctic Ice*, aired 12 January 2003 on the PBS Nature series, and the large-format book of color photography and text *Under Antarctic Ice: the Photographs of Norbert Wu* published in 2004 by the University of California Press.

Among the many favorable reviewers, NSF-funded antarctic biologist Gerald L. Kooyman, Scripps Institution of Oceanography, writes, "The book is not only visually pleasing but is also an excellent reference source for the identification of common invertebrates and for photographic ideas. With its exceptional photographs and lucid text [by science writer Jim Mastro], it is about as close as you can come to visiting Antarctica without actually going there."

This work is notable because:

The project exemplifies the partnership approach NSF uses in its Antarctic Artists and Writers Program to provide operational support, but no direct funding, to artists and others who otherwise would not be able to work in the Antarctic.

Primary Goal Indicator: Public understanding of science (AC/GPA selected)

Secondary Goal Indicators:

Other Indicators:

No other indicators apply.

OPP/ANT 2005

Program Officer: Guy Guthridge

NSF Award Numbers:

0000373

Award Title: Science, Operations, and Maintenance Support for the United States Antarctic Program (USAP)

PI Name: Thomas Yelvington

Institution Name: RAYTHEON TECHNICAL SERVICES COMPANY LLC

PE Code: 5140

Submitted on 01/21/2005 by Guy G. Guthridge
ANT: Approved 03/09/2005 by Altie H. Metcalf
OPP: Approved for OPP on 03/09/2005 by Altie H. Metcalf