The Antarctic Sun

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December 19, 2004

# Balloons in hunt for cosmic rays

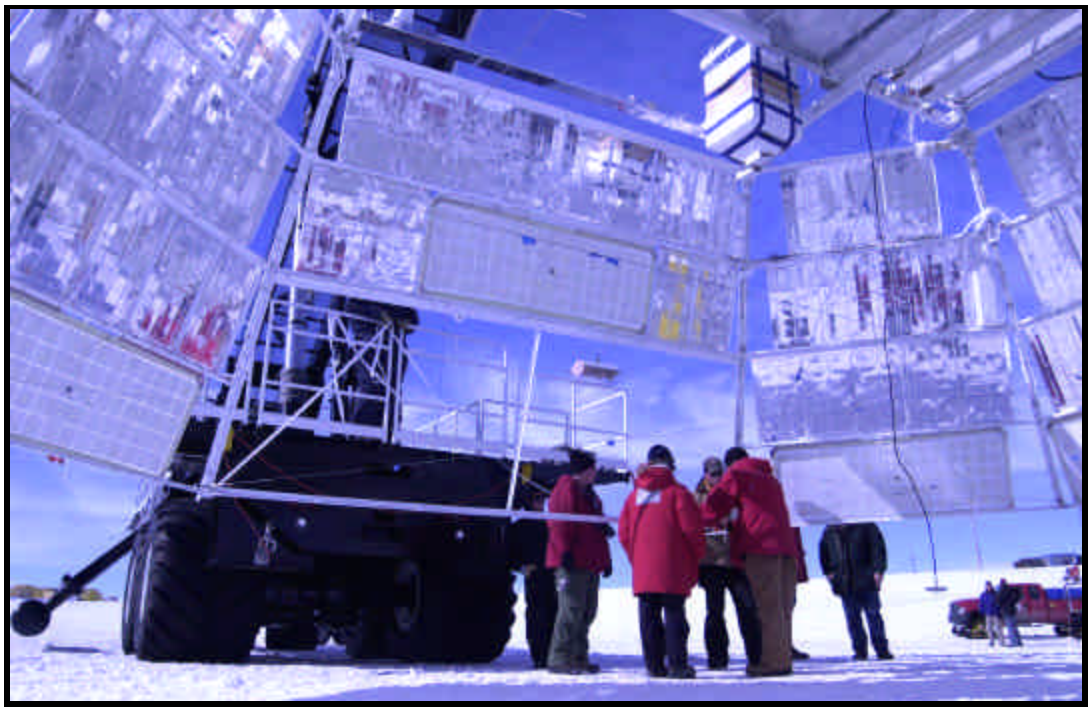

Photo by Brien Barnett / *The Antarctic Sun*

*The BESS team tapes up a few wires at the last minute before the instrument is driven to the launchpad*

## Get carried away

*Two balloons lifted off last week, carrying astrophysics instruments designed to study several aspects of cosmic rays. Read stories about the science projects and long duration balloons on pages 7 to 11.*

# BESS pursues clues to antimatter

By Karl Horeis
*Special for The Antarctic Sun*

John Mitchell is surprised to be here. Not here, in Antarctica, but to exist in the universe at all.

That's because he believes, like most astrophysicists, that matter and antimatter annihilate each other when they meet. Current thinking suggests the Big Bang would have created equal parts matter and antimatter at the start of time. So the question remains: where is the antimatter?

"If anything, the real exceptional thing is that we're here," he said this week from the Long Duration Balloon facility on the Ross Ice Shelf where he co-leads a joint American-Japanese team. Young Japanese scientists sat at computers, monitoring data from an instrument attached to a 243m-tall helium balloon that was launched Dec. 13. Sailing on circumpolar winds more than 39km above sea level, the instrument at the bottom of the balloon is seeking, among other things, an antihelium nucleus. Finding just one nucleus would be hugely important.

Scientists in the lab have created the components of an atom of antimatter — antiprotons, antineutrons and antielectrons, or positrons. And they have created antihydrogen, which has one of each component, but they have never seen or been able to create an

**See Antimatter on page 10**

## Quote of the Week

"All the good stuff sinks to the bottom, like soup."

*- South Pole worker who met his girlfriend at the bottom of the world*

Photo by Brien Barnett / *The Antarctic Sun*

*A spectator watches the BESS balloon take flight.*

Ross Island Chronicles By Chico


# Cold, hard facts

## Long Duration Balloons

Constructed of: **polyethylene film**
Length: **Up to 243m** (taller than the Washington Monument)
Volume at altitude: **1.1 million cubic meters**
Diameter: **120m**
Thickness: **.002cm**
Similar to: **sandwich bag material**
Max payload weight: **3,600kg**, including instrument, parachute, solar array and assorted electronic flight gear and cabling.
Time from launch to max altitude: **2 hours**
Max altitude at flight: **42km**
Max duration: **Up to 30 days**
Antarctic duration record: **18 days** (TIGER I)

*Source: National Science Balloon Facility, http://www.nsbf.nasa.gov/*

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**It's a Harsh Cartoon** **Matt Davidson**

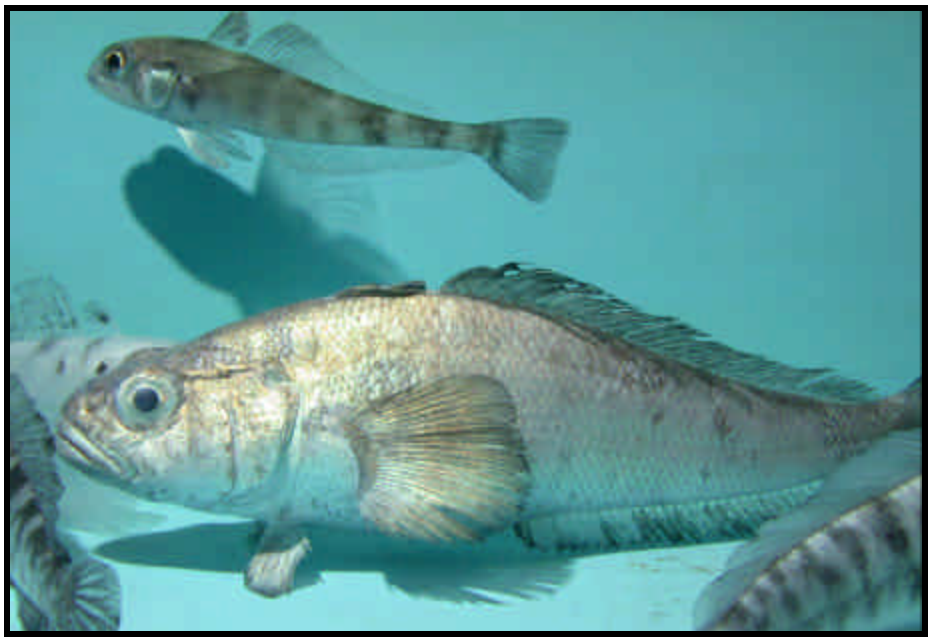


Photo at left by Paul Cziko and above by Kevin Hoefling / Special to *The Antarctic Sun*

*Left, diver Kevin Hoefling holds the fish that he and Paul Cziko found last month. The men didn't recognize the fish underwater and brought it to the lab to check it more carefully. It still doesn't match any of the fish described in the literature, and may be a new species. Above, the unclassified fish swims in the Crary Lab aquarium.*

# Mystery fish discovered near McMurdo

By Emily Stone
*Sun staff*

Paul Cziko and Kevin Hoefling were diving in about 15m of water, at the intake jetty at McMurdo Station last month when they spotted an unusual fish perched on a rock.

The 34cm-long, silver fish didn't look like anything the divers had seen before. So Cziko, a research assistant with Art DeVries' fish biology group, decided to bring the fish to the lab.

"I didn't really know what it was," he said. "I couldn't identify it underwater."

That fish might end up being a new species. It doesn't look like anything Cziko, DeVries or the other fish researchers have seen. They took measurements of the fish and counted the pores on its head and the bones in its fins, and it doesn't match anything in the fish literature.

The group will send the information to fish taxonomists to see if they can identify it. Cziko said he'll likely run some genetic tests on the fish to see what it's related to. If he ends up being convinced that it's a new species, he said he will write up a formal description of the fish to submit to a peer-reviewed journal.

DeVries said it's unusual, but not unheard of, to discover new species of Antarctic fish. He identified one five years ago during a cruise on the *Nathaniel B. Palmer*. Still, after so many years studying the fish here, he is always surprised to see something new.

"In 30 years of fishing, you'd think that we would have found it all," he said.

*NSF-funded research in this story. Art DeVries, University of Illinois.*

## Continental Drift — What is your on-Ice Hobby?

**"Spending time with my husband … when he's here."**

Dee Werner
*McMurdo admin for IT/operations from Greybull, Wyo., sixth season*

**"Reading."**

Doug Schwieder
*South Pole heavy mechanic from Idaho Falls, Idaho, third season*

**"Waiting for the sea ice around Palmer to leave."**

Nicole Middaugh,
*Palmer Station research assistant from Anchorage, Alaska, first season*

# NSF: Iceberg poses no threat to personnel

## Annual long-range supply effort, icebreaking operations on schedule

A statement from The National Science Foundation

National Science Foundation officials said Friday that iceberg B-15A is not blocking access to McMurdo Station, the U. S. logistics hub for much of the nation's research activity in Antarctica, contradicting widely circulated reports to the contrary.

Karl Erb, director of NSF's Office of Polar Programs, said the real effect of the enormous iceberg had been to shield large parts of the Ross Sea from wind and ocean currents, with the result that sea ice had formed over a larger area than usual in the sea-lanes approaching McMurdo Sound.

Before McMurdo Station can be resupplied, icebreakers have to open a channel each year through which the resupply ships can proceed, and the icebreaker task will be more difficult this year.

Erb expressed confidence that the U.S. Coast Guard and its crew aboard the icebreaker *USCGC Polar Star* will succeed. He added that NSF is currently arranging for a backup icebreaker that can assist the *Polar Star* if necessary. This is in response to a Coast Guard recommendation.

"There is absolutely no truth to reports circulating widely that the stations are facing a crisis when it comes to supplies of any kind, including food. Personnel at McMurdo and South Pole stations are in no danger," Erb said.

Some news media have conveyed the misimpression that an enormous iceberg, B-15A, is blocking ship access to the McMurdo Station seaport.

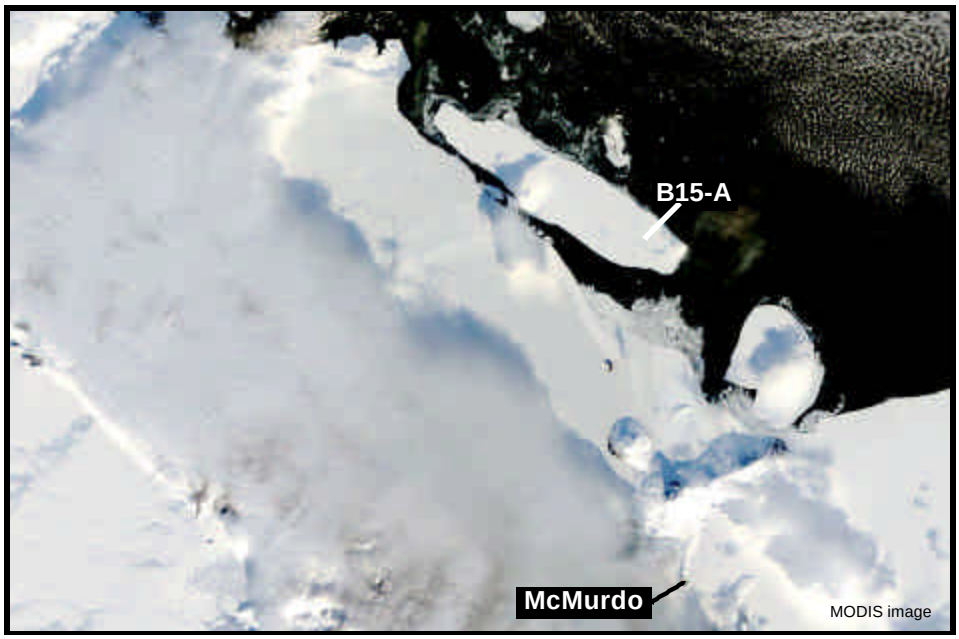
The U.S. research station at the geographic South Pole is more than 1,200km inland, and supplies are airlifted there from McMurdo after arriving on ships.

B-15A is a fragment of a much larger iceberg that broke away from the Ross Ice Shelf in March 2000.

Scientists believe that the enormous piece of ice broke away as part of a long-term natural cycle (every 50 to 100 years, or so) in which the ice shelf — which is roughly the size of Texas— sheds pieces much as human fingernails grow and break off.

The berg initially drifted toward McMurdo Sound and grounded near Cape Crozier on Ross Island.

It has since broken into pieces that still are very large. Some remain in place, but the largest splinter is B-15A At approximately 160 km long it is moving north at roughly one to three kilometers per day.




The berg's fate is unclear, as it depends on unpredictable forces caused by winds and tides as well as other forces.

Possibilities for the fate of B-15A include colliding with the attached, but floating, Drygalski Ice Tongue or continuing north, eventually to melt into the sea. The impact with the ice tongue could come as soon as Dec. 24.

The U.S. Coast Guard icebreaker *Polar Star* left Seattle, Wash., on Nov. 4 and should reach the edge of the sea ice about Dec. 27. It will begin immediately to cut a channel in the sea ice for the supply ships.

Officials agreed that the position of B-15A presents no obstacle to navigating the ship to the ice edge and beginning its work of opening a channel through this year's roughly 150km of sea ice. In a normal year, the icebreaker clears a channel through perhaps 20km of first-year ice. First-year ice means it is the first year that ice has covered that part of the sea. Multi-year ice would be thicker, depending on the number of years it has accumulated.

In some prior years, the Coast Guard deployed two icebreakers — *the Polar Sea* and the *Polar Star* — to open the channel. The *Polar Sea* is in dry dock for a major refit. NSF is negotiating to bring a chartered icebreaker to assist the *Polar Star* this year.

*The National Science Foundation, through its Office of Polar Programs, manages the U.S. Antarctic Program. The NSF is an independent federal agency that supports fundamental research and education across all fields of science and engineering, with an annual budget of nearly $5.47 billion. NSF funds reach all 50 states through grants to nearly 2,000 universities and institutions. Each year, NSF receives about 30,000 competitive requests for funding, and makes about 10,000 new funding awards. The NSF also awards more than $200 million in professional and service contracts annually.*

Photo courtesy of the NSF

*The Russian ice breaker* Krasin.

## Deal brokered for Russian breaker

A preliminary agreement appears to be approved by the National Science Foundation contracting a Russian icebreaker to assist with breaking a channel to McMurdo Station this season.

The *Krasin* will assist the U.S. Coast Guard ice breaker *Polar Star* with what may end up to be the longest channel through the sea ice on record. The other two U.S. Coast Guard ice breakers, the *Polar Sea* and *Healy*, were not available.

# around the continent

## SOUTH POLE

### El Dorm moves

By Katie Hess
*South Pole correspondent*

On the evening of Dec. 12, the building formerly known as the Elevated Dorm, El Dorm, El Doumo, Beaker Box or the Blue Box, was dragged from its home since 1991 next to the Hypertats across the skiway to the Dark Sector. It took three bulldozers pulling with a fourth steering from behind to move it. Martin Lewis coordinated the historic move and operators of the night included Megan Whitmore, Jennifer Teague, Bob Spotz and Dave Watson — with support from Amber Neuman.

The El Dorm now resides just past the Martin A. Pomerantz Observatory (MAPO) under the new identity of the Counting House where it will be used as a laboratory by the IceCube researchers. Iron workers prepared the building over the three weeks leading up to the relocation by removing the interior and reinforcing it from the inside with 23 cables. The panel crew jacked the building and slid two skis beneath the bottom frame. When the iron workers welded the skis on, the building became ready for the big move.

Residents of South Pole showed off their artistic sides on Sunday at the Art Show held in the new dining facility. Artwork included everything from furniture to jewelry, to photography to a stamp and philately collection. It made for a very entertaining but relaxed, social way to spend the afternoon.

A four-person, private expedition of skiers was dropped off by Adventure Logistics and Expeditions (AL&E) last week at 89 degrees South. They skied "the last degree" to the Geographic South Pole arriving early Monday morning. Skiers hailed primarily from the U.K. and left soon after arriving at the South Pole.

'Tis the season at South Pole to get a little festive. Behind the Ceremonial Pole marker, blocks of firn (the snow atop the glacial ice) await more South Pole creativity. Ambitious sculptors are encouraged to have their masterpieces ready for the annual competition held Sunday.

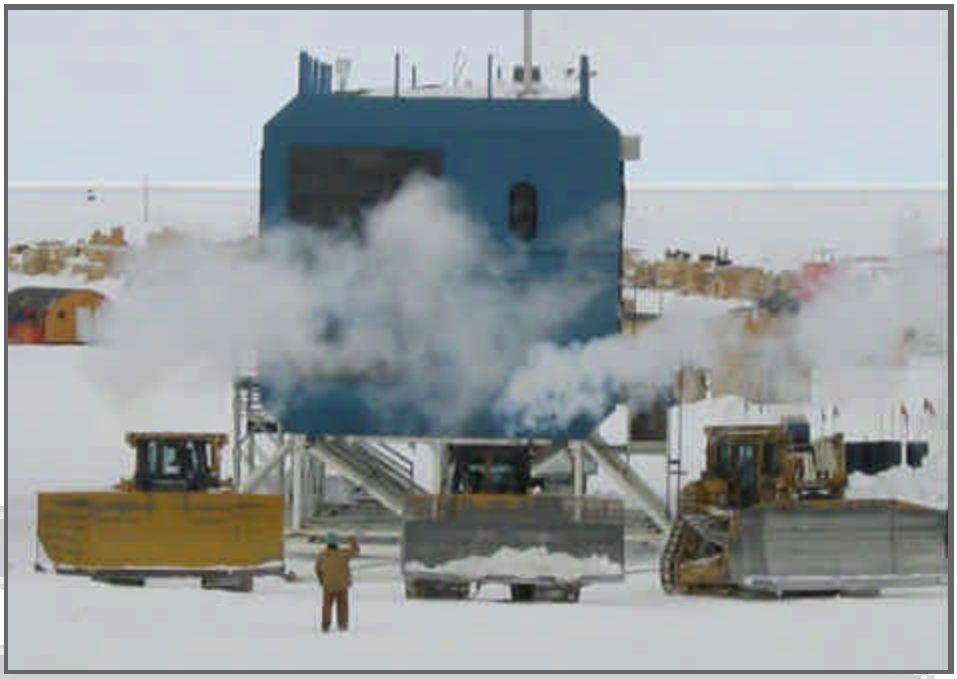


Photo by Mark Eisinger / Special to *The Antarctic Sun*

*Martin Lewis directs three bulldozers moving the El Dorm to a new location and a new purpose. The dorm will become laboratories for the IceCube science project.*

Sick calls are double the average for South Pole. Since summer season began, there has been an average of 80 patient visits per week, equivalent to a third of the station population. The report stated that about 25 percent of the station population has been infected with an upper respiratory "cold" virus. A report noted that a virus is causing similar symptoms at McMurdo, but has not been as prevalent there, and perhaps is more prevalent at Pole because of the close quarters.

## PALMER

### *Bahia Paraiso*

By Kerry Kells
*Palmer correspondent*

This past week was a busy one for station activities but scientists were limited by the sea ice, which has again encroached upon the station and limited boating possibilities. The polar oceans research group made it out to a few of the local islands at the beginning of the week.

On Wednesday we had a special science lecture: video footage of the *Bahia Paraiso*, the Argentinian supply vessel for Esperanza Station, as it struck an underwater pinnacle off of Palmer Station on January 28, 1989. The *Bahia* carried 114 crew and 81 tourists.

The footage was taken by a tourist. After the tour of station, the video recorded the departure of the *Bahia* between Delaca and Litchfield Islands.

When the 130m long ship ran aground and tore a 9m gash in the hull, he kept the video camera rolling and captured the passengers as they boarded the life rafts and paddled, or were towed, towards Palmer Station.

**See Continent on page 6**

## the week in weather

**McMurdo Station**
High: 41F / 5C
Low: 23F / -5C
Max. sustained wind: 23mph / 37kph
Windchill: 1F / -17C

**Palmer Station**
High: 46F / 8C
Low: 24F / -4C
Max. sustained wind: 18mph / 30kph
Precipitation: 4mm

**South Pole Station**
High: -25 F / -31C
Low: -31F / -35C
Peak wind: 25 mph / 40kph
Max. Physio-altitude: 3120m

# Continent From page 5

The station was overrun with stranded tourists and crew who arrived in bright orange life rafts.

The tear in the hull of the *Bahia* and the capsize caused approximately 956,000 liters of diesel and jet fuel to spill into the local marine environment.

A 16km radius was covered by the slick. Response was quick with a plan in action 36 hours after the accident.

The clean up managed by the NSF involved the combined efforts of the US Navy, private contractor specialists, NOAA and the U.S. Coast Guard. The research vessel *Polar Duke* (now retired) transported supplies and passengers in the efforts.

Langdon Quetin, the principal investigator with krill research, was on station at the time of the wreck and involved in the assessment of damage and clean-up. The fuel spill affected many of the seabirds and the intertidal communities of the area.

All South Polar skua chicks died, almost all cormorant chicks died and limpets, mollusks, marine algae and seastars were affected.

Quetin followed the video with underwater footage on his groups' dive at the *Bahia*, now just a rust-colored hull partially visible above water.

He dives every year at the *Bahia* to assess the growth of marine organisms.

He also showed a short video on the divers collecting krill from under the ice.

This past week also included Art in the Bar, a multi-media visual and performance art show and wine tasting organized by workers Zee Evans and Kelsi Giswold.

All forms and mediums of art were accepted and the results were a variety of visual art and performances that included pastel drawings, photography, knitting, a quilt in progress, a mixed-media lighting display, block prints and albumen prints.

Albumen print processing is a photograph technique that was offered for community participation earlier this week.

This project requires mixing a "homemade" emulsion and applying this to watercolor paper, adding a light sensitive solution to the top of the paper, printing a negative on a transparency and then exposing the transparency onto the paper in natural sunlight. The resulting effect is sepia/brownish toned photographic print on a slightly textured paper.

The performance art included several violin recitals, some guitar playing and a poetic recital.

All wine for the wine tasting was donated from the community. Another art show night is planned for later in the season.

Photo by Cara Sucher / Special to *The Antarctic Sun*

*The hull of the sunken* Bahia Paraiso *rusts in the water near Palmer Station.*

## SHIPS

## Icebreaker on its way

By Don Peltonen
Ship operations liaison

The U.S. Coast Guard Cutter *Polar Star* crossed the Antarctic Circle Dec. 14 and entered the pack ice of the Ross Sea. The ship had already stopped in Hobart, Tasmania where scientists with the Interannual Variability in the Ross Sea-Antarctica (IVARS) group boarded on Dec 11.

On the way to the edge of the fast ice the *Polar Star* will stop at several locations so scientists on board can take measurements and samples.

The *Polar Star* is scheduled to arrive at the edge of the fast ice on Dec. 27 and begin breaking a channel to the ice pier.

The Aviation Detachment will fly two helicopters to McMurdo Station to support the icebreaker and science missions.

The distance of this year's fast ice edge from McMurdo is unprecedented. This season could well be the longest break-in in history — the previous record was in 1963 with 62 miles of fast ice.

That year the break-in started just west of Beaufort Island. This year the fast ice extends well north of Beaufort Island. With B-15A on the move, this year's situation is also more dynamic.

The crew aboard the *Polar Star* is monitoring the conditions and will finalize a channel route upon arrival in the area.

The extent of the fast ice is a concern but first-year ice conditions and the warm weather are encouraging.

After breaking the initial channel, the *Polar Star* will moor at the ice pier to fuel. Subsequent icebreaking will be conducted to widen and groom the channel for the arrival of other vessels.

A fuel tanker is scheduled to arrive at the fast ice edge in mid-January.

Depending on channel conditions, *Polar Star* may escort the fuel tanker to the ice pier prior to the arrival of the research vessel *Nathaniel B. Palmer* in late January.

The cargo vessel *American Tern* is scheduled to arrive at the ice pier in early February.

Russian icebreakers *Khlebnikov* and *Shokalskiy* will also be in the area this season conducting tourism cruises.

Lieutenant Commander Don Peltonen from U.S. Coast Guard Pacific Area is this season's Ship Operations Liaison for Support Forces Antarctica.

He served as a helicopter pilot on the U.S. Coast Guard Aviation Detachment for Deep Freeze 1989 and reported to Pacific Area last September.

Peltonen is scheduled for three seasons as Ship Ops. He is assisted this season by Lieutenant Commander Lisa Mack, Operations Officer on U.S. Coast Guard Cutter *Polar Sea.*

She served on *Polar Star* for Deep Freeze 1995 and *Polar Sea* for Deep Freeze 2004.

Both U.S. Coast Guard representatives are glad to be here and encouraged by the warm welcome and assistance they received in Christchurch and McMurdo.

## *Gould* science goes on

Compiled from reports by Skip Owen

The *Laurence M. Gould* continued to move from sampling site to sampling site among the islands of the Antarctic Peninsula, allowing two science groups on board to gather plankton and salps.

Divers went underwater nightly to capture live, relatively unscathed salps, gelatinous sea animals with barrel-shaped bodies, for experiments on board.

The plankton were scooped up in fine nets called tows.

The stops included Deception, Anvers and Brabant islands, then the *Gould* followed the pack ice south to the Antarctic Circle.

The weather was calm and sunny, with light winds and calm seas.

They stopped at Palmer Station on Dec. 16.

## *Palmer* in port

The research vessel *Nathaniel B. Palmer* spent a week in port in Lyttleton preparing for its next science cruise.

Photos by Brien Barnett / The Antarctic Sun

*Above, a ribbon of protective plastic falls away as the balloon that will carry BESS to the edge of space rises after being released from the launchpad. At right, spectators gather for the launch with Castle Rock rising behind them. Below, spectators gaze at the balloon in the final minutes before it is released.*

# CREAM takes off

By Brien Barnett
*Sun staff*

The long journey to a better understanding of cosmic rays began with the launch of the CREAM instrument.

The Cosmic Ray Energetics and Mass payload carried on a balloon launched Dec. 16 will serve as the first test of the payload designed to capture hydrogen, helium and other heavy extra-solar nuclei which travel across the galaxy at the speed of light. The data acquired during the flight may lead to a better understanding of how supernovae accelerate the particles and how those particles traverse our galaxy. The particles posses energies far beyond anything that ground-based particle accelerators can produce and can only be seen high above Earth's atmosphere.

Scientists are learning more about the composition of cosmic rays, but need much more data on the highest energy particles. CREAM was originally designed for use with an Ultra Long Duration Balloon (ULDB), which can carry an instrument for up to 100 days. However the ULDB balloon is in testing. Primary investigator Eun-Suk Seo, a professor at the University of Maryland, said her team is working to develop international collaborations to design and build a duplicate version of CREAM to allow LDB flights every year to attempt to gather as much data as possible to make up for the lack of ULDB time.

CREAM has been refined thanks to previous Antarctic flights.

**See CREAM on page 8**

# Science in the sky

By Brien Barnett
*Sun staff*

Sending up world-class scientific instruments on thin balloons isn't a simple task.

That's why the pros from Texas are sent to McMurdo Station each year to ensure that multi-million dollar instruments make it off the Ice into near-space.

The National Scientific Balloon Facility is based in Palestine, Texas, and launches and recovers balloons worldwide for NASA.

This week, the NSBF crews launched two payloads, Balloon-borne Experiment with a Superconducting Spectrometer (BESS) and Cosmic Ray Energetics and Mass (CREAM).

The high-tech balloons have been used in Antarctica for almost 20 years now.

The balloons are made of ultra-thin polyethylene film but are designed to be stronger than the same type of material used for plastic sandwich bags. At only 0.002cm thick, the balloons must be handled carefully from production to launch. At the factory, the film is cut into banana-peel shaped sections called gores and heat-sealed together to form the balloon. As many as 180 gores are used to make the largest balloons.

The balloons are called zero-pressure balloons because the bottoms remain open, which allow them to equalize to the pressure surrounding it.

At launch, technicians hook giant tanks of helium to tubes leading to the balloon and fill it so about a fifth to a quarter of the balloon is filled. It is then launched and expands as it rises. These large balloons carry payloads weighing as much as 3,600kg and fly up to 42km high for as many as two weeks.

The balloons travel around Antarctica in a great circle during a special time of the year when a counterclockwise wind sets up over the continent. Once the science equipment is ready to go, the balloon crew launches a smaller Pathfinder balloon equipped with a global positioning system.

Operators track it for several days to see whether the vortex has set up enough to launch the larger balloons. Local forecasters check and recheck the weather around McMurdo Station for optimal conditions of low wind at the ground. It then becomes a cat-

**See LDB on page 8**

# Cream From page 7

Data from the Advanced Thin Ionization Calorimeter (ATIC) experiment, flown in 2001, and last year's Transition Radiation Array for Cosmic Energetic Radiation (TRACER) instrument, along with other ground-based instruments, have shown a rainbow-like graphic curve at very high power levels. Scientists are wondering if that curve, which they call a "knee" curve, reflects the speed limit of supernovas. If that's true, then other calculations will begin to fall into place.

CREAM is as close as it gets to being a satellite without riding a rocket. Designed and built under strict ULDB guidelines, the 1,800kg instrument looks more like its space-based cousins than most balloon projects. However the advantage of the balloon program over a space-based mission is in the cost. Seo said to put the CREAM program into space would have cost about 10 times as much as the approximately $10 million it costs now, without a significant gain in the data it acquires.

Photo by Brien Barnett / *The Antarctic Sun*

*Eun-Suk Seo, lead scientist for CREAM.*

The suite of instruments aboard CREAM includes a timing-based charge detector (TCD), calorimeter and transition radiation detector (TRD). The TCD and TRD identify the charge and energy of the particle by stealing a piece of its energy as it pases through. The calorimeter, however, destroys the particle and reads the shower of secondary particles that are produced. It's the first time all three instruments have been aboard a ballon-based experiment. Data are recorded onboard as well as transmitted by satellite to operators.

CREAM is a relatively small payload. It is powered by a single-direction solar array that produces about 900 watts of power. The instrument itself uses about 380 watts with the rest going to the tracking and management tools. In addition, about 400 kg of ballast will be added to keep the balloon at the optimal operating height about 40 km above sea level.

*NASA/NSF-funded research in this story: Dr. Eun-Suk Seo, University of Maryland Institute for Physical Science and Technology, http://cosmicray.umd.edu/cream/cream.html*

Photo by Brien Barnett / *The Antarctic Sun*

*Balloon handlers pull a sheet of protective canvas down on the launchpad during assembly.*

# LDB From page 7

and-mouse game deciding when to launch, with LDB technicians and scientists waiting sometimes for days for the perfect moment to get out the "Boss."

The Boss is a massive, specially-built vehicle used to launch the balloons. The nearly 45,000kg Boss is designed to control the balloon and its payload like a surgeon, delicately moving it into position and releasing it at the touch of a button as the balloon takes the weight of the payload.

As the balloon rises it expands, reaching the size of a small sports stadium. It skims the upper stratosphere at the edge of space.

## Poor man's space program

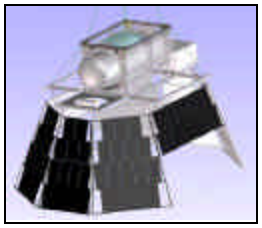
The balloon program also saves research dollars because it provides researchers the opportunity to study cosmic rays and other astronomical features at a fraction of the cost of a full space flight. The primary investigators of both BESS and CREAM estimated it would cost about 10 times as much to put their instruments aboard a space shuttle. It also allows them to train graduate students and other future investigators.

"I can't let a student work on a $100 million experiment, but I can let them work on a balloon experiment," BESS primary investigator John Mitchell said. "In terms of training it's much better because students can work on things, build things and analyze the data."

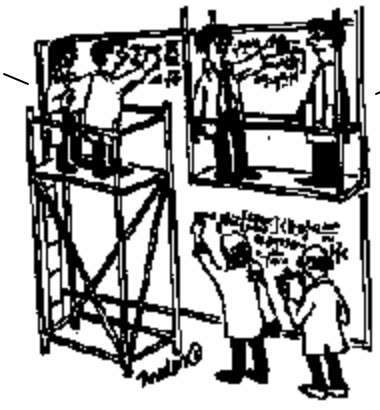
The scientists work full tilt during the balloon flight but begin fretting as the balloon returns to the beginning point of its journey near McMurdo. That's because it's time to cut the balloon loose and attempt to retrieve it from the ice.

Once the flight has made one or two trips around Antarctica a command is sent to the module to release it from the balloon. The payload is in free-fall for a time before a parachute activates to slow its descent. The payloads are designed to withstand the 10G shock when the parachute opens, as well as the eventual impact with the snow, ice or rock.

If all goes well, the payload lands at a good site within a reasonable distance from McMurdo and a plane is sent to recover it. If not, such as with last year's TIGER mission, the payload and its data sit on the Ice awaiting a more complicated recovery mission.



**BESS**



*Scientists work on different parts of a large puzzle to understand the physical universe.*

**CREAM**

new experiments

Photos on this page by Brien Barnett / *The Antarctic Sun*

*The "Boss" launchpad vehicle hoists BESS at its assembly area outside the "Pig barn" at the Long Duration Balloon facility near Williams Field. At nearly 45,000kg, the Boss is built with a low center of gravity and enough power to accelerate the payload into position and get out of the way when the balloon launches.*

*The payload is suspended from a single pin at the top of the crane. The balloon's cables lift off the top of the vehicle and the crane as it rises and picks the payload off the pin.*

# BESS on data quest

By Brien Barnett
*Sun staff*

The first of the two major astrophysics experiments launched via a long duration balloon at Williams Field this week is midway through its round-the-continent flight. The Balloon Borne Experiment with a Superconducting Spectrometer (BESS) is in its eleventh balloon flight, but its first in Antarctica.

The team of Americans and Japanese operating BESS is on a quest to study cosmic ray particles and antiparticles. The particles and antiparticles will give insight on the early universe, said John Mitchell, the American principal investigator co-leading the BESS project. If the team is really lucky, the instrument may find an antimatter nuclei consisting of antiparticles, although that is unlikely. Its main goal is to gather higher numbers of statistics of known antiprotons, the antiparticle of protons, that have been tracked while establishing the lowest energy range seen for the particles.

Mitchell noted that the instrument has been tested in annual flights, mostly over Canada. It has been refined over the years and has been specially modified for flight over Antarctica. For example, up to 75 percent of the material that made up BESS in the northern latitude flights was reduced for the polar flight. Those revisions paired with the long duration balloon will give it 10 times more flight time than it has accumulated and produce an immense amount of data for later analysis.

Most of the antiprotons the team will find over the 10-day flight were created by interactions of primary particles with the interstellar gas that fills the Milky Way. When these primary particles collide with matter in the gas, a shower of antiprotons and other secondary particles is formed. Another possible source of the antiprotons is the evaporation of small, primordial black holes, which have the mass of a small mountain. BESS is designed to detect antiprotons from all of these sources. Using complex analysis, the team will sort out the antiprotons from other particles that pass through its superstrong magnetic field.

The superconducting magnet generates a field that causes incoming particles to bend depending on their charges and energies, allowing the researchers to sort antiprotons from other particles. The particles also must pass through a series of devices, all optimized to time and measure the particle's energy without stopping it. Onboard computers track the data and produce graphics to report back to the team, which is based at McMurdo Station.

The first version of BESS, back in the early 1990s, carried about eight gigabytes of onboard data storage for the one-day flight. This flight carries nearly 3,600 gigabytes, which is about the same as 45 high-powered home and gaming computers. The instrument is built around a superconducting magnet that takes several hours to be prepared for flight and requires liquid helium to keep it cooled and running efficiently. When charged, the magnet can ruin credit cards and pick up objects such as a wrench or coins that are within the field. The solar panel structure at nearly eight meters long by six meters wide and three meters high is the largest ever flown, according to David Sullivan of NASA's National Space Balloon Facility.

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*The BESS instrument has been described as a locomotive coming through a covered bridge. The peak of the "bridge" shelters electronics below it.*

*A weather balloon is a mere speck in the sky above the BESS payload. This view shows the giant solar array and instrument tethered to the crane before launch.*

Photo by Brien Barnett / *The Antarctic Sun*

*Akira Yamamoto, the co-principal investigor with BESS, watches as Hideyuki Fume tapes a wire that stabilizes the solar panel array.*

# BESS From page 9

BESS isn't alone in studying cosmic rays or antiprotons, but it may be the best at the latter. A proposed experiment intended for the International Space Station was delayed after the space shuttle Challenger exploded in 1986. BESS has been working so well over the past decade that most of the goals for the space project have been met, Mitchell said.

If the circumpolar winds do their job, BESS will return to the vicinity of McMurdo Station around Wednesday of this week and the data and instrument will be recovered for another flight. The team hopes to return to Antarctica in 2006 or 2007 to repeat the flight when the sun is at its 11-year minimum and produces the least interference. By flying then, Mitchell said, the antiproton data will likely be even more accurate and complete.

"To find a single particle of antihelium would be pretty darn exciting."

*—John Mitchell*

# Antimatter From page 1

atom of antimatter any heavier or more complex.

"To find a single particle of antihelium would be pretty darn exciting," said Mitchell, the American principle investigator on the Balloon-borne Experiment with a Superconducting Spectrometer (BESS). "What you'd ultimately like to find would be an anticarbon or something. But certainly to find a particle of antihelium would be a big step."

Researchers have been able to create the subatomic antiparticles inside accelerators by colliding high-energy particles into other matter. The same process occurs naturally when particles, sometimes called cosmic rays, collide with interstellar matter. However, it's difficult to get these building blocks to join together into antimatter if they are all blasting away from each other. That's why full atoms of antimatter are so rare.

"All the constituents of antimatter are present — it's just the atoms themselves that are missing," Mitchell said.

As the BESS balloon soared high over Antarctica, the team expected to have recorded several hundred antiprotons daily. But to find a complete antinuclei (made of antiprotons and antineutrons) would be a first-time event.

The researchers hope to find a random "leak" from the antimatter domain. They believe antimatter may exist in domains far away from our galaxy, possibly settling away from matter after the high-energy environment created by the Big Bang at the start of time.

"We are living in a positively-charged world," explained BESS team member Hideyuki Fuke. "Antimatter is negatively charged."

When the two meet, they annihilate one another, changing from matter to energy in a burst of light such as gamma rays. This has been proven by the short-lived antiprotons created in accelerators.

"If we can find a very strong gamma source, it may be the point where antimatter and matter are meeting," said Akira Yamamoto, the Japanese principle investigator with BESS.

Some scientists describe antimatter as the hole in the dough that remained after the galactic cookie cutter stamped out matter. The BESS team has described it as more similar to matter. Antimatter should have the same mass as its matter partner, but the opposite charge.

But is it still rocks, planets and galax-

**See Antimatter on page 11**


## An antimatter encounter

Karl the dishwasher, having finished his work at the Long Duration Balloon galley, walked to the balloon barn to see what the BESS scientists were doing on their antimatter experiment.

He spoke with BESS team member Hideyuki Fuke about what would happen if he met an antimatter version of himself.

"Ahhh, good question. Unfortunately, when matter and antimatter meet, we call it 'annihilation.' All of you disappear. So you cannot meet anti-Karl," he laughed. "You can never shake hands with anti-Karl."

**Q: What is antimatter?**

**A:** Antimatter is defined as having the same mass as its matter partner, but the opposite charge. For example, helium has a charge of plus two. A particle of antihelium (which the BESS team is looking for) should have a charge of negative two. An atom of matter is made up of protons, neutrons and electrons. Scientists believe an atom of antimatter is made of antiprotons, antineutrons and antielectrons, also called positrons.

**Q: Where did antimatter come from?**

**A:** The theory states that equal amounts of matter and antimatter were created during the Big Bang at the beginning of time. Some of the major questions for astrophysicists is why the universe is now asymmetrical? Why is there only matter around? What happened to all the antimatter?

Photo by Brien Barnett / *The Antarctic Sun*

*Shinya Matsuda, left, and Sadakazu Haino check data arriving from BESS.*

# Antimatter From page 10

ies like we're used to?

"We think so," said Tetsuya Yoshida, the BESS project manager.

It could be that antimatter particles cannot pass through Earth's atmosphere without interacting with matter.

"So, we must go up," said Yoshida, pointing skyward. The BESS team has sent its sensors to high altitude where they can get a sample of cosmic rays unfiltered by Earth's protective atmosphere.

But how can they expect to detect an antimatter nucleus using a big detector made of matter, if the particle will be annihilated when it hits matter?

"We must make a thin-material detector," Yoshida said. It must be thin so that the tiny particle would pass through the detector without hitting particles of matter. Particles of cosmic radiation pass through solid objects day and night, said Fuke.

"They are passing through you right now," he said with a laugh.

The detector is made of an ultra-thin superconductor and very light materials such as plastic and aluminum.

## Asymmetry

The fact that there is now more matter around us than antimatter — that the two are no longer symmetrical — is the result of high-energy elementary particle phenomena, Yoshida said.

"We have a chance to see what happened in the early universe," he said of this year's flight. "The symmetry-breaking of matter and antimatter, producing primordial black holes or producing super-symmetric particles — which are candidates for being dark matter — such phenomena can occur in a high-energy state in the universe — or high temperature. So if we see antiprotons or antimatter originate from these sources then it means that we have succeeded to investigate elementary particle phenomena in the early universe. That's exciting!"

According to Mitchell, a theoretical antisun would create light just like a sun, so from a distance you wouldn't be able to tell it was a sun or an antisun.

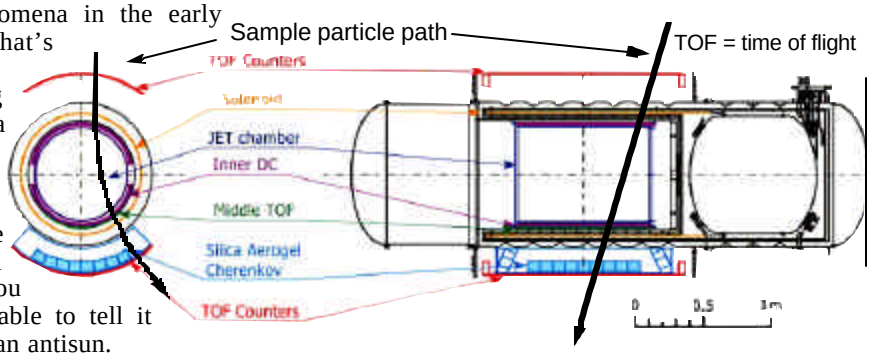
"You'd have to be there to know but of course you can't exist there," he said. "Anyway, we're not out of our solar system yet, so making it out of our Galaxy is a long way off."

But with the 2,250kg BESS instrument soaring along 39km above the frozen Antarctic, Mitchell and other scientists are one step closer.

*Karl Horeis is a dining attendant at McMurdo Station. He is a journalist in the United States, most recently in Nevada.*

Photo by Brien Barnett / *The Antarctic Sun*

*Co-principal investigator John Mitchell checks on readings from a malfunctioning instrument aboard the BESS payload. Makato Sasaki later shut down the unit until the payload reached its maximum altitude.*




Graphic courtesy BESS

*This cutaway view shows the central system of the BESS instrument. The pieces, including a superconducting magnet, help the scientists track and record information about an incoming particle.*

Track BESS and CREAM online at http://tower.nsbf.nasa.gov/ice0405.htm

*NSF/NASA-funded research in this story: John Mitchell, National Aeronautics and Space Administration Goddard Space Flight Center, http://bess-gsfc.gsfc.nasa.gov*

# Profile Helo pilot stays steady in life

By Kristan Hutchison
*Sun staff*

Barry James' blue eyes could be described as twinkling and his cheeks as merry.

In the hallways at McMurdo Station, he's always ready with a "hi" for the guys and a hug for the women. When he lifts off from the station at the controls of an A-Star or Huey 212 helicopter, he continues the light-hearted banter, pointing out sights and joking with the passengers.

For seven years James has flown passengers and cargo to field camps and remote research sites, from the top of Mount Erebus to the bottom of the Taylor Valley.

"Barry's a good guy and he's well thought of by the community and his peers," said Jack Hawkins, flight manager for Petroleum Helicopters Incorporated (PHI), the helicopter support contractor for the U.S. Antarctic program. "He'll always have a smile on his face and be willing to do a job for you."

James, 51, was slow to find his career. Born and raised in San Antonio, Texas, he dropped out of junior college when he couldn't make enough money driving forklifts to cover the costs.

It was then, in his 20s, that he took a ride on a glider at a carnival and decided that he'd like to fly.

"You're just up there soaring. It's a different sensation," James said.

He decided to go back to night school, studying to be an aircraft mechanic and working during the day bending sheet metal. Many of his classmates were Vietnam veterans and when James told them he wanted to fly, they suggested he join the Army. At 27, he dropped out of night school to follow their advice, earning his pilot's license in the Army in 1980 along with an associate degree. His 16 years in the Army took James to Alabama, Alaska and Oklahoma. Then he was sent to Desert Storm, leaving on his daughter's tenth birthday.

"Until then it had been fairly short periods of time, just training exercises and stuff like that. That was five months," James said. "And of course, up until then it had been just exercises. That one was real."

When he came back he was sent to Honduras for four months and then to Korea for a year. All the while his family remained in Fort Sill, Okla. He returned to face one of the toughest periods of his life, starting with divorce, then being released from the Army in March 1996 as it downsized. Suddenly unemployed and with alimony to pay, he couldn't cover the mortgage and lost his house.

"That's a mid-life crisis handed to you on a platter," James said. "You have to laugh. If you don't, you cry."

The experience gave James perspective, which helps him weather small daily turmoils. Hawkins describes him as even-keeled.

"Looking back on it, of course it wasn't fun," James said. "But there was a period of about a year in there where things couldn't have got much worse, and I survived it, so now, nothing is quite as serious as it used to be."

Around that time James was finally able to combine his earlier college credits and a few new classes to earn his bachelor's degree in aviation management at age 42. He got a job with PHI the same year, flying crews to and from oil rigs in the Gulf of Mexico. For the past seven years he's also flown in Antarctica for PHI from October to mid-February. The challenge and beauty of flying in the Antarctic provide a counterbalance for the monotony of flying back and forth over the blue gulf waters the rest of the year.

Photo by Kristan Hutchison / *The Antarctic Sun*
*Pilot Barry James sits in the cockpit of a helicopter.*

"(Antarctica is) the most challenging flying that I've done," James said. "We have to fly the machine and ourselves to the edge of the envelope and know when to stop."

Small helicopters stop flying at -40C and 40 knot winds. James has been at 3,500m on Mount Erebus when the temperature was -35C. Flying into the Dry Valleys, helicopter pilots have to be careful of sudden gusts that can knock the aircraft around. For all the challenges, PHI has a good safety record over the past nine years, James said.

"A whole lot of what we do down here is know when to quit," James said. "You've got to listen to your own comfort level."

James is beginning to consider when it will be time for him to quit Antarctica in general. He has a home to return to "in the hill country of Texas," an hour west of Austin. Every chance he gets he fishes for bass in the reservoirs nearby, not really caring what's on the other end of the line. He also has three children — boy, girl, boy — the youngest now in college. And three grandchildren — girl, boy, girl — all in Oklahoma.

"I always go see them as soon as I go home from the Ice and I go see them right before I leave," James said.

When his youngest grandchild was born three years ago, James was on the Ice. He proudly showed her photo to friends, but didn't hold the child until she was several months old. He considers that missed birth and many other missed birthdays when asked how many more seasons he will fly in Antarctica.

He's committed to at least one more Antarctic summer, the last of PHI's current contract.

"If we get the contract back, then I'll have to make a decision," James said.

Someday he wants to hop on his '98 Harley Softail, visit his grandkids in Oklahoma and then just keep going.

"I don't know which direction," James said. "but it doesn't matter; somewhere."