

A newsletter of unusual reports on various subjects. Published on an irregular schedule as an exchange with others of a like nature. Comments should be sent to: Gene Duplantier, 17 Shetland Street, TORONTO, Ontario, Canada M2M 1X5

NATIONAL POST, THURSDAY, NOVEMBER 5, 1998

ASTRONOMY

Astronomers find signs of another Earth

Hope hangs on a star system 57 light years away

BY ROBERT MATTHEWS

LONDON • The next starry night, cast your eyes towards the patch of sky between the tail of the Plough and the head of the Little Bear. According to findings just unveiled by astronomers, you could be looking at the location of the first Earth-like planet found beyond our solar system.

During the past three years, astronomers have made a steady stream of claims about supposed new planets orbiting other stars. The first was made in December, 1995 in Switzerland, and the count now stands at about a dozen. Yet until now, all claims have been for nothing more exciting than giant balls of gas so huge their gravity makes their parent stars perceptibly "wobble".

Now, however, Dr. Hans Deeg of the Astrophysics Institute at

Tenerife may have bagged the big prize: evidence for a truly Earth-like planet following an orbit that could allow the existence of life.

Since 1994, Dr. Deeg and his colleagues have been using a worldwide network of telescopes to keep a close watch on CM Draconis, a star system about 57 light years away. Made up of two small, dim, reddish stars circling one another, CM Draconis would normally attract little attention. Yet those ho-hum characteristics make the star the perfect target for a simple yet powerful way of detecting Earth-like planets.

Known as the transit method, it relies on the fact that a planet crossing the face of a star will blot out a small fraction of the star's light, causing a sudden fall in its brightness. By watching out for these tiny, but regular ebbs in brightness, astronomers think they can detect the existence of planets too small to produce any othertell-tale signs.

The method was proposed more than 40 years ago by a Russian astronomer, but only recently have instruments been sensitive

enough to detect the dips caused by an Earth-sized planet.

There was another problem: knowing which star to look at. For even if it does have planets, there is no certainty their orbits will be tilted correctly to produce transits visible from Earth.

That is what makes CM Draconis the ideal target.

First, its two stars are known to orbit each other edge-on to the Earth — virtually guaranteeing that any planets they might have will also be edge-on, thus allowing transits to occur.

The stars' small size is another plus, says Dr. Deeg: "The two stars are also only about a quarter the diameter of the sun, so the transit of even an Earth-sized planet across one of these small stars would cause a detectable brightness drop."

Like many planet-hunters before, members of the Transits of Extrasolar Planets team have had to endure false alarms. In May, 1994, one telescope detected a sudden drop in brightness of the type expected from a relatively big planet. It proved to be nothing more than a speck of dust on one of the telescope detectors.

But now, after sifting through the first three years of data, covering more than 600 hours of observations, the TEP team thinks it might have hit pay dirt.

The evidence, published in the journal *Astronomy & Astrophysics*, takes the form of six

small but definite dips in the light coming from the CM Draconis system. Dr. Deeg says they are the type of dips expected from planets roughly the size of Earth.

"We have essentially ruled out the presence of planets much larger than about 2.5 times larger than the Earth," he says. "What may have caused some of these six potential transit events are planets about 1.5 to 2.5 times the radius of the Earth."

The TEP team is analyzing the data to see which of the transits provides the best evidence. "Then we'll go back to the telescope and check if new transits occur at the times we'd predict," says Dr. Deeg. If the six events hold up, they may do more than merely point to the existence of a planet: Its orbit is likely to lie at the right distance from the central stars to give it a similar temperature range as Earth. "Our detection method is sensitive to the whole distance range of the habitable zone around CM Draconis," says Dr. Deeg.

Once Earth-like planets have been found, it will be possible to do much more than simply watch them go around their stars.

"We may be able to analyze their atmospheres spectroscopically while they are crossing the face of their stars," he says. "And that might allow us to detect gases like free oxygen that indicate the presence of life."

The Daily Telegraph

The Toronto Sun, Friday July 3, 1998

WASHINGTON, D.C. (Reuters-CP) — Armageddon may be coming to more than just a theatre near you.

Astronomers have found an asteroid in a place where asteroids have never been found before: Orbiting entirely between the Earth and the sun. While this asteroid does not seem to be on a collision course with the Earth, there may be more out there.

Since this one was so difficult to see, there could be others in orbit that no one

would spot until the last minute.

Astronomy professor David Tholen of the University of Hawaii and graduate student Robert Whiteley said yesterday they used a special camera to spot the asteroid.

Most asteroids orbit in an ellipse that extends at least partly outside the Earth's orbit. That means there is a point in the orbit during which the asteroid can be easily spotted against the darkness of space.

Once astronomers can see the aster-

oid, they are able to map out its course.

But this new asteroid — dubbed 1998 DK36 — always has the sun somewhere in the background from the Earth's perspective. So it is hard to see.

Tholen said there could be others like it, coming out of the sun — and no one had been looking out for them.

"1998 DK36 is nothing to lose sleep over," Tholen said. "It's the ones we haven't found yet that are of concern."

Little investigation of flying objects

A panel of international scientists studying UFOs has concluded that the truth is still out there — but extraterrestrials aren't part of it.

In the first scientific report on the UFO phenomenon in many years, the team of astronomers, atmospheric physicists, and other scientists said that some puzzling UFO sightings remain unexplained and their resolution may shed light on "unusual phenomena currently unknown to science." However, they also said they found "no convincing evidence" that extraterrestrials were involved in any UFO incident.

The report criticized the reluctance of many scientists to lend their expertise to investigating UFO sightings when physical evidence is available.

Citing a famous 1973 case where witnesses both on the ground and inside a U.S. army helicopter claimed it was buffeted by a green glow and buzzed at close range by a gray metallic object, the report said no follow-up scientific investigation of the aircraft was made.

The Universe

TERENCE DICKINSON

Headed by retired Stanford University astrophysicist Peter Sturrock, the report is based on seven days of meetings last fall by a panel of nine scientists. Expenses for the meetings and the subsequent report were paid for by the Laurance S. Rockefeller Fund.

After reading a summary of the report released last week, I had a feeling I had heard all this before. Sure enough, a little rummaging through my files uncovered two previous scientific studies in the 1970s, both headed by Sturrock, that used similar language and reached virtually identical conclusions. I'm not necessarily arguing with those conclusions, but this new report does seem to confirm my own feeling that not much has changed in the scientific investigation of UFOs in the past two decades.

For one thing, UFO investigation is fraught with blind alleys and is aston-

ishingly time-consuming. I can say this from first-hand experience. In the 1970s, I was a volunteer scientific field researcher for J. Allen Hynek's Centre for UFO Studies and investigated many cases first hand.

I was most impressed by peoples' genuine interest in trying to understand what they saw, but I was also surprised that ordinary phenomena, particularly twinkling stars and planets near the horizon, could completely baffle whole groups of on-lookers and prompt them to file a UFO report.

It reached a peak one week in the summer of 1972, when I was working at the Strassenburgh Planetarium in Rochester, N.Y. The planetarium switchboard was receiving dozens of flying saucer reports each day. A common feature of the reports was the

glow of irregularly pulsing lights on the edge and underside of the saucers. It was my own X-Files case!

There I was, conducting interviews and patrolling the city

in my dark maroon Mustang, closing in on the

mysterious aerial phenomenon. Then I

saw it! Sure enough, it looked like a saucer with overlapping rows of irregular pulsing lights. As

I sped toward it, the UFO turned and

headed toward me. As it flew over I could hear

the engine of a light aircraft and saw the rows of lights on its

underside spelling out in moving letters an advertising slogan for a local car dealer. It sure made a great UFO.

Eureka!
Algae embedded beneath the ice in one of Earth's coldest, driest deserts suggest life could exist in other parts of the universe, scientists say. The microbes discovered in Antarctica were able to photosynthesize and decompose in conditions similar to those on Mars and Jupiter's moon Europa.

INTERNATIONAL EXPRESS Tuesday June 2 1998

It's a planet, Jim, but not as we know it

ASTRONOMERS have taken the first picture of a planet outside our solar system.

One scientist called the discovery "unbelievably exciting".

Experts at Nasa said the sighting challenges conventional theories about the birth and evolution of planets and offers new insights into the formation of the Earth and its neighbours.

The planet, found within the constellation of Taurus, is about 450 light-years away and was flung about 130 billion miles from the stars that ejected

it. The object is two to three times the size of Jupiter, the largest planet in the solar system.

"The results don't directly tell us about the presence of any planets like Earth," said Susan Terebey of the Extrasolar Research Corporation in Pasadena, California.

"But this observation pushes back the clock on planet formation. It provides valuable new clues to the origin of our solar system."

Nasa said Ms Terebey believed the planet may have been flung into deep

space by a gravitational "slingshot" from its parent stars. It was her team that used the orbiting Hubble Space Telescope to make the discovery.

Future observations call for additional photos at a later date to confirm the object's movement across the sky and to determine that it is a planet and not a dwarf star.

"This is unbelievably exciting, seeing a possible planet for the first time," said Washington astrophysicist Alan Boss. "This is a major, unprecedented observation."



STAR TURN: The planet, left, and parent star

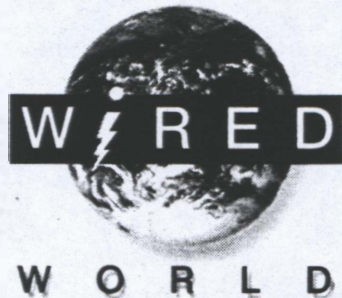
Computer idle? Help spot UFOs

Communally we can pull off what no one can do on their own

By JOAB JACKSON

Sounds like science fiction, but by early next year about 110,000 people around the world are going to be able to use their personal computers to scan the skies for extraterrestrial signals.

The project is called SETI@home and is an offshoot of the nonprofit Search for Extraterrestrial Intelligence Institute (SETI). The institute has use of the world's largest radio



telescope in Arecibo, Puerto Rico. It also has a supercomputer sifting through 28 million channels looking for signals — perhaps some old show on intergalactic television, or some other signal, unintentional or not, drifting off a planet somewhere in the cosmos.

Fall short

It's a start, though SETI's efforts still fall short of the muscle needed to sift through all the different frequencies for some glimmer of intelligent life.

That's where SETI@home will help. This project will break down some of the data from that Puerto Rican telescope into 50-second chunks and send it out over the Internet to home computers, which in turn can churn through them in their idle moments.

Its expected start-up date is January 1999. Beta testing with a small

group of users is already taking place.

Although the technique of distributed computing is already used in a limited way in business, this awesome potential of tapping the millions of computers worldwide is just beginning to be understood.

"Distributed computing is a method that breaks a large task into many small bits that individual computers can solve separately," is how Boardwatch magazine neatly sums it up.

Distributed computing can utilize untold amounts of processing power that otherwise would go to waste. Very rarely is all the processing capability utilized on the average home PC.

Useful cycles

Much of the time it sits idle, waiting while its owner talks on the telephone or is diverted elsewhere. Even while a computer runs a spreadsheet or word-processing program, most of its cycles remain unused. SETI@home created a small program that puts those cycles to work.

Don't care for searching out little green men? How about secret keys? Take a look at Distributed.Net (<http://www.distributed.net>), a nonprofit coalition run by 20 individuals.

Last year, as part of a promotional campaign, the data-security firm RSA Labs challenged computerphiles to discover a secret message encrypted with RSA's 56-bit key. (The "key" to unlock the message was 56 bits long, meaning the message was encrypted in one of approximately 72 quadrillion different ways.)

With the combined effort of approximately 20,000 computers the world over, Distributed.Net was able to find the right key within 250 days.

"We had people from every time zone, almost every country partici-

pating," says David McNett, one of Distributed.Net's cofounder.

How long would it have taken one person with a single computer to break the code? "The sun would burn out sooner than one person could crack it," McNett boasts.

Now the stakes have been raised: RSA has issued a 64-bit encrypted message, and, of course, Distributed.Net continues to welcome volunteers.

At John Hopkins University in Baltimore, professor of computer science Baruch Awerbuch hopes to harness distributed computing for a cause almost everyone can agree on — making money.

Awerbuch foresees a time when you might actually be paid for your extra cycles. In other words, your computer can be processing someone else's accounting package or graphics program, earning you cash while you sleep.

In a project funded by a \$1-million three-year federal grant from the Advanced Research Project Agency — the people who brought us the Internet — Awerbuch is studying the technology and economics of sharing computer power over the Internet.

"This sharing should not be viewed as an altruistic thing," Awerbuch says of his project. "To the contrary, this is purely an entrepreneurial arrangement, where you trade what you own in exchange for cash."

Besides, participating in a project with a task wholly beyond what any one individual could accomplish has its own rewards as well.

Whether or not aliens are ever found, there are tangible benefits to SETI@home. In an age when computers threaten to fragment communities, projects such as these help bring together people from around the world in a common cause — or in SETI@home's case, even different worlds).

SETI@home: <http://setiathome.ssl.berkeley.edu>

Distributed.Net: <http://www.distributed.net>

RSA Secret Key Challenge: RSA Secret Key Challenge: <http://www.rsa.com/rsalabs/97challenge/> ●

NOW JUNE 25-JULY 1, 1998

TORONTO STAR Tuesday, October 27, 1998

Dancing atoms may run future computers

COPENHAGEN (Reuters) — Danish scientists say they've created a computer chip on which a single atom jumping back and forth could generate binary code.

Applying this technique, information stored today on one million CD-ROMs could be put on a single disc, says physicist Dr. Francois Grey, the team leader.

Using a scanning-tunnelling microscope, a four-man team at the Danish University of Technology was able to remove from a hydrogen-coated surface on a silicon chip, one of a pair of hydrogen atoms. That left the remaining hydrogen atom jumping back and forth.

"This is basic research. It's not something you can put in a computer tomorrow," said Grey, adding it might take a decade or two before the technology becomes commercially viable.

Scientists elsewhere have been able to make single atoms jump back and forth at super-cold temperatures, but the Danish team was the first to succeed at room temperature, Grey said.

The Toronto Sun, Thursday October 29, 1998

Sphinx gets lift

ALEXANDRIA, Egypt (AP) — A 2,000-year-old granite sphinx was raised yesterday from the ruins of a sunken city where Cleopatra had a palace. Egypt's Supreme Council of Antiquities wants to turn the ruins of Alexandria's royal court into an underwater museum.

The Toronto Sun, Thursday September 10, 1998

Search for aliens — at home

NEW YORK (AP) — While you surf the Net, your home computer might soon also be performing a loftier task — scouring the heavens for signs of extraterrestrial life.

Home computer users are being enlisted in an effort to analyse little slices of the sky for faint radio signals from distant civilizations.

Researchers at the University of California at Berkeley are developing software, SETIathome, to analyse the vast amounts of data collected by the world's largest radio telescope, the 300-metre-diameter instrument at Arecibo, Puerto Rico.

Project leaders hope to get at least 100,000 volunteers to down-

load the software from <http://setiathome.ssl.berkeley.edu> next April.

SETI (Search for Extraterrestrial Intelligence) uses a technique called "distributed computing" to spread the load of crunching the data collected by the telescope, which can scan 168 million radio frequencies simultaneously.

Bigfoot's trail runs hot with acrimony

More than 30 years ago, in a small clearing amid the dense old-growth forests of western Oregon, Rene Dahinden's life was suddenly imbued with a sense of purpose.

Mention to him the slight peculiarity that he wasn't even present to witness the seminal event in question, and he'll shrug it off, exhale heavily and smile.

"I didn't need to be there to know what I know," says Mr. Dahinden, 68, flashing an all-but-tooth-free grin. "That out there, somewhere, is an animal beyond our understanding."

Mr. Dahinden's closeness to the event in question can perhaps be explained by what it left behind, the now-legendary Patterson film, 18 seconds of celluloid purported by true-believers to be the only real film footage of Bigfoot on Earth.

The images it captured are as familiar as they are confounding: A large, black-haired, upright figure, far too heavily muscled to be explained away as a man in a monkey suit, Mr. Dahinden says, strides swiftly across the clearing, through a creek bed, and into the dense brush surrounding.

The film, now 51% owned by Mr. Dahinden, was the launching pad for a 30-year-old obsession to either prove the film is legitimate or prove it's a fake. He has been unable to do either.

"However much people say 'we are scientists,' you just can't be when it comes to this film," he says in a voice still thickened by a strong German accent despite his more than 40 years in Canada. "The film is an emotional thing. It grabs you."

For Mr. Dahinden, the film was the culmination of everything he had learned since his first exposure to the Bigfoot legend in 1951.

Fresh from his native Switzerland, Mr. Dahinden's first home in Canada was on an Alberta farm, where the farmer freely spun Bigfoot yarns, some rumor, some hearsay, some culled

from the legends of local natives.

By 1956, Mr. Dahinden was captivated enough to pull up stakes and move to Harrison Hot Springs, the site of a curious event for the British Columbia centennial celebration called the Harrison Sasquatch Hunt.

John Green, who was beginning his own explorations of the Bigfoot legend, remembers a young Rene Dahinden turning up for the hunt, eager to cut through the centennial celebration's hype and separate the myth from reality.

'WHEN I FIRST HEARD OF THIS FILM, I SAID TO MYSELF, 'I WON'T BE ABLE TO PROVE THAT IT'S REAL, BUT I'LL SURE AS HELL BE ABLE TO PROVE IT'S A FAKE. I'LL FIND THE GUY IN THE MONKEY SUIT.'

Rene Dahinden

"There are people in this business that are phony, no question," said Mr. Green recently, "and Rene is definitely not that. He's in this in a very real, genuine way."

Mr. Dahinden and Mr. Green began to collaborate on their work. They shared information and investigated hundreds of sightings, called themselves field researchers and shunned the few academic anthropologists who dared tread on their turf.

"In the beginning, we were trying to get a Sasquatch," Mr. Green recalls. "I eventually reached the conclusion that that was about like buying tickets in a lottery."

Mr. Green began to share infor-

mation with the growing legions of Bigfoot researchers in hopes that pooled resources might turn up more iron-clad evidence. But Mr. Dahinden saw that as a betrayal, and broke off with Mr. Green. They haven't spoken in more than 20 years.

Mr. Dahinden, however, has never wavered from his course. A film 18 seconds long has consumed half a lifetime. He has examined it frame by frame, looking for hints of tampering. He has consulted Hollywood make-up artists to confirm that the figure is too exacting to have been faked. Rene Dahinden, whose has spent half his life examining evidence and reports on Sasquatch, is stumped.

"When I first heard of this film, I said to myself, 'I won't be able to prove that it's real, but I'll sure as hell be able to prove it's a fake. I'll find the guy in the monkey suit,'" he said. "Well, 30 years later . . . let me just say this: It's a very, very complex strip of film."

Almost as complex, according to Grover Krantz, a professor of anthropology at Washington State University, is how Mr. Dahinden wrangled his way into part ownership of the film. Dr. Krantz, who has been at odds with Mr. Dahinden over the intricacies of the Patterson film for decades, said Mr. Dahinden railroaded Mr. Gimlin out of his stake in the film.

Nonsense, says Mr. Dahinden: Mr. Gimlin grew weary of the endless hassles — and little financial benefit — of owning the film, and turned it over to him.

The conflict is a microcosm of the endless backbiting that seems to rage in the Bigfoot community. Mr. Dahinden calls Dr. Krantz and Dr. John Bindernagel, both with doctorates in anthropology, "bloody fakes."

The academics describe Mr. Dahinden as an annoyance and a triviality whose claim to the film — after all these years, still the best potential evidence that such a creature could exist — is a moral travesty. "I just don't think

he has a shade of moral right to have any part of that film," said Mr. Green. "It's not his, and it never was."

Moral implications aside, Mr. Dahinden has allowed his very serious research to be interrupted by moments of frivolity. Lately, Mr. Dahinden has become the poster boy for Kokanee Beer, a B.C. brewery suddenly fond of Sasquatch for its ad campaigns.

There is the blurred still-frame poster of the beast in full stride, fitted with a similarly blurred case of Kokanee in its grasp.

'THEY LOVE TO TALK, THOSE PH.DS. BUT LET'S GET RIGHT DOWN TO IT: IT'S MY BLOODY FILM, AND I'LL DO WITH IT AS I GODDAMN PLEASE.'

Rene Dahinden

It is Mr. Dahinden's toothless visage that greets beer-store customers in B.C., while on television, he consents to an interview while a Sasquatch, in this case, a guy in a monkey suit, shakes his trailer home while Mr. Dahinden tells the interviewer that Sasquatch is "a load of hooey."

Perhaps, says Mr. Green, his former associate has finally found his true calling. "He won an award for best actor in a TV commercial," said Mr. Green. "What they didn't know was that he wasn't acting."

For the ever-gregarious Mr. Dahinden, academic criticism of his less-than-academic use of the film falls on gleefully deaf ears.

"They love to talk, those Ph.Ds," he says. "But let's get right down to it: It's my bloody film, and I'll do with it as I goddamn please."

National Post

We now have new eye on Universe

BY ART McDONALD

Two thousand metres underground is a strange place to go to study the sun.

No light penetrates to this depth, but the Sudbury Neutrino Observatory (SNO), which opens Wednesday, will use neutrinos which can penetrate almost anything.

This unique neutrino telescope, the size of a ten-storey building, has been created deep in INCO's Creighton Mine near Sudbury, Ontario, by a team of scientists from Canada, the U.S. and the U.K. The observatory is a major opportunity to view our Universe in new ways, studying fundamental puzzles about our sun and about the smallest and largest regions of the world around us.

These elusive neutrinos are the key to the puzzles and this new Canadian Observatory will detect them with the best substance for this purpose: 1,000 tonnes of pure heavy water on loan from Canada's reserves.

As other scientists build their optical telescopes on the tops of remote mountains to avoid the city lights, the SNO scientists go far underground to avoid the cosmic rays which would light up their detector like the Northern Lights if it were built on the surface of the earth.

There are more neutrinos than any other type of sub-atomic particle, yet we are normally oblivious to their existence. Enormous numbers were produced in the original Big Bang and more are produced steadily by the nuclear reactions powering the sun. These neutrinos stream through us continuously but only once in our lifetime might one stop in our body, with no noticeable effect. However, when detected by SNO, neutrinos can reveal information about our sun and stars which cannot be obtained by other means, including questions as fundamental as the future evolution of our Universe: Will it expand forever, or collapse in a Big Crunch billions of years from now?

The SNO detector is an achievement of engineering as well as science: an ultra-clean laboratory the size of a ten-storey building, the largest plexiglass sphere ever built (to hold the heavy water) and 9500 ultra-sensitive light sensors to observe the faint bursts of light produced by the

neutrinos. Originally proposed in 1984, the SNO project has been under construction since 1990 when funding was committed by a consortium of Canadian federal, provincial and industrial supporters and government agencies in the U.S. and U.K. The total construction cost has been \$74 million, but if attempted anywhere else in the world it would have cost over \$500 million. In Canada the heavy water, valued at \$300 million, is on loan from AECL with the cooperation of Ontario Hydro and the \$150 million infrastructure of the mine is being provided by INCO for only the daily incremental operation costs.

SNO scientists are beginning operation of the Observatory this month

The Sudbury Neutrino Observatory can challenge our current thinking about the sun, and our Universe on the smallest and largest scales

and will celebrate the Official Opening Wednesday with Canadian and international government and scientific representatives present, including Professor Stephen Hawking of Cambridge University. During the next few years they will provide answers to some of the most fundamental questions posed by humans since they began to wonder about the world around them. How does the sun shine? What is the future of the Universe? How does the Universe work on the smallest scales, well inside the atom?

Neutrinos, along with electrons and quarks, are thought to be basic building blocks of matter. However, neutrinos are so elusive that many of their most basic properties, such as their mass, have not yet been determined. They are known to be produced extensively by the nuclear reactions which power the sun, but all measurements performed to date of the number reaching us from the sun

have shown fewer than predicted by the best modern theories. This may be because these theories are incomplete or incorrect, or it may be because the neutrinos are changing their properties in transit to the earth so that they were not detected by previous detectors. SNO can determine which answer is correct.

The changed neutrino properties, which could be observed by SNO, could only occur if the neutrinos have mass. If they do, it would have several basic scientific implications. Even a tiny mass, combined with their enormous numbers, could create a gravitational attraction for the rest of the Universe which would slow the expansion which has been occurring since the original Big Bang. Secondly, the current Laws of Physics, which work extremely well on the microscopic scales occupied by the basic building blocks such as electrons and neutrinos, have no place for a neutrino mass. A clear indication of mass would require a revision to our current theories and would provide a signpost for the broader theories which would take their place. The Observatory can challenge our thinking about the sun, and our Universe on the smallest and largest scales.

When the Observatory has done its job and the answers are available, we will understand our Universe more completely, will rewrite our texts in these areas and will have educated a generation of Canadian and international students in many frontier areas of study. In addition to the many technological innovations created in building this challenging project, past experience has demonstrated that improvements in fundamental knowledge are ultimately of strong benefit to mankind.

From their vantage point deep beneath the Canadian Shield, SNO scientists will soon train their new scientific eye on the Universe. Our ability to observe our world will take on another dimension as neutrinos are used with greater sensitivity than ever before to probe the outer and inner reaches of nature.

Art McDonald is the Professor of Physics, Queen's University, and the director of the Sudbury Neutrino Observatory Institute.