

Space Times

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University of Toronto Astronomy and Space Exploration Society

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Acknowledgements

Editor-in-chief:
Alexandra Heeney
alex.heeney@utoronto.ca

Editorial Staff:
Victoria Mothersill
Madeleine Hayles

Graphics/Photos:
Ross Churchley
Alexandra Heeney
George McBirnie

Illustrations:
Jennifer Martin
Lauren Gillis

Contributing Writers:
Ross Churchley
Anita Kappukatt
Andrew Lambe
KC Li
George McBirnie
Tahir Merali
Benjamin Schmidt
Isaac White
Jiayi Zhou

Layout:
Alexandra Heeney

Funding:
Alexandra Heeney
Andrew Lambe
Tahir Merali

Club Contact:
space.society@utoronto.ca

Club Website:
<http://asx.sa.utoronto.ca>

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From the President

By Tahir Merali

The University of Toronto's Astronomy and Space Exploration Society is an undergraduate student-run group now entering its 4th year. This magazine was established to enrich the understanding of space and astronomy for lay-people to the field. There is occasion within every organization to celebrate. What you read here is a celebration of the research and opportunities out there in the Canadian and global space field.

This publication is just one arm of our organization. Throughout the school year we orchestrate incredible events at U of T that are open to everyone. Our keystone event, the symposium, brings in four distinguished speakers to discuss cutting-edge topics. Some examples from the past are:

- Professor Michael Brown (California Institute of Technology), the man who led the team that recently discovered the "Tenth Planet", which along with Pluto, is not considered a planet anymore (see article, "What's in a Name?" on page 2).
- Dr. Carolyn Porco (Space Science Institute), the lead imaging scientist on the Cassini Mission to Saturn
- Canadian Astronaut Chris Hadfield (Canadian Space Agency) who explained his first-hand experiences in space and Canada's role in exploring the Red Planet.

In only three years, the symposium has brought in over 4000 high school students, university students, professors, and members of the public from Toronto as well as from across Canada.

But wait, that's not all! The ASX hosts an annual public lecture series and a series of smaller lectures focusing on very specific topics in the space world – ranging from the private space industry to theoretical astrophysics to planetary science to space in the medical field. Every year we host a combined conference with



another space organization in which our ASX members volunteer and participate. The ASX goes great lengths to bring space into the limelight. We were instrumental in saving the McLaughlin Planetarium from demolition. We also host observing events, making use of our very own telescope.

None of these events would have been possible without the time and dedication of volunteers and students just like you! This newsletter, the brainchild of Alex Heeney and her team, is driven by passionate individuals. If you would like to join our group and take an active role in your community, send an email to space.society@utoronto.ca and we will add you to our email list. If you are seeking to get some hands-on experience volunteering and planning events, please acknowledge that in your email, as well.

Celebrate and enjoy this publication and its many issues to come! Stay tuned for information on our events – hope to see you out there!

What's in a name?

That which we call a dwarf planet/ By any other word would be studied as closely.

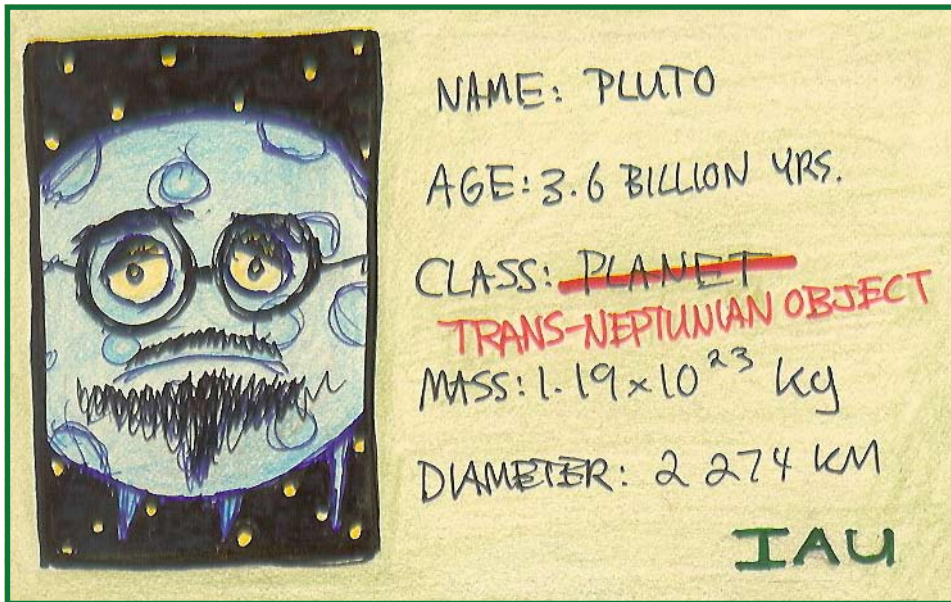


Illustration by Lauren Gillis

By Ross Churchley
Thompson Rivers University '10

From its discovery in 1930, Pluto was always an outsider among the nine planets: a tiny, icy world with an elliptical orbit that crosses Neptune's. Over the course of the last fourteen years, however, astronomers made a string of discoveries that called into question what it means to be a planet.

Since 1992, astronomers have found hundreds of Trans-Neptunian Objects (TNOs) in the outer reaches of our solar system. Like Pluto, they are small and mysterious: smaller than the Earth's moon and trillions of kilometers away, they appear as mere specks of light in telescopes. Not much is known about the TNOs apart from their size and eccentric orbits.

Last year, astronomer Mike Brown and his team discovered the hefty Eris, which they nicknamed "Xena" as an alternative to its nine-syllable original designation, "2003 UB₃₁₃." Currently the most distant known object in the solar

system, Eris takes a calculated 557 years to go around the sun. Its discovery stood out from that of other TNOs for another reason, though: its size. Eris is larger than the first trans-Neptunian object ever found – Pluto, long considered the ninth planet.

The need to classify Eris led to a controversy. Many astronomers believed that neither Pluto nor Eris should count as major planets, because of their tiny size and the existence of hundreds of similar objects beyond Neptune. Other astronomers, however, disagreed with Pluto's possible demotion: should it be thrown from the ranks of the major planets after being a planet so long in the public eye?

This situation is not unprecedented. A similar confusion arose upon the discovery of the asteroid belt: the first four asteroids to be discovered – Ceres, Pallas, Juno, and Vesta – were considered planets for over sixty years, until dozens more were discovered and they were reclassified as "minor planets."

However, the term "major planet" was

never officially defined, until Eris and the other recently-discovered TNOs forced the issue. The International Astronomical Union (IAU), responsible for classifying and naming objects, set the question to its General Assembly of astronomers in Prague this August: what, exactly, is a planet?

The IAU first considered a draft resolution that would define a planet to be an object massive enough to have a "nearly round" shape because of its own gravity. This would have kept Pluto and added Eris to the planetary club. Ironically, Ceres would have become a planet again, along with Charon, Pluto's moon – and dozens of other objects. Mike Brown speculated on his website that the definition would have made at least 53 known objects planets!

The final definition passed by the IAU added a single criterion to become a planet: that the object has "cleared the neighbourhood around its orbit." Although the IAU didn't explicitly define the phrase, only eight planets could make the cut. Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune are each thousands of times larger than anything else sharing their respective orbits – something that, because of the other TNOs, neither Pluto nor Eris can claim.

Despite the debate and controversy surrounding the new definition, it won't have much effect outside of elementary schools. What we call an object doesn't change its place in the solar system, its orbit around the sun, or any of the interesting characteristics that make astronomers want to study it. Scientists will continue to explore the universe around us because, in the end, the language we use to describe discoveries is less important than the discoveries themselves.

The start of private space travel

The Ansari X-Prize



A specially-designed jet plane carried SpaceShipOne to 14 km before launching the 2004 X-Prize winner to its goal. Photo courtesy of Scaled Composites, LLC.

More about the Ansari X-Prize

Upcoming plans for the next X-Prize Cup
<http://www.xprize.org>.

More information about the Canadian teams:
<http://www.davinciproject.com>
and
<http://www.canadianarrow.com>.

To learn about the winner of the Ansari X-Prize:
<http://www.scaled.com/projects/tierone/>

By Andrew Lambe
ASX Projects Coordinator

While human space travel is still dominated by large government agencies like NASA, the era of private space travel may be just a few years away. The possibility of such a change is the result of an idea from entrepreneur and space enthusiast Peter Diamandis. Inspired by the story of Charles Lindbergh's historic flight from New York to Paris in 1927, for which Lindbergh was awarded a \$25,000 prize, Diamandis decided to raise funds for a prize of his own. With the help of some wealthy financial backers, he created the Ansari X-Prize (Ansari is the name of one of the principal donors).

Diamandis created the Ansari X-Prize in 1995 in order to spur development of cheap access to outer space by private companies. A \$10 million (all figures US) prize was offered to the first privately-funded group that could launch a three-person spacecraft to a height of 100 km (the defined boundary of outer space), and then repeat the flight within two weeks with the same craft. Twenty-six teams from around the world took up the challenge, including two Canadian teams. The Canadian teams were: the Da Vinci Project,

led by Brian Feeney, and the Canadian Arrow, led by Geoff Sheerin.

The winning team was led by renowned aircraft designer Burt Rutan and financed by Microsoft co-founder Paul Allen. The craft, called SpaceShipOne, completed successful flights on September 29 and October 4, 2004 and thus won the prize. Although this spaceship cost about \$20 million to design and build - yes, more than the prize money - it is still far cheaper than Space Shuttle Endeavor, which, according to NASA's website, cost about \$1.7 *billion*.

If there is one thing that the Ansari X-Prize shows, it is that space travel can be a relatively inexpensive and profitable venture. Soon after SpaceShipOne's victory, billionaire Sir Richard Branson announced his intention to buy several of Rutan's spacecraft and start his own space tourism company, Virgin Galactic. The Canadian teams also have plans for turning their X-Prize entries into space tourism ventures, as do a number of other former X-Prize competitors. With this sudden surge of interest and investment, it is only a matter of time before sub-orbital space tourism flights occur on a regular basis.

Humans and space don't mix

By Anita Kappukatt

You would think that after forty years of space traveling experience, performing experiments in zero gravity, and even bringing monkeys along for the ride, humans would be well-adapted to weightlessness. But what most people don't know is that the human body is completely unsuited to microgravity environments, where gravity has little or no effect (also referred to as weightlessness). In fact, every major biological system in our bodies is affected negatively if we end up floating in the big black. These effects can be either temporary or permanent. In addition to the problems space's low gravity environment presents to the human body, there are also the problems of motion sickness and space radiation. Furthermore, the sun rises and sets every 90 minutes when astronauts are in an earth orbit, which disrupts our natural REM cycle. The change in light-dark patterns, which humans are not used to, alters people's sleep-wake cycle and increases their vulnerability to infection, disease, and depression. Here's a brief summary of the main physiological changes that can take place in zero gravity, or "zero g":

Skeletal System: One of the most serious effects of space travel is the loss of bone density. In space, human bone density decreases at a rate similar to accelerated osteoporosis, and the risk of fracturing a bone is five times greater than on Earth. A trip between 3-6 months can cause bone loss that can take up to 3-6 years to replace. Even though exercise helps in preventing bone loss, some researchers believe that bone density can never be fully recovered.

Circulatory System: We depend on blood to carry nutrients, waste and hormones to the right places in our bodies.



Gravity provides the downwards force to help fluids get to the right place. Without this force, body fluids redistribute towards the chest and upper body. This can cause an astronaut to have a 'puffy face' look, which usually goes back to normal in a few days. But the astronaut's body still detects 'excess' fluids, and gets rid of much-needed liquids by sweating and urination. In space, the body functions with less fluid and the heart becomes smaller. Upon return to Earth there's not enough fluid to function normally.

Red blood cell count also decreases, reducing the amount of iron and oxygen in an astronaut's system. This condition is called space anemia.

Immune System: Studies have shown that the saliva of cosmonauts contains more bacteria and viruses when in space than on Earth, increasing their risk to disease and infection. This is because fewer white blood cells, the cells that are made to destroy germs, are produced in microgravity conditions.

Internal Clock: The space shuttle crew,

if orbiting the earth, experiences 45 minutes of light followed by 45 minutes of darkness. Sleep disturbance is very common. Almost half of the medication used on board the spacecraft is used to help astronauts sleep! Sleep is very interrelated with how well the immune system works.

This article isn't meant to scare people off from pursuing their dreams of becoming an astronaut. Instead, I would simply like to call attention to some of the problems zero gravity presents for the space traveler. To counteract these physiological changes, we use dietary supplements, hormonal treatments and medication, as well as electrical stimulation and plenty of exercise. The positive side is that research into these areas in space biology helps scientists understand everyday diseases such as insomnia and osteoporosis and aids them in the search for better treatments.

Further reading

Space physiology in depth :

<http://nsbri.org/HumanPhysSpace/index.html>



UTSDC : taste the rainbow



By Isaac White
Former Vice-Chair UTSDC

The University of Toronto Space Design Contest (UTSDC) is an exciting contest for high school students interested in human settlement in space. The contest, now entering its third year, provides design challenges for teams of students who in turn produce a written report, create a display, and present their proposal to a panel of judges. More specifically, in the first year of the contest, students were required to come up with a proposal for an almost entirely self-sustaining space station. It had to have a means of viable income and maintain a stable population as well as allow for some transient activity. The design challenge for the second year of the contest was based upon the assumption that the winning space station from the previous year was already in place and that a lunar base needed to be established to effectively control traffic systems, and provide a docking area for repairs and easy access to Earth.

The designs presented by students have been, by and large, quite ingenious and well thought out. The grand prize winner in the contest's inaugural year was a grade 10 student from Thornhill Secondary. Working by himself, he cre-

ated a proposal for a station known as The Tesus.

That a single grade 10 student can win the grand prize goes to show that, though useful and recommended, teams are not required to effectively participate in this contest. Through hard work and dedication, anything is possible.

The aim of the UTSDC is to allow students to explore an important growing field in a structured manner with the help of a wide variety of experts in space-related fields. Professors and members of the space industry judge and provide quality feedback to students' proposals and designs. We encourage students with not only science oriented interests to participate; there are many aspects one must consider when attempting to create a viable settlement in space, and not least among these are socio and economic issues.

The UTSDC has had a number of prestigious guest speakers and judges, including Julie Payette, a Canadian astronaut, and Bob Richards, founder of the International Space University. In previous years, students have greatly enjoyed their talks. The UTSDC executive works hard to make the talks and speakers as diverse and as interesting as possible.

The UTSDC is a growing organiza-

tion; it hopes to improve and increase its scope with each new year. The second year of the contest not only involved more student participation than in the first but it was a larger event in total. Students were invited to come live in U of T residences for the two nights the conference was in session. This gave them the opportunity to get to know one another and exchange ideas and information. It also allowed the UTSDC to incorporate new and exciting activities into the contest framework. Students were given a rudimentary course in model rocket construction and were later able to fire the rockets off in the field. Tours of the U of T astronomy facilities were also provided.

The challenge for this coming year, though still in the works, will build upon the designs of the last two years. We encourage all those interested to please visit our website. We hope to see you next year!

Further Reading:

Tesus Design Proposal:

<http://utsdc.sa.utoronto.ca/documents.php>

Registration information:

<http://utsdc.sa.utoronto.ca/index.html>

If you have any questions, contact:
space.design@utoronto.ca

All the physics I know, I learned from movies

By George McBirnie
University of Waterloo '07

People say that there isn't anything good on TV these days. They're right. This, however, is because everything good has moved on to a better place. The silver screen is the modern teacher, and it has taught me well.

There is so much I have learned from movies, but the physics of space is a subject that I have truly taken to heart. To see the predicted effects of my chosen discipline play out before me in computer-animated beauty is a marvelous thing to behold. Some movies can also, of course, enlighten me as to how wrong my lessons in class have been.

Serenity is such a movie, and it wastes no time in showing me the error of what I have learned. In one of the very first scenes I am informed of the lie that is conservation of momentum. I was always taught that an object in motion will stay in motion unless a force acts on it to stop it. In order to come to a stop above a planet, however, the starship *Serenity* merely turns off its thrusters, points them downwards, and then proceeds to descend vertically. This situation is so much more elegant and intuitive than the necessity of it firing its engines in the opposite direction to halt. Nature has always favoured the simplest explanations, after all.

The elegance continues as the ship descends through the atmosphere, the glass windows acting as perfect insulators against the fiery heat. This is just as it should be. The authors of the books referencing the supersonic Blackbird jet as having a cockpit temperature of several hundred degrees Celsius in flight clearly do not have the technical understanding



Illustration by Jen Martin

possessed by the makers of this film. The glass also doesn't break in various crash landings, or even during the space battle. This is because glass is clearly the greatest material humanity has ever invented. Why we do not make all our buildings and cars out of it, I do not understand. It would lead to a much safer and more reliable world for everyone.

Revenge of the Sith, another great educational film, reaffirms the falsehood that is conservation of momentum in its first battle scene. Rather than allege the silly notion that a droid, originally upon the wing of a space-fighter and moving at its speed, would continue to move forward with the fighter's speed once the droid is damaged and disabled, it shows the droid more accurately being left behind by the untouched craft. How could it, after all, be able to keep up with a spaceship travelling forward at high speed if it is unable to hold on? The display of such an important, and often misinterpreted, aspect of physics is a great step forward

in educating the public.

Another fact that everyone needs to take from this movie, for safety reasons, is that everything explodes! Every last little thing! It doesn't matter what part of a spacecraft is hit with a laser, a yellow-red fireball always appears at the point of impact. Telling people that flames need oxygen gives them a false sense of security that could lead to disaster. Shame on my high-school science text for putting me at risk like that.

The last movie to receive mention here, *X-3: The Last Stand*, reveals a frightening truth. I cannot begin to express how much I appreciate learning that government-owned satellites can indeed get high enough resolution video, in real time, to count the fingers on my hands. This warning may just grant me enough time to obtain sufficient tinfoil to be prepared.

Until next time, keep seeing those movies. The knowledge they impart is second to none.

Mars rover, still roving (hooray!)

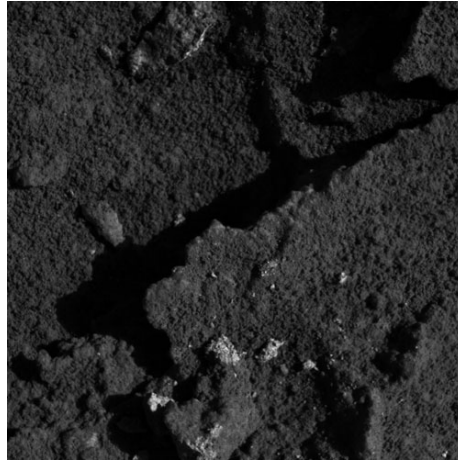
By Benjamin Schmidt

The Mars Exploration Rovers, which landed in January of 2004, have proven to be incredibly durable and adaptable as they have outlasted their expected mission length of ninety days by over three years. The two rovers, named Spirit and Opportunity, were built and controlled by the Jet Propulsion Laboratory (JPL), the branch of NASA responsible for most robotic missions. The six-wheeled rovers are about the same size as a golf cart and are powered by solar cells and rechargeable batteries.

The primary goal of the mission is to search for evidence of past water on the surface of the planet, since that could mean that Mars was once capable of supporting life. The discovery of life on Mars – either past or present – would be very significant because it would imply that life might not be uncommon in our galaxy and the universe.

Vision

Each rover is equipped with nine cameras: six are used for navigation and the other three are for scientific use. The four cameras located on the front and rear of the rovers are known as Hazcams and are used to see obstacles immediately in the path of the rover. The two panoramic cameras on the mast are called Navcams, and help the engineers controlling the



As can be seen here, the microscope camera can capture very small details.

rover to see the terrain ahead and plan a route for the rover to take. The Navcams and Hazcams are stereo (3D) black and white cameras. Two of the scientific cameras are colour, stereo panoramic cameras mounted on the mast with the Navcams. Several different filters are available to analyze the Martian atmosphere and terrain. The third science camera is a monochromatic microscope mounted on the end of a robotic arm. It allows scientists to analyze the rocks and soil encountered by the rovers, and is one of the most important instruments used to search for evidence of past water.

Problem Solving

The engineers at NASA face particularly daunting challenges with these rovers

since they are complex machines and technicians cannot simply go to Mars to fix them. Fortunately, the engineers at the JPL have been able to solve several problems encountered by the rovers using various strategies. One of the main tools they use is a third rover in the lab that is identical to the ones on Mars. With it, they can simulate situations encountered by Spirit or Opportunity, such as a stuck wheel, and try out various solutions, such as driving backwards to redistribute lubricant in the bearing. The engineers are also able to reprogram the rovers, allowing them to overcome software glitches and compensate for changing circumstances including decreased power levels due to dust on the solar arrays.

Conclusion – mission results

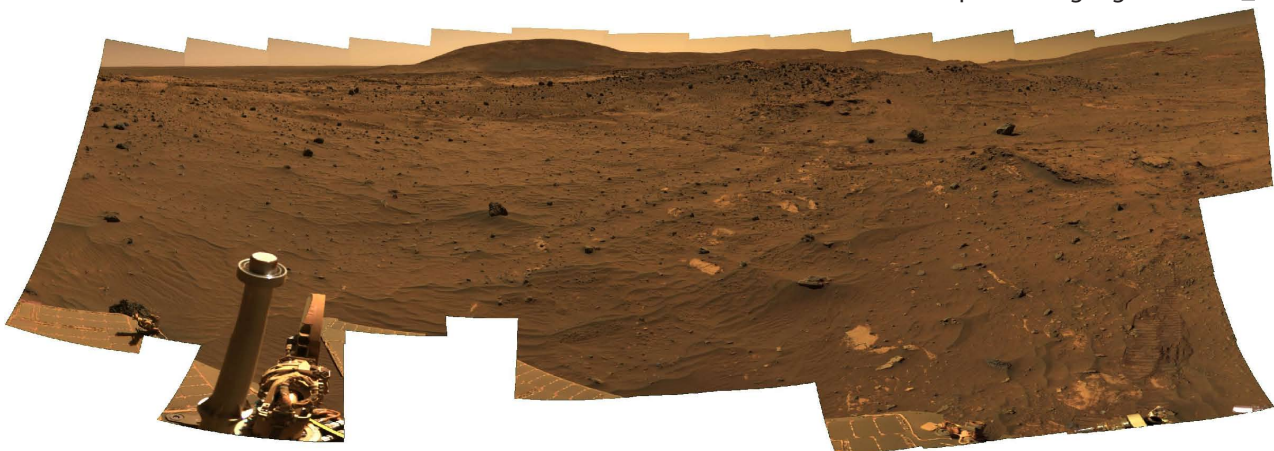
Spirit and Opportunity have both allowed scientists to collect a wealth of information about the geology and atmosphere of Mars. According to NASA, “Opportunity has landed in an area of Mars where liquid water once drenched the surface.” This discovery could mean that there was once life on Mars.

Further reading

http://www.nasa.gov/mission_pages/mer/

<http://marsrovers.jpl.nasa.gov/home/index.html>

http://axonchisel.net/etc/space/mars-exp-rover-highlights.html#s_welcome



The images from Spirit’s Pancam are being used to build a large scale panoramic photograph, called the McMurdo Panorama. As seen here, it is only partially complete, as of yet.

Galaxy clusters tell the story of the beginning and the end of the universe

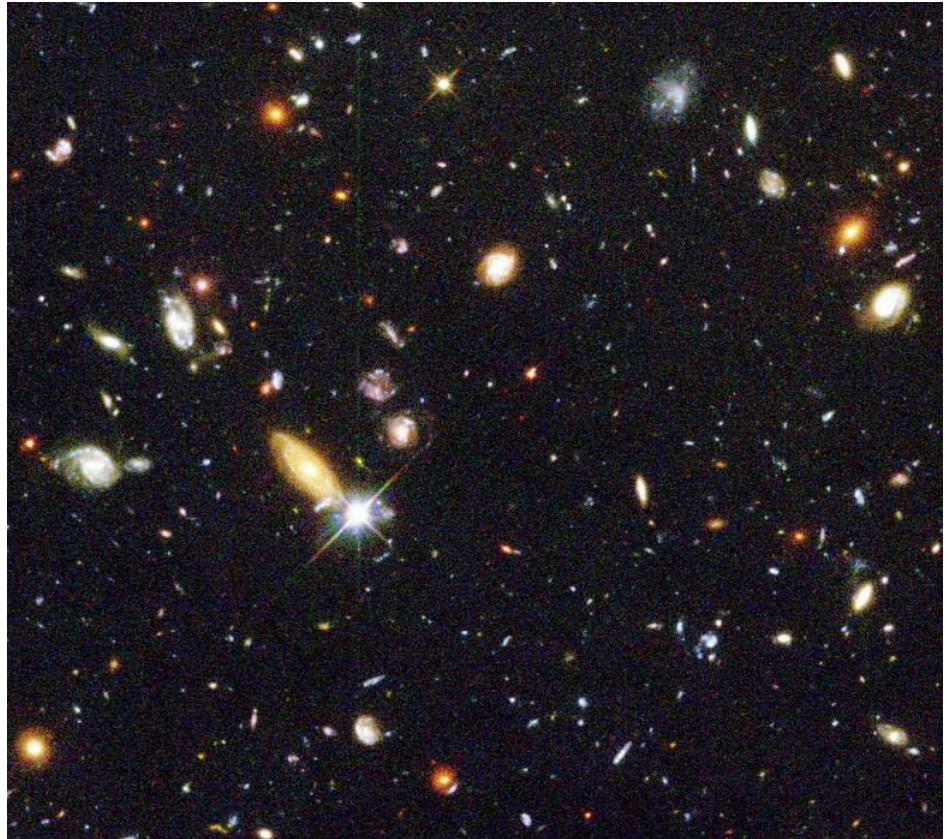
By K.C. Li

We live on a planet that orbits an average star in a remote corner of the Milky Way galaxy. We are but a speck among the billions of stars of our galaxy, but it doesn't end there. The Milky Way galaxy is only one of thousands of galaxies that belong to the Virgo Supercluster of galaxies.

Galaxy clusters are the largest structures in our universe, and they are not simply collections of neighbouring galaxies. Hot hydrogen and helium gas reside in the space between galaxies in a plasma state that can reach 100 million degrees. In the plasma state, gas electrons are stripped from protons. This ionization emits X-rays. It is through studying these X-ray emissions that we learn about the physics governing clusters.

In a galaxy cluster, there is so much gas that the total mass of gas in a cluster is greater than the billions of stars that make up the cluster. Though this mass is astounding, it cannot theoretically keep the cluster of galaxies intact. Something ten times more massive needs to be present for the force of gravity to balance the expansion of the universe due to the Big Bang. This missing mass is believed to be composed of something we call "dark" matter; the matter is dark because it cannot be detected through radiation (such as X-rays or light), but scientists are confident of its presence because of its gravitational influence on celestial bodies. That is, celestial bodies tend to move in a way that does not quite fit Newton's gravitational laws; they move as though there's some sort of extra mass present. Since we can't see or detect this mass, we call it "dark".

Understanding the nature of this dark matter is extremely important. Since galaxy clusters are the largest structures of the universe, the presence of so much dark matter in them means that this



Above: The Hubble Deep Space Field

matter must be prevalent throughout the universe. Determining how much matter is in our universe is crucial for predicting how the universe will evolve. At a certain critical amount of matter, the universe will stop expanding and remain in that state. If the matter content exceeds this critical amount, the universe may eventually stop expanding and contract as per the Big Squeeze theory. Below that critical amount, the universe will expand without bound. The dark matter in galaxy clusters is studied indirectly by looking at the pressure of the enveloping hot gas that is affected by the gravitational force of the dark matter.

Galaxy clusters not only foretell the future, they are also a window into the past. The universe was formed out of fluctuations in the density of the initial particle soup of the Big Bang. By analyz-

ing how many clusters there are at different distances from us and how they are scattered, we can determine how these clusters were formed from ancient gas, and at what age of the universe they were formed. Thus, we begin to understand how the universe evolved to its current state. Through this information, we can even estimate the size and age of the universe.

On the web

Video showing how clusters form:
<http://galaxydynamics.org/galacticencounters.html>

Galaxy clusters and the Chandra X-Ray space telescope:
http://chandra.harvard.edu/xray_sources/galaxy_clusters.html

From star wars to stewardship over Spaceship Earth

By Jiayi Zhou

It has been almost a hundred and fifty years since the poet Walt Whitman chastened the 'Learn'd Astronomer' for retreating in scientific detachment and sullyng the very subject so ardently pursued through proofs and figures. With his meditation, Whitman aptly illustrated the schism that was to come between science and the humanities, between technological advancement and its ramifications for societies and the environment. Nowhere has this been more pronounced than in the exploration of that final frontier of which Whitman first wrote.

News of government funding for space missions is invariably coupled with controversy about their necessity and financial legitimacy. Funneling money towards space exploration is a hard-sell next to a perpetually ailing health care system and incessant appetites for tax cuts. The clinical vastness of space provides the perfect backdrop for an allegory of relentless technological pursuit at the expense of lesser mortals stuck in the harsh grindstone of everyday reality.

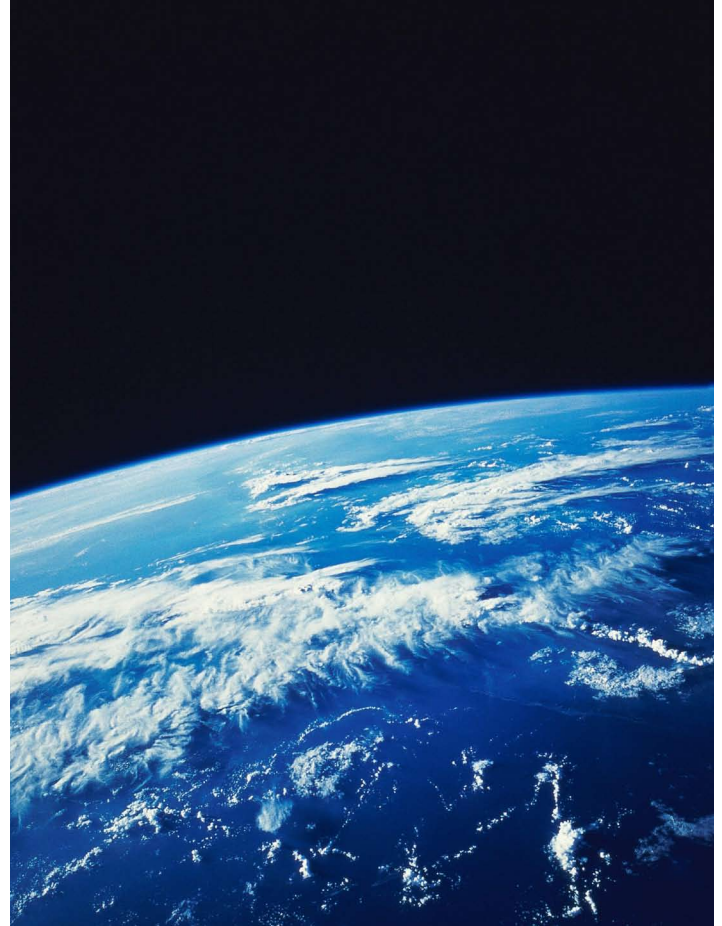
Critics argue that forays into the outer reaches have gone the way of the Cold War and the Space Race - no more than pointless militaristic bluff-matches or proof of



a ticket into the superpowers club. It is ironic then that human endeavours into space find new relevance today precisely because of the demise of those Star-Wars scenarios. As space exploration loses its bellicose edge, truly utilitarian opportunities have begun to multiply.

In going boldly where no one has gone before, whether with manned-missions or satellites, we come closer to understanding the planet we come from. These foreign worlds frozen at other stages of planetary evolution provide clues about the past, as well as the future, of Earth. Climate models about the atmospheric changes of Mars and Venus offer invaluable information about the possible outcomes of the current warming trends of Earth's climate systems.

By looking outward into the emptiness, we notice the fragile isolation of spaceship



earth. When Astronaut Rusty Schweikert describes his experience in outer space, he says: "You look down there and you can't imagine how many borders and boundaries you crossed. At the Mideast you know there are hundreds of people killing each other over some imaginary line that you can't see. From where you see it, the thing is a whole, and it's so beautiful. And you wish you could take one from each side in hand and say, 'Look at it from this perspective. Look at that. What's important?'" He is not alone. Astronauts

who have ventured outside Earth can all attest to the realization of our self-contained system's startling vulnerability. "It isn't important in which sea or lake you observe a slick of pollution, or in the forests of which country a fire breaks out, or on which continent a hurricane arises. You are standing guard over the whole of our Earth," said Yuri Artyukhin, a USSR cosmonaut.

But the value of perspective doesn't end with willy-nilly feelings of goodwill and harmony towards our fel-



low beings. The truth is, for many purposes, that the view from the sky looking down is the only meaningful way to monitor the blue marble we call home. Earth observation goes far beyond the traditional weather imaging. Today, the perspective from space is essential in everything from the delivery of humanitarian aid

to the study of marine biodiversity. Shockingly, humans can accomplish great things even when we're not trying to kill each other.

While it is true that NASA or its Russian counterpart Roskosmos will likely never see the extravagant budgets of the glory days during the Cold War, a consortium of

space agencies from around the world have sprung up in their stead. Space missions can no longer be considered just frivolous pursuits for rich countries; they are an international effort that span the fields of science and humanitarian causes.. Whether it is deep space exploration that furthers the research of scientists around the world or near earth observation that becomes increasingly necessary for our insight into the world's economic, environmental, and humanitarian challenges that are to come, technologies in space are no longer a relic from the Jetsons' age of the 60's. Nor is it an Utopian dream of futurists from their refuge in ivory towers. In fact, when speaking about the establishment of a global Earth Observation sys-

In going boldly where no one has gone before...we come closer to understanding the planet we come from.

tem, South Africa's Director General of the Department of Science and Technology notes that it is the developing countries that have the most to gain.

Sure, space will always hold that irresistible allure of the unknowable. Of curiosity for curiosity's sake. It will retain the whiff of elitism and cowboy ethic for colonies far out in the last wild frontier, but shove over, tough guys; space is no longer only about shoot-em up games of who has the bigger rocket.

An international summer opportunity

By Tahir Merali
ASX President

Do you wish you could do something amazing and exciting this summer instead of just sitting on the computer all day? Imagine a program where you share a poolside with astronauts, you tour and touch NASA simulators, you interact with students from all over the globe, and you develop ideas for the future exploration of the heavens. How about a unique two-week international program based at NASA's Johnson Space Center (JSC) in Houston, Texas? If your curiosity is piqued, read on...

The International Space School (ISS) offers a chance for high school students from

over 20 different countries to be sponsored and receive a special behind-the-scenes perspective of NASA, the world's most distinguished space agency. Established in 1995, the program encompasses a wide spectrum of activities. Given the task of designing a manned mission to Mars, students build on the basics they've learned in lectures by distinguished professionals within the NASA community, including astronauts, engineers, scientists and medical staff. Tours of the JSC facilities showcase real-time simulators used to train astronauts, equipment used in conducting cutting-edge research, as well as Mission Control, just to name a few. All these tours are exclusive – students see and

touch what the public cannot! This means NASA's resources are at *your* fingertips!

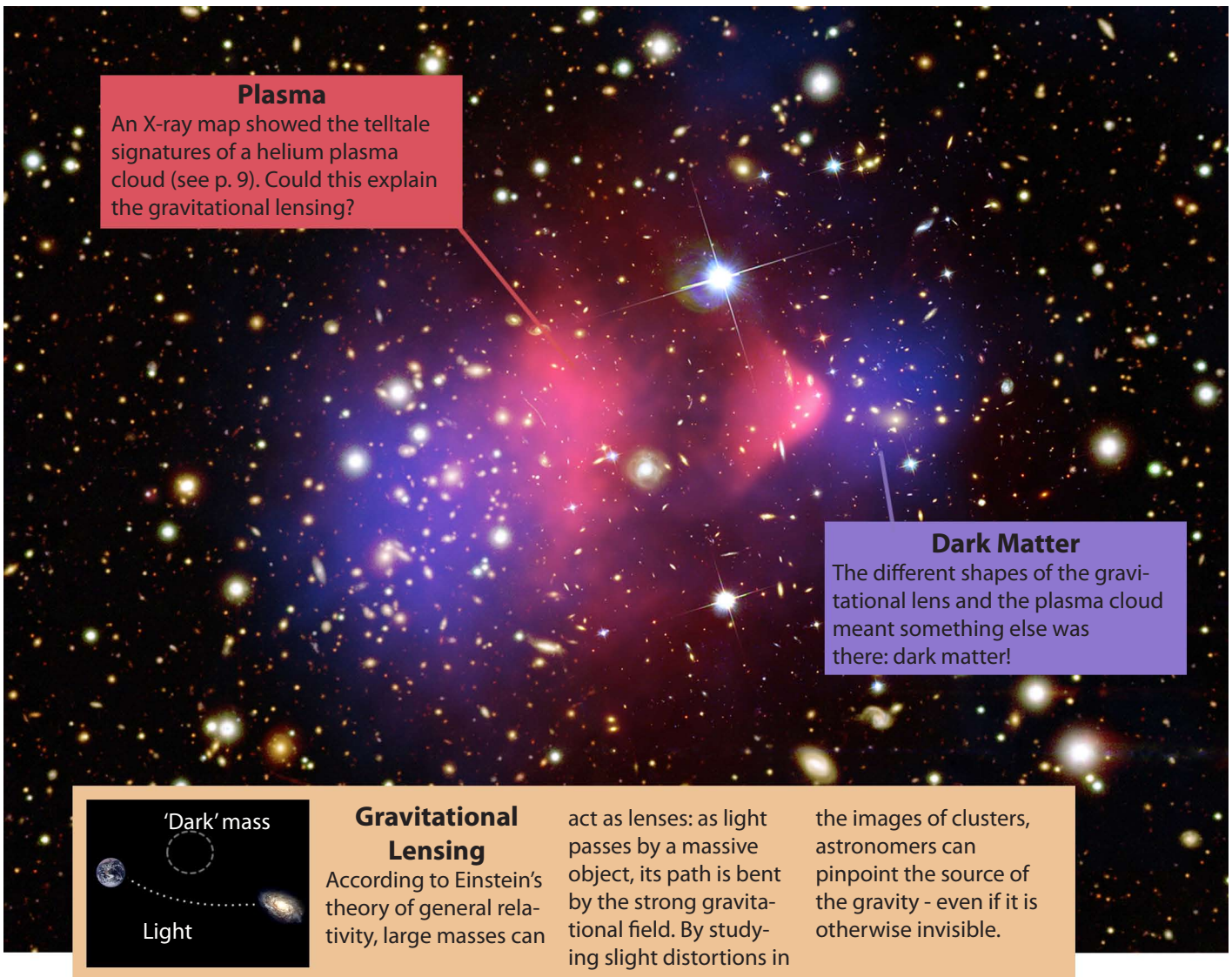
While in the Houston area, there is, of course, much sight-seeing to do, an offering of social events every evening, and time to spend with your amazing host families. There is never a dull moment. Some students are lucky enough to get the chance to live with an Astronaut and family! After the sights and tours are done, the most important element is the international collaboration between students and the special multicultural atmosphere. Through the knowledge spread between peers, the groups grow into very close-knit families.

So what is the end result of this grand adventure? You

present to ISS and NASA officials about your group's findings from the mission you developed, you gain lifelong memories, and make friends from all corners of the world. I can say from personal experience that it was the best time of my life. Two members of the ASX, including I, are graduates of the ISS program.

If you are looking for applications, tips, or are just curious to know more, contact issalumni@gmail.com or visit the ISS website which is currently being re-developed at <http://www.intspaceschool-find.org>. The summer of 2007 is just around the corner. As Les Brown said, "Shoot for the moon. Even if you miss, you'll land among the stars".

Dark matter confirmed



There just wasn't enough stuff!

It was a major astronomical puzzle: the amount of matter that astronomers could see wasn't nearly enough to account for the fast motion of galaxies at the edge of their clusters. Most scientists thought that "dark" matter - extra mass that couldn't be seen - could explain it. There was just one problem: since dark matter couldn't be seen, there wasn't any evidence for its existence! Until now. In August 2006, astronomers examined the effects of gravitational lensing (see insert) in the Bullet Cluster to find the composition of its mass. This image explains their observations. - Ross Churchley

University of Toronto Astronomy and Space Exploration Society
21 Sussex Ave, Rm 427
Toronto, Ontario
M5S 1J6
Contact: Alex Heenev
E-mail: space.society@utoronto.ca
Phone: 1-647-241-3404
Website: <http://asx.sa.utoronto.ca>



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