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Overview

stronomy appeals to people of all ages. It is both an exciting frontier science and a part of almost every culture, including those of Canada's Aboriginal peoples. The Canadian astronomical community professional and amateur astronomers, astronomy educators and communicators - is planning for International Year of Astronomy (IYA) 2009, a celebration of the 400th anniversary of the development of the astronomical telescope, by Galileo. The goal is to offer an engaging astronomy experience to every Canadian, and to cultivate partnerships that sustain public interest and engagement in astronomy.

will have efficient, effective access to inspiring and informative information, graphics and images about Canadian astronomy.

In this document, we present an overview, budget, and possible funding sources for the two websites and IYA Canada 2009. Together with the many existing EPO activities of the Canadian astronomical community, they will inform Canadians about our astronomical achievements and heritage, the impact of astronomy on our economy and our culture. They will inspire young people, and attract at least some of them to careers in science and tech-

Astronomy is useful because it shows how small our bodies, how large our minds. ~ Henri Poincaré

> As part of its astronomy education and public outreach (EPO) initiative, the Canadian Astronomical Society, working in partnership with the rest of the astronomical community, is developing two dedicated websites, in both English and French: the existing *cascaeducation.ca* site that serves teachers and students (but offers much for the general public), and *Astronomy-Canada.ca* that will specifically serve the public, especially through the mass media. This website will provide a gateway through which all Canadians

nology — the engines of our economy. They will provide a legacy of opportunities for Canadians to discover the sky, and the universe, whether they live in a city centre, or in the remotest part of our land.

This booklet is addressed to individuals and organizations who, through their partnership, financial, or in-kind support, can make these three projects happen, and enable millions of Canadians to connect with their universe.

Introduction

stronomy is the study of the universe - everything beyond Earth. Astronomy is rooted in almost every culture. It is used to measure the passing of time, through the day, and through the year, and to navigate by day and by night. It has deep connections with religion and philosophy, because of the fundamental questions that it asks. It has been a fundamental science for centuries; the names of Copernicus, Galileo, Newton, Hubble, and Einstein stand out. It is still a forefront science. Some of the greatest discoveries of the last decade are in astronomy: planets around other stars, the accelerating expansion of the universe due to "dark energy", and the precise determination of the "vital statistics" of the universe from the left-over radiation from its creation. The latter two were ranked as "science breakthroughs of the year" by the prestigious journal Science. Over the centuries, astronomy has also spurred the development of mathematics and computation, and led to major technical advances in fields such as imaging and communication.

But astronomy is not just for astronomers; "the stars belong to everyone", as the eminent and beloved Canadian astronomer Helen Sawyer Hogg reminded everyone through her decades of public outreach. It is an enjoyable hobby for tens of thousands of Canadians, and virtually everyone relates to the beauty of the night sky. Astronomy reveals our cosmic roots, and our place in time and space. It deals with the origins of everything, and addresses one of the most fundamental questions – are we alone in the universe? It promotes environmental awareness through images of our fragile planet, seen from space. It reveals a universe that is vast, varied, and beautiful – the majesty of the night sky, the wonder of the rings of Saturn, the spectacle of a solar eclipse, the imponderables of a black hole. It has inspired artists and poets over the ages. It harnesses curiosity, imagination, and a sense of shared exploration and discovery. It attracts young people to science and technology, and hence to careers in these fields.

Astronomy in Canada

Astronomy in Canada began with its use, by First Nations and Inuit people, for practical purposes such as timekeeping and navigation. Explorers from Europe, seeking the fabled northwest passage, used astronomy for the same purposes. When European settlers moved westward in the nineteenth century, and built the trans-continental railway, they needed astronomy for precise timekeeping and measurement of latitude and longitude. This led to the establishment of the federal government's Dominion Observatory, in Ottawa, in 1902.

The remnants of Supernova 1987A, discovered by Canadian astronomer Ian Shelton. (Credit: NASA and ESA)



The small telescope at the Dominion Observatory was used for fundamental astronomical research, as well as for more immediately-practical purposes. Staff astronomer J.S. Plaskett successfully championed and planned for a much larger telescope: when the Dominion Astrophysical Observatory opened in Victoria BC in 1918, its 1.83m telescope was briefly the largest in the world! This marked the beginning of significant government investment in basic astronomical research in Canada.

Meanwhile, astronomy was being taught in several universities across the country, and there was an increasing need for telescopes for both teaching and research. The University of Toronto's Professor Clarence A. Chant championed the construction of a major observatory for thirty years, with eventual success: when the university's David Dunlap Observatory (DDO) opened in Richmond Hill, Ontario in 1935, its 1.88m telescope was the second-largest in the world, resulting in Canada having two of the three largest telescopes in the world until the late 1950s! The DDO telescope was used to co-discover the first example of a black hole in space, in 1972. University

Proposed stamp design showing First Nations Art. (Credit: Gerald Gloade)

research in astronomy thus grew in parallel with government research, as it continues to do.

Since that time, Canadian astronomers can boast of an impressive array of research achievements, and have become respected leaders in international astronomy; here are just a few:

• Applying radar technology to study radio wave emission from the sun that, since 1946, has been internationally used to measure the sun's "activity".

• Exploring and understanding the dozens of meteorite impact craters that have been preserved in the Canadian shield, and that have had profound effects on life on Earth.

• Establishing major radio observatories (the Dominion Radio Astrophysical Observatory in Penticton in 1960, and the Algonquin Radio Observatory in 1966) that have each made significant contributions to basic research. Together, under the inspired leadership of Allen Yen, they formed the first "long-baseline interferometer", equivalent to a single radio telescope 2000 km across in its ability to reveal fine detail in the objects that it studied, such as quasars – galaxy cores energized by supermassive black holes.

• Through international collaboration, becoming a partner in the largest observatories in the world: first, the Canada-France-Hawaii telescope (CFHT) in 1979, still one of the most productive telescopes in the world; then the Gemini telescopes in Hawaii and Chile; and now planning for the world's largest telescope - the Thirty-Meter Telescope (TMT). Canada is also an integral partner in the construction of the world's first global observatory, the Atacama Large Millimeter/Submillimeter Array (ALMA) being developed high in the Atacama desert of Chile.

• Successfully launching and operating the suitcase-sized "Humble Space Telescope", MOST (*Microvariability and Oscillations of STars*), the most precise light-measuring device in astronomy.

• Establishing the Canadian Institute for Theoretical Astrophysics (CITA), in 1984, now a world-class – and costeffective – centre for understanding the universe through theory and computer simulation, and a major stimulus for theoretical and computational astronomy across Canada.

• Solving "the solar neutrino problem", and thus solidifying our understanding of our nearest star – using the *Sudbury Neutrino Observatory*, located deep within a nickel mine. This \$500M project was accomplished for \$50M as an international partnership, by making good use of Canada's available supply of "heavy water".

• In 2007, astronomer Richard Bond won Canada's top science prize, the Herzberg Medal, for his contributions to cosmology.

But Canadian astronomy is not reserved just for professionals and for researchers. Amateur astronomers, astronomy educators and communicators have distinguished themselves. Terence Dickinson is known worldwide for his astronomy books, and Jack Newton's astrophotographs have been published in books and magazines around the world. David Levy, born and educated in Canada, is one of the most prolific comet discoverers of all time. And the Royal Astronomical Society of Canada, most of whose 5000 members come from the amateur ranks, is a recent winner of Canada's top prize for excellence in science outreach. Amateur and professional astronomers enjoy a mutually beneficial relationship: professionals provide the knowledge that amateurs crave; and amateurs voluntar-

ily "spread the word" to the public.

Research in Astronomy in Canada

Today, astronomical research in Canada is carried out in universities, supported by the Natural Sciences and Engineering Research Council (NSERC) of Canada, and by the Canada Foundation for Innovation (CFI), and also in the National Research Council (NRC) - specifically by the Herzberg Institute of Astrophysics (NRC-HIA), which operates, for the community at large, the facilities mentioned below, as well as the more modest facilities at the Dominion Astrophysical Observatory (DAO) at Victoria, and the Dominion Radio Astrophysical Observatory (DRAO) near Penticton. NRC-HIA also hosts the Canadian Astronomy Data Centre (CADC) and the associated Canadian Virtual Observatory.

Fifteen Canadian universities offer graduate education in astronomy, from University of Victoria in the west, to St. Mary's University in Halifax in the east. Most of these have some local facilities for observational and theoretical studies, and for teaching, and all of them have access to national facilities in Canada and elsewhere. The Canadian Institute for Theoretical Astrophysics is hosted by the University of Toronto, and supports theoretical astrophysical research across the country. Canadian astronomers have recently established the Association of Canadian Universities for Research in Astronomy (ACURA) to co-ordinate universities' participation in astronomy, especially in the development of the next generation of large-scale facilities.

Through NRC, Canadian astronomers also have access to excellent international facilities: the 3.6m CFHT telescope atop Mauna Kea on the island of Hawaii, at an elevation of nearly 4200m, and, with the Netherlands and the UK, the *James Clerk Maxwell Telescope*, a sophisticated millimetre-wave

The Cygnus Region radio map created by Jayanne English (University of Manitoba) with the support of Russ Taylor (University of Calgary) for the Canadian Galactic Plane Survey. (Credit: Jayanne English and Russ Taylor)

radio telescope at the same site, and, along with seven other countries, the twin Gemini 8m telescopes in Hawaii and in Chile. Balloon-borne telescopes, Canada's first astronomical satellite MOST, and participation in other space astronomy missions are funded through the Canadian Space Agency. Canada is also a partner in the James Webb Space Telescope, the planned successor to the Hubble Space Telescope, and in the North American Program in Radio Astronomy, which includes the Atacama Large Millimetre Array, and the proposed Square Kilometer Array, to be the world's largest radio telescope.

Education and Outreach in Astronomy in Canada

Astronomical education and outreach are carried out in a wide variety of settings. In the formal education system, astronomy is part of the elementary and secondary school science curriculum in most provinces, and is taught in most universities, most commonly in the form of introductory astronomy courses for tens of thousands of students majoring in other fields. Canada's planetariums, science centres, and public observatories play a major role in communicating the nature and excitement of astronomy, as do science journalists, and the many professional and amateur astronomers who give public lectures, and organize observatory tours and star parties. These activities will intensify during International Year of Astronomy 2009, celebrating the 400th anniversary of the development of the astronomical telescope, by Galileo. This celebration will take many forms, and will reach millions of Canadians across the country.

The Long-Range Plan for Astronomy in Canada

In 1999, Canadian astronomers developed and agreed upon a long-range plan (LRP) for the development of research facilities, and of highly-qualified personnel to put them to good use. The LRP outlined the extensive economic benefits of astronomy, including its contributions to high technology in Canada. It presented a plan for the development of new research facilities, both on the ground and in space. These included the highperformance computing facilities that are so essential for modern astronomy, and in which Canadian astronomers have been international leaders. It also examined astronomical EPO in Canada, and made recommendations for new and effective ways to communicate Canadian astronomy to the Canadian public. In 2004, the LRP was comprehensively reviewed, in the light of developments in the previous five years. Its recommendations and priorities remain the same.

The Canadian Astronomical Community

Professional Astronomers

Most of Canada's professional astronomers - those with advanced degrees, working in the field – belong to the Canadian Astronomical Society - Société Canadienne d'Astronomie. CAS-CA was founded in 1971 and incorporated in 1983. Its membership includes over 400 professional astronomers and over 150 graduate students in astronomy. Its mission is the promotion and advancement of knowledge of the universe through research and education. It holds an annual conference, attended typically by 300 astronomers. Its voluntary committees are active in guiding the main areas of astronomical research and education. Most of all, it participates actively and productively in the planning and realization of major scientific projects in astronomy. In 1992, it established Cascatrust as a charitable trust for the advancement of education and research in astronomy.

In addition, there are many professionals in related fields, such as engineering, computer science, and information science, whose work is closely related to astronomy, and essential to its progress and health.

Amateur Astronomers

Amateur astronomers are people who do astronomy voluntarily, as a hobby, not for pay. In a sense, the term "amateur" is unfortunate, since many amateurs do astronomy with a high degree of skill. In particular, many bring skills in technology, computing, and communication from their "day job". Many contribute to EPO, and some even make significant contributions to astronomical research. But they are varied in their interests: some are "armchair astronomers" who are happy to read about astronomy, or attend club meetings and lectures; others are more interested in sky phenomena – and may indeed know the sky better than many professionals do! Whatever their interests, they provide strong grass-roots support for astronomy. city of Canada. Many of the Centres run club observatories for their members, or participate in remotelyoperated facilities around the world. A bi-monthly publication, the *Journal*, features lively and interesting articles about astronomy in Canada and astronomical research by Society members and professional astronomers. The Society's *Observer's Handbook* is the most respected publication of its kind in the world. Enthusiastic members

In two recent surveys, Canada ranked first in the world in astronomical productivity.

There are about a hundred astronomy clubs in cities or towns across Canada, most of the larger ones being part of the RASC or FAAQ described below. Many of these clubs meet in universities, planetariums, libraries, and other community centres, and organize partnership programs with these and other organizations. There are also about a dozen annual "star parties" in the summer, in dark locations across the country, attracting up to a thousand people to each. In fact, national, provincial, and local parks are frequent and natural "partners" for astronomy.

Founded in 1868, the Royal Astronomical Society of Canada (*www.rasc. ca*) is Canada's largest astronomy organization, with over 4,000 enthusiastic amateurs, educators, and professionals in Canada and elsewhere. The Society and its 28 Centres offer programs and services with national reach and local flair in every province and large help raise awareness about the issue of light pollution. Most Centres have a particular emphasis on imaginative local programs for public education and outreach, promoting science literacy and astronomy while bringing the wonders of the night sky to youth groups, schools and the general public. The Society's efforts to promote astronomy were recognized by a *Michael Smith Award* – a national award for excellence in presenting science to the Canadian public.

The Federation des Astronomes Amateurs du Québec (FAAQ) is a non-profit organization representing over 1,600 amateurs, grouped in 35 clubs in all regions of the province of Québec. The FAAQ's mission is to support its members in the practice of their scientific hobby (astronomy) and in the sharing of their activities and knowledge with schoolchildren and the public. Over the last few years, the FAAQ has developed workshops, and trained volunteer members to be able to respond to the great demand, from teachers, for these activities.

Over 80 percent of the clubs organize at least one major activity for the general public each year. As an example: in 2006, a total of 294 such activities were organized, with more than 15,000 people attending. Equally importantly, 174 workshops were given in different schools, attended by almost 7,000 students.

The FAAQ's outreach programs are supported financially by the Québec Government, and it intends to continue increasing its activities for schools and the general public. For more information, see *www.faaq.org*.

Planetariums and Science Centres

Canada has five major planetariums, in Montreal, Winnipeg, Calgary, Edmonton, and Vancouver, and many smaller ones. There are also science centres, the largest being the National Museum of Science and Technology, in Ottawa, and the Ontario Science Centre, in Toronto; these have extensive astronomy programming and exhibits. The planetariums alone attract almost a million visitors each year, in total. The Ontario Science Centre is the mostvisited cultural facility in Canada. So these facilities play an important role in astronomy education and outreach. They reach the public, but they also have extensive programs and resources for teachers and students. This is important, because astronomy is part of the school curriculum in most provinces, and most teachers have little or no background in astronomy, or astronomy teaching. As an example of the important role of planetariums: the Montréal Planetarium produces French-language resources that can

be used by francophone teachers and students across Canada.

The five major planetariums have recently been collaborating in the productions of shows about Canadian astronomy, with participation by Canadian astronomers. These productions have been supported by grants from Heritage Canada.

Astronomy Communicators

Astronomers have an obligation to communicate the nature and importance of their work to the public. Most scientific research in Canada is paid for by taxpayers, and that is certainly true for astronomy. Surveys show that Canadians' interest in science and technology – especially astronomy – is high, but they do not feel well-informed about current developments and issues. The mass media have the highest impact on public awareness, understanding, and appreciation of science.

Canada is fortunate to have some excellent science journalists, such as Bob McDonald, and science programs, such as McDonald's *Quirks and Quarks*, and Discovery Channel Canada's *Daily Planet*. And we can boast of one of the best astronomy writers anywhere – Terence Dickinson. Dickinson's books have sold over a million copies world-wide. His newspaper column in the *Toronto Star* reached thousands of people every week. And he edits *Sky*-*News*, Canada's magazine of popular astronomy.

These communicators have diverse backgrounds. Some have no formal background in science at all. Others have an undergraduate degree in astronomy, or another science, and may come from the science centre community. A few come from the ranks of amateur astronomy. And a few are professional astronomers with a special interest in EPO, who write popular articles or books, or advise on TV productions. There is a growing movement to train science researchers to become effective producers of EPO material, through regular workshops and conferences that bring them together with EPO specialists.

But the Canadian astronomical community recognizes that few newspapers, radio or TV stations have science specialists, so it is also important to reach the public through non-specialist journalists, and that is one reason for developing the website *AstronomyCanada.ca* described below. Canada has much to be proud of in astronomy – thanks to the Canadian taxpayers – so it makes sense to develop efficient, effective ways to reach the public through the mass media.

Bernard Malenfant speaking to a group at the l'Observatoire du Mont-Mégantic Astronomy Festival, July 2007. Credit: (Jayanne English)

Supporting Formal Education

ASCA embarked on its first major education initiative in 2001, supported by funds from the PromoScience program of NSERC, and the Youth Science and Technology program of the Government of Ontario. It was decided, on the recommendation of an Advisory Board, that the first priority should be to support the teaching of astronomy in the schools, since this is where most Canadians get a formal introduction to astronomy. Few teachers have any background in astronomy, or astronomy teaching. In the 1990's Canadian ministries of education collaborated in developing the Pan-Canadian Science Protocol. This recommended including astronomy in the senior elementary school and secondary school science curriculum, and most provinces followed this recommendation.

Astronomy is a particularly important addition to the school curriculum. It provides an example of an alternative approach to "the scientific method", namely observation, simulation, and theory, in contrast to the usual "experiment and theory" approach. It can promote rational thinking, and an understanding of the nature of science through examples drawn from the history of science, and from present issues such as pseudo-science. It can be used to illustrate many concepts of physics, such as gravitation and light. By introducing students to the size and scale of objects in the universe, it gives them experience in thinking more abstractly about scales of time, distance, and size. It is the ultimate interdisciplinary subject, and "integrative approach" and "cross-curricular connections" are increasingly important concepts in school curriculum design.

The centerpiece of CASCA's initiative is a website www.cascaeducation. ca. This definitive, bilingual website aims to fulfil the needs of all Canadians teaching and learning astronomy, both in and out of school. For teachers, there is a comprehensive outline of provincial curriculum expectations, teaching resources including complete lesson plans, and a "how-to" on teaching astronomy. For students, there are frequently-asked questions (and answers), science fair ideas, information on astronomy-related careers, profiles of Canadian astronomers, resources for the Guide and Scout astronomy badges, and even a Canadian Junior Astronomer Program which is available to young people across the country - even in rural and remote areas. For everyone interested in astronomy, including teachers and students, there is a wealth of general information on current events, sky observing, astronomy clubs, science centres and planetariums, resources for family astronomy and camping astronomy, advice on purchasing telescopes, and information about Canadian astronomy and its history.

Equally important: the website is constantly updated and expanded by CASCA's part-time education coordinator, who is an experienced teacher with a background in astronomy. This ensures that the website material is current, accurate, relevant, and useful. The education coordinator also prepares material on education for CASCA's free quarterly on-line newsletter. This includes material of interest to university instructors and graduate teaching assistants. Tens of thousands of university students take astronomy courses each year. Most of them are non-science students who are taking astronomy to fulfil a science-elective degree requirement. These students are a challenge to teach, but the website material helps university instructors to meet this challenge.

CASCA will continue to maintain, update, and expand this website, since over a hundred thousand Canadian students continue to study astronomy in the schools each year. Workshops for schoolteachers are now held at most CASCA annual meetings, and we support workshops at other meetings, such as those of the Science Teachers Association of Ontario. The need for teacher and student support is ongoing.

(Credit: RASC)

AstronomyCanada.ca

ublic interest in astronomy is "universal". Astronomy-based news items are almost always exciting and positive, but far too few of these media reports use Canadian images, graphics, and information, or report on Canadian astronomical achievements - even though most of these achievements are funded by the Canadian taxpayer. We have much to be proud of; in two recent surveys, Canadian astronomical productivity ranked first in the world. Most Canadians are unaware of this; they seem to think that most astronomy is done by the Hubble Space Telescope!

The Long Range Plan for astronomy in Canada specifically recommended, as the first priority in Canadian astronomy EPO, the creation of a state-ofthe-art website to promote Canadian astronomy. While many Canadian professional and amateur astronomers are personally active in EPO, and while CASCA and many universities have news or public-affairs services, there is a need for an effective, high-impact web presence - to be called AstronomyCanada.ca (and its French-language equivalent). This website would contain images, graphics, and information of special interest to the mass media. But it would also be useful for every Canadian astronomer – amateur or professional - engaged in EPO.

This website would also have a strong impact on formal and informal education. Students and teachers receive much of their astronomical information (and mis-information) from the media. The school science curriculum encourages students to learn about Canadian science and scientists. Textbook authors are constantly on the lookout for effective images and graphics. Planetariums and science centres also need these to illustrate their programs and exhibits. Professional and amateur astronomers who give public lectures use them in their presentations.

Most important of all: the general public, through *AstronomyCanada.ca*, would have direct access to current information about Canadian astronomy. They could follow up, in detail, the topics that they hear about only briefly in the media.

AstronomyCanada.ca will serve as a central resource for communicating the achievements, activities, and aspirations of Canadian astronomy to the public, both directly and through the media. It will be regularly updated with striking images and graphics, and clear and informative text. This material will be produced by Canadian astronomers, working in partnership with communication specialists. It will be targeted at the interested public, the media (print and electronic), public outreach workers, teachers and students. The audience will be assumed to have an interest in science, without having an astronomy or other science background. It will be especially targeted at reporters, editors, government decision-makers and the like. The images, graphics, and information will be simple, clear, and correct.

AstronomyCanada.ca will be a onestop gateway to Canadian astronomy, including facilities, projects, organizations, and activities. It will highlight recent newsworthy discoveries and breakthroughs. It will present a fresh, modern appearance. This combination of "medium and message" will encourage and entice viewers to visit the site regularly.

Astronomical images, with supporting graphics and text, play an important role in informing and inspiring the public. AstronomyCanada.ca therefore needs a graphics/image expert to work in partnership with the astronomers who supply the images. Astronomy educators and communicators will also add their expertise, to ensure that the material is both clear and correct. A professional web designer will ensure that the material is easily accessable to users. A "pipeline" will be created to ensure that the material gets the attention of key people in the mass media, and other target audiences.

The key process in this process will be the coordinator, who establishes and nurtures the relationship between the astronomers and the imaging and communication specialists.

AstronomyCanada.ca will also link to the many existing websites, and to education and outreach programs, thus promoting and supporting them, rather than duplicating them. It will be a partnership project, including professional and amateur astronomers and their institutions and organizations, industry, government, and the formal and informal education communities. The media have already expressed a strong desire for such a clearing-house.

International Year of Astronomy 2009

YA 2009 is an international celebration of astronomy, marking the 400th anniversary of the development of the astronomical telescope, by Galileo Galilei, in 1609. It is organized by the International Astronomical Union, and is supported by UNESCO -- the United Nations Educational, Cultural, and Scientific Organization. It's goals are to

• illustrate the remarkable cultural influence of astronomy over time, and better connect science with today's culture

• demonstrate that astronomy is one of the most captivating branches of the natural sciences, and an ideal inspiration for people of all ages, especially children

• remind humanity that we are responsible for the long-term future of our planet

• show astronomers as truly a global family of peaceful international collaborators

• encourage a stronger perspective of

scientific and critical thinking in society

Throughout the world, the emphasis will be on grass-roots activities which engage the public, especially children. The international website *www.astronomy2009.org* will contain a wealth of ideas about the variety of ideas which are planned; an IYA Canada website is to be launched in autumn 2007. This is an excellent time for countries, such as Canada, to increase and expand their EPO activities.

The IYA Canada Committee

The Canadian astronomical community has established an IYA Canada Committee which is broadly representative of every part of the community: professional and amateur astronomers, planetariums and science centres, astronomy educators and communicators, First Nations and Inuit communities. It includes representatives of the organizations that carry out or support astronomy: the universities, the Canadian Space Agency, the National Research Council, for instance. Its

Children participating in the Scouts Program learn about astronomy.

membership is listed in Appendix A. The IYAC Committee has established subcommittees to deal with program, resources (funding, sponsorship, and partnership), and communications. Volunteers are rapidly being recruited for these subcommittees.

IYA 2009 in Canada

The IYAC Committee's overarching goal is "to offer an engaging astronomy experience to every person in Canada, and to cultivate partnerships that sustain public interest in astronomy". How will this be done? By celebrating four centuries of exploring the universe. By sharing astronomers" passion and achievements with taxpayers and their families. By creating legacy elements. And by having fun!

The IYAC Committee exists especially to coordinate, encourage, and support regional and grass-roots local initiatives, as well as national ones. The emphasis will be on broadly conceived programs with some legacy or sustainability elements, and on highlyleveraged activities arising from the community. Amateur astronomers in particular have been very imaginative in creating local partnerships such as with schools, parks, even wineries! In fact, we urge every professional and amateur astronomer to use their interests and imagination to develop their own local IYA projects and activities.

To accomplish these things, four broad theme have been identified, so far:

• observing the sky

• sharing discoveries, and promoting astronomy as an accessible hobby

• connecting astronomy everywhere: arts, culture, history

• leaving legacies for both the short term and the long

IYA 2009 and Canada's Aboriginal Peoples

Around the world, astronomy is rooted in almost every culture; this includes aboriginal peoples, and this is certainly true in Canada. The IYA Canada Committee is fortunate to include representatives from Cape Breton University, which is a leader in bringing together conventional Western science knowledge with the holistic understandings and worldview of Aboriginal peoples. They have developed the following vision of partnership between IYA and Canada's Aboriginal peoples:

"Important relationships among people, animals, land, and the night sky are told in stories from cultures around the world. We see International Year of Astronomy 2009 (IYA 2009) as an opportunity to reawaken these stories, to help celebrate our shared and diverse knowledges about the universe in which we live. Towards this vision, our Cape Breton University colleagues (both its Institute for Integrative Science & Health, and Mi'kmaq College Institute) in Sydney, Nova Scotia, have invited an Aboriginal community partner (Membertou First Nation), an Aboriginal science organization (Unama'ki Institute of Natural Resources), and an eco-friendly business (Cape Breton Explorations) to join us in a partnership for all of Canada. From our home on the east coast, where the light of each new day is first received and then journeys westward across our country, we will reach out to all Canada's Aboriginal peoples to invite collective participation in IYA 2009 celebrations. We envision two major legacy projects: a collection of night sky stories that showcases the diverse, rich knowledges among Canada's Aboriginal peoples and dark sky preserves wherein these stories can be brought to life for all ages."

International Year of Astronomy 2009 in Canada: to offer an engaging astronomy experience to every person in Canada, and to cultivate partnerships that sustain public interest in astronomy.

Other EPO Activities

The cascaeducation.ca and AstronomyCanada.ca websites, and IYA are three special projects to meet specific needs and opportunities. At the same time, Canadian astronomers and their organizations and institutions will continue their many present EPO activities. The spe-

cial projects will support and enhance these.

Astronomy clubs play a major role in EPO by taking telescopes and astronomy to the people. The RASC was a recent winner of the *Michael Smith Award* for outstanding science EPO. Every university astronomy department offers free public lectures and open houses; planetariums and science centres produce exhibits and programs; in each case, often in partnership with local astronomy clubs.

Budget and Funding

Budget

Much of the Canadian astronomical community's EPO work is voluntary, or part of the mission of the astronomers and their organizations and institutions. But there are costs associated with the three national flagship projects described in this brochure: the website for teachers and students; the website for mass media and the public; and IYA 2009 which is a special opportunity to reach everyone, while leaving a legacy behind – some of which will be captured and sustained in the first two websites.

The cost of the education website *www.cascaeducation.ca*, including the one-fifth-time education coordinator, her expenses, and the maintenance of the website, is slightly more than \$15K a year, or about \$50K over three years (all sums expressed in 2007 dollars).

The cost of developing and maintaining AstronomyCanada.ca, the website directed to mass media, including formal and informal educators, and the public, is about \$500K over three years. This includes a half-time coordinator, the part-time services of a science writer, an image specialist, a graphics specialist, a podcast producer, web support, travel, hardware, promotional material, and other miscellaneous costs. In addition, the Canadian astronomy community will provide at least \$100K of in-kind support through their voluntary administrative and advisory duties.

In the Appendix, we have listed a wide range of ideas which could be

implemented for IYA 2009 in Canada, subject to funding. The core cost includes a national coordinator, part-time fundraising assistance, the creation and maintenance of a central website, and associated expenses. Over 2008 and 2009 (and part of 2010 to ensure that the legacy components are properly completed and transferred), the core cost would be \$250K. Specific activities would be funded through grants, donations, sponsorship, and in-kind contributions from the astronomical community and its partners.

Funding

Much of the existing Canadian astronomy EPO requires no additional funding. Amateur astronomers' contributions are entirely voluntary. Many professional astronomers are willing and able to do some EPO, even though their primary duty is research and/or university teaching, because they recognize its importance, or because it is enjoyable and satisfying. For planetariums and science centres, and for professional science educators and communicators, EPO is their mission. These ongoing EPO activities of CASCA are guided by a volunteer committee.

But the Long-Range Plan recommends larger, more sustained activities. And the efficiency and effectiveness of all Canadian astronomy EPO could be greatly increased by modest funding, for coordination and communication, and for specialized expertise in graphics, web development, media relations, and other areas in which astronomers do not have the time or expertise.

Organizations such as CASCA, RASC, and FAAQ are small, and administratively lean. They are run by volunteers, supported by at most one staff member. They do not have large budgets or endowments for new EPO initiatives. But they have large numbers of members who are voluntarily active in EPO. CASCA has a small endowment fund called the Westar Fund, which can be used to provide seed money. It is used primarily for the CASCA-Westar Visiting Lectureship, which sends experienced astronomers to small communities without astronomical facilities, to give lectures and interact with teachers, students, and the public. It is presently being used, in a necessarily limited way, to launch IYA activities.

The National Research Council operates the visitor centre at the Herzberg Institute of Astrophysics in Victoria, and conducts public outreach at its radio observatory near Penticton. The NRC also produces useful educational material related to its activities. But NRC is not able to provide grants for external projects, carried out in universities, for instance.

In Canada, there are no federal or provincial EPO funding programs corresponding to those found in the US. For instance: every NASA mission has an associated EPO program. The National Science Foundation Education Division has grants programs to support both formal and informal education. NSF research grants have an additional EPO component. The Natural Sciences and Engineering Research Council (NSERC) Canada has a *PromoScience* program, but it has limited funding, a restricted mandate (interactive activities for K-12 students and their teachers), and is highly-oversubscribed. Some provincial ministries such as the Ontario Ministry of Research and Innovation have EPO programs that are similarly restricted and over-subscribed. CASCA received support from both these sources to establish its education website for teachers and students.

We will continue to approach these and other such sources where possible.

The Long-Range Plan for Canadian Astronomy, developed in 1999, strongly recommended that "approximately 1.5 percent of any (astronomy) project budget be allocated towards the support of related outreach efforts", with the highest priority being a stateof-the art website to inform and excite Canadians about Canadian astronomy. Canada's investment in such projects, over the past decade, approaches \$100M. During the first five years, no funds were allocated to EPO, other than NRC's establishment of a visitor's centre and there are no such funds on the horizon.

A further source of support would be from business and industry. The 1999 Long-Range Plan for Canadian Astronomy estimated that the direct economic impact on high-technology business would be in the range of \$450-750M over the present decade. Canadian companies have special expertise in fields such as observatory and telescope design and construction, optical and radio wave detectors, and space systems - to mention only a few. Such companies can benefit from sponsorship of astronomy EPO facilities and programs that reach millions of Canadians.

For IYA 2009, the range of possible

contributors, sponsors, and partners is even greater, because of the wide variety of activities that are possible, because of the grass-roots and community nature of these activities, and because of the audience – every Canadian. These activities will occur on street corners, in parks, in theatres, in educational facilities, on radio, TV and the Internet.

Stars and Nebulae in the Milky Way. (Credit: Canada-France-Hawaii Telescope / Coelum)

Dozens of Canadian corporations already support science and technology EPO, and this is an opportune time for them to become supporters of Canadian astronomy. IYA provides a score of major projects of interest to an even wider variety of sponsors – educational kits, posters, commemorative pins, bumper stickers, calendars, children's contests, mobile astronomy displays, websites, TV documentaries, planetarium programs, public lectures, concerts, art exhibits, and a wealth of other local activities.

Many of these will involve partners. Producers of planetarium programs and TV documentaries are already aware of government and corporate funding sources. The Canadian IYA website will provide links to groups or individuals who have experience in organizing and funding such resources and events.

Corporate support could therefore take several forms. Sponsors can produce and distribute material such as posters and educational kits, in return for prominent display of their logos. Media sponsors can publicize both national and local events; their logos will reach millions of Canadians. Supporters can provide in-kind services such as web development or hosting. Or they can provide direct financial support. Both RASC and CASCA can accept donations, and issue receipts for tax purposes, the latter though its CascaTrust foundation. Sponsors and partners, who provide financial or in-kind support, will be recognized in proportion to their contributions. They will be entitled to use the official IYA Sponsor logo, and to have their name and logo prominently displayed on websites (cascaeducation.ca, Astronomy-Canada.ca or IYA) and other marketing materials. They will enjoy enormous exposure through internet and media coverage of IYA and other astronomy events. Sponsors at the highest levels will be invited to special VIP events and ceremonies, and may even have a role in developing and planning EPO and IYA activities. They will have the satisfaction of contributing to scientific literacy and literacy for millions of Canadians.

Fundraising requires coordination and, thanks to the two committees listed in the Appendices, this is now possible. CASCA has provided seed money to begin the fundraising process, which should soon be self-supporting.

Legacy

anadian astronomers, and their organizations and institutions, look forward to using IYA 2009 as an inspiration for increasing the quantity, quality, and variety of their already-impressive education and public outreach activities. IYA will strengthen existing partnerships, and create new ones. Through more

effective communication and coordination, it will encourage, facilitate, and support programs and projects that reach millions of Canadians each year. For more information or to offer your support, please contact: Professor Jayanne English (EPO: english@physics. umanitoba.ca) or Dr. Jim Hesser (IYA: James.Hesser@nrc-cnrc.gc.ca)

The Education and Public Outreach Committee of the Canadian Astronomical Society

Mohaddesse Azimlu, graduate student, Department of Physics and Astronomy, University of Waterloo; representative of the Graduate Student Committee of the Canadian Astronomical Society.

Professor Martin Connors, Canada Research Chair and Professor, Centre for Science, Athabasca University, Athabasca, Alberta.

Dr. Dennis Crabtree, National Research Council and Gemini Telescope Group Leader, based in La Serena, Chile; Vice-President, International Astronomical Union Commission on Communicating Astronomy to the Public; member of the IAU Working Group on IYA2009.

Professor Michael De Robertis, Department of Physics and Astronomy, and Associate Dean, Faculty of Science, York University, Toronto.

Professor Jayanne English, Department of Physics and Astronomy, University of Manitoba, Winnipeg; Chair, Education and Public Outreach Committee of the Canadian Astronomical Society.

Professor William E. Harris, Department of Physics and Astronomy, McMaster University, Hamilton; Fellow of the Royal Society of Canada.

Dr. James E. Hesser, Director: Dominion Astrophysical Observatory; recipient of the Michael Smith Award for excellence in science outreach.

Professor Ray Jayawardhana, Department of Astronomy and Astrophysics, University of Toronto; award-winning science writer.

Professor Robert Lamontagne, Department of Physics, University of Montreal; Press Officer of the Canadian Astronomical Society (ex-officio).

Nathalie Martimbeau, Harvard-Smithsonian Center for Astrophysics, Cambridge MA USA; formerly staff astronomer, Planetarium de Montreal.

Professor Peter Martin, Chair: Department of Astronomy and Astrophysics, University of Toronto; President of the Canadian Astronomical Society (ex-officio).

Professor John R. Percy, Department of Astronomy and Astrophysics, and Ontario Institute for Studies in Education, University of Toronto; past chair of the Education and Public Outreach Committee of the Canadian Astronomical Society.

Professor Carmelle Robert, Department of Physics, Laval University, Quebec; representative of the Board of the Canadian Astronomical Society.

Professor Joanne Rosvick, Department of Physical Sciences, Thompson Rivers University, Kamloops BC.

International Year of Astronomy 2009 Canada Committee

Professor Cheryl Bartlett, Canada Research Chair in Integrative Science, and Professor of Biology, Cape Breton University, Nova Scotia.

Ruth-Ann Chicoine, Communications Advisor, Canadian Space Agency, St.-Hubert, Quebec.

Dr. Jeffrey Crelinsten, The Impact Group, Toronto; science writer and historian; former president of the Canadian Science Writers Association.

Professor Jayanne English, Department of Physics and Astronomy, University of Manitoba, Winnipeg; Chair of the Education and Outreach Committee of the Canadian Astronomical Society.

Dr. James E. Hesser, Director of the Dominion Astrophysical Observatory, Herzberg Institute of Astrophysics, National Research Council; Past President of the Canadian Astronomical Society; Chair of the Steering Committee.

Professor Peter Jedicke, School of Language and Liberal Studies, Fanshawe College, London, Ontario; Past President of the Royal Astronomical Society of Canada.

Remi Lacasse, Past President of la Federation des Astronomes Amateurs du Quebec.

Pierre Lacombe, Director of Planetarium de Montreal; also representing la Federation des Amateurs du Quebec.

Dr. Phil Langill, Department of Physics and Astronomy, University of Calgary; Director of the Rothney Astrophysical Observatory.

Dean Lindsay Marshall, Associate Dean, Mikmaq College Institute, Cape Breton University; former Chief and CEO, Chapel Island First Nation.

Bob McDonald, Canadian Broadcasting

Corporation, award-winning science journalist and author.

Professor John R. Percy, Department of Astronomy and Astrophysics, University of Toronto; past Chair, Education and Outreach Committee, Canadian Astronomical Society.

Scott Young, Manager: Manitoba Planetarium, Winnipeg; President of the Royal Astronomical Society of Canada.

Dr. Andrew Woodsworth, Project Director, Natural Sciences and Engineering Research Council of Canada.

These two groups of volunteers are directing these new initiatives, including IYA Canada 2009.

Canadian Activities for International Year of Astronomy 2009

Canadian astronomers already engage in a wide variety of creative activities and partnerships to inform and engage the public, including teachers and students. Dozens of ideas have been suggested for additional activities for IYA 2009, limited only by the availability of funding and other support.

Enabling a million (or more) Canadians to look through telescopes, as Galileo did, at the moon, planets, sun, and other celestial objects, at star parties, observatory open-house events, and sidewalk and roof-top sky viewing events.

Hands-on activities for youth, such as the construction of safe, inexpensive replicas of Galileo's telescopes – or perhaps even a whole "kit" of hands-on materials.

Opportunities for students (and the public!) to participate in astronomical research.

Astronomy in shopping malls – and anywhere else where large numbers of Canadians go.

A mobile astronomy-in-a-van exhibit to tour Canada.

Art and writing contests in school systems, and other creative activities in which students can create and disseminate astronomythemed work.

An official IYA 2009 Canadian calendar, perhaps including the winners of the children's art contests.

Special emphasis on astronomy workshops for schoolteachers across Canada.

Promoting appreciation for First Nations and Inuit traditions in astronomy.

Promoting dark skies (and energy conservation) by combating "light pollution", and organizing dark-skies events, including cross-Canada measurement of light pollution by students.

A legacy of "dark sky sites" across the country, in cooperation with national and provincial parks, and with First Nations.

A website – *AstronomyCanada.ca* – designed to bring Canadian astronomy images, graphics, and information to Canadians, both directly and through the mass media.

A multi-part TV documentary on astronomy, and its relation to culture, society, and everyday life.

Development of a planetarium program on Canadian astronomy to be shown in Canada's five major planetariums, attended by tens of thousands of people.

Non-technical public lectures on astronomy across the country, by outstanding public speakers, also to be videotaped and made available on-line. Communicating astronomy from around the world: beaming a solar eclipse from Asia, connecting Canadian schoolchildren with children elsewhere.

Web or video casts from Canada's astronomical observatories, including those in Hawaii, Chile, and in space.

Meeting astronomers, and sharing astronomy through new technologies.

Use of modern information and communication technologies to enable students and the public, everywhere, to interact with Canadian astronomers.

A useful, relevant poster on Canadian astronomy to be distributed to every school in Canada, as well as to other public places.

Installation of sundials, models of the solar system etc. in parks.

Events that link astronomy and the arts – astronomy-themed music, theatre, and art events, some of which would tour the country. The more imaginative, the better!

A souvenir pin or bumper sticker for every participant in IYA: "I Discovered the Universe".

A series of astronomy-themed Canadian stamps; a proposal has already been submitted.

Continuation and expansion of Canadian astronomers' alreadyextensive programs of star parties, open-house events, and public lectures.

In general: we urge every amateur and professional astronomer, and astronomy group to look for special opportunities to bring more and better astronomy to the public in 2009.

A special IYA 2009 website to coordinate, support, and publicize these activities, and provide ideas and guidance to help local groups to succeed in their efforts.