

Cassiopeia

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Solstice

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The first day of summer! This is a smaller than average issue but one that is still packed full of useful insights and important announcements. Take a look at the "[Briefly Noted](#)" section for some time sensitive summer school information. Visit the Atacama desert with Chris Wilson in her update on [Alma](#) or ponder the continuing [threats to Radio Astronomy](#) with Ken Tapping's feature article.

Wishing you a safe and productive summer!

Brian Martin (brian.martin@kingsu.ca)

From the new President ...

Up the down staircase. Do you ever get the urge when standing at the bottom of a down-bound escalator, to make a headlong rush to the top? If yes, then perhaps you are suited to a career in modern astronomy! With the growing advances world-wide, it seems that one has to run just to stand still, and it takes a mad dash to re-emerge at the top. The older one gets, the more immobilizing can be the “what ifs” borne from experience. Will my way be blocked by some down-bound traffic? What if I fatigue half-way up? Even if I reach the top, is there a support system (maybe an ambulance!) for me? To succeed, each one of us needs to keep some of the madness that comes with youthful enthusiasm, and we need to foster a new generation with the confidence to make the dash as we pass the torch. There are some indications that I am no longer youthful, but I am still perhaps sufficiently mad and unencumbered to be of some use as the CASCA President. I certainly believe passionately that ours is a great science for humanity, in which Canada can show leadership and excel.

When is a web webbed? Like it or not, our science has become a “big science” which requires major injections of funding. Just look at the goals on which our community has agreed in the Long Range Plan (LRP). Without these investments for the long term, then the privilege we enjoy in the short term in carrying out our day-to-day research and training will vanish or be rendered irrelevant. These are reasonable investments to expect in a country like Canada, but not assured or to be taken for granted. Looking at the anticipated funding sources for the LRP – CSA, NSERC, NRC, and CFI (and with the CFI the implied provincial contributions) – reveals the challenges. Attached to the Industry Canada foot, each of these offers some toe-hold for us, but none has been designed with the end-to-end needs of astronomy research at the fore and taken together as a support network or web they are not inherently highly interconnected. Now to morph the escalator analogy, throw this chicken-footed bird into a rapidly moving torrent and ask it to make progress upstream. Lunacy you cry. Would progress be better if this “ugly duckling” had webbed feet? A search for more coherence, perhaps an emergent swan, has been the focus of an inter-agency Working Group this year whose first report is anticipated soon.

From patchwork to coherence. The LRP is the critical distillation of many possible ways forward into the essence, what we are now focused on achieving. This coherence and the ability to make hard choices need to remain the hallmark of our discipline. The LRP itself needs to be a living document, ready to respond to the creative ideas so characteristic of our community and to the changing collaborative opportunities internationally, and yet remain coherent and focused. Helping us to match resources to expectations (or vice versa!) is a new organization ACURA which harnesses the energies of our universities. While still a fledgling, it appears to have webbed feet, and perhaps with time it will help create a paradigm shift so that we can instead rise up and fly upstream. CASCA, ACURA, and Industry have come together in the Coalition for Canadian Astronomy which lobbies for LRP funding. This

is a remarkable innovation that has achieved great profile for our discipline in Ottawa, wide-spread multi-party buy-in for the LRP concept, plus impressive new funding. Still it is a heady challenge. ACURA has matured and more industries have come on board, so that the Coalition is increasingly well prepared for another mad dash up the escalator; since CASCA member participation is essential, this could be your opportunity to satisfy that pent-up urge!

New opportunities. Both the LRP and the update in the Mid-term Review (MTR) have a breathtaking number of recommendations. Progress can be measured by the extent to which each has been achieved. Likewise, progress can be made by addressing individual recommendations. Two will be mentioned here.

NSERC initiative. Another step toward coherence would be to adopt envelope funding for an Astronomy and Astrophysics GSC within NSERC. This was in fact proposed in 2003 by NSERC, but it foundered for several reasons including many not really related to us (e.g., the restructuring of GSC 09 and whether it would have an envelope). The MTR subsequently discussed this and gave its endorsement. NSERC is now considering this again and this time as a mature and cohesive community we need to ensure this outcome on favorable terms to optimize this aspect of the LRP.

CSA initiative. The MTR also recommended “that CASCA conduct a study of the needs of Canadian astronomy in the area of space astrophysics to inform the next Long Range Plan.” Yes, it is time: current space projects are in hand and the lead time for developing new ones is long. A very important Canadian Space Astronomy Workshop (CSAW) is being held at the CSA on 23-24 November which will require a lot of forethought. So block off this time, prepare, and participate.

Peter Martin

Feature Articles

[Latest Threats to Radio Astronomy](#) *Ken Tapping*

Latest Threats to Radio Astronomy

Ken Tapping

Over the last few months, some new issues have arisen in the never-ending process of protecting radio astronomy in the face of more and more demands for space in the spectrum for new radio services. Some of these have appeared out of things that have been evolving for some time; others are new.

Ultra-Wideband Technologies

These are systems based upon the assumption that the operating bandwidths are so huge that the spectral power per Hertz will be so small that conventional radio services won't even know UWB signals are falling in their band. We are not convinced this would be the case for radio astronomy bands.

After largely futile attempts to develop viable models to estimate what the interference problems if any might be between UWB systems and other spectrum uses, such as radio astronomy, commercial pressures have overcome caution and have led to these systems entering the market. The USA went ahead before international discussions were completed, and because of the close connections between US and Canadian markets, Canada will probably have to follow suit. Our national spectrum managers are proving supportive and we should be able to get some help if this becomes a significant interference problem. Something new has arisen in Europe, which we hope to keep under control.

There is a footnote in the Radio Regulations, number 5.340, listing all the bands for which radio astronomy or other passive (non-transmitting) radio services are the sole users. A proposal has arisen in Germany to remove two bands from the 5.340 list: 1400-1427 MHz (cosmic neutral hydrogen) and 23.6-24 GHz (ammonia). The argument is that these bands fall within frequency bands to be used by ultra-wideband radars. The 1400-1427 MHz band would be good for wall and ground penetration radars and the 22-26 GHz band for automobile collision avoidance radars. The proponents of these systems argue that they are short-range and their power is distributed over such a wide bandwidth that the power per Hz would be negligible. However, footnote 5.340 is allegedly inhibiting their deployment. The danger is the possibility of gradual demolition of 5.340 by small nibbles. In addition, taking a band out of the 5.340 list opens the door to other transmissions, not just UWB. This is unacceptable. The radio astronomers involved in spectrum protection issues are

fighting this, and Industry Canada agrees that proposals like this are rather silly. With a bit of luck and effort we should be able to keep this within the German borders or possibly kill it. This will not stop the radars but it is not yet clear how much of a problem they will be, or will be at all. We want that footnote left alone. We have been assured that the 23 GHz issue is a temporary one, to allow the deployment of collision avoidance radars in the 22-26 GHz band pending the availability of equipment in the intended band, which is up near 70 GHz. However, once a large capital investment has been made, with cars all over the place using these systems, with the concomitant need to maintain stores of spares etc., once established, those vehicle radars might be very difficult to move out of the 23 GHz band.

Industry Canada supports us in our desire to keep the list and protection measures for radio astronomy unchanged. UWB systems lie outside the normal spectrum management process, and keeping UWB outside means these devices are not allowed to interfere with any official spectrum user, such as us. Modifying the Radio Regulations in any way to accommodate or recognize UWB implies official acceptance as UWB being another service, with "rights".

Broadband Internet Over Power Lines

Another system that has defied attempts to make prior estimates of the magnitude of potential interference problems has been the proposed use of electrical power lines to transmit broadband information (up to maybe 70 MHz). Modelling methods are still being discussed in Geneva. Canada has been evaluating a test system near Sault Ste. Marie. Indications so far are that when the link is in use, communication attempts by nearby radio amateurs have been completely obliterated. The situation for radio astronomy in the VHF bands could be rather difficult, but as yet, we have no data.

However, once again the USA has leaped ahead of the international discussion (and competition) and has started to put these systems into commercial operation. Canada may once again be forced to harmonize with the US . We await results.

We continue to liaise with Industry Canada on this one.

Cross-Border Leakage - Intended and Unintended

In setting up a satellite system that serves users on the ground, one specifies a "service area", where the intended user community is located. Inside this area the power levels are sufficient to meet the needs of the user community. Inevitably, the service area is surrounded by a "coverage" area, where the power levels are lower, and insufficient for users. In order to

avoid interfering with systems licensed to operate in the coverage area, the ITU specifies the maximum power levels on the ground outside the service area. However, problems arise when the coverage area spills across a border into a neighbouring country, and when the company operating the satellite system has strategic plans to expand the service across the border at some later date. In principle, there is no need for Country A to inform Country B about "coverage" signals extending across the border. This could be serious. If for example, we do build a Large Adaptive Reflector radio telescope at the HIA's Dominion Radio Astrophysical Observatory, we would like to use this instrument, which would be one of the largest radio telescopes in the world, to access as much spectrum space as possible. One thing we can do is to liaise with our national spectrum managers to have some national protection, perhaps temporary, for bands of interest that are not allocated internationally to radio astronomy. However, un-notified coverage signals coming from satellite services licensed to operate south of the border could make the chosen bands unusable.

It could be worse than that. A spokesman for one company said that in order to save money in hardware modifications, it is one of those "unreported but widely practiced procedures" is to build systems that put service level signals on the ground over the currently licensed and that part of the coverage area planned for future expansion of the service. In that way money is saved later on, when the system is expanded into the new (Canadian) service area. If there is no prior notification of this, things could get even stickier for radio astronomy.

There are some bipartite working arrangements between the USA and Canada , and we need to ensure that to the best extent possible, we know enough about what the other guy is up to in order to identify or problem areas. Ken Tapping is a member of the US Committee on Radioastronomy Frequencies, which provides a valuable additional forum for discussing issues like this. The next meeting is in early April.

Creating Undesired Loopholes

Industry Canada pointed out this one. Those guys continue to be very helpful. The USA is currently discussing a proposal to modify two ITU Resolutions that list potential bands and services that could cause interference problems for radio astronomy, and list the obligations of the concerned parties to work together as required to solve the problem. The changes would do two things: (a) they would create a "Window of Opportunity" extending until the publication of the results of the 2007 World Radio Conference or even beyond that, where new satellite services being registered inside that window will be exempt from the requirements in those resolutions, and (b) stop any future "Band-by-Band Studies".

The ITU has set up a series of studies wherein radio astronomers and other spectrum users identify particular radio service bands that could cause interference to particular radio

astronomy bands. The objective of these studies is to find out if the problem can be avoided, and if not, what can be done about it. With new services appearing all the time, and with new radio astronomy bands being allocated and new technologies being deployed, it is obvious that whether we like it or not, this study process will probably have to be kept going for the foreseeable future.

The Canadian national position on this is to oppose the loopholes and promote the ongoing band-by-band study process.

Things Look Grim?

The issues reported here might create the impression that "they" are out to get radio astronomy. This is not the case. The process of competition to get spectrum space has been going on as long as there has been a radio spectrum, and that this process has been very Darwinian. With the incredible rate of growth of new radio communication and other technologies, the competition has become very fierce. At science conferences our objective is to present our ideas/results as clearly and honestly as possible, so that our peers will be honestly convinced, or not. With billions of dollars at stake, the companies in the communications business have to focus on the main objective, which is to get what they want, in the best way they can. With the pressure this high, protecting our science involves jumping into the arena too. Our national spectrum managers do help, but they gauge the importance of issues relevant to us on the basis of how vigorously we participate in dealing with them. People are trying on various proposals all the time, and we have to respond.

News

[An Alma Update](#) by Chris Wilson

[Milestones at NRC's HIA \(2006 Spring\) / Du neuf à l'IHA du CNRC - printemps](#) by Jacques P. Vallée

[Gemini Update](#) by Dennis Crabtree

ALMA Update

1 Recent news

1.1 Construction Progress

The big news for ALMA in May was the approval of NSF's request for additional funding for ALMA by the National Science Board. This action provided the NSF Director with spending authority that covers the revised baseline cost of ALMA as approved by the ALMA Board. It was the first step to acquiring the needed additional funds; discussions with the U.S. administration and congress are yet to come. As you may recall from previous newsletters, ESO was able to approve the additional funding required for ALMA in late 2005 and the need to secure additional funds from the U.S. side has been a major preoccupation of the last six months.

In physical construction news, the outside shell of the main building at the 5000 m high site has been completed and the contract to finish the interior has been let. The contract for construction of the Operations Support Facility (OSF) at the 3300 m site, an ESO responsibility, has been approved by the ALMA Board at their June 2006 meeting. After a review of the feasibility of building a separate power station for ALMA, it has been decided to connect to the Chilean grid rather than construct and operate a stand-alone facility. Successful fringing tests using the intermediate frequency (IF) downconverters were carried out in the lab in Socorro, New Mexico, in which the IF output from two warm multiplier assemblies were passed through the backend analog and digital subsystems to the correlator where cross-correlation power spectrum and phase plots were run.



Figure 1: the completed shell of the main building for the Array Operations Center for ALMA at the high site (5000 m elevation)

Dr. Paola Andreani has recently been selected to be the Manager of the European ALMA Regional Center (ARC) for ESO. Her counterpart on the North American side is Dr. John Hibbard of NRAO. Dr. Chris Carilli was recently selected to head the North American ALMA Science Center (NAASC) in Charlottesville, (<http://www.cv.nrao.edu/naasc/>) which includes the North American ARC and which will be responsible for user support for the North American community and other aspects of ALMA operations. A major task for the North American community is securing the money for ALMA operations, which will ramp up over

the next few years in preparation for Early Science observations in 2010. We took advantage of the recent AAS meeting in Calgary to have a meeting between U.S. and Canadian scientists involved in ALMA operations planning to begin to define what role Canada will play in the operations era. We will be having a series of telecons and an additional face-to-face meeting over the summer to work out the details before the U.S. operations plan is submitted to the NSF in the early fall of this year.

1.2 ALMA Science Meetings

The second world-wide meeting on "Science with the Atacama Large Millimeter Array" will be held in Madrid, Spain, on 13-16 November 2006. Registration for this meeting is open until July 1, 2006 and is limited to 250 people. The conference will cover a wide range of topics, which will include the main scientific drivers of ALMA: the formation and evolution of galaxies, the physics and chemistry of the interstellar medium, and the processes of star and planet formation. The web page for the conference, including the preliminary scientific program and registration information, is available at <http://www.oan.es/alma2006/>.

Students and postdocs will be interested to know that HIA will be hosting a summer school on Submillimetre Observing Techniques, which will include talks on observing with ALMA, from 14-17 August 2006 in Victoria. Registration for this meeting is open until June 30, 2006, and information about the school can be found at <http://hia-ihh.nrc-cnrc.gc.ca/astroschool/>.

Chris Wilson presented an overview of the ALMA project and the types of science it will do at the CASCA meeting in Calgary. In case anyone missed the talk (it was moved from the second day to the first day to accommodate the late arrival of Jim Stone, who was the first speaker), the talk will be available on the Canadian ALMA web site at <http://www.almatelescope.ca/>.

There was also a special session on ALMA at the AAS meeting in Calgary, with science talks on star formation by Doug Johnstone (HIA), nearby galaxies by Jean Turner (UCLA), and high redshift galaxies by Andrew Blain (Caltech).

2 ALMA Science Advisory Committee

The ASAC met 28-29 January, 2006, at the University of Maryland. The ASAC had three charges for that meeting: to review the progress in the science software development for ALMA; to review the plans and progress toward the scientific integration of the Atacama Compact Array into the baseline ALMA project; and to review the existing analysis on the imaging performance of the hybrid ALMA array and advise the project on whether additional work needs to be done in this area.

Regarding the science software development, the ASAC noted the continued progress by the software development teams. The fact that the major redevelopment of AIPS++ (to be renamed CASA) required for ALMA data reduction remains to be completed means that there continues to be a risk on the development path. In addition to the technical work remaining to be done, there is some concern that scientists (both expert and novice users) may be hesitant to adopt the new software given the history of the development of AIPS++. The ASAC recommended that the ALMA software team develop a plan to encourage adoption of the software as the system becomes available to science users. The ASAC also recommended that the ALMA project be 100% committed to sole use of the ALMA science software during the commissioning period and noted that it is essential that the computing resources are available to support this use.

Regarding the scientific integration of the Atacama Compact Array (ACA), the ASAC noted that there has been substantial progress in the integration of the ACA into the baseline ALMA project. The work on calibration has revealed the need for additional clarification in the calibration requirements, specifically in the area of the cross-calibration accuracy between the ACA and the 12m array. The ASAC report proposes precise definitions for this requirement and three other calibration requirements that are already in use for ALMA but are not always clearly defined. The addition of the ACA increases the number of observing modes and the ASAC recommended that the project carry out a detailed study of both the calibration and the scheduling impact of these new modes. Finally, the ASAC noted that the Design Reference Science Plan does not include projects using receiver bands 4 (125-163 GHz or 1.8-2.4 mm) or Band 8 (385-500 GHz or 0.6-0.8 mm), or detailed information for the use of the ACA, and recommended that the DRSP be updated to include this missing information.

Regarding the polarization and mosaicing performance of ALMA, the ASAC believes that having two designs for the 12m antennas should not preclude any of the Level 1 science goals for ALMA, including imaging fidelity and wide-field polarization, as long as tight control of key antenna specifications is maintained. The ASAC recommended that the Antenna or System Engineering IPT use EM modeling to estimate the beam and its sidelobes and that these results be compared to the results from holographic data and fed into further work by the Science IPT on mosaic image fidelity and wide-field polarization imaging.

On other issues, the ASAC feels that ALMA outreach and public relations need a higher profile with better coordination between the different groups involved. The ASAC recommended that a fully-integrated and properly resourced IPT be formed to ensure that ALMA has a single public face that reflects the scientific excitement and technological excellence of the project. The full

ASAC report is available at http://www.alma.nrao.edu/committees/ASAC/asacreport_2006jan.pdf

John Richer (Cambridge) is the new chair of the ASAC and Lee Mundy (Maryland) is the new vice-chair. The next ASAC meeting will be held September 16-17, 2006 in Florence, Italy, where the ASAC will review the revised Commissioning and Science Verification Plan, the revised Calibration Plan, and the existing work on developing complete descriptions of the ALMA observing modes.

3 ALMA Developments in Canada

3.1 Band 3 Receiver Development

The Band 3 Receiver Development continues to keep pace with the ALMA project. Over the past three months the team has completed the testing of the first Band 3 pre-production cartridge, including the phase stability measurement. The cartridge passed its testing with flying colours and has met or exceeded all of the ALMA requirements. The team also prepared for and passed the Test Readiness Review which examined the acceptance test plan of the Band 3 cartridge to ensure that the performance characteristics can be verified. The review panel consisted of the Front End IPT leader and deputy-leader, Front End IPT systems engineer, and the project managers of the North American and European Front End Integration Centers. The review panel was satisfied with the proposed acceptance test plan prepared by the Band 3 team. Congratulations to all.

An important milestone in mixer testing at HIA has been passed with the completion of the automated mixer test set. This automation enables the team to perform noise temperature measurements of the double sideband (DSB) and sideband separating (2SB) mixers without any operator intervention. The automation substantially reduces the manpower required for the mixer testing operation and increases the accuracy and repeatability of the measurements.

Beyond the ALMA project, the Band 3 team has been drumming up business for its innovative technology. A license agreement was signed with Nanowave Technologies Inc of Toronto to manufacture and market the HIA 4-8 GHz cryogenic amplifiers for other commercial applications. HIA received a modest amount of royalty payment after the signing of the license agreement. Two customized units were sold to CEA Saclay, a French physics research laboratory in Paris, to measure shot noise levels of materials at cryogenic temperature. As well, Dr Bernard Placais and Dr. Christian Glattie from the Ecole Normale Supérieure in Paris have expressed a keen interest to use the HIA amplifiers to study the DC and RF characteristics of single-walled carbon nanotubes. The Band 3 team is in the process of formulating the technical requirements of a new generation of cryogenic amplifiers to operate up to the 30-40 GHz range.

For more information on the ALMA Band 3 Receiver Project contact Keith Yeung (Project Manager, keith.yeung@nrc-cnrc.gc.ca), Stephane Claude (Project Engineer, stephane.claude@nrc-cnrc.gc.ca), or Doug Johnstone (Project Scientist, doug.johnstone@nrc-cnrc.gc.ca).

3.2 Software

Software work for the ALMA Offline system and the ALMA Common Software system is continuing in Calgary and at DRAO. Raymond Rusk continues to work on the porting of the AIPS++ application libraries for the reduction and analysis of radio astronomy data into the new CASA framework. In the new framework, the libraries are accessible through a direct Python binding as well as an ALMA Common Software (ACS) Corba binding. He has completed porting the Calibrator tool for synthesis calibration and is in the final testing stage of porting the Measures tool, which is used for handling units, quantities, and reference frames including coordinate and time conversions. He is also working on the Coordsys tool, which is used for creation and manipulation of coordinate systems, and the Image tool, which is used for accessing and analyzing images. Work on these modules should be complete by mid-September.

Since the previous report, Dr. Gary Li, who has worked on the ALMA offline software for the past two years at the University of Calgary, returned to his roots in the geophysics community. Gary was a valued member of the Off-line team and we wish him well in his new position. Shannon Jaeger, Gary Li's replacement, joined the offline team just in time to attend the ALMA Offline Developer's meeting which was held in Calgary from June 1-6, 2006. Shannon will be spending a couple of weeks in Socorro during July to come up to speed on CASA development. She is currently working on the migration of the Functionals tool to the new framework.

The ALMA Offline Developer's meeting was held at the CASCA/AAS conference hotel June 1-6, 2006. This meeting allowed the offline developers to mix and become acquainted with some members of the Canadian astronomical community. It also provided an excellent environment in which the team could rapidly debate some key implementation details necessary for the first release of CASA planned for later this year. A follow-up meeting to be held in conjunction with the Tuscon ADASS meeting is planned for this fall.

David Fugate, an ALMA Common Software worker located at the University of Calgary, has accepted a position at Microsoft to begin in early August. David's expertise from four years of developing ACS software, both with NRAO in Socorro and at the University of Calgary, will be difficult to replace. We wish him the best of luck as he returns to the United States with his new Canadian bride.

Chris Wilson was heavily involved in the second user test of the ALMA Pipeline which began in early March and ran for a month. Brenda Matthews from HIA and John Hibbard and Ed Fomalont from NRAO were the other astronomers involved in this test. The test focused on flagging and calibration of single field interferometric data. Because no real or simulated ALMA data are available yet, the test used data from the VLA and the Plateau de Bure interferometer. The test was quite successful, with the testers who had participated in the previous year's test noting that there had been a lot of progress in the pipeline algorithms. The next user test is planned for late fall and will include full end-to-end processing of the data for the science target for the first time.

HIA hosted a successful ALMA Archive team meeting in Tofino from May 12-13, 2006, with 6 of the 8 members in attendance. Technical issues and the distribution, coordination, and scheduling of tasks were the focus of the meeting. Norman Hill continues to attend the weekly ALMA Archive team teleconferences. Delays in hiring continue to prevent the CADC from making its full contribution to the ALMA Archive development; once the position is filled, work will begin on the design and implementation of the Request Handling component of the Archive system.

Chris Wilson wilson@physics.mcmaster.ca

Canadian ALMA Project Scientist

(with input from Séverin Gaudet, Doug Johnstone, and Raymond Rusk)

File translated from T_EX by [I_TH](#), version 3.40.

On 20 Jun 2006, 17:07.

Milestones at NRC's [HIA](#) (2006 Spring)

edited by:

[Dr. Jacques P. Vallée](#)

Late March, **Helen Kirk** and **Wes Fraser**, Univ. of Victoria PhD students working at HIA, each won an NSERC Canada Graduate Scholarships. Helen is working with Doug Johnstone on star formation processes, while Wes is working with JJ Kavelaars on outer solar system formation.

In April, the HIA DG, **Greg Fahlman**, received notification from NSERC of the renewal of the Major Facilities Access Grant - Infrastructure, to enable eligible students and postdocs to travel to offshore telescope facilities in which Canada is a partner: CFHT, JCMT, Gemini North and South, and those operated by NRAO under the NRC-NSF NAPRA agreement, as well as expanded trips for students to learn queue observing. The grant, in existence for the past 23 years, starts again in April 2006 and ends in March 2009.

Through the NRC IRAP program, HIA provided some technical support to BLT [Broadcast Live Technologies] in Victoria, to evaluate and characterize the antenna designs for a Sportsbug receiver. It will allow spectators at a sporting event to listen, through a lightweight ear piece, to a play-by-play broadcast or even eavesdrop on communication between coaches and players. Special thanks to **Pat Niranjana** for setting up the equipment.

In late April, **Jim Hesser** once again continued his association with BC's Scientists in the Schools programme, visiting 5 schools from Squamish to Pemberton, and making 18 presentations to some 430 students about solar system, meteoritic impacts, black holes, ALMA, etc. The thirst for information by the children remains unchanged.

Du neuf à l'[IHA](#) du CNRC - printemps

édité par:

Fin mars, **Helen Kirk** et **Wes Fraser**, étudiants au doctorat à l'univ. de Victoria et travaillant à l'IHA, ont chacun gagné une Bourse d'étude graduée du Canada du CRSNG. Helen travaille avec Doug Johnstone sur les processus de formation des étoiles, tandis que Wes travaille avec JJ Kavelaars sur la formation du système solaire lointain.

En avril, **Greg Fahlman**, le DG de l'IHA, fut avisé par le CRSNG du report du Fonds d'accès aux grandes installations - infrastructure, pour permettre aux étudiants et postdocs d'aller aux télescopes outremer qui sont en partenariat avec le Canada: TCFH, TJCM, Gemini Nord et Sud, et ceux de NAPRA sous l'entente CNRC-NSF NAPRA, et pour de plus longs voyages pour apprendre le systè d'observation en queue. Le fonds, en exisce depuis 23 ans, débute de nouveau en avril 2006 et se termine en mars 2009.

Via le programme IRAP du CNRC, l'IHA a apporté un support technique à BLT [Broadcast Live technologies] de Victoria, pour évaluer et caractériser les dessins d'antenne pour un récepteur Sportsbug. Ceci va permettre aux spectateurs d'un événement sportif d'écouter, via un appareil auditif peu pesant, le commentaire en temps réel et même espionner la communication entre un coach et ses équipiers. Un remerciement spécial à **Pat Niranjana** pour la mise en oeuvre de l'équipement.

Fin avril, **Jim Hesser** a continué de nouveau son association avec le programme BC's Scientits in the Schools, en visitant 5 écoles de Squamish à Pemberton, donnant 18 présentations à 430 écoliers sur le système solaire, les impacts météoritiques, les trous noirs, ALMA, etc. La soif de connaître des enfants restent grande.

On May 6, the Royal BC Museum celebrated International Astronomy Day once again. HIA contributors included **James Di Francesco, Eric Peng, Russell Redman** for the Ask the Astronomer's Booth, **Jim Stillburn** for the Telescope Making event, and **Steve Ewald** for the StarLab planetarium.

Early May, the HIA contribution to the Conceptual Design Review for the 30-meter Telescope was highlighted at the Pasadena meeting. The HIA contributions are in the area of Adaptive optics, instrumentation, modeling, site testing, enclosure, operations/software.

At the beginning of June, **Maria Sempere** has started as a Visiting Worker at the HIA in Victoria. She will be working with the Millimeter Astronomy Group.

Le 6 mai, le Royal BC Museum a comme d'habitude fêté la Journée Internationale de l'Astronomie. La contribution de l'IHA fut: **James Di Francesco, Eric Peng, Russell Redman** pour la boutique 'Ask the Astronomer', **Jim Stillburn** pour la fabrication d'un télescope, et **Steve Ewald** pour le planétarium StarLab.

Au début de mai, on a célébré les apports de l'IHA lors de la rencontre à Pasadena pour une Evaluation du concept et des plans pour le Télescope de 30 mès. Les contributions de l'IHA sont importantes en optique adaptative, instrumentation, modelage, tests des sites, dôme, et opérations/ logiciels.

Début juin, **Maria Sempere** fréquente l'IHA de Victoria en tant que Travailleuse Invitée. Elle travaillera en collaboration avec le Groupe d'Astronomie Millimétrique.

Gemini Update

Dennis Crabtree (NRC-HIA)

Michael West, formerly of the Department of Astronomy and Physics at Saint Mary's University has been hired as head of Science Operations for Gemini South.. Most recently Michael was on the faculty at the University of Hawaii Hilo. He was also a postdoctoral fellow at CITA between 1989 and 1991. Michael maintains his association with Canada by serving on NSERC's GSC 17. Michael brings a wealth of observing experience and proven scientific leadership to his new role with Gemini and the Canadian Gemini Office looks forward to working with Michael in the future.

The Gemini Director, with input from the ITAC and a panel of independent experts, has chosen an international team led by Dr. Michael Liu of the Institute for Astronomy at the University of Hawaii to conduct a major campaign to directly image planets around nearby stars using NICI. Harvey Richer (UBC) and Pawel Artymowicz (Toronto) are the two Canadians on the team. The NICI Campaign is planned to begin in 2006 and will be carried out over the next two to three years using 50 nights of observing time.

Gemini has (almost) reached a steady state of operations with only a few new instruments expected to arrive in the next couple of years. Later this year, NICI and FLAMINGOS 2 will be delivered to Gemini South while in 2007 Gemini will take delivery of the Gemini South adaptive optics system (the basis for MCAO) and a laser guide star system. This reduction in the arrival of new instruments and commissioning of new telescope modes has allowed Gemini to put more effort towards optimizing scientific operations.

Gemini's operational efficiency has improved significantly in the past few semesters. Both Gemini telescopes now operate in multi-instrument mode every night. For example, science observations may be taken with GMOS until the moon rises at which time MICHELLE observations will be taken and then, if the seeing improves, Altair/NIRI programs will be executed. This increased flexibility has allowed Gemini to optimize operations and increase program completion rates. Gemini queue completion goals are:

- Band1: 90 % or more of the queue programs are completed, in the sense that 100 % of their requested data have been acquired or all their allocated time has been used.
- Band 2: 75 % or more of the queue programs are completed.
- Band 2 and 3: 80 % of started queue programs should have at least 75 % of the requested data obtained.

Gemini's open shutter efficiency has been routinely monitored since August 2004. The

shutter-open efficiency is defined as the sum of all science exposures plus calibrations obtained between evening and morning nautical twilight divided by the total usable time available. Gemini's peak shutter-open efficiencies typically exceed 80% and the average values are in the range of 60-70%. These values are comparable for all instruments on both telescopes. As might be expected, the two GMOS instruments have among the highest efficiency values because individual exposure times tend to be longer for optical observations. These results compare very favorably with those reported elsewhere for other large telescopes.

More details on Gemini operations plus science highlights are available in the latest edition of ***Gemini Focus*** (http://www.gemini.edu/files/pio/newsletters/nwsltr31_12_2005.pdf)

Gemini operates almost completely in queue mode. In order for the queue to operate efficiently, the various observing condition bins must be (over)filled. Gemini receives a lot of proposals for the best image quality or photometric conditions, but, as expected, has trouble attracting proposals for the poor conditions.

Poor weather proposals: often the queue contains insufficient proposals for the poorest conditions, despite the best efforts of the National TACs to pass on a balanced package of proposals to Gemini. To encourage submission of more poor weather proposals, those with the following observing condition constraints will receive special consideration at the TACs. Neither the PI nor partner country will be charged for any time used:

- Image Quality of "any" and Cloud Cover of 70%-ile or worse (non-photometric)
- Cloud Cover of 90%-ile (typically 2 magnitudes of cloud cover and unusable in the mid-IR) and any other combination of conditions

The Sky Background constraint can be specified and it is acceptable for these programs to request dark time.

Another effect of the queue is to limit visits to the telescopes by graduate students and post-docs. HIA manages an NSERC grant that supports travel to the telescopes managed by HIA for those who do not have their own source of funds. The terms of reference of this grant does allow for visits to Gemini as long as the student or PDF has been awarded time by CTAC. Gemini encourages visits by students and prefers visits of 2 weeks or longer to allow the student to fully benefit from the experience.

The Gemini tool for Phase I proposal submission has been upgraded. PIT now allows PIs to print out their proposals, including figures, properly formatted. There are restrictions on the formats of the figures (no PostScript files) and PIs should remember that CTAC receives black and white copies of the proposals.

Reports

[CTAC/CATC](#)

Canadian Time Allocation Committee for Gemini & CFH Telescopes - summary for semester 2006b

Proposal Statistics

CFHT: For this semester, 30 Canadian proposals were received, requesting 118 nights. The allocated time for Canada was 27 dark nights for the Legacy Survey, and 40 nights for the regular proposals. Thus the Canadian oversubscription factor (requested time to available time) was 2.2 overall (including the Legacy Survey). After subtracting the LS obligation, the general observer proposals faced an oversubscription of 3.0.

Gemini: For Gemini North, CTAC received 35 proposals requesting 463 hours, and for Gemini South CTAC received 22 proposals requesting 255 hours. Given Canada's share of 214 hours on GN and 176 hours on GS, the Canadian over-subscription was 2.2 for GN and 1.4 for GS.

Peer review: Two independent referee reports were requested for each proposal. The referees' response rate was very good with 87% for CFHT, and 76% for Gemini. CTAC wishes to thank the many referees for their valuable scientific evaluations.

CTAC meeting & voting members

Current members of CFHT/Gemini CTAC are:

Doyon, René (Univ. de Montréal)
Ellison, Sara (Univ. Victoria), Chair/Présidente
English, Jayanne (U. Man. - Winnipeg)
Ferrarese, Laura (NRC-HIA Victoria)
Hoekstra, Hendrik (Univ. Victoria)
Martel, Hugo (Univ. Laval, Québec City)
van Kerkwijk, Marten (Univ. Toronto)
Wade, Gregg (RMC Kingston)

The CTAC Technical Secretary, Dr. **Jacques P. Vallée** (NRC-HIA, Victoria), supervises a number of things, including computer processing, communication linkage, procedure and interface with HIA.

The CTAC meeting was held on 5 & 6 May 2006 at HIA Victoria. As always, CTAC ranked proposals according to their scientific merit and technical feasibility.

CTAC points of interest

1. As in previous semesters, the Canadian over-subscription on Gemini South was considerably less than on Gemini North.
2. Gemini proposers should share the total observing time requested between partner countries.
3. Semester 2006b sees the introduction of a poor weather band for Gemini. Proposals which don't make the nominal cutoff but can be done in poor conditions will be forwarded to a separate Gemini queue.

International TACs

At these international meetings, joint proposals are discussed, and time assignments and scheduling are finalised. The final observing schedules can be seen on the CFHT and Gemini web pages.

The CFHT International TAC/SAC met in Montréal at the SAC meeting held in mid-May 2006, and CTAC was represented at this meeting by **Henk Hoekstra** and **Laura Ferrarese**.

The members of the Gemini International TAC met in Tucson on 2006 June 1-2, and CTAC was represented by **Henk Hoekstra**.

As usual, CFHT & Gemini TAC summaries and copies of referee reports (names withheld) are sent from HIA in Victoria by email to the PIs of the proposals.

Comité d'Allocation de Temps Canadien des télescopes Gemini & CFH - sommaire du semestre 2006b

Statistiques des demandes de temps

TCFH: Pour ce semestre, 30 demandes de temps canadiennes ont été reçues, et un total de 118 nuits fut demandé. Le temps alloué pour le Canada fut de 27 nuits noires pour le Relevé du Legs [LS], et de 40 nuits pour les demandes de temps. Le facteur de pression canadien (temps demandé/disponible) fut de 2.2 au total (incluant le Relevé du Legs). Si on soustrait l'obligation LS, les demandes de temps générales font face à un taux de sursouscription de 3.0.

Gémini: Pour le télescopes Gémini Nord, le CATC a reçu 35 demandes pour 463 heures, et pour Gémini Sud le CATC a reçu 22 demandes pour 255 heures. Comme la part du Canada est de 214 heures sur GN et de 176 heures sur GS, ceci donne un facteur de pression de 2.2 sur GN et de 1.4 sur GS.

Arbitrage: Pour chaque demande TCFH ou Gémini, on a fait participer deux arbitres indépendants. Le taux de réponse des arbitres a été très bon: 87% pour le TCFH, et 76% pour Gémini. Le CATC veut remercier les arbitres pour leur travail scientifique de qualité.

Réunion du CTAC et membres votants

Les membres du CATC pour les télescopes Gemini & TCFH sont:

Doyon, René (Univ. de Montréal)
Ellison, Sara (Univ. Victoria), Chair/Présidente
English, Jayanne (U. Man. - Winnipeg)
Ferrarese, Laura (NRC-HIA Victoria)
Hoekstra, Hendrik (Univ. Victoria)
Martel, Hugo (Univ. Laval, Québec City)
van Kerkwijk, Marten (Univ. Toronto)
Wade, Gregg (RMC Kingston)

Le Secrétaire Technique du CATC est le Dr. **Jacques P. Vallée** (IHA, Victoria), supervisant le processus informatique, les liaisons de communication, la procédure et l'interface avec l'IHA.

La réunion du CATC a eu lieu les 5 et 6 mai 2006 à l'IHA de Victoria. Comme d'habitude, le CATC a classé les demandes selon le mérite scientifique et leur faisabilité technique.

Points d'intérêt du CATC

1. Depuis plusieurs semestres, la sur-souscription canadienne pour Gémini Sud est considérablement plus basse que pour Gémini Nord.
2. Les demandeurs au Gémini devraient partager leur temps d'observation requis entre les pays partenaires.
3. On introduit au semestre 2006b une bande pour piètre température sur Gémini. Les demandes de temps qui sont au-dessous de la limite nominale mais qui peuvent être faites en piètres conditions seront acheminées dans une queue à part de Gémini.

CAT Internationaux

À ces rencontres internationales, on discute les demandes conjointes, et on finalise les allocations de temps et l'horaire.

Le CAT International pour le TCFH s'est réuni à Montréal pendant la rencontre du Comité Scientifique Aviseur en mi-mai 2006. Le CATC était représenté par **Henk Hoekstra** et **Laura Ferrarese**.

Les membres du CAT international pour Gemini se sont réunis à Tucson le 1-2 juin 2006, et le CATC était aussi représenté par **Henk Hoekstra**.

Comme d'habitude, l'IHA envoie aux chercheurs principaux par courriel depuis Victoria les rapports des arbitres (anonymes) et le sommaire du CATC.

Sara Ellison

Chair, Canadian Time Allocation Committee (CTAC) for Gemini and CFHT

Sara is a Professor at the Univ. of Victoria, BC. Much of her research involves distant galaxies and quasars.

CTAG Chair, Sara Ellison (left), with Magellanic penguin (right) in Argentinian Patagonia in 2005.



Sara Ellison

Présidente, Comité d'Allocation de Temps Canadien (CATC) pour Gemini et le TCFH.

Sara est professeure à l'Université de Victoria, CB. Sa recherche touche les lointains quasars et galaxies.

La Présidente du CATC, Sara Ellison (à gauche), avec un pinguin de Magellan (à droite) en Patagonie d'Argentine en 2005.

Briefly Noted

[A Summer School on "\(Sub\)Millimetre Observing Techniques"](#)

[Canadian Space Astronomy Workshop / Atelier canadien sur l'astronomie spatiale](#)

A Summer School on "(Sub)Millimetre Observing Techniques"

14-17 August 2006

Victoria, BC, Canada

Registration Deadline: 30 June 2006 <http://www.hia-ihc.nrc-cnrc.gc.ca/astroschool>

This summer school is timed to coincide with the arrival of new instrumentation on the James Clerk Maxwell Telescope and to precede the first open call for proposals to the Herschel Space Observatory (expected within the year). In addition, two days will be spent on the basics of interferometry with a focus on ALMA, eSMA and EVLA, to which all Canadian astronomers have direct access.

Never observed in the submillimetre? No problem!

The workshop will include introductory talks about the generalities of radio telescopes and the basics of observing in this part of the spectrum as well as specific talks about the facilities mentioned above.

At the recent CASCA meeting, we were again reminded of the effectiveness of multiwavelength studies in approaching astronomical problems ranging from cosmology to star formation. Most impressive was the relevance of submillimetre and millimetre observations to the study of a wide range of astronomical objects with the information that, after the CMB, submillimetre photons carry the bulk of the energy in the universe (dominating early galaxies, merging galaxies, the Milky Way, star-forming regions, planets and protoplanetary disks). This is an excellent time to become familiar with the techniques and instrumentation in this part of the electromagnetic spectrum even if your current work does not involve submillimetre telescopes.

The school is geared primarily toward graduate students (the future user community of all these wonderful facilities), but senior undergraduates or postdocs (and even faculty) are also most welcome.

A maximum of 50 participants will be registered.

The registration and accomodation reservation deadline is 30 June 2006. The website includes information about registration, accomodation, invited speakers and the schedule. It can be found at <http://www.hia-ihc.nrc-cnrc.gc.ca/astroschool>.

Creating Ideas for the Next Decade / Des Idées innovatrices pour la prochaine décennie



Agence spatiale
canadienne Canadian Space
Agency



Atelier canadien sur
l'astronomie spatiale (CSAW)

**Des idées innovatrices
pour la prochaine décennie**

23 et 24 novembre 2006

Centre spatial John H. Chapman
Longueuil, Québec

Nous encourageons les universitaires,
les représentants des secteurs privé et public et
d'autres groupes intéressés à participer à cet atelier.
Aide financière possible pour les étudiants.

Consultez le site Web pour obtenir des détails
concernant la présentation des résumés.

www.espace.gc.ca/csaw-fr

Credit: Photo Hubble/NASA de C.R. O'Dell (Rice University)

Canadian Space
Astronomy Workshop (CSAW)

**Creating Ideas
for the Next Decade**

November 23 – 24, 2006

John H. Chapman Space Centre
Longueuil, Québec

Participation from academia,
industry, government and other interested
groups is encouraged. Some financial assistance
is available to students.

Please see the website for details
on submitting abstracts.

www.space.gc.ca/CSAW

Credit: NASA/Hubble Photo by C.R. O'Dell (Rice University)

Canada

Canadian Space Astronomy Workshop (CSAW)

November 23 and 24, 2006

Canadian Space Agency - Longueuil, Quebec

To support planning for Canada's participation in future space astronomy missions by developing science priorities and generating ideas for future space instruments and missions, the **Canadian Space Agency will host the first Canadian Space Astronomy Workshop (CSAW)** on Thursday and Friday, November 23 and 24, 2006, at the John H. Chapman Space Centre in Longueuil, Quebec.

Recent successes for Canadian contributions to international satellite missions such as ODIN, VSOP, and FUSE, and balloon-borne experiments such as BLAST, and Canada's own astronomy satellite, the highly

Atelier canadien sur l'astronomie spatiale (CSAW)

Les 23 et 24 novembre 2006

Agence spatiale canadienne - Longueuil (Québec)

Pour mieux planifier la participation du Canada aux futures missions d'astronomie spatiale, tout en stimulant l'établissement des priorités scientifiques et la création d'idées qui autoriseront les futures missions et instruments spatiaux, l'**Agence spatiale canadienne organisera le premier Atelier canadien sur l'astronomie spatiale (CSAW)** les 23 et 24 novembre 2006, au Centre spatial John H. Chapman, à Longueuil, au Québec.

L'exploitation de MOST (le très fructueux télescope canadien d'astronomie spatiale) et la participation du

successful MOST telescope, have made this a fertile period in space astronomy in Canada . **The future promises to be just as exciting**, with guaranteed access to international space observatories such as JWST, Herschel, Planck, and ASTROSAT through active participation by Canadian astronomers and industry partners.

Those in the research community, **academia, industry, government and other interested groups are welcome to attend**, and some financial assistance is available for students. Details about the **call for ideas and posters** will be announced shortly and updated information about the workshop can be found at www.space.gc.ca/CSAW.

See you there!

Canada à diverses missions satellitaires internationales (comme ODIN, VSOP et FUSE) et au projet BLAST (expériences emportées par ballon), sont autant de facteurs qui contribuent à la pleine éclosion de l'astronomie spatiale au Canada. **L'avenir s'annonce tout aussi palpitant**, puisque le Canada s'est assuré d'un accès à diverses plateformes spatiales internationales, dont les observatoires JWST, Herschel, Planck et ASTROSAT, grâce, notamment, à la participation active d'astronomes canadiens et de partenaires industriels.

L'invitation est donc lancée aux membres des milieux de la recherche, **de la communauté académique, de l'industrie et du gouvernement, ainsi qu'aux autres groupes intéressés**. Un appui financier est également disponible pour les étudiants. Les détails relatifs à **l'appel d'idées et d'affiches** seront annoncés sous peu. Pour de plus amples informations sur l'atelier, cliquez sur l'hyperlien suivant : <http://www.espace.gc.ca/csaw-fr>.

Au plaisir de vous y rencontrer!

In The Classroom

[Wake Up! - Experiential Learning in the Classroom](#) by Heather R. (Scott) Theijsmeijer

[Astronomy Education and Outreach in Canada](#) by John Percy

Wake Up! - Experiential Learning in the Classroom

by Heather Theijsmeijer

I recently attended a conference for Physics teachers, and was treated to a presentation by the tag-team duo of Ben Newling and Dennis Tokaryk from the University of New Brunswick and Atlantic Canada Association of Science Educators. After a morning of talks on the latest advancements in medical physics and the applications of biophotonics, their workshop stood out: within the first five minutes the speakers had us all standing up, running around the room and demonstrating vectors with our arms. It was silly, a little bit tiring, and a good eye opener for those of us who hadn't thought about "what is a vector?" in a very long time.

The activity, and the rest of the talk, focused on *experiential learning* – basically learning by doing. While in the past, this has often meant "learning through experience" (performing a lab, in order to see a concept at work in a contrived setting), the term has recently come to mean any kind of learning which occurs by physically doing something.

Developed initially by Dr. David Kolb in the early 1980s, the learning process can be divided into four sections, taught in any order, with one leading directly into the other: *active experimentation*, *concrete experience*, *reflective observation* and *abstract conceptualization*. From an educational psychologist's point of view, this cycle is ideal in the sense that it exercises both the left (logical, symbolic) and right (intuitive, concrete) sides of the brain, as well as teaches to the kinesthetic and tactile learners in the class. It also provides a framework for how the material learned in class can be applied in the real world.

For educators, it gives you a chance to be creative in the classroom, and shift the onus of learning on to the students. This also means giving up a bit of control, and letting the students run the show for a bit. While you may not wish to leave all the learning in the hands of your students, a task designed with experiential learning in mind provides a good break from the typical routine of your class.

Some examples of experiential learning activities are included below. You may find that you already use some of these in your courses. Try taking it a step further and experiment with your students to see what works best – you yourself will then also be learning by doing!

- **Performing Labs:** Given a set of equipment and a series of instructions, demonstrate a previously-known law or result. This is one of the more basic applications of Experiential Learning
- **Designing Labs:** This takes labs one step further. Using a particular set of equipment,

have your students demonstrate a previously-known law or result. The catch? They have to come up with the procedure themselves and the level of accuracy needed. They then experiment with the lab until it works.

- **Active and Original Research:** Have your students answer an open-ended question, which may or may not have a correct answer. Decision making exercises
- **Debating and Role Playing:** Give the students an issue and have groups debate both sides. Sometimes forcing them to argue for the side they do not agree with is an even more valuable experience
- **Game Shows:** A game show style of lesson has students competing, communicating their knowledge and taking risks in the best interest of their team. Definitely not an everyday activity, but this one certainly breaks up the routine. Try Jeopardy!, Pictionary, Hollywood Squares or any of your favourites.

These types of activities will keep students interested in your courses, engaged with the material and provide them with experiences which they will remember. The skills developed in this way will not only help them as students, but will also encourage them to continue on into astronomy or astrophysical research.

For more information on experiential learning, visit the following websites:

- An overview: <http://www.agelesslearner.com/intros/experiential.html>
- David A. Kolb on Experiential Learning: <http://www.infed.org/biblio/b-explrn.htm>
- Experiential Learning in Astronomy: <http://www.astro.washington.edu/dept/selfstudy/node52.html>

Astronomy Education and Outreach in Canada 2002.5 - 2006.0

John R. Percy University of Toronto
Chair: CASCA Education and Outreach Committee

Overview

The Royal Astronomical Society of Canada (RASC) is primarily aimed at non-professionals; it has more than 4500 members from all walks of life, and publishes a bi-monthly journal. Most professional astronomers and graduate students in Canada belong to the Canadian Astronomical Society (CASCA), which has over 500 members. The Canadian professional astronomical community undertook a major planning exercise in 1999, and this was comprehensively reviewed in 2004. Education and outreach were key aspects of the plan and the review. One of the

recommendations of that plan was that 1 percent of the budget of Canada's major astronomical facilities should be devoted to education and outreach, and we are pursuing that goal. Unlike in the US, where there are science education funds available through NSF, NASA, and other sources, there are few Canadian agencies which support science education and outreach. One is the *PromoScience* program of the Natural Sciences and Engineering Research Council of Canada (NSERC). CASCA, the RASC, and some local institutions have obtained support from that source.

CASCA embarked on a major education and outreach initiative in 2001, and this has continued. This includes a professionally-designed, bilingual education website <http://www.cascaeducation.ca> which is maintained by a part-time education coordinator who is a high school teacher, and can identify or produce useful content. This website includes a variety of useful, relevant material for teachers, students, amateur astronomers, and the general public. One feature is the *Canadian Junior Astronomy Program*, which provides different levels of engaging extra-curricular activities for young people, anywhere there is Internet access. In an effort to monitor local needs, CASCA convened meetings of the local "astronomical communities" in Victoria BC and Halifax NS. There are formal or informal networks around most of the astronomy centres in Canada.

CASCA has recently begun planning for the next phase of its education and outreach initiative -- a "virtual" outreach program. It will provide high-quality information, images, and graphics for the mass media, and for those many professional and amateur astronomers who give presentations in courses and for the general public. Through a website *AstronomyCanada*, it will make this material freely available, including to schools, and the public.

Articles on astronomy education and outreach in Canada are published in CASCA's quarterly newsletter *E-Cass* www.casca.ca/Links/Newsletter.php and in the Education Notes column in the *Journal of the RASC* www.rasc.ca/journal/journal.html

Education sessions, including plenary speakers, are part of CASCA's annual conference.

Elementary and Secondary School

Astronomy is typically taught in grades 1 (age 6), 6 (age 11), 9 (age 14) and 12 (age 17), though the curriculum differs from province to province. CASCA's education website is particularly useful for grade 6 and 9 teachers. *Skyways*, an excellent guide for teachers, was written by Mary Lou Whitehorne and published by the RASC. *Skyways* was professionally translated into French (and updated in the process) in late 2005, with support from NSERC. Teachers' workshops are now held

in conjunction with CASCA's annual conferences; the 2005 workshop was so popular that it was repeated on two consecutive days.

Undergraduate and Graduate Education

A number of Canadian universities offer graduate education in astronomy: the Universities of Victoria, British Columbia (in Vancouver), Alberta (in Edmonton), Calgary, Manitoba (in Winnipeg), Western Ontario (in London), Waterloo, McMaster (in Hamilton), York (in Toronto), Toronto, Queen's (in Kingston), Montreal, McGill (in Montreal), Laval (in Quebec City), and St. Mary's (in Halifax). CASCA has an active Graduate Student Committee, with representatives from each university. It organizes meetings and workshops, and advocates on behalf of graduate students. Across the country, graduate students have a great interest in education and outreach, and make significant contributions at their institutions. An article on graduate education in astronomy in Canada was published in the 29 August 2003 issue of *Science NextWave* (now ScienceCareers.org) which is available on-line.

Almost every university offers a course in Introductory Astronomy, usually designed for non-science students, or for a general audience. Several of Canada's community colleges -- which specialize in high-level technical and vocational education -- also offer astronomy courses as part of their Liberal Studies program. Some universities offer courses for science students, and a few offer complete programs in astronomy, or astronomy and physics. CASCA's education website includes a section on effective teaching at the post-secondary level.

Observatories and Planetaria

There are major planetaria in Vancouver, Calgary, Edmonton, Winnipeg, and Montreal, in addition to several smaller facilities across the country. They report regularly in the CASCA on-line newsletter *E-Cass*. Regrettably, there is no major planetarium in Toronto after the closing of the McLaughlin Planetarium in 1995, though the Ontario Science Centre in Toronto has astronomy exhibits and programs, and has several astronomers on staff. Supported by Heritage Canada, the five major planetaria have collaborated in producing shows on *Origins* and on

Astrobiology. More than 50,000 people viewed the *Origins* show, within a few months. More than 800,000 people visit Canadian planetariums each year. There is a Planetarium Association of Canada, and also a Canadian Association of Science Centres.

The National Research Council (NRC) Dominion Astrophysical Observatory, in Victoria, opened a visitor centre "Centre of the Universe" in 2001, which has diverse, popular programs, including a small planetarium, and interactive exhibits. The adjacent 1.8m telescope plays an important role in programming and, thanks to volunteers, is open for sky viewing on many summer nights.

There is also a visitor centre at the Dominion Radio Astrophysical Observatory in Penticton BC, which attracts almost 10,000 visitors a year. It has exhibits, presentations, and an annual open house; it also provides resources for schools and communities in the area, and produces a weekly newspaper column (by Ken Tapping) that is widely read.

Since mid-2003 NRC-HIA has made these popular weekly articles on astronomy available in both official languages on both the main NRC web site and on HIA's; see http://hia-ihc.nrc-cnrc.gc.ca/spot/skygazing_e.html or http://www.nrc-cnrc.gc.ca/randd/education/astronomy_e.html.

In 1999-2000 NRC's Margaret Kennedy, Stephanie Côté and Jim Hesser prepared in collaboration with *Teach* magazine a large, bilingual poster, *Canadian Skies*, with activities linked to science curricula across Canada that has been distributed to thousands of schools. In March 2004 *Canadian Skies* and its associated educational activities were made available on NRC's web site: http://www.nrc-cnrc.gc.ca/education/canadianskies_e.shtml.

In late 2005, it was revised and updated.

NRC's Creative Services and HIA-CU partnered with Heritage Canada's Virtual Museum Project involving 18 organizations in Australia, Canada and the U.S. to produce the bilingual website, "Cosmic Quest: Discovering Astronomy through Science and Culture". This site went public in early 2004 and may be found at:

<http://www.virtualmuseum.ca/Exhibitions/Cosmos/english/rover/>

Canada 's off-shore facilities that are partially funded by NRC contributions have increased their E/PO activities, as described on their web sites:

- Gemini (<http://www.gemini.edu/public/>),
- CFHT (<http://www.cfht.hawaii.edu/Outreach/outreach.html>)and
- JCMT (<http://outreach.jach.hawaii.edu/>).

These include *HOKU*, an on-lineastronomy newsletter begun in 2001 by CFHT personnel for educators and parents. The production by the Gemini E/PO staff, and distribution by the Canadian Gemini Office, of Gemini virtual tours on CD-ROM (also available as an interactive exhibit at CU), and the beautiful CFHT calendars and posters are also notable.

Amateur Astronomy

The RASC has 27 Centres across the country, and over 4500 members. This reflects the continuing popularity of astronomy in Canada . There are also over 60 independent clubs. Among other things, they organize over 20 major star parties, including StarFest, in Ontario, which attracts up to 1000 participants. The Federation des Astronomes Amateurs du Québec (<http://www2.globetrotter.net/faaq/>)

is a consortium of over 30 clubs, with over 1400 members, in the province of Québec. The RASC publishes the *Journal of the RASC* which, for many years, has

sought a balance between the needs of its largely non-professional readers, and its aim to also provide a forum for Canadian astronomy at large.

Public Education and Outreach

Almost every university astronomy group has programs for the public, including lectures and observatory tours. The University of Toronto's Department of Astronomy and Astrophysics celebrated its 100th birthday by organizing a series of four major public lectures, attended by over 4000 people. The University of Western Ontario has received funding to create an in-depth outreach program that will operate all year CASCA has continued its CASCA-Westar Visiting Lecture Program, which sends experienced astronomer-educators to smaller centres which do not have local astronomy resources. Two visits were to First-Nations (aboriginal) communities.

The RASC has an extensive and varied program of public education which reaches over 100,000 Canadians annually, through a wide variety of programs, many of them in partnership with other local organizations. The RASC was the 2003 winner of NSERC's *Michael Smith Award* for excellence in science outreach.

Astronomy is also well-represented in the Canadian news media. The achievements of Canadian astronomers are well reported (in two recent surveys, Canada ranked #1 in the world in astronomy research productivity). Terence Dickinson and Dan Falk are known for their books and articles, and *SkyNews* magazine, edited by Terence Dickinson, provides high-quality articles and images for those with a special interest in astronomy. *Discovery Channel Canada* regularly covers astronomical and space topics, with some emphasis on those involving Canadians. It appears that the number of Canadian newspapers now having star charts and other astronomical information has declined somewhat, after a long history of successful astronomy outreach through this medium. A speculation that modern, largely urban Canadians are losing contact with the night skies, likely due to not being able to see them properly, is perhaps borne out by news stories about the amazing sights to be seen during an electricity blackout in August 2003 -- the largest such blackout in North American history.

The International Dark-Sky Association has chapters and individual members active in Canada , and several Dark Sky Preserves have been established.

In 2004, the late Helen Sawyer Hogg, founding president of CASCA and a leader in public education in astronomy, was inducted into the Canadian Science and Technology Hall of Fame.

Many of the most successful public programs are local partnerships of the "astronomical community" -- professional and amateur astronomers, planetariums and science centres, and school teachers. CASCA, along with these partners, has begun planning for the 2009 International Year of Astronomy.