A C U R A BULLETIN

Bulletin no.2, March 2008

The Circuitous Road to TMT in Canada

Canadian astronomers have been expert users of large optical telescopes since the 1917 inauguration of the Dominion Astrophysical Observatory (DAO) 72-inch reflector, then the largest in the world. When the University of Toronto David Dunlap Observatory 74-inch telescope was commissioned in 1935, two of the four largest telescopes in the world were in Canada (and two in the U.S.A.).

During the long 1935-1975 lull in major Canadian facility development, punctuated by the demise of a number of projects, observational optical astronomy relied extensively on Canadian access to facilities generously provided by U.S. observatories. In September 1979 the 3.6-m Canada-France-Hawai'i Telescope was inaugurated on Mauna Kea. Canada, through NRC, again owed an important share (42.5%) of a large telescope that was to become the most powerful 4-m class instrument in the world, thanks to the quality of its 4 200 m altitude site. The CFHT has had a tremendous impact on the vitality of Canadian astronomy. It also helped Canadian astronomers to rediscover important truths:

- a united community can achieve great things
- access to world-class facilities leads to world leadership
- world-class facilities require international partnerships
- a major share of a great project is a potent motivator.

When the 8-to-10-m "New Generation Telescopes" era opened in the 1990s, Canadian astronomers argued for a 25% share of the two 8-m telescopes of the Gemini Observatory. But NRC at that time could only secure 15%. New technologies allow such telescopes to be built at real costs similar to those of the 4-m instruments of the 1970s. Between 1975 and 2005, the real GDP of developed countries increased by a factor of ~2.5. Thus, whereas there had been eight 4-m class telescopes built in the 70s there are now thirteen 8-to-10-m telescopes in operation.

Much larger extremely large telescopes (ELTs) are now technically feasible. Participation in such facilities is given high priority in (1) the 1999 Canadian Long Range Plan for Astronomy and Astrophysics, (2) the 2000 U.S. Decadal Review Committee Report and (3) the European seventh Framework Program (FP7). Hence projects arose for the Canadian 20-m Very Large Optical Telescope (VLOT), the 22-m Giant Magellan Telescope (GMT, Carnegie Observatories and partner universities in the US and Australia), the 30-m California Extremely Large Telescope (CELT, Caltech and University of California), the US Association of Universities for Research in Astronomy (AURA) 30-m Giant Segmented Mirror Telescope (GSMT), the Swedish Euro-50 telescope and the European Southern Observatory (ESO) 100-m OverWhelmingly Large (OWL) telescope.

The A|C|U|R|A Bulletin aims at providing a report of activities to member institutions, for the information of members and decision makers and to facilitate the task of administrators supporting ACURA projects in various forums.

The Bulletin appears at the equinoxes and winter solstice.
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IN THIS ISSUE

Four of the large optical observatories that will have marked the history of Canadian astronomy shown at the same scale. They house the Dominion Astrophysical Observatory 1.8-m telescope (1917), the 3.6-m Canada-France-Hawai'i Telescope (1979), one of the Gemini Observatory twin 8-m telescopes (2000) and the Thirty Meter Telescope (2016).

In Canada, a working group formed under the leadership of University of Toronto astronomer Ray Carlberg. In 2001, a $150 000 Collaborative Research Opportunity award was granted by NSERC for in-depth examinations of all ongoing ELT projects and early partnership discussions with their proponents. The Carlberg study resulted in the goal being set in 2003 to join the CELT project as a "second to none partner". The project was the furthest ahead. The commonality of scientific interests and complementarities of technological expertises meshed nicely. At a meeting between ACURA, Caltech, UC and AURA representatives in June 2003, an understanding was reached whereby the VLOT, GSMT and CELT efforts would be combined and each of the four partners would seek funding for 25% of a 30-m telescope - nominally CELT- cost, estimated at $700 million US of 2003. The partners also agreed that one of the major elements to be provided by ACURA would be the telescope enclosure, Canadian industry having established itself as world leader in the field.

World-Class Optical Telescopes with Canadian Shares

Telescope	First Light	Canadian %
DAO 1.8-m	1917	100
DDO 1.9-m	1935	100
CFHT 3.6-m	1979	42.5
Gemini North 8-m	2000	15
Gemini South 8-m	2002	15
TMT 30-m	2016	25 (goal)

Fifteen ACURA universities then submitted a proposal to the Canada Foundation for Innovation for a $125 million contribution to the project, the University of Toronto acting as lead institution. An international review committee rated the project as "one Canada cannot afford not to join". In 2004, the CFI granted a $4M interim award which, with matching contributions of $2 million from each of Ontario and British Columbia and $4 million from NRC/HIA, allowed ACURA to become a partner in the US$80 million telescope detailed design study (DDP).

The Canadian effort was still short approximately $7M of providing the 25% share of the DDP funding. To fill this gap, the collaboration turned to the NSERC Special Research Opportunity (SRO) Program in 2006, requesting $6M from NSERC with three of the ACURA universities committing to an additional $0.5M. NSERC granted the award in January 2007.

It had taken four years of efforts and contributions from three federal agencies, two provincial innovation funds and three universities to secure $20 million for ACURA's share of the six-year design study cost.

A formal agreement between the four partners, covering the DDP phase, was drafted in 2006, the CELT Telescope being renamed the Thirty Meter Telescope (TMT). ACURA was now a 25% partner in the TMT, which is an incorporated entity with ACURA having three seats on the twelve-member Board of Directors.

In October 2006, the US National Science Foundation asked AURA, its operator of national optical astronomy facilities, "to withdraw from the TMT and GMT partnerships to act as the Program Manager for the US GSMT technology development effort" and to help conduct an evaluation of the relative merits of the two U.S. ELT projects, TMT and GMT. The TMT agreement was modified to suit the new three-partner situation. Caltech and UC approached the Moore Foundation for a financial contribution toward the TMT design study that NSF/AURA was originally expected to provide. The Foundation agreed in October 2007. The TMT Board's Strategy Group explored the interest of Japan in joining the TMT partnership. The National Astronomical Observatory of Japan (NAOJ) consulted its advisory committee who voiced strong support. Japan now has observer status on the TMT Board.

The TMT design study is now fully funded to its March 2009 completion. At that time, construction could begin as soon as full funding for the project is identified. The partners have to secure an additional $750M in as-spent funds from existing or new partners, as well as to develop a funding plan for the subsequent operation. First light could be as soon as 2016. Two sites remain possible: Cerro Armazones in northern Chile or Mauna Kea, Hawai'i.

MOORE FOUNDATION AWARDS $200 MILLION TO TMT

December 10, 2007

The Board of Management of the Gordon and Betty Moore Foundation announced its decision today to make a $200 million leadership gift to the California Institute of Technology and the University of California to build the $750 million Thirty Meter Telescope (TMT).

Caltech and UC together will contribute an additional $100 million. Other project partners are challenged to raise the rest of the money.

GORDON AND BETTY MOORE FOUNDATION *Creating positive outcomes for future generations*

The generous Moore Foundation award includes a $30 million unrestricted contribution, the rest being contingent on partner contributions. This could allow construction to start before full financial commitments are secured by the other TMT partners. ACURA members will ask the Canada Foundation for Innovation to contribute some $60 million which, with matching funds, would provide at least $150 million over three years. The Moore Foundation – and NAOJ – needs TMT examining in detail possible appeasements to local controversies surrounding the Mauna Kea site option. This may affect the start of TMT construction.

The Innovation Pathway to the SKA

Advances in astronomy are intimately linked to technological innovation. Since it inception and growth as a result of intense technological development in radar during the 1940's, radio astronomy has been a major stimulus to the growth of astronomical knowledge. Four of the five Nobel Prizes in astrophysics arise from discoveries at radio wavelengths associated with new sensor technology: the discovery of pulsars, the invention of radio interferometry and aperture synthesis, the discovery of the Cosmic Microwave Background relic radiation from the Big Bang, and the direct confirmation of a prediction of Einstein's theory of General Relativity using a radio pulsar binary system. The success of observations at radio wavelengths in probing the universe is partly due to the penetrating power of radio radiation to reveal phenomena in the universe that would otherwise be hidden and to Nature's propensity to generate radio waves almost everywhere. But the overriding lesson of the past decades is that advances in radio astronomy and telecommunications technology march in step; the scientific quest driving technology innovation, and advances in the telecommunications, computing and electronics allowing ever more powerful telescopes to be designed and constructed, thereby advancing the frontiers of human knowledge of the cosmos.

The Square Kilometre Array (SKA) carries on this tradition of innovation. The SKA is a global project to design and build a next generation radio telescope. The SKA will be one of the largest scientific projects ever undertaken. It is a machine designed to answer some of the big questions of our time: what is Dark Energy? What is the nature of dark matter? Was Einstein right about gravity? Can we detect gravitational waves? When and how did the first stars and galaxies form? What was the origin of cosmic magnetism? How do Earth-like planets form? Is there life, intelligent or otherwise, elsewhere in the Universe? The SKA will have a collecting area of up to one million square metres, with a central collecting area the size of 200 football fields and a surrounding grid of radio antennas extending to distances of several thousands of kilometres (see images next page). Using innovative design based on recent advances in information and communications technology, the SKA will image the sky 10,000 times faster and deeper than the biggest radio telescopes currently available.

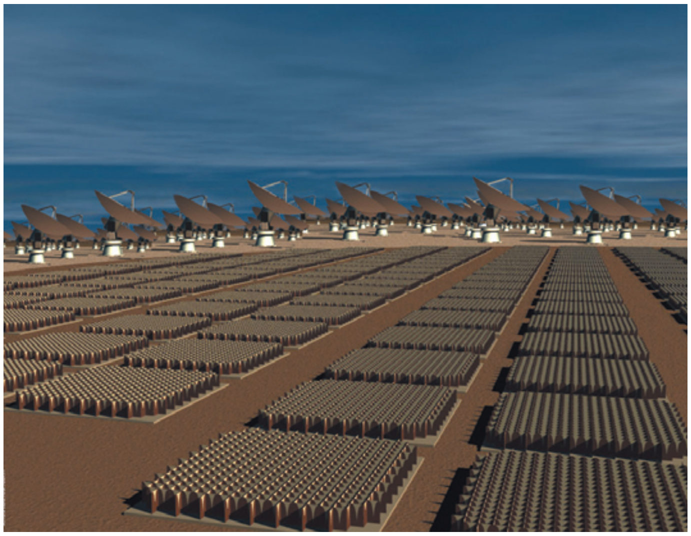
The SKA was initiated as a global enterprise with Canada playing a leading role. The concept was born within the Large Telescope Working Group of the International Union of Radio Science in 1993. It was developed further as an international collaboration at a workshop in Penticton, Canada in 1994,organized by the CASCA Radio Astronomy Committee. A subsequent report written by the Seaquist committee in 1996 titled "Canadian Radio Astronomy in the 21st Century: The Challenge", identified the SKA as one of the most promising directions for the future of Canadian radio astronomy. In 1997, eight institutions from six countries (Australia, Canada, China, India, the Netherlands, and the U.S.A.) signed a Memorandum of Agreement to "Cooperate in a Technology Study Program Leading to a Future Very Large Radio Telescope". An international SKA science meeting held in Calgary in 1998 articulated the science goals of the SKA and resulted in the first SKA science case edited by Russ Taylor (U Calgary) and Rob Braun (ASTRON, Netherlands) in 1999. In 1999 Russ Taylor was appointed SKA International Project Scientist. By August 2000 the international consortium had grown to include eleven countries who signed an MOU to establish the International SKA Steering Committee (ISSC). Russ Taylor was appointed the initial Executive Secretary of the ISSC and together with Peter Dewdney from NRC represented Canadian interests in the SKA. The Canadian Long Range Plan for astronomy in 1999 and its mid-term review in 2005 identified the SKA as one of the highest priority astronomy projects in Canada for the post-2010 era.

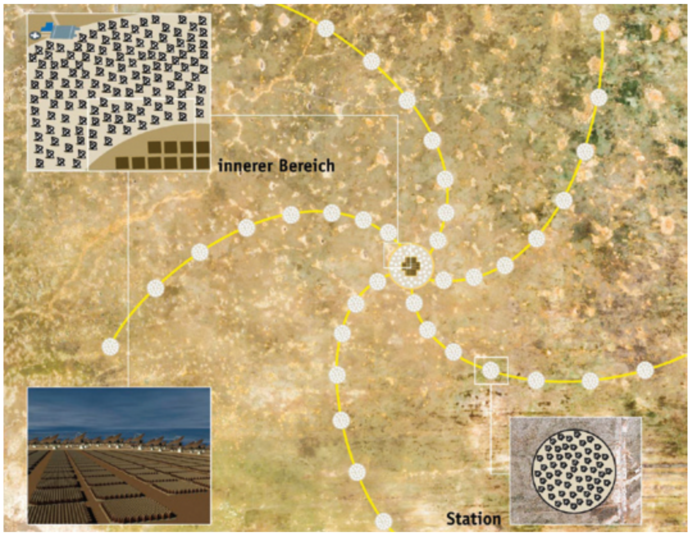
Today the international SKA project involves more than 50 institutions in 17 countries and over $300M is being spent in the next five years on technology R&D, site development, and construction of prototype telescopes. The European Strategy Forum on Research Initiatives (ESFRI) Roadmap for Research Infrastructures[1] lists the SKA as the next generation radio telescope for Europe. The European Commission has funded a four-year Preparatory Phase program for the SKA with work packages totalling €22.2 M. This PrepSKA program is coordinated by the United Kingdom Science and Technologies Facilities Council, and includes seven major work packages with participation from the international SKA collaboration, including Canada. The US 2000 Decadal Review on astronomy identified R&D for the SKA as a national priority for this decade. The National Science Foundation has funded a $12M, five-year SKA Technology Development Program with Canada as a major partner.

In 2006 the ISSC short-listed Western Australia and South Africa as potential sites for the central core of the SKA. Pathfinder telescopes are under construction at both sites at a cost of over $100M each, and construction of the full SKA is targeted to begin at the selected site in 2014 for completion by 2020 at a cost of €1.5 B.

Canadian participation in the international project and the Canadian SKA program is coordinated by the Canadian SKA Consortium Board, which has representation from ACURA, the National Research Council and participating industries. Russ Taylor serves as the chair. The Canadian SKA Consortium requires $30M for 2008-2012 to maintain a 10% partnership in the SKA. The funds will facilitate technology R&D and science planning at ACURA universities (Calgary, McGill, UBC, Victoria, and York) and at the NRC Herzberg Institute of Astrophysics as part of the international PrepSKA program. These partners have demonstrated world-leading technology innovations in the area of advanced materials radio antennas, ultra-low noise radio frequency amplifiers, and new-technology, wide-area imaging radio receivers that are key innovations needed to enable the SKA. The Canadian technologies will be deployed on the SKA prototype pathfinder telescope at the proposed SKA site in Western Australia.

1. Office for Official Publications of the European Communities, 2006, IBN 92-79-02694-1, (http://cordis.europa.eu/esfri)





Left: a computer rendered image of a portion of the central collecting area (inner core) of the SKA. The SKA will consist of tens of thousands of radio antenna equipped with new-technology receivers to instantaneously image large volumes of the universe. This image represents only a small part of the entire SKA, shown on the right. Outside of the central core SKA several SKA "stations", each an array of hundreds of antennas, will extend to distances of three thousand kilometres. The entire array will be linked by ultra-high speed optical fibre communications to bring the data from each antenna to a central supercomputer.

WHAT'S IN A NAME?

That which we call a Rose,
By any other word, will smell as sweet
Romeo and Juliet, Act 2, Scene 2

A department with an astronomy group cannot be told by its aroma alone, like a rose can, or a chemistry lab! Its name must announce it for it to be known. Astronomy is a discipline with strong appeal. Advertising its presence can be beneficial to the department.

There are 49 Canadian universities granting graduate degrees in physics[1], 23 of which being engaged in astronomy. Sixteen of the latter have modified the name of their physics department over the last twenty years. In 15 of the 16 cases, it is the word **Astronomy** that has been added to **Physics**[2]. A small survey of these departments was carried out to find out why the word was added and if any objection had to be surmounted. It revealed that the agreement of the « non astros » in these departments was generally easily obtained and that the main and often only objective was to increase the visibility of the *department*: Visibility to students, to decision makers, to scientific communities and to the public.

A benefit generally expected is increasing student enrolment. How well has that been achieved? The Table compares the 1998-2007 evolution rates of student populations engaged in astro[3] according to whether or not the departments have added « **astro** » to their name. Figures in brackets are the number of individuals in 2007. Toronto, UBC and Western are excluded, their « **astro** » names pre-dating ~1990. McGill is also excluded because it had no astronomy program before the year 2000.

The growth of the undergraduate enrolment has been more positive in departments with « **astro** » than in those without « **astro** » (20% vs 8% per year). In a few cases it has been possible to verify that the global growth of undergraduate enrolment has been slower than that of the « **astro** » enrolment. For graduate students, the growths are similar in « **astro** » and without « **astro** » departments. An interpretation is that « **astro** » attracts students interested in astronomy to the departments but that many later switch to other disciplines or to other establishments for graduate studies. Likewise, many graduate students come from other establishments.

Mean Annual Growth of Populations Engaged in Astronomy

Department name	Undergrad.	Graduate
with astro (11)	**+20%** (63)	**+ 6%** (108)
without astro (7)	**+ 8%** (34)	**+ 7%** (67)

1. www.cap.ca/edu/physdept.html
2. Laval added **optique** to **physique et génie physique**
3. According to the 1999, 2004 and 2008 ACURA surveys of undergraduates involved in astronomy projects.

January 2008 Board Actions

At its 23 January, 2008 meeting at the Vancouver Airport Fairmont Hotel, the ACURA Board of Management

- Welcomed new members Edwin Bourget, VR Recherche-création, Laval, Rose Goldstein, VP Research, Calgary and Ted Hewitt, VP Research and International, Western Ontario
- Recognized outgoing past-Chairman Don Brooks for his services since the creation of ACURA in 2004
- Recommended the approval by Council of the financial statements examinations for FY 2006 and FY 2007
- Outlined the terms of agreements that must bind Coalition partners for ACURA to manage the Coalition account
- Endorsed member institutions preparing a Letter of Intent to the CFI for the funding of the TMT construction
- Endorsed member institutions preparing a request to the NSERC SRO program in support of their contribution to SKA
- Asserted that the Agency Committee on Canadian Astronomy should discuss forthcoming funding initiatives
- Decided that ACURA must revert to dialogs with all organisations planning ELT projects, notably AURA
- Recommended that developing the next LRP be started as soon as possible by all organisations concerned
- Recommended the re-appointment of the Executive Director for a second three-year term ending on 17 May, 2011.

ACCA: an Update

The formation of the Agency Committee on Canadian Astronomy was proposed by the Coalition for Canadian Astronomy in December 2006. The goal was to assist planning and coordinated funding by all the partners responsible for various elements of the LRP: NRC, NSERC, CSA, CFI, Industry Canada, HIA, ACURA and CASCA. NRC President Coulombe agreed to take the lead and invited agencies to appoint representative. The first ACCA meeting, chaired by Dr. Coulombe, took place on September 10, 2007 and allowed members to discuss the Committee's role. The Minutes of that meeting are not available yet. The possibility of ACURA being invited at the next ACCA meeting, scheduled for April 3, 2008, was discussed.

Since then, a number of items, some time sensitive, have accumulated that could populate the ACCA agenda:

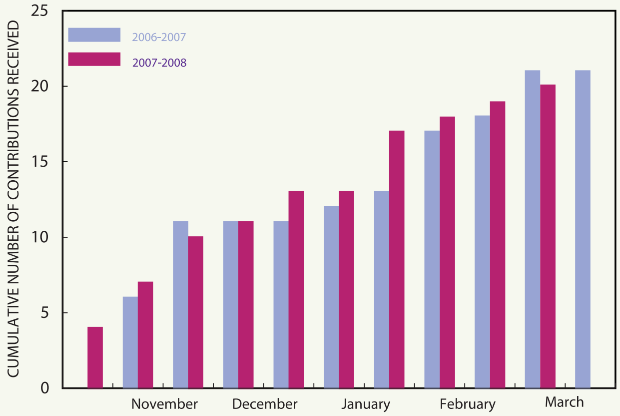
- An ACURA-NRC Agreement on mutual collaboration in astronomy;
- Funding for the TMT construction following the Moore Foundation award;
- A forthcoming NSERC SRO request to support to the SKA effort in Canada and complement resources requested in the Astronomy MC submitted by NRC;
- Envelop funding for astronomy and astrophysics in the NSERC funding process and
- Initiation of a new astronomy Long Range Plan.

The Protracted Trickle of Member Dues

It takes five months to receive all the membership dues assessed to the 21 ACURA member universities.

The bar graph illustrates the trickles for FY 2006-07 and 2007-08. Invoices are mailed to member representatives in mid-October. About half the contributions arrive before the Holidays pause. In early January, reminders are e-mailed to delinquents. Some members are candid enough to apologetically explain the delay – oversight, misfiled, 'stuck in the system', etc. – but it is not clear that the reminders alone are responsible for the recovery in the New Year. Maybe things are just like that in some universities.

So far, the protracted trickle of dues has merely led to hopefully avoidable administrative charges for ACURA and not to cash flow problems. But, in January 2008, ACURA took over from CASCA the payment of invoices for services received by the Coalition for Canadian Astronomy. ACURA, CASCA and industry contribute to the Coalition account managed by ACURA for the payment of these invoices. They add up close to the ACURA annual income from membership dues. They did cause cash flow problems for CASCA whose income is half that of ACURA. Prompt contributions to the Coalition account by ACURA members, CASCA and industry will avoid the cost and embarrassment of late payments of invoices.



Astronomers in Canadian Universities

The evolution of the population of astronomers in Canadian universities is an indicator of the vitality of the discipline. Driven by student demand and by the availability of faculty positions and research funds, it reflects the engagement of our establishments in astronomy and the response of granting agencies. This briefly describes the evolution over the last eight years.

In the fall of 1999, the institutions that were to create ACURA compiled their first census of the astronomical research and teaching capacity in all Canadian universities. This was repeated by ACURA in the falls of 2004 and 2007. The surveys have had population completeness of 90%, 92% and 99%. Data for the few universities who did not respond were estimated. The results are summarized in Table 1. Figures in brackets are the annual percent rates of growth with respect to the previous survey. Reid and Matthews 2007 (*Cassiopea* No. 132) obtained similar results from their 2000 and 2005 surveys focussed on gender diversity.

The vitality of the astronomical populations in Canadian universities is remarkable. The annual growth rate for faculty members has been 4.4% since 1999. For PDFs, graduates students and undergraduates involved in research, the rates have averaged 9.5%. In the mean time, the sum of all NSERC grants to astronomy programs grew by 2.0% per year.

The strong increase in the number of adjunct professors between 1999 and 2004 is probably related to retirements during that period. Note that these trends are not much subject to $\sqrt{n}$ noise. They mostly reflect strategic decisions.

These national results can instructively be expressed as ratios and subdivided into regional statistics. Table 2 gives population ratios and their 1999-2007 mean annual growth rates for the four provinces with large contingents.

As a complement, the Figure shows the evolution of the CASCA member populations in Canada since 1992. The data for the American Astronomical Society, normalized to Canada's population is also shown for comparison. CASCA members include faculty members, adjuncts, PDFs, and planetarium and HIA staff. The difficult 1990's led to a low point by the end of the decade. The growth since resulted from the replacement of retired faculty members that began around 2000, facilitated by the new Canada Research Chairs program (CRCs in Table 1) from which astronomy much benefited. It is also no doubt driven by the development of LRP projects. Comparison of the graduate student population for 2007 in Table 1 (270) with the same population in the Figure (158) suggests that the CASCA student membership could be increased (This may also be true for the AAS). In fact, it increases by nearly 20% p.a. since 1999, 13% faster than the graduate enrolment: Students are joining CASCA in growing numbers.

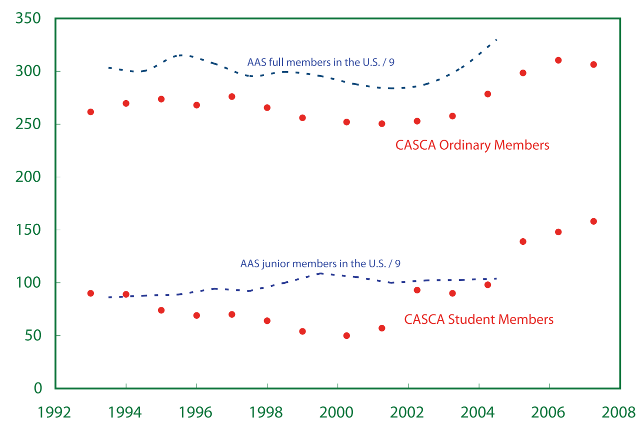


Table 1: Persons Engaged in Astronomy Research and Teaching in Universities and Annual Growths (%)

Epoch	Tenured or tenure stream	CRCs	PDFs	Graduate Students	Undergrad. Research	Adjuncts	Total
Fall 1999	102	0	44	159	63	17	385
Fall 2004	123 (4)	14	80 (13)	224 (7)	96 (9)	44 (21)	567 (8)
Fall 2007	145 (6)	24	92 (5)	270 (6)	155 (17)	43 (-1)	707 (8)

Table 2: 2007 Population Ratios and their 1999-2007 Mean Annual Growths (%)

Province	Faculty per million population	Graduates per million population	Graduate per faculty member	PDF per faculty member
British Columbia	5.3 (3)	9 (6)	1.6 (6)	0.5 (16)
Alberta	4.3 (2)	7 (-1)	1.7 (0)	0.9 (1)
Ontario	4.8 (4)	9 (4)	1.9 (6)	0.8 (9)
Québec	3.2 (5)	10 (10)	3.0 (11)	0.6 (11)

ERRATUM
Bulletin no. 1, Table on p.2: the amount for LOT/TMT should have read 125 instead of 12.5.

Contact Us:

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