Self Study, DAA, Contents

DEPARTMENT OF ASTRONOMY AND ASTROPHYSICS (DAA) SELF STUDY 2009

CONTENTS

Appendix

EXECUTIVE SUMMARY

Astronomy and Astrophysics deals with profound questions, basically how did the Universe evolve and how do stars and planetary systems form. It also allows us to probe Nature in extreme otherwise inaccessible conditions, ranging from the ultra-low densities in intergalactic space to the ultra-high densities in neutron stars and the ultra-high temperatures shortly after the Big Bang. It provides continual reminders of the incompleteness of our understanding, not just of the behaviour of normal matter under extreme conditions, but also of the very nature of the main constituents of our Universe. It is an exciting, thought-provoking, and accessible science of broad appeal, with research and teaching very naturally closely linked.

The excellence and high performance of Canadian Astronomy and Astrophysics is well documented through the ISI country and discipline rankings, which show we are leaders in the G20 and the highest impact science in Canada. Within Canada, the University of Toronto is in a unique and enviable position of leadership, thanks to the century-long programs of the Department of Astronomy and Astrophysics (DAA) and the outstanding success of the Canadian Institute for Theoretical Astrophysics (CITA, 1984). The stimulus provided by the endowment and establishment of the Dunlap Institute for Astronomy and Astrophysics will consolidate and enhance the University's work in astronomy and astrophysics within the top tier internationally and deepen our commitment and contributions to research, teaching, and public outreach.

DAA is one of the smallest departments (9.5 FTE, 6 administrative/technical staff) in the Faculty of Arts and Science. Nevertheless, it has a pre-eminent national and international role in research and in outreach provides one of the more prominent modes of contact between the University of Toronto and the public. This couples with a long tradition of commitment to teaching at all levels. In undergraduate studies there is strength spanning specialist programs to breadth courses. With top professors engaged in the classroom our reach has blossomed to a "head count" of over 3000 students in our courses per annum, to the point that the DAA has the highest student/faculty (FCE/FTE) ratio among the physical and mathematical sciences in the Faculty. Despite the stresses of this success, and on diminishing resources, we are continuing to innovate to bring the latest research to the classroom, to inspire research opportunities, and to provide hands-on, experiential learning to all of these students. Graduate students, many with international backgrounds, are high performers as well and very successful in their subsequent careers. The demand is high and the enrolment is still expanding, standing at 35 pursuing the PhD degree. The Graduate Department, comprising about 20 active research faculty members including appointments at UTM, UTSC, and CITA, is also engaged in postdoctoral training, an essential stage in our discipline. DAA currently hosts eight world-class postdoctoral fellows and postdocs are a mainstay of CITA's high international reputation.

To a great extent, our continued success depends on the development and implementation of national Long Range Plans for the discipline through which hundreds of millions of dollars are invested for the Canadian university community through the Canadian Space Agency (CSA), CFI, NRC, and NSERC, mostly in international ventures. The priorities of DAA are in synergy with this national and international effort, and with this world outlook we are making the most of these opportunities.

The key is to recruit, nurture, and retain high quality personnel, bringing together unique talents in observation, theory, instrumentation, and computation to address the outstanding, perplexing, and far-reaching questions raised by the discipline, and in doing so earn the essential support required from the University and the funding agencies, inspire the next generation of students and researchers, and give back to the community through our extensive outreach programs.

1. INTRODUCTION

1.1 Scope

This report has been prepared to familiarize members of the External Review Committee and subsequent Chair Search Committees with DAA and its programs. The timing coincides not only with the final year of the Chair's second term but also with the beginning of a new Faculty of Arts and Science effort in academic planning. This document was prepared to the extent possible with the involvement of faculty, students, and staff, through departmental meetings, delegation of drafting sections, and a e-mail calls for input and comment on drafts of this document. This Self Study describes and assesses changes that have taken place in the unit and its programs, including faculty complement, undergraduate and graduate programs (enrolments, class sizes and their distribution, the learning environment, etc.), and research. At times reflective, analytical, and self-critical, this evaluative process has attempted to assess the scope and quality of the teaching programs and scholarly activities of the department and the appropriateness of all areas of activity in the unit or program. In doing so it also raises a number of opportunities and real/potential problems of interest and concern to the department.

The DAA web pages www.astro.utoronto.ca are often a primary source of information. Many web entry points within this document are "clickable" when being viewed electronically.

1.2 Brief history

A history of the DAA and DDO can be found at www.astro.utoronto.ca/about/History.

Astronomy and Astrophysics within the University

- University of Toronto founded in 1826. PhD degree introduced in 1897.
- Astronomy and astrophysics emerged under Chant in 1905 with academic program and soon the Department.
- Graduate program expanded under F. Hogg; Department's first PhD awarded 1953.
- Department moved from the old Physics Building to the (then new) McLennan Labs in 1967, firmly establishing the St. George campus base.
- In mid-1960s U of T campuses at Mississauga and Scarborough (UTM and UTSC) opened, in each case bringing new faculty appointments adding to the graduate teaching complement focused at St. George.
- Canadian Institute for Theoretical Astrophysics (CITA www.cita.utoronto.ca) established 1984, a national institute hosted by the UofT.
- Department of Astronomy and Astrophysics (DAA), the largest and most influential such academic unit in Canada, celebrated its centennial in 2007.
- Department expanded to additional space in Astronomy Building in 2006.
- Dunlap Institute for Astronomy and Astrophysics (DI www.di.utoronto.ca) established in 2008 on sale of the David Dunlap Observatory (DDO).

Optical astronomy

- The David Dunlap Observatory (www.astro.utoronto.ca/DDO) opened in 1935. The 1.88-m reflector was second in size in the world only to the 2.5-m reflector on Mount Wilson in CA. Using this foundation, the Observatory and the Department quickly acquired an international reputation as staff pursued three main goals: (a) fundamental research; (b) training of young astronomers; and (c) education of the general public. The emphasis on optical astronomy continues to the present day, though with considerable metamorphosis.

- The 0.6-m UofT Southern Observatory (UTSO) established 1970 at Las Campanas in Chile under an agreement with the Carnegie Institution of Washington. UTSO's Helen Sawyer Hogg Telescope moved in 1998 to the National Observatory of Argentina.
- UofT leadership in establishing national and international facilities: CFHT (1970s), Gemini (1990s), and the TMT (2000s).
- Instrumentation development agreements with the Observatories of the Carnegie Institution of Washington, providing access to the du Pont and Magellan telescopes (2000s).

Expanded scope

- First theorist appointed in 1946, Williamson, a former student of Chandrasekhar's.
- In 1948 Williamson's interests spread to include the new subject of radio astronomy. In 1953 MacRae interested the Department of Electrical Engineering (EE) in collaborating to build a small radio observatory at DDO.
- 46-m antenna at Algonquin Radio Observatory of NRC opened in 1965. Collaboration led by Yen in EE recorded the first VLBI fringes (ARO – DRAO, Penticton) in 1967.
- Exploitation of national and international radio astronomy facilities: VLA, JCMT, synthesis telescope at DRAO, anticipating ALMA and the eventual SKA.
- Multiwavelength astronomy to the fore, with department members using (for example) Einstein, Chandra, and XMM-Newton in the X-ray regime, FUSE and HST in the ultraviolet (and optical), and IRAS and Spitzer in the infrared.
- Current space astronomy: Collaborated in establishing the UofT Space Program (www.research.utoronto.ca/u-of-t-space-program). Sponsored by the Canadian Space Agency, department members active in international teams using MOST, Planck and the Herschel Space Observatory (SPIRE and HIFI), and are planning programs for the JWST (NIRCam and the FGS).
- Instrumentation rejuvenated at St. George campus: Netterfield's Stratospheric Telescope Integration Facility (STIF) opened 2003; optical instrumentation labs established by Moon and Abraham; Mochnacki works closely with the Institute for Aerospace Studies (UTIAS) in the Faculty of Engineering.
- Computing: MacRae introduced (1960s) a new course for our senior students, the first offered in programming and computer usage for undergraduates in FAS. Large scale computing facilities developed subsequently (CITA has specialized in leading edge clusters, DAA on project oriented systems). Most advanced are now in a university-wide collaboration that we helped form, SciNet (www.scinet.utoronto.ca), largest of seven major HPC facilities in Canada.

The curriculum at both the undergraduate and graduate levels has undergone enormous changes over the past century, and in this rapidly changing discipline there are continual changes being made to best meet the needs and aspirations of the students. New methods of teaching, including experiential learning and web-based technology are being introduced. The teaching program is described in Section 3.

Part of our legacy includes faculty who have had formative parts of their career in Toronto and then gone on to other universities or institutes. From the entire faculty list at www.astro.utoronto.ca/about/History#faculty one can note (departures since the late 1950s) Oke, Searle, Demarque, Racine, van den Bergh, McLaren, Madore, and Lilly (also Tremaine, Kaiser and Rafikov from CITA).

There are incidentally 13 minor planets named after University of Toronto astronomy people (www.astro.utoronto.ca/about/asteroids) and one simply called Toronto.

1.2.1 The Dunlap Institute for Astronomy and Astrophysics (DI) www.di.utoronto.ca

The DDO was sold in 2008 and the proceeds invested in an endowment to establish the Dunlap Institute for Astronomy and Astrophysics (DI) as an independent academic unit (EDU B) with its own Director. The DI is under development. It is hoped that ultimately the resources available through the DI, in synergy with the current efforts in DAA and CITA, will elevate Astronomy and Astrophysics activities in the University to a level matched only by the top centres internationally, allowing us to reach otherwise elusive heights as we seek to realize many other priorities. The multi-faceted Institute is expected to assume a prominent leadership position in research, teaching and advanced training, and public outreach. Specific objectives well aligned with those of DAA and highly complementary to those of CITA (also established with DAA leadership) are to:

- create an international centre of research excellence in astronomy and astrophysics
- participate in the development of scientific instrumentation for world-class observatories
- promote interaction and provide leadership to create major national and international research collaborations
- engage in grand computational astrophysics problems
- promote advanced training opportunities for graduate students, postdoctoral fellows, and research associates
- organize and host international workshops and meetings
- provide a primary means for channeling information on astronomy and astrophysics to the general public.

1.3 Scorecard/accomplishments from the *Stepping Up* planning period

In the most previous university-wide planning exercise called *Stepping Up* we established a number of priorities required for DAA to perform to its potential on the international stage, in teaching and research. We stated that "*We are enthusiastically committed to working together to achieve these dreams*" and this hallmark of a congenial Department working together has served us well.

1. creation of the Dunlap Institute for Astronomy and Astrophysics (Dunlap Institute)

✓ DI established as an EDU B in 2008 with major endowment from sale of the David Dunlap Observatory

2. bring together the very best personnel – faculty, postdoctoral fellows, students, and staff – develop each to full potential and unite their talents so as to grapple most effectively with these profound questions

✓ expanded graduate and postdoc programs with targeted fellowships, strong international recruitment

✓ recruited Moon to held-over faculty position

✓ CRC award to Jayawardhana, renewal for Yee

✓ Carlberg and Netterfield, Fellows in the Cosmology and Gravitation program of the Canadian Institute for Advanced Research (CIFAR)
✓ Steacie Fellowships for Abraham, Jayawardhana, Netterfield
🡻 new faculty position awarded for late in planning period, then lost to hiring freeze

3. as the top Department in Canada, continue to lead the development of Canadian astronomy by example, by creating networks, and by specific initiatives
✓ CFHT SNLS, DRAO Planck Deep Fields, BRITE

4. as *one of the most important centers of astronomy in North America,*[1] provide leadership within international partnerships in attacking key astronomical problems
✓ Gemini Deep Deep Survey, RCS 2, SpARCS, BLAST, Herschel, Planck

5. in support of the above, and looking to the future, form partnerships to design and build the major observing facilities required – the 30-m optical telescope our immediate focus
✓ CFI and NSERC grants for Detailed Design Phase of the TMT

6. train expert personnel in designing instrumentation, executing observational campaigns, performing large-scale simulations, scientific analysis of the large data sets, and theory; maximize impact by providing top research opportunities and access to top facilities
✓ nurtured senior undergrad, summer research, graduate students, and postdoc programs

7. renew guaranteed access to a major optical telescope, Magellan being crucial
🡻 Magellan agreement expired; ✓ du Pont agreement expanded

8. establish laboratories for instrumentation and experimental astrophysics
✓ four new laboratories in the basement of the Astronomy Building

9. establish top-tier facilities for computational astrophysics and capitalize on strength in analysis of huge data sets
✓ dedicated cluster for SNLS; collaborated in creation and funding of SciNet

10. consolidate space for astronomy and astrophysics activities on the St. George campus
✓ moved part of Department into AB, the old Nursing Building
🡻 not large enough for whole Department, now split between AB, McLennan Labs, and some rooms over the highbay. Renovations not completed for lack of funding. Separated from CITA.

11. develop and maintain effective links with cognate departments and faculties
✓ participated in FAS Science Chairs monthly meetings; worked across university on Space

12. communicate widely the stunning results of our astronomical research, through our popular and accessible science literacy courses, and multi-faceted public outreach.
✓ expanded enrolment by 50% while at the same time reintroducing tutorials; enhanced tour program orchestrated by the graduate students, involving students, postdocs and faculty; many individual talks to schools, clubs, associations, etc. Huge effort on International Year of Astronomy 2009, including novel efforts with the Dunlap Institute.

---

[1] According to the then most recent international review (May 1999)

Essential collaborations within UofT for which we had high expectations were:

1. Wide-ranging stimulating interactions with CITA: theorists, modelers, observers, experimentalists, and instrumentalists all engaged.

✓ continued as before; ↓ negatively affected by being in separate buildings.

2. Extrasolar planets: DPES/UTSC Centre for Extrasolar and Solar-system Planets, strongly supported by DAA (2 recent complementary hires), CITA, and Physics.

↓ UTSC has not followed through on the hiring plan.

3. Computation – simulation and analysis – with Physics, Chemistry, UTIAS, etc.

✓ established SciNet, the most powerful facility in Canada (3rd among universities in the world).

4. Early Solar system: geochemistry experiments on interplanetary and cometary-return (including interstellar!) dust particles, with Geology.

~ some progress and planning re astrobiology; workshop sponsored by CIFAR

5. TMT: UTIAS and engineering (structural, control, fluid dynamics), Physics (optics, IOS initiative), industry.

✓ TMT detailed design phase has proceeded with university engagement through DAA, but not as far-reaching as should be possible in the future.

6. Advanced shops and fabrication facilities: STIF; development in Dunlap Institute; overlapping technical interests/needs with Physics, Chemistry; Nortel Institute.

~ good relationships with Physics might lead to joint shops with DI; with delay in DI, collaborations with engineering still need to be developed.

7. Nanosatellite (stabilized) for asteroseismology of the 300 brightest stars: jointly with UTIAS and Dynacon, as with MOST.

✓ BRITE developed and to be flown by Austria and perhaps CSA.

2. COMPLEMENT

Information on the faculty members, librarian, and staff members is available at www.astro.utoronto.ca/staff.html. Here we provide the context and introduce some issues of concern.

2.1 Faculty

DAA, one of the smallest departments in the Faculty in terms of the number of faculty, has needed to plan its faculty renewal carefully in order to provide critical mass for research in important areas, whether existing or newly emerging, and to teach burgeoning high-demand academic programs. During the past 10 years, the term of the current chair, DAA has renewed over half of its faculty. We carefully recruited top faculty on the basis of strong teaching and research. The "academic trajectories" of the St. George department's past six hires illustrate their rich international background: UBC, Oxford, HIA, Cambridge; Yale, Harvard, Berkeley, Michigan (F); Harvard, Berkeley, CITA; Seoul, Cornell, Caltech; Amsterdam, Caltech, Cambridge, Utrecht (F); and UTSC/Hefei, Caltech, QMC, CITA. These newer recruits together with existing mid-career strength constitute an invigorated, ambitious, and vibrant DAA.

Together with contemporary hires in CITA and at UTSC we have achieved our goals of (i) consolidating strength in extragalactic astronomy and stellar astrophysics, (ii) developing critical mass in the areas of star formation and extrasolar planets and high energy astrophysics, and (iii) making a deliberate start in the area of astronomical instrumentation (the position awarded in *Stepping Up*, but recently cancelled, was targeted at instrumentation – see Section 2.1.2 below).

Table 2.1 Graduate Faculty complement by academic unit at the beginning of two decades

DAA		CITA		UTM		UTSC	
2000	2010	2000	2010	2000	2010	2000	2010
Bolton	Abraham	Bond	Bond	Lester	Lester	Dyer	Artymowicz
Carlberg	Carlberg	Kofman	Martin	Percy			Dyer
Clarke (0.65)	Jayawardhana	Martin	Murray				Lowman*
Clement, C.	Matzner	Murray	Pen				* planetary physics
Clement, M.	Mochnacki	Pen	Pfeiffer				
Garrison	Moon		Thompson				
Lilly	Netterfield (0.5)						
Mochnacki	van Kerkwijk						
Netterfield (0.5)	Wu						
Seaquist	Yee						
Yee							

Nevertheless, as Table 2.1 shows, the DAA complement is not quite holding steady over the decade in which our undergraduate enrolment has sky-rocketed, graduate expansion has been successfully implemented, and an increasing number of postdocs have being engaged.

As we enter the next decade and planning cycle, there are only 9.5 FTE faculty members in DAA. Statistically, 1/7 of these professors will be on sabbatical research leave at any one time. Thus typically about 8 or 9 FTE faculty are responsible for sustaining the whole range of undergraduate teaching programs on the St. George campus, from specialist degrees to breadth courses, and also the departmental administration. This is lean and very much stretching the capacity.

UTM and UTSC. At the other two campuses, in Mississauga and Scarborough, from the very beginning there is a long tradition supporting astronomy, both at the undergraduate level and taking part in the tri-campus graduate department.

Astronomy begins at UTSC, from JRASC, 58, 183, 1964.

> Dr. Robert Roeder, formerly of the Department of Physics at Queen's University has accepted an appointment as Assistant Professor in the Department of Astronomy here. One of Dr. Roeder's responsibilities will be to initiate courses in astronomy at Scarborough College, the first of the off-campus colleges which will open its doors in September 1965.

There have been two or more FTE astronomy and astrophysics appointments even over decades in which the enrolment was a fraction of what it is now. Given the huge enrolment on these campuses, the FTE should be increasing, but a major issue in the short term at least is to stabilize the existing complement in both astronomy and physics (see Section 6.4).

Graduate complement. In line with University policy, these faculty members come together with DAA, and also CITA, to form the tri-campus Graduate Department of Astronomy and Astrophysics. This tri-campus unit has a Graduate Chair, historically the same person as the DAA chair (and until 2008 the Director of the David Dunlap Observatory). The graduate department comprises about 20 active research faculty members who are responsible for all aspects of graduate instruction. The entire graduate faculty complement, showing rank and research interests, is given in the Appendix, Table A1. It is a small but effective group. Erosion of strength at UTM and UTSC, whether planned or by attrition, would have a significant impact.

The untimely passing of Lev Kofman in CITA, a great intellectual, leader, teacher, and mentor, is a terrible loss that will not be quickly overcome.

There are nine Professors Emeriti with various ranges of engagement including two minor, yet important, contributions to the teaching program.

2.1.1 Issues

(i) With the end of "mandatory retirement" it is impossible to predict retirements or properly plan. However, there is a "normal retirement date" (NRD) based on age 65 that can be noted. In the next seven years, seven members of the graduate faculty will reach their NRD. This is about twice the statistical rate expected for an age distribution spread evenly over the range of a 35-40 year career and reflects the fact that our faculty has not been renewed with enough regularity to keep the mean age from increasing.

(ii) There are no automatic replacements of faculty who retire. There are external pressures which are putting further appointments at UTM and UTSC in jeopardy. A case in point is that Percy has not been replaced, making the situation at UTM particularly dire.

(iii) The DAA *Stepping Up* position was originally scheduled to be filled in the late years of that planning period. Many departments did fill *Stepping Up* positions, but our position and others scheduled late in the planning period ended up being cancelled last spring (2009) even though we have had bridging money to fill it for several years. It really ought to be reinstated in the next academic plan; surely there is no deliberate erasure of institutional memory.

(iv) Because of the introduction of the end of mandatory retirement after some *Stepping Up* positions were filled, some departments have ended up with more faculty members than planned. A new equilibrium has not been reached and, now in a tight budget situation, this locking up of resources has impacted other departments very unequally. DAA has no faculty members beyond their NRD.

(v) One graduate DAA faculty member is female, severely lagging the changing demographics.

2.1.2 Recap of intended faculty renewal in DAA from the last plan (*Stepping Up*)

A top priority is in the area of **instrumentation** ("*persons with the capacity for innovative research and scientific leadership involving astrophysical experimentation and instrumentation*"). Activity in instrumentation and experimental astrophysics is both unifying and enabling. It broadens and deepens student experience. New leadership opportunities are opened up internationally and nationally. Developing expertise in instrumentation is a top priority of the Canadian Long Range Plan (LRP), through establishing advanced university laboratories. In DAA this is building out of missions in STIF (Netterfield), the new optical/near-infrared laboratories in the Astronomy Building (Abraham, Mochnacki, Moon – instrumentation for access to existing large optical telescopes; development of nanosatellites), and work toward the TMT (Carlberg, Moon) and next-generation facilities in space like JWST (Abraham, Martin). This was the top priority position urgently needed to strengthen this pillar, and was approved for a position starting July 2009. Unfortunately it, along with other unfilled *Stepping Up* positions, was first delayed because of budget issues and then chopped in anticipation of a new round of academic planning (even though in DAA the priority has not changed over this period).

Modern telescopes and space missions generate enormous data sets, hitherto unimaginable. With CITA, DAA has developed expertise in processing such data (for the record CFHLS, RCS, EXPLORE; Boomerang, CBI, Boom2k, Planck; BLAST, Herschel/SPIRE, SCUBA2; IRAS, ISO, MSX, Spitzer; MIGA, VGPS, IGPS). This has required new algorithms and significant computing power and disk space and has produced end products of interest to a wider community. This on-going effort is broadening the experience for students, refining expertise and infrastructure to support telescopes and observatories being put in place through the Canadian LRP, and providing a focus on problem-solving common across areas. Combined with the acquisition of top-tier facilities for doing computational astrophysics in SciNet and in house, this speaks to the need for a **computational astrophysicist** for both teaching and research programs.

These identified needs in instrumentation and computation are consistently-held priorities over the last decade, going back to the *Raising Our Sights* plan. Given the research opportunities and demand for our teaching programs this is still a conservative plan.

2.2 Faculty librarian

The Department and DDO have had a librarian since the 1960s. Lee Robbins, our current full-time professional Faculty Librarian, is responsible for the library of the DAA serving the undergraduate and graduate departments, CITA, and DI (see 5.1.4). Historically there was a full-time professional library assistant, but now due to budget pressures there is only occasional part-time student help and internships (students from Information Science).

2.3 Administrative and technical staff

Table 2.2 provides an overview of the DAA staff. The first five are in the base budget. The last position is not in the base budget but is supported with ongoing funding originating in large undergraduate enrolment; therefore, from a budget point of view this is a distinct type of position. The loss of DDO staff and the time needed to develop the DI has reduced support of some DAA activities during the interregnum.

A commentary is provided in Section 6.2 on the various functions/services that one would expect to find and how these are being addressed in our organizational structure.

Table 2.2 DAA Administrative and Technical Staff

Position	Principal Activities	Incumbent
Department Manager	budget and planning; personnel; space; assists chair and graduate/undergraduate coordinators	Angela Choi
Financial Officer	accounting; audit	Gautam Patel
Computing Facilities Manager	support IT for research, teaching, administration	Hugh Zhao
Undergraduate Administrative Assistant	administrative assistant in undergraduate area and general office duties	Lillian Lanca
Graduate Administrator	administrator in graduate area and general office duties	Angie Ho
TA Administrator/ Observatory Demonstrator	supervise TAs, especially in large courses; student use of telescopes	Michael Williams

Table 2.3 gives the FTE staff (USW and P/M staff) in AST and the cognate physical and mathematical sciences departments. Again, DAA is lean relative to activity.

Table 2.3 Administrative and Technical Staff by Department

AST	CHM	CSC	GLG	MAT	PHY	STA
6.0	43.0	34.7	15.5	10.8	47.1	4.5

2.4 Structural budget deficit

The DAA base budget within the Faculty of Arts and Science is completely dominated (98%) by commitments to salaries and benefits for faculty members, librarian, and administrative and technical staff – those described in the previous sections. There is a structural budget deficit which can be traced to departments having to absorb the annual "step increases" of unionized staff for many years and, adding to this pernicious buildup, crippling across-the-board base budget cuts in the last two years. The only way for DAA to solve this internally is to adjust complement, which has been done to some extent by eliminating junior staff in the library and in computing support. The pain has been temporarily delayed by careful stewardship of income from a variety of prestigious awards to faculty members. This is not a sustainable model. The grace period has been planned to last through the first year of the term of the new chair, but then DAA will be at the edge of a cliff.

3. ACADEMIC PROGRAMS

Our teaching program – for graduates students, undergraduate specialists, science students in other disciplines, non-scientists, and the public – is informed directly by our engagement at the forefront in research. Every aspect of the curriculum is continually under consideration and updated as required. Teaching is a priority for all faculty members and teaching assistants, with a mentoring program and a formal Education Discussion Group (involving graduate students as well). DAA has a major focus on graduate and postdoctoral training on the one hand, and science literacy courses on the other, because within a liberal arts curriculum there is a central role for an appreciation of the cosmos. Training of highly qualified personnel has always been a priority. There are currently eight postdoctoral fellows in DAA and 35 graduate students (see Tables A2 and A4, respectively, in the Appendix). We have international drawing power: more than a third of the graduate students and most of the postdoctoral fellows are from abroad. DAA offers undergraduates, some 3000 per year, several courses of study to suit students with different backgrounds and different depths of interest. Four science programs are offered: a Specialist program in Astronomy and Physics, Major and Minor programs in Astronomy, and a Specialist program in Planetary Science. Our high-flying researchers teach the *large* first and second year breadth courses with enthusiasm; these of course account for much of the 1500 FCE. DAA has a long-standing commitment to outreach. Ours is a highly accessible science, with a large amateur base as well, and we demonstrate in practice that our mission includes bringing our quality research to the public and providing expert views and credible sources to the media (Section 7.1). Several important aspects of the teaching program are described below.

3.1 Postdoctoral training

Postdoctoral training in theoretical astrophysics is the mainstay of CITA where there are up 25 postdoctoral fellows. Such advanced training has taken place over the years in DAA as well, with small numbers but high quality. This program is now receiving even higher priority with eight postdoctoral fellows at present and more being hired (see Appendix, Table A2). Former DAA postdoctoral fellows have had considerable career success (see Table A3). There are now an initial two postdoctoral fellows in DI. Postdoctoral fellows are active in the outreach programs and a few have had an opportunity to teach at the undergraduate level when there was a need for replacement teaching. Many are active in providing summer research opportunities for undergraduates and some have seized the opportunity to present advance/specialized mini-courses for graduate students.

3.2 Graduate program www.astro.utoronto.ca/graduate

Past international reviews have confirmed the Department's very high standard of graduate training. Students' PhD theses regularly rank alongside those from the best departments worldwide. Most graduate students now opt for our new direct entry PhD, which emphasizes immediate engagement in research and sets its sights clearly on providing the strong preparation required to move on to top research and teaching positions, while still finishing within five years.

Table 3.1 summarizes the formal courses offered at the graduate level (www.astro.utoronto.ca/graduate/grad_program#CourseCategories). Some preparatory and most elective and specialized courses are given every other year (e.g., www.astro.utoronto.ca/graduate/grad_current). The mini courses provide an opportunity to explore topics that might fall outside normal course offerings or lie in emergent areas.

Table 3.1 Graduate instruction in Astronomy and Astrophysics

RESEARCH	
Research Projects	
AST 1501 Y	Introduction to Research
AST 1500 Y	Directed Research
AST 3500 H	Non-Thesis Research Project in Astronomy/Astrophysics
Ph.D. Thesis Research	
AST 400x Y	Ongoing assessment of thesis research (x=2,3,4,5)
COURSES	
Preparatory Courses	
AST 1410 H	Stars
AST 1420 H	Galactic Structure and Dynamics
AST 1430 H	Cosmology
AST 1440 H	Radiation Processes and Gas Dynamics
Elective Courses	
AST 2010 H	Physics of Stellar Atmospheres
AST 2020 H	Physics of Stellar Interiors
AST 2030 H	The Interstellar Medium and Star Formation
AST 2040 H	Extragalactic Astronomy
AST 2050 H	Observational Techniques
AST 2060 H	General Relativity I: Theory
AST 2070 H	General Relativity II: Applications and Cosmology
Specialized Courses	
AST 3010 H	Advanced Topics in Stellar and Galactic Astronomy I
AST 3011 H	Advanced Topics in Stellar and Galactic Astronomy II
AST 3020 H	Advanced Topics in Interstellar Matter and Star Formation I
AST 3021 H	Advanced Topics in Interstellar Matter and Star Formation II
AST 3030 H	Advanced Topics in Extra-Galactic Astronomy and Cosmology I
AST 3031 H	Advanced Topics in Extra-Galactic Astronomy and Cosmology II
AST 3050 H	Theoretical Cosmology
Mini Courses	
AST 3100 H	Lecture Series in Specialized Topics
COLLOQUIA AND SEMINARS	
AST 2000 L	Current Literature Seminar
-	Astronomy and Astrophysics Colloquium
-	CITA Seminar

Table 3.2 Graduate student ratings 2000-09

Feedback on the instructors and value of the courses is summarized in Table 3.2 from evaluations in the period 2000-09 (scale 0 to 5).

	Teaching	Course
Average	4.09	4.09
Standard deviation	0.73	0.66

Student satisfaction with many aspects of the graduate program has been surveyed and the detailed results are tabulated in Table A17 in the Appendix.

3.2.1 Ph. D.

Since 2000, most candidates are accepted directly into the Ph.D. program after specialist undergraduate preparation in physics and mathematics and sometimes (depending on the university) astronomy and astrophysics. The program leading to the Ph.D. is intended to be completed in five years (15 sessions). Students are immediately engaged in original research through two required research courses, with different supervisors, normally completed during the fall/winter of the first year and in the following summer. The core of the program is a thesis embodying the results of original research which must be submitted for appraisal in accordance with the regulations of the School of Graduate Studies (www.sgs.utoronto.ca). As a first step, a candidate is required to prepare a written Ph.D. thesis proposal (possibly on a theme growing out of one of the first two research courses, but not necessarily) and defend it in an oral examination conducted by a panel of faculty members. The intention of this “qualifying examination” is to assess the candidate's ability and readiness to carry forward and complete successfully independent Ph.D.-level research. This assessment is based on the candidate's graduate record to date, including graduate lecture courses and research performed, together with the presentation and defense of the proposed Ph.D. thesis.

Students participate in the Department's weekly seminar series and various regular discussions sponsored by research field (e.g., astrophysical fluids, early universe, stars), and attend astronomy and astrophysics seminars and colloquia arranged by the Department, CITA, and Physics. An endowment fund supports student travel for observations and for conferences, workshops, and summer schools.

While there are many formal graduate courses offered (Table 3.1; also relevant to the Astronomy and Astrophysics M.Sc. and the Collaborative Program in Astrophysics M.Sc. – see below), the obligatory (minimal) course requirement is small (four half courses). Therefore, successful execution of the program relies heavily on faculty-student interaction, with close monitoring of the student’s progress in all areas by the supervisor and by a three-member Ph.D. committee. This is a challenging but stimulating approach. Mentoring programs for faculty and proactive “nurturing” PhD committees are key tools, which with heightened awareness, vigorous attention, and continual renewal will promote optimal results.

Details of the Ph.D. program requirements may be found at www.astro.utoronto.ca/graduate/grad_program#PhDDegree.

3.2.2 Growth of Enrolment in Ph.D. Program and Careers of Graduates

Table A13 in the Appendix gives the recent graduate enrolment. This reflects the plan for expansion of the graduate student population by about 35%, from 30 in 2000 to above 40 in the coming decade. This growth is in line with the renewed graduate supervisory capacity, student demand, research opportunities that we have generated, and the goal of the Faculty and University to increase the proportion of graduate to undergraduate students through this period. The cohort of 35 graduate students (2009-10) is listed in the Table A4 in the Appendix. The new-student intake for 2009-10 was six. If anything, the growth is too conservative for a very active discipline with international prominence.

Table 3.2 Ph.D. degrees awarded 1953-2009

PERIOD	No. of Ph.D.s
1953-1959	4
1960-1969	20
1970-1979	30
1980-1989	28
1990-1999	31
2000-2004	15
2005-2009	23
TOTAL 1953-2009	**151**

As shown in Table 3.2, the "production rate" of Ph.D.s for the last several decades has been about 3 per year. Accompanying the graduate expansion we expect to be graduating more than twice as many Ph.D.s per year. This assumes that the target of five years for completion of the degree can be achieved. According to the statistics in Table A16 in the Appendix, and our experience with active Ph.D. committees for recent graduate students, this seems possible. Of course the numbers are small and so subject to considerable fluctuation; eight students graduated in 2009 and up to nine should graduate in 2010.

Thus a major focus during the coming period will be to ensure that quality is maintained as the program expands. Since we already attract a large pool and are presently turning away well-qualified students, this does seem tractable. See the statistics in Table A12 in the Appendix. As with faculty recruitment, this will require wide proactive advertising, individual initiative, and uncompromising dedication to excellence. This is demonstrably our "culture" already. Nevertheless, we will be revamping both our printed materials and web site as well as developing more personal contacts.

The discipline is growing world-wide and there is a demand for our graduates. Historically, they have done well in their further careers (see Table A5 and Section 4.3.3). Although some graduates migrate to industry or into computing or remote sensing, most go on to postdoctoral positions and then to professional positions as faculty or staff members in astronomy observatories and institutes.

3.2.3 Financial Support for Graduate Students

All graduate students in Astronomy and Astrophysics are supported financially for a period of five years from first registration in the graduate program with a guaranteed minimum package set by the Faculty and University. Financial support is combined from a variety of sources, including scholarships external to the university (e.g., NSERC and OGS Fellowships), university scholarships, endowed departmental scholarships, teaching assistantships, and research grants (research assistantships). The current DAA policy sets the minimum package at a level \$3.5K higher than the University's. Thus domestic students receive a minimum package of about \$26K. International students receive further supplements (over \$8K) to offset the fee differential and mandatory health coverage. Students who bring in external support are rewarded with a top-up.

Tables A14 and A15 in the Appendix summarize some aspects of the financial support.

3.2.4 M.Sc.

Admission is the same as for the Ph.D. program and the program requirements are similar to what is accomplished in the first 1.5 to 2 years of the Ph.D. program (though with advanced planning and dedication, the M.Sc. program can be completed in one year (three sessions)). Candidates in the direct-entry Ph.D. program who have successfully completed those requirements, and who wish to terminate their studies at that point, may request consideration for award of the M.Sc. degree. For details see www.astro.utoronto.ca/graduate/grad_program#MScDegree.

3.2.5 Collaborative M.Sc. Program in Astrophysics

Since 1998, the graduate units of Astronomy and Astrophysics, and Physics, and the Canadian Institute of Theoretical Astrophysics have participated in the Collaborative M.Sc. Program in Astrophysics. This program is intended to foster graduate education in Astrophysics, particularly in those areas of study that overlap traditional departmental boundaries. There is a heavier reliance on formal course work, which provides useful foundations especially for theoretical work. Thus the program requires the equivalent of ten half courses as follows: three half courses from Astronomy and Astrophysics; three half courses from Physics; two further half courses in astronomy, physics, or from a cognate department (e.g., chemistry, math, computer science); a supervised research project in the field of astrophysics, equivalent to two half courses. The program is normally completed in one year (three sessions). For more details, see www.astro.utoronto.ca/graduate/gradmsc.

3.3 Undergraduate program www.astro.utoronto.ca/undergrad

The wide variety of instruction that DAA offers to undergraduates with diverse interests is described for prospective students at www.artsci.utoronto.ca/prospective/programsofstudy/progs/astro.
For current students, the full range of programs and courses is described at www.artsandscience.utoronto.ca/ofr/calendar/prg_ast.htm. There is a long history to this and so it is sometimes forgotten how favourably this array of offerings is seen from an outside perspective. *"UofT's astronomy course offerings greatly exceed those offered by other universities in number and quality. UofT offers a real astronomy undergraduate program, as opposed to the usual physics program with some astronomy electives. That's rare and worth emphasizing."* The courses and instruction are also well received by the students themselves, as discussed in Section 3.3.10 below.

Our undergraduate specialists are in demand at the top graduate schools. Their training includes hands-on practice in excellent observatories (see Section 5.1.1). Additional research opportunities are given through ROP, summer employment, and the senior research project. A computer lab, well equipped in hardware and astronomical software packages, is used in conjunction with research work and upper-level practical astronomy. Our outreach to non-scientists is particularly worthy of note, being our area of contact with the greatest number of FCEs and the general public. As well as engendering an appreciation of the development of ideas, scientific methods, reasoning, and a capacity to stay abreast of future developments and above all to be skeptical and critical (initiating life-long learning), it is our mission to contribute to common knowledge on the great intellectual issues raised by considering the cosmos. The origin and evolution of the Universe provides a big picture perspective on the human place in the cosmos and the large and critical questions that face us in the world and that define the broader intellectual landscape.

The variety of opportunities is summarized in Table 3.3 (for detailed course descriptions see www.artsandscience.utoronto.ca/ofr/timetable/winter/ast.html).

Table 3.3 Undergraduate instruction in astronomy and astrophysics

First Year Seminar	
SCI 199 H1 F,S L0111	Great Astronomical Issues
SCI 199 H1 F,S L0112	Astronomy at the Frontier
Breadth Requirement	
AST 101 H1 F	The Sun and Its Neighbours
AST 201 H1 S	Stars and Galaxies
Research Opportunity Program	
AST 299 Y1 Y	Research Opportunity Program
AST 398 H0	Independent Experiential Study Project
AST 399 Y0	Independent Experiential Study Project
For Science Students	
AST 121 H1 S	Origin and Evolution of the Universe
AST 210 H1 F	Great Moments in Astronomy
AST 251 H1 S	Life on Other Worlds
Astronomy and Astrophysics Major and Minor Programs	
AST 221 H1 F	Stars and Planets
AST 222 H1 S	Galaxies and Cosmology
AST 320 H1 S	Introduction to Astrophysics
AST 325 H1 F / AST 326 Y1 Y	Introduction to / Practical Astronomy
Astronomy and Physics Specialist Program	
AST 425 Y1 Y	Research Topic in Astronomy
Planetary Science Specialist Program	
PLN 420 H1 F	Interdisciplinary Seminar in Planetary Science
PLN 425 H1 Y	Research in Planetary Science

Range of courses offered. Some commentary on our course offerings is presented in the subsections below, from the perspective of the present requirements of the Faculty's Honours B.A./B.Sc. degree (see 3.3.11 re recent curriculum renewal) In summary these four-year degrees require (see details at www.artsandscience.utoronto.ca/ofr/calendar/degree.htm#BABSC)

- standing in at least 20 full courses (several constraining criteria, plus pre-requisite and exclusion rules for each course). "Y" is the designator for a full course; many courses are given as half courses ("H").
- one of the following program requirements (Hon. B.A. or Hon. B.Sc. depends on the program(s) completed):
    - One specialist program
    - Two major programs, which must include 12 different courses
    - One major and two minor programs, which must include 12 different courses
- the Distribution (breadth) Requirement, at least one full course equivalent in each of three areas: humanities, social science, science (see revisions of this component at www.artsci.utoronto.ca/main/facultygovernance/arts-science-council/arts-science-council-2008-2009/april-6.09/breadth-req.pdf)
- a Cumulative GPA of 1.85 or more by the time of graduation.

3.3.1 First-year Seminar

DAA participates actively in this Faculty-wide initiative which provides first-year undergraduates an opportunity to learn in a seminar setting with capped enrolment (24) in each section. Each department offers two different sections (or four half-year sections), regardless of department size, and so the commitment of DAA's teaching resources to this initiative is relatively substantial. These seminars can be taken by either science or non-science students (and satisfy the breadth requirement for the latter).

3.3.2 Breadth Requirement

Our outreach to non-scientists is a priority. We therefore offer several courses at the first and second year level which are suitable for students who are enrolled in programs in other disciplines (see also 3.3.4). Two courses *The Sun and Its Neighbours* and *Stars and Galaxies* are specifically designed for students of the Humanities or Social Sciences and are often used to fulfill the present breadth requirement (new changes will increase demand). These are already so popular that to produce a sustainable teaching load these have been consolidated in Convocation Hall. The latter course, AST 201 is also offered in the summer term.

3.3.3 Research Opportunity Program (ROP)

DAA also participates actively in this Faculty-wide initiative which provides opportunities for (largely) second and third year undergraduates to work individually with a professor on a research project.

3.3.4 For Science Students

Science students appreciate the opportunity to have astronomy and astrophysics courses targeted for science students, even if they are specializing in other areas of the physical or life sciences. *Origin and Evolution of the Universe*, *Great Moments in Astronomy*, and *Life on Other Worlds* serve this need. Demand for the latter has grown so strong that a section could be offered (again) each term.

3.3.5 Enrolment

The above courses account for most of the enrolment. Table 3.4 shows the available figures for AST enrolment, both as the total number of students taught ("head count") and as full course equivalents (FCE). None of these enrolment figures include the four SCI 199H courses (48 FCE). There was a decrease in 2003-4, as anticipated, due to consolidation of four sections of AST 101 into one (fall only) in Convocation Hall and four sections of AST 201 into one (spring only) in Convocation Hall, thus limiting timetable flexibility/availability. Conservative enrolment caps on these courses have been relaxed in several succeeding years, which has significantly boosted enrolment well beyond the historical numbers.

Table 3.4 Course enrolments in AST

DISCIPLINE / YEAR	1998 -9	1999 -0	2000 -1	2001 -2	2002 -3	2003 -4	2006 -7	2007 -8	2008 -9
Head Count	1924	2218	2306	2452	2393	1991	2878	3158	3054
FCE	983	1130	1174	1249	1219	1021	1443	1584	1535

Table 3.5 FCE in AST and other physical and mathematical science departments

DISCIPLINE / YEAR	1998 -9	1999 -0	2000 -1	2001 -2	2002 -3	2006 -7	2007 -8	2008 -9	FTE	FCE/ FTE
AST	983	1130	1174	1249	1219	1443	1584	1535	10.0	153.5
CHM	3637	3579	3188	2621	2958	3216	3069	2687	39.7	67.8
GLG	1187	1152	991	1030	995	719	741	794.5	15.5	51.3
PHY	2211	2088	1872	2260	2531	1864	1991	1741	44.2	39.4
CSC	3433	3794	4550	4564	4427	1929	2048	1866	46.0	40.5
MAT	6190	6398	6194	6658	7174	4679	5109	4914	43.9	112.0
STA	1826	1984	1977	2103	1818	1349	793	1087	16.5	65.9

Table 3.5 compares the available FCE enrolment figures for the cognate physical and mathematical sciences departments.

As plotted in Figure 3.1, these data indicate that while AST has steadily increased over the last decade, the other disciplines have decreased. The bulge of the “double cohort” has gone through and the undergraduate enrolment is being decreased intentionally by the Faculty, and yet the demand for AST is strong. Final numbers are not available for 2009-10, but the AST enrolment as of November is up by 86 FCE (6%) compared to 2008-09, which should make this a record year.

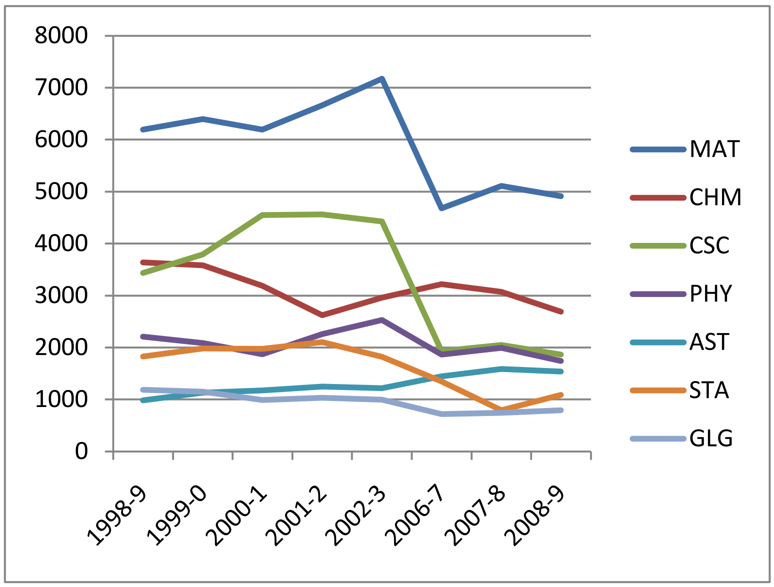


Figure 3.1. FCE by department over two ranges of time

<u>Student/faculty ratio.</u> The second last column of Table 3.5 gives the current FTE data by department compiled by the Faculty of Arts and Science. The FTE includes tenured/tenure-stream faculty and Lecturers/Senior Lecturers in the St. George department. In the case of AST, it includes Martin (0.5), though this temporary assignment will disappear back to CITA next year while the FCE will remain the same or more probably increase. The last column gives the FCE/FTE for the most current data.

These data are presented in Figure 3.2 by department, ranked in increasing FTE. The scaling is chosen such that the FTE, FCE, and FCE/FTE relative to DAA are readily seen.

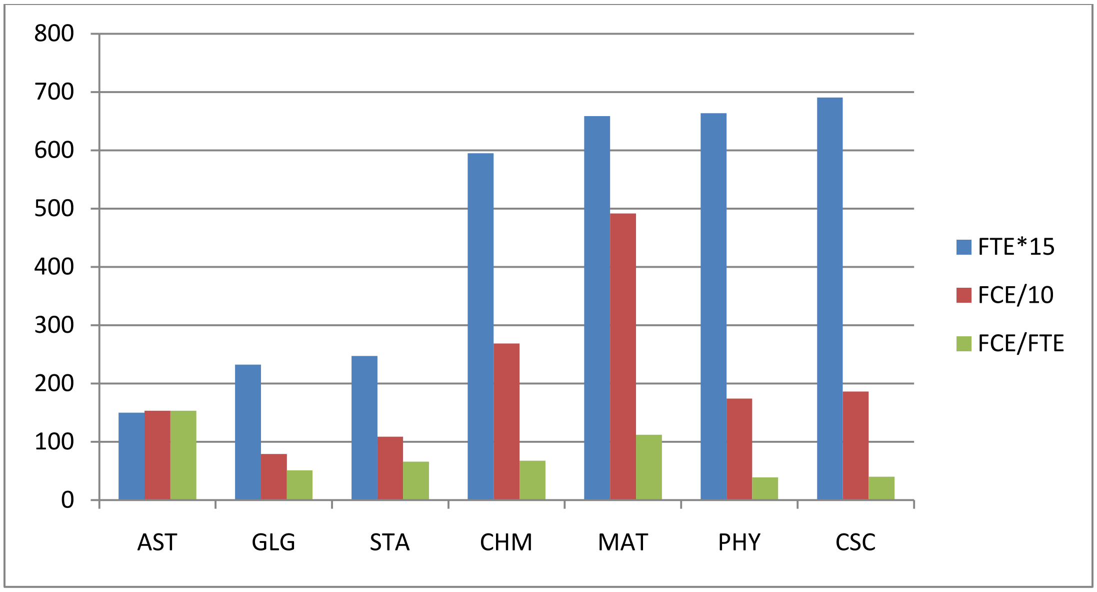


Figure 3.2. Most recent FTE, FCE, and FCE/FTE by department

3.3.6 Major and Minor Programs

These are Science Programs and share the same AST core courses. Both also require some physics and mathematics, and the Major program adds more course requirements in mathematics, applied mathematics and computer science. For details see www.astro.utoronto.ca/undergrad/progdes/aamp and www.astro.utoronto.ca/undergrad/progdes/aaminp. These and the specialist students make effective use of the undergraduate observatories described in Section 5.1.1.

3.3.7 Specialist Programs

The Astronomy and Physics Specialist program contains primarily courses in physics and mathematics, along with important courses in astronomy. It builds on the Major program with more requirements in physics, mathematics, and statistics (but dropping those in computer science) and with the addition of a full-year capstone course AST 425Y, a research-oriented course with individual instruction. The aim is to provide a proper balance between astronomy and astrophysics and the other physical and mathematical sciences which play important roles in modem astronomical research (students often take chemistry and computer programming as well). For details see www.astro.utoronto.ca/undergrad/progdes/apsp.

The Departments of Astronomy and Astrophysics, Chemistry, Geology and Physics offer an interdisciplinary specialist program in Planetary Science. The aim of this program is to provide information about different techniques for studying the nature and origin of planets and planetary systems. The Planetary Science Specialist Program adds the PLN 42x courses, and requires courses in chemistry and geology as well. The latter are at the expense of some of the requirements in physics and mathematics (program requirements are kept to a total of 14 full courses (plus the two breadth courses) out of 20). Students interested in pursuing graduate studies in one of these disciplines include core courses from the appropriate departments in their course selection. For details see www.astro.utoronto.ca/undergrad/progdes/pssp. This program is still being nurtured and might evolve further either at St. George or with the implementation of a previously-planned focus on planetary science (solar-system and extrasolar) at UTSC.

Students in our Specialist Programs generally have a higher CGPA in progress and on graduation than those in the Major and Minor Programs (see Tables A6 and A7 in the Appendix). Re the GPA itself, see www.artsandscience.utoronto.ca/ofr/calendar/rules.htm#grading.

3.3.8 Enrolment in Programs and Careers of Graduates

Over the decade there has been a significant increase in the enrolment in the specialist and major/minor programs (see Table 3.6). The gender ratio (Table 3.7) is relatively good for the physical sciences.

Table 3.6 Program enrolments in Astronomy and Astrophysics

PROGRAM/YEAR	1999-0	2000-1	2001-2	2002-3	2003-4	2004-5	2005-6	2007-8	2008-9
AST/PHY Specialist	27	30	31	37	38	36	33	40	30
Planetary Science Specialist	1	3	2	5	2	5	4	3	2
AST Major	18	20	29	39	43	51	37	36	43
AST Minor	8	9	15	20	21	12	11	15	13
TOTAL	54	62	77	101	104	104	85	94	88

Table 3.7 Program enrolments in Astronomy and Astrophysics, by gender

PROGRAM/ YEAR	2004-2005		2005-2006		2006-2007		2007-2008	
	Female	Male	Female	Male	Female	Male	Female	Male
AST/PHY Specialist	14	22	12	21	12	21	12	18
Planetary Science Specialist	3	2	3	1	3	1	0	2
AST Major	11	40	11	26	11	26	11	32
AST Minor	4	8	2	9	2	9	4	9
TOTAL	32	72	28	57	28	57	27	61

Many graduates of these programs have gone on to graduate studies in major astronomy departments around the world. However, we have launched a new program re other career opportunities for our current program students, called Backpack to Briefcase (www.physics.utoronto.ca/alumni-and-friends/news/backpack-to-briefcase-the-business-of-science). Through our AstroGradNetwork (www.astro.utoronto.ca/undergrad/agn) we keep in touch with these program students, though a comprehensive database is difficult to keep up to date. Graduates become professional astronomers or follow careers in teaching, planetarium work, science journalism and broadcasting, or in space-related activities such as geophysics, meteorology, aerospace studies, remote sensing, computer science, and software development (Starry Night being a notable success).

3.3.9 Research Opportunities

We are always looking for research opportunities to engage our undergraduates. These are formalized in the ROP 299 and 398/399 courses and the capstone AST 425Y research course. They also include a vigorous summer research program (www.astro.utoronto.ca/alljobs/summerjobs) sponsored in part by the NSERC USRA program and UofT Excellence Awards (UTEA). Other students are hired from individual research grants and other funding (recently TMT detailed design). Professional Experience Year (PEY) students from the Faculty of Applied Science and Engineering are also employed.

3.3.10 Student ratings

Each undergraduate course is evaluated by the students using a standardized questionnaire. These reveal that our courses are generally both well taught and well received. Some details of the metrics are shown in the figures below and in Tables A9 – A11 in the Appendix. Taking the ratings course by course, Table 3.8 gives the averages and standard deviations of these metrics.

Table 3.8 Undergraduate student ratings 1998-2009 (scale 0 – 7 and percentage)

	Teaching	Learning	Retake
Average	5.4	4.9	73.9
Standard deviation	0.7	0.6	14.7

Figure 3.3 shows a histogram of the ratings of the instructors (teaching) over the academic years 1998-2009 (Table A9 gives details and comparison to Faculty-wide results aggregated by session).

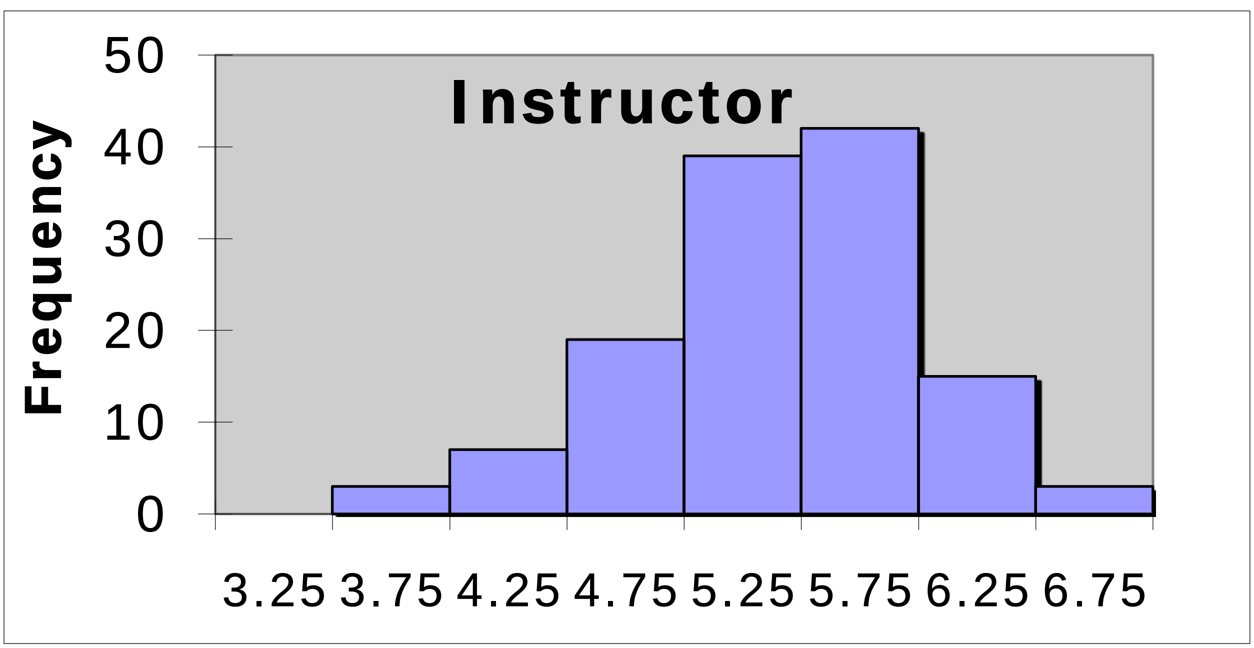


Figure 3.3. Histogram of undergraduate ratings of instructor. "All things considered, performs effectively as a university teacher:" (scale 0 to 7 == outstanding).

Figure 3.4 shows a histogram of the ratings of the learning experience (Table A10 gives details and comparison to Faculty-wide results aggregated by session).

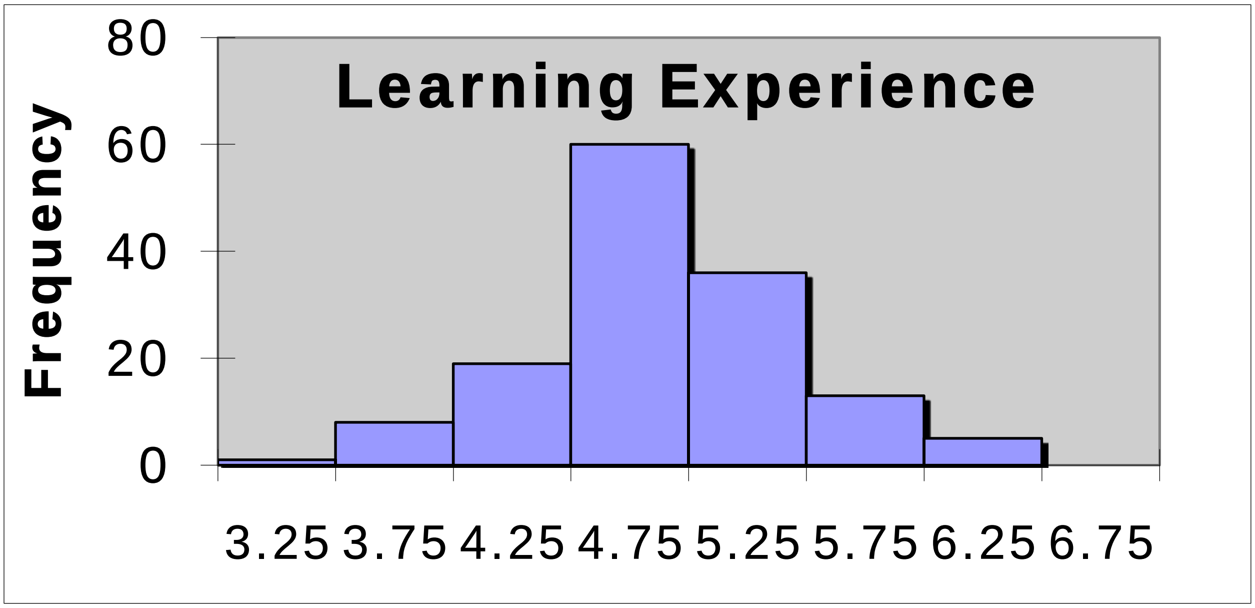


Figure 3.4. Histogram of undergraduate ratings of learning experience. "The value of the overall learning experience is:" (scale 0 to 7 == outstanding).

Figure 3.5 shows a histogram of the ratings of the retake percentages (Table A11 gives aggregates by session).

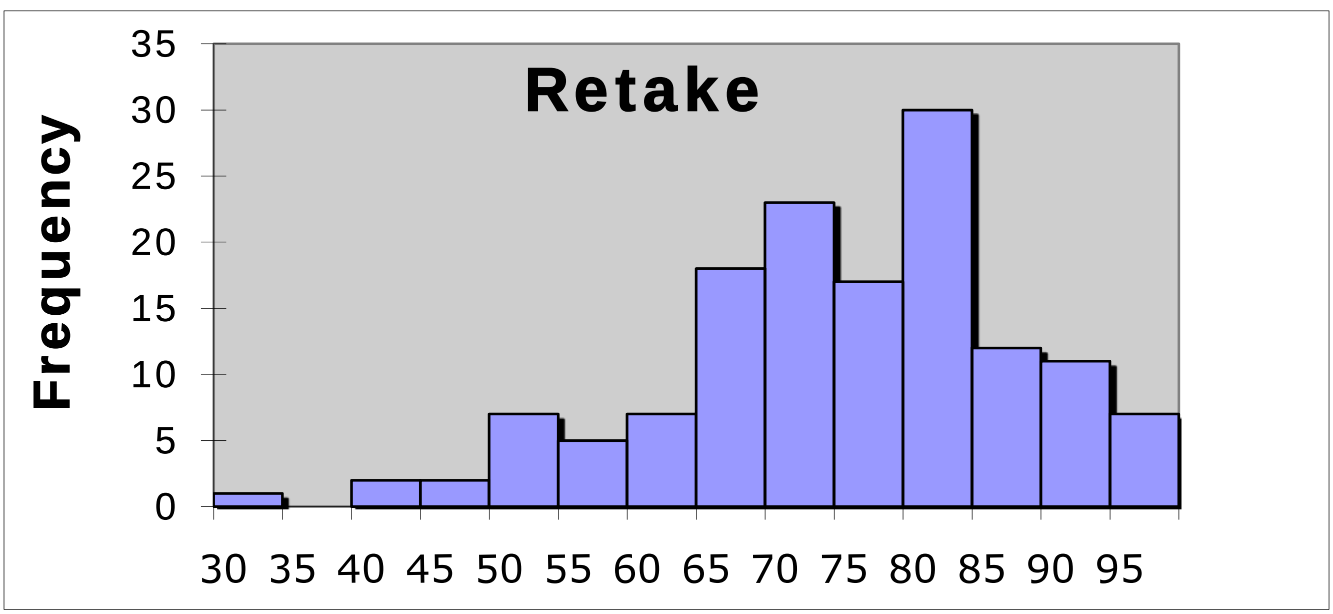


Figure 3.5. Histogram of percentage of undergraduates who would retake the course. "Considering your experience with this course, and disregarding your need for it to meet program or degree requirements, would you still have taken this course?"

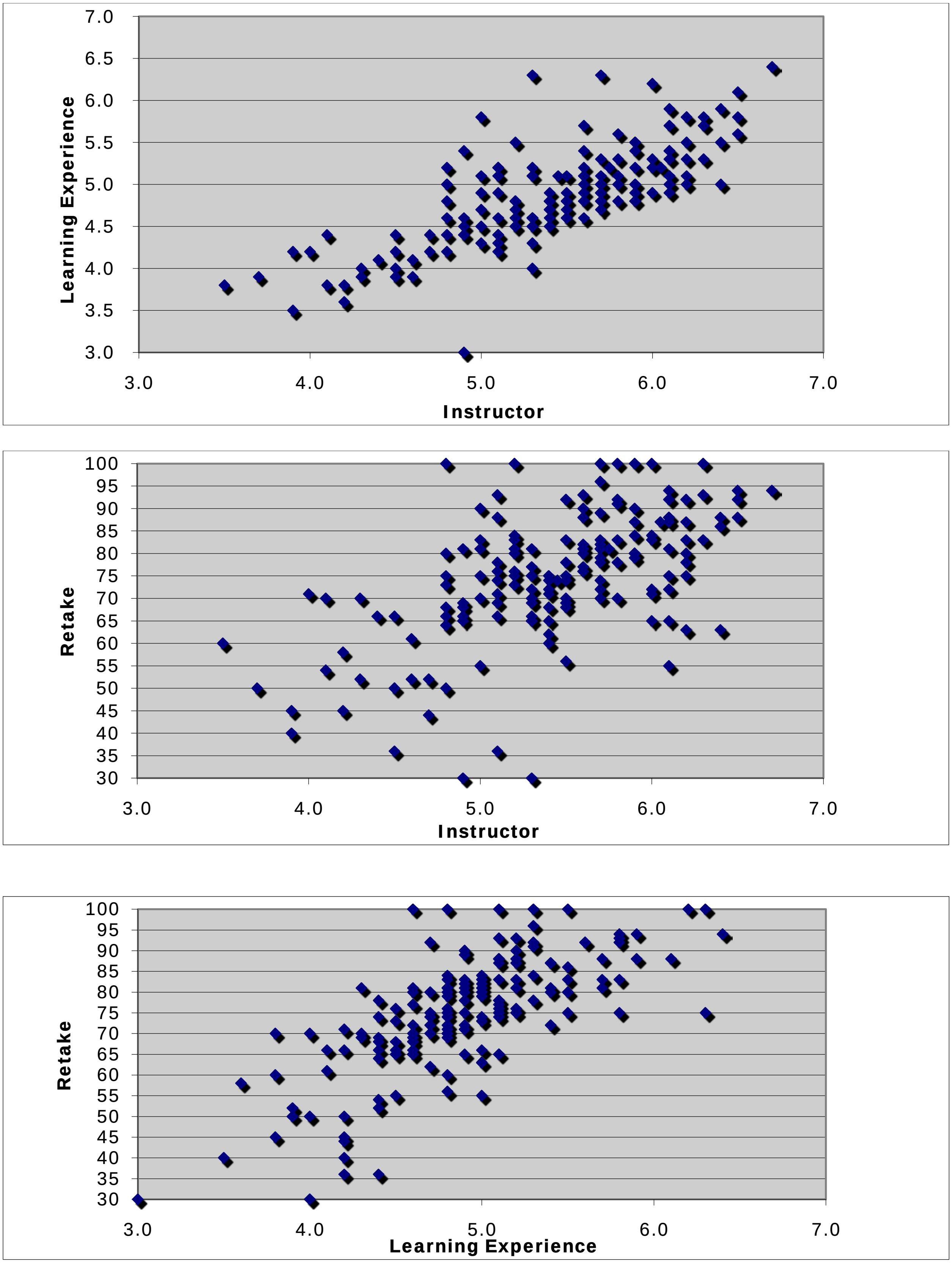


Figure 3.6. Correlations of the ratings of the undergraduate courses

3.3.11 Curriculum renewal: New windows on the Universe at UofT

The Faculty of Arts and Science has made a major effort during 2006 and 2007 on Curriculum Review and Renewal (see final CRRC report at www.artsci.utoronto.ca/main/facultygovernance/arts-science-council/arts-science-council-2007-08/oct-3-07/ccrcfinalreport.pdf). This has spawned further studies and passed in stages through governance. Our Associate Chair Undergraduate, Ray Carlberg, participated in the process and with the Chair kept DAA current on the discussions and outcomes and provided feedback. The general goal for all honours bachelor degrees is to achieve the following learning objectives:

a) Depth of knowledge that cultivates critical understanding and intellectual rigour in at least one field of study.
b) Competencies in learning and applying knowledge that are fundamental to responsible and effective participation in the workplace, in the community, in scholarly activity, and in personal life:
    i. Critical and Creative Thinking
    ii. Communication
    iii. Information Literacy
    iv. Quantitative Reasoning
    v. Ethical Thinking and Decision-Making
c) Breadth of knowledge across a range of knowledge areas that reflect the richness of the arts, the complexity of global cultures, and the varied structures, processes, and concepts of the social and natural world.
d) Integration of skills and knowledge developed in a student's course of study within an inquiry-based activity in the upper years.

Through faculty meetings the DAA's programs have been examined for compliance (existing programs largely are) and changes deemed necessary (all desirable) are already being implemented. For example, we have put in place guidelines re communications competency in the 2nd, 3rd, and 4th year courses. Courses appropriate to fulfilling the "breadth requirement" have been so designated. AST 425Y, our capstone course, has been revised to ensure that it is integrative. A parallel course without the full up "undergraduate thesis" will be offered for Majors as AST 424H. We have tentatively decided not to attempt to provide the ethical thinking and decision-making competency embedded within our courses, recognizing that there are appropriate courses already given in other jurisdictions and room in the course-count to accommodate this. A formal submission for approval by the Faculty will be forthcoming later this academic year.

New windows on the Universe at UofT. Effective science teaching requires a laboratory component and for astronomy in particular this has been well studied (Prather et al., 2009, Physics Today, Oct 2009, 41-47). Considerable educational research has underscored how difficult it is for many students to grasp key concepts in the lecture environment even as augmented by a plethora of web-based learning tools. We are addressing this by bringing our TAs, all active researchers, into regular face-to-face contact with undergraduates in our large enrolment courses through new small-group tutorial sessions. A pilot project in 2008-9 proved very successful and this is now fully implemented for the 2400 students in AST 101/201. It will also be rolled out for AST 251 this winter and AST 210 next fall, thus improving the student experience for another 750 students in these popular courses for the science streams. The essential next step for these large enrolment courses is a teaching planetarium. Through enhanced hands-on and experiential learning for our undergraduates, this will have dramatic effect on the impact of our courses. It will also be an important asset for our outreach program (Section 7.1).

Teaching planetarium. A planetarium gives the students an opportunity to visualize concepts that are hard to demonstrate on an ordinary flat screen and will be used with interactive groups of about 25 students. These presentations will allow us to more effectively demonstrate concepts ranging from the motion of the Sun, Moon, and planets in the sky, to the structure of our Galaxy, and super-computer simulations of the formation of planets, stars, galaxies, and structure in the universe. The students will be able to run the planetarium display themselves, interactively. Low cost high quality digital projectors and innovative domes have revolutionized planetaria, greatly increasing their power over the old “star balls.” When coupled with access to easy-to-use high quality modern telescopes the students gain their own link with precisely the same sky that has inspired and puzzled astronomers, mathematicians, and physicists, located sailors and explorers, and united cultures ancient and modern as they seek to understand the motions of the stars and the origin of the world and physical universe. We propose to purchase the largest possible high quality “portable” planetarium, a high quality digital projector, and the software and associated database which allows us to download and adapt professional planetarium shows. Based on our current enrolment we expect to schedule more than 100 planetarium demonstrations just for AST 101 and AST 201 each term. This will give each student at least two opportunities to learn in the planetarium. The longer term goal is to have a permanent planetarium in a new Astronomy Building, but this step is a good investment and would make a large impact immediately.

We have selected a high quality portable planetarium because long-term dedicated space is not assured at this time to warrant an expensive permanent dome and portability allows any number of locations to be served. As seen in the quote we have obtained, the dome is only about 15% of the price with most going into the projector and software. A similar sized hard dome in a dedicated room costs about $200K and changes the cost equation. Nevertheless, this is a high end unit that offers easy wheel-chair access and has walk-in entry (as opposed to crouching or crawling into some other units). The Eluminati (www.elumenati.com) and Geodome (geodome.info) products were recently highlighted at the White House star party and have been used with success at Burning Man (www.burningman.com). The Geodome Theatre is the largest offered and just fits within the available space in the Astronomy Building. The projector is a professional level video projector with a purpose-designed expensive fish-eye lens.

Teaching telescopes. An exciting planetarium is best when coupled to telescopes to ensure that students gain direct experience of the cosmos, being able to see mountains on the moon, the rings of Saturn, the colours of stars, and the beauty and structure of nebulae and nearby galaxies. We propose to acquire a dozen 8” telescopes, with computer control (i.e., find “Venus” in the menu, press a button and it moves to Venus). These will be mounted on the existing stations on the 15th floor balcony of the McLennan Labs, allowing a full tutorial group of 50 to have one telescope per four students. Students will control their experience and explore, rather than queue in a long line for a cursory glimpse. It is practical to schedule at least one good viewing session per student per term. We know that there is considerably more student demand for our astronomy courses; however, before allowing any more expansion we want to bring the courses to this high level of quality instruction. Of particular importance, we have recruited an experienced person to the newly-created position of super-TA/Observatory Demonstrator, to maintain these facilities, develop new programs, manage the facility, and optimize the use of the TA talent.

Telescopes of the quality and aperture we want are available as commodity items in a fairly competitive market driven by amateur astronomers. The leading supplier is widely considered to be Meade. We select a high optical quality 8” with full computer control at a price of US$2,600 per unit. We will need power cables and to modify or install some mounts on our 15th floor observatory balcony.

The one-time cost of the facilities will greatly increase the effectiveness of our TA budget of $271K per year.

Item	Quantity	Unit cost	Total Cdn
Planetarium	1	US96,000	102,720
Spares and supplies			5,000
Telescopes+ supplies	12	US2,600	33,384
Mounts, eye piece, filters, supplies			10,030
Room renovation			27,000
Total			**178,134**

Immersive experiences and visualization. This facility has powerful applications far beyond being a planetarium; it can be used for a wide variety of visualization tasks throughout the Faculty and University. The proposed software and database has a whole “geoscope” capability and can be used for immersive displays of all sorts, being frequently used, for example, in geography. A growing use is to connect multiple sites to view immersive real-time presentations. Beyond the University there is a huge interest in the schools and public, which is only limited by the scheduled availability of the resource and the TAs to run the facility.

4. RESEARCH AND SCHOLARSHIP

We are addressing nothing less than the fundamental structure of the Universe and our place within it. The UofT has been participating vigorously in these revolutionary advances through DAA, hosting CITA, leadership in the Cosmology and Gravitation Program of the Canadian Institute for Advanced Research (CIFAR), creation of an astrophysics cluster under the Canada Research Chair (CRC) program, and establishment of the Dunlap Institute for Astronomy and Astrophysics (DI). We are thus already positioned well among the publicly-funded research-intensive universities. In practice we also compete for faculty, postdoctoral fellows and graduate students, and, in the accompanying research, with the best private universities (e.g., Caltech, Johns Hopkins, MIT, Princeton). Thus in developing our priorities, our sights are set high.

4.1 Research Diversity

The Department is actively engaged in a wide range of observational and theoretical research, with a focus that shifts slowly over the years as it follows opportunities arising from new instruments, new developments in analysis and simulation, and new theoretical approaches. A shift towards extragalactic studies that started last decade (last two hires early this decade) has led to arguably the strongest pillar, cosmology, ranging from theoretical studies of the early universe to measurements of the cosmic microwave background, studies of large-scale structure, and investigations of the formation and evolution of galaxies. Highlights over the past decade have been the first microwave background measurements showing that the Universe was geometrically flat (using the balloon-borne telescope Boomerang; Netterfield), the discovery that big galaxies had already formed when the universe was still relatively young (Gemini Deep Deep Survey; Abraham), and the first good evidence that the so-called dark-energy is well described by a cosmological constant (CFHT supernova legacy survey; Carlberg). The second pillar deals with stars and planets, with the focus recently shifting from a historical strength in stellar evolution to one in star and planet formation (three hires mid-decade). A highlight was the first image of a planetary mass object near a young solar analog (Gemini high-precision adaptive optics, postdoc Lafreniere, with Jayawardhana and Van Kerkwijk). The third pillar, in high-energy astrophysics, is also more recent (one hire mid-decade, most recent hires in both DAA and CITA), and uses observations, simulations, and theory to understand supernova explosions, gamma-ray bursts, neutron stars, and black holes, and the extreme (astro)physics occurring under the corresponding ultra-high temperatures and densities, and ultra-strong gravitational and magnetic fields. A highlight has been the theoretical identification and understanding of a class of objects bizarre even among these extreme objects, viz., the magnetars, neutron stars powered by ultra-strong magnetic fields (Thompson).

In faculty planning consideration is given to the balance among important research areas, and among theory, phenomenology, observation, experimentation, and instrumentation, important factors in providing an effective teaching curriculum, particularly at the graduate level. The present graduate faculty complement, showing research areas, is summarized in Table A1.

4.2 Research Initiatives

Through large surveys in progress, we are presently examining the multiplicity of stellar systems (using advanced adaptive optics), weather on low mass stars (using precision photometry), and the most distant galaxy clusters identified optically (RCS2, using wide-field imaging). We established the Canadian Megaprime Science Centre for the Canada France Hawaii Legacy Survey (CFHLS). The MOST satellite is being exploited to probe stellar structure (asteroseismology) and characterize extrasolar planets. The International Galactic Plane Survey, and now its extensions to higher latitude, the DRAO Planck Deep Fields, is exploring the Galactic ecosystem.

The Department also pursues theoretical research into the formation of structure within galactic, stellar, and planetary systems. This work includes theoretical and computational studies of dynamical collapse and the creation of star clusters, supermassive black holes, and protoplanetary disks; the modeling of Milky Way gas and dust (including the dramatic effects of massive stars); and the dynamical evolution of Solar System and extrasolar planets. It benefits strongly from interaction with CITA and use of the Sunnyvale and SciNet computer clusters, and is distinguished especially by tight collaborations with observational groups.

Strategic planning needs to continue re future major observational facilities. The stratospheric telescope program is a responsive student-friendly initiative in cutting-edge research. The successful BOOMERANG mission, dramatically successful in its own right, flew the prototype detectors for the recently launched Planck Surveyor satellite with which we are engaged (precision cosmology, Galactic star-formation science). Similarly BLAST and now BLASTpol use SPIRE submillimetre-camera technology, precursor to our present involvement in the Herschel Space Observatory (HSO). Success with the microsatellite MOST has led to new possibilities with nanosatellites like BRITE. Our research using the Spitzer Space Telescope, in the infrared, leads naturally to programs with the James Webb Space Telescope (JWST; successor to Hubble). Essential ground-based facilities in the JWST era are the Thirty Meter Telescope (TMT) and the Atacama Large Millimeter Array (ALMA).

Particular mention should be given to the TMT and the Association of Canadian Universities for Research in Astronomy (ACURA). The Department, with active support from the President and Vice-President Research, has been working with ACURA on this flagship project. The goal is to build on the national effort spearheaded by Carlberg to ensure a partnership for Canada in the TMT along with Caltech, the UC system, and eventually AURA, Japan, China, ...

4.3 Impact

4.3.1 International recognition

The Association of Universities for Research in Astronomy – which runs the Space Telescope Science Institute (Hubble and the successor James Webb Space Telescope (JWST)), three leading national suites of ground-based telescopes for the US national community, and the US Gemini effort, all under contract with NSF – invited DAA to apply for International Affiliate status. Our application, supported by the Dean and President, was endorsed “unanimously and enthusiastically” in 2004 and renewed in 2007. International Affiliates are a select few, DAA being the only one from Canada. Others are Cambridge, Leiden, and Swinburne.

4.3.2 Publications and Impact

The number of refereed publications by DAA researchers for the past decade (complete to 6 Nov 2009) has been studied by searching in the ISI Web of Science with the following strategies:

- Journal publications for DAA
- Timespan=1999-2009
- Databases=SCI-EXPANDED (Science Citation Index Expanded)
- Address=(Univ Toronto SAME (Dept Astron OR Dept Astron & Astrophys).

This resulted in 624 publications. DAA papers are in top journals, e.g., the Astrophysical Journal and Nature. Given the new faculty that we have been hiring, the growing number of postdoctoral fellows, and the expanding graduate program, we were optimistic that the publication rate would increase and indeed it has. Figure 4.1 shows that the publication rate in the last planning period is double that in the previous decade.

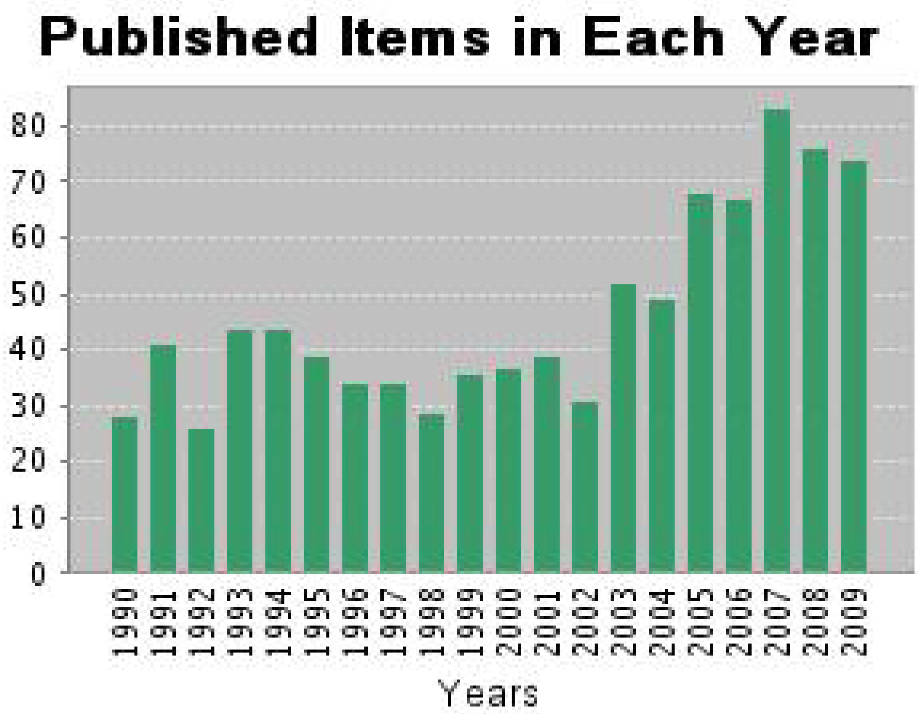


Figure 4.1. DAA refereed publications

These particular 624 publications have been cited 16,249 times (obviously there are different elapsed times over which these citations have arisen; see the effect in Figure 4.2). These are comparable to the numbers for CITA: 516 publications cited 23,668 times. Some of these publications will be in common between DAA and CITA.

It is difficult to get consistent bibliometric data among institutions, but independent Thomson ISI data (2003-7) would rank University of Toronto astronomy and astrophysics 17 among North American universities (AAU) in publications, where for comparison Caltech, UC Berkeley, Arizona, Johns Hopkins stood at 1, 2, 3, 4 and Harvard 25. For the public universities among these, Toronto was 10 of 15. For citations, the rankings were 18 and 11, respectively, with Caltech, UC Berkeley, Princeton, and Arizona the top 4. Thus, Toronto is very competitive.

The citation history of all DAA refereed publications is presented in Figure 4.2. The upper (purple) bars show the effect of the time elapsed since a publication appeared, whereas the lower (maroon) bars show the ongoing impact of many papers from previous decades. Note again the evidence that DAA is becoming increasingly productive. Of the 1,175 publications overall, over half (624) were in the last decade (1999-2009). Likewise, the sum of the citations for all refereed papers is 37,073, compared to 16,249 citations for the papers published in the last decade. The annual citations might well exceed 4000 this year for the first time.

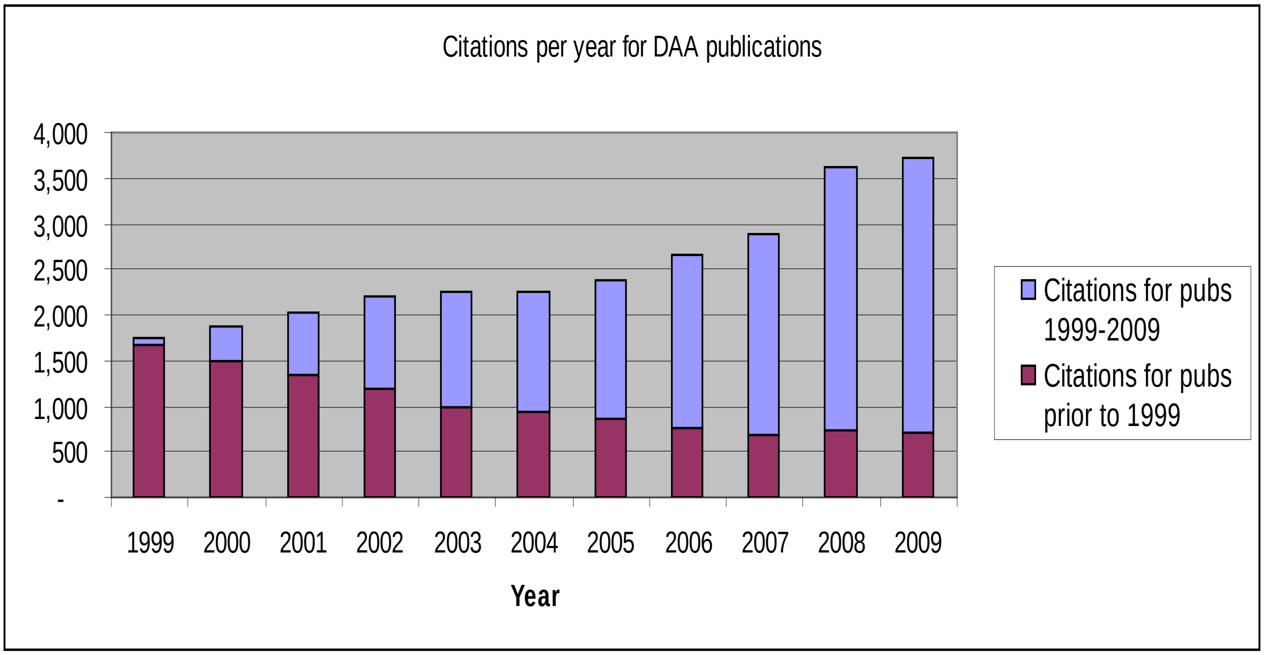


Figure 4.2. Citations of DAA refereed publications

Figure 4.3 shows the publications data for conference proceedings (not abstracts). There were 82 proceedings, cited 136 times. This is a less popular mode of publication and /because it has less impact.

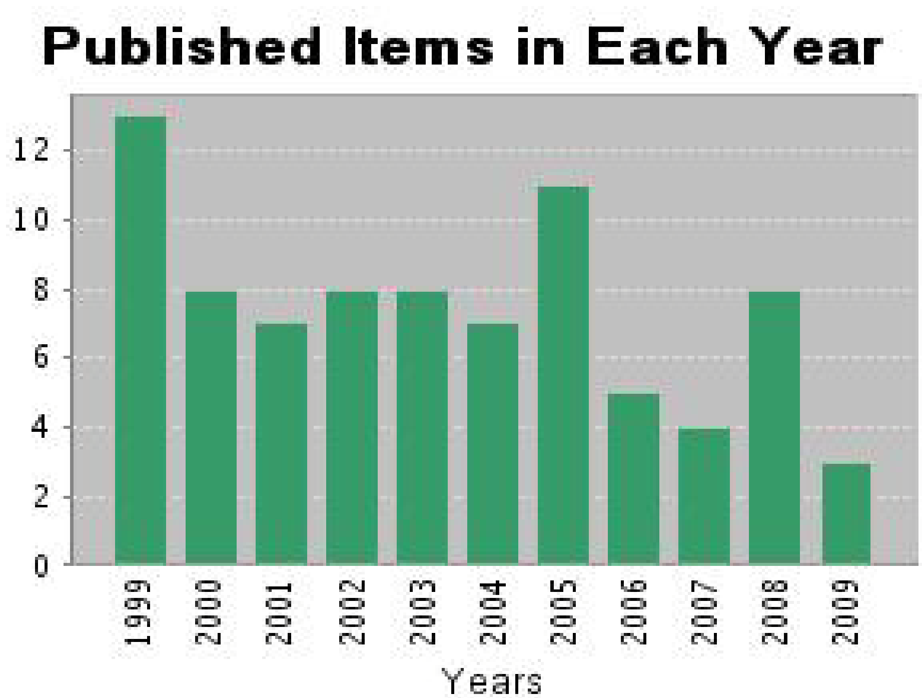
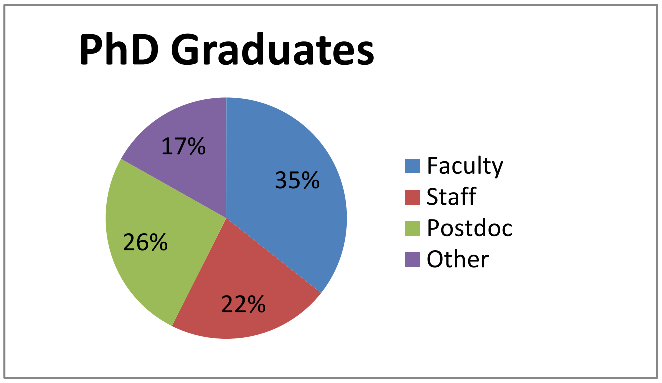
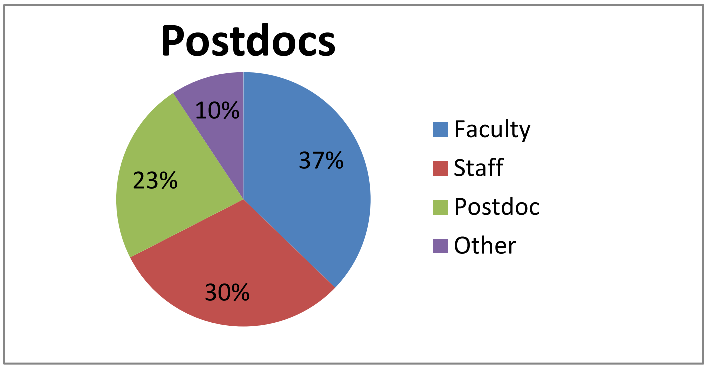


Figure 4.3. DAA conference proceedings

4.3.3 Placements

Of the 101 PhD graduates over 1979-2009 (Table A5 in the Appendix), 36 (13 in Canada) hold faculty positions in universities, 22 (9) hold professional astronomer staff positions in government laboratories, observatories, universities, 26 (7) are postdocs, and 17 are working outside the field (industry, financial sector, software, writing, secondary school, civil service, including 3 unknown).





Of 42 postdocs in the same time period (Table A3), 16 (7 in Canada) hold faculty positions, 13 (1) hold professional positions in government laboratories, 10 (2) are in further postdoctoral positions, and 4 are working outside the field (industry, federal civil service, and secondary education; 1 unknown).

Faculty of DAA and former students are frequently chosen for major leadership positions, e.g., CFHT Executive Director (Racine, McLaren, Fahlman), HIA Director General (van den Berg, Lilly, Fahlman), Observatories of the Carnegie Institution of Washington Director (Searle, Freedman).

Personnel from DAA have founded and developed most astronomy programs in Canada: McMaster (4 faculty members), Queen's (4), St. Mary's (3), Waterloo (3), York (3), Calgary (2), Montreal (2), UWO (2), Victoria (2), and Alberta, Brandon, and Laval. Combined with CITA's record, Toronto is having a great impact.

4.3.4 Awards

Prestigious awards to DAA St. George faculty include the Allouette Senior Award (Canadian Aeronautics and Space Institute), Beals Prize (Canadian Astronomical Society), Canada Research Chairs, CIFAR Fellows, FRSC, Herzberg Medal (Canadian Association of Physicists), Killam, PREA/Early Researcher Awards (Ontario), Rutherford Medal (Royal Society of Canada), Steacie Fellowships, Top 40 under 40, and the Vainu Bappu Gold Medal (Astronomical Society of India). Major recognition for teaching includes the Northrop Frye Award, the Faculty of Arts and Science teaching award, and the Award for Exceptional Commitment and Achievement in Adult Learning (Continuing Studies). Our recent librarian has been honoured by the Physics-Astronomy-Math Special Libraries Association. Awards for our graduate students include the Connaught Fellowship, Delta Kappa Gamma World Fellowship, Dimitris N. Chorafas Foundation award, Gordon Cressy Student Leadership Award, NSERC scholarships (PGS, CGSD, and Vanier), OGS, OGSST, and the Plaskett Medal (best thesis; Canadian Astronomical Society).

4.3.5 Grants

For the DAA faculty (first part of Table A1) the sustained annual grant total is over $800K, largely from NSERC individual Discovery Grants (averaging more than 50% more than the typical grant in GSC 17). They hold many more one-time-only grants through CFI, OIT/ORF, NSERC (CRO, SRO, Steacie supplement, RTI), and CSA (contracts, Small Payloads, SSEP), totaling $6,550K over the past 5 years (equivalent to an average $1,310K per annum). Except for a little from contracts, in the Canadian system there is no overhead flowing directly to the department or researcher from these research grants. Many more grants are held in CITA, UTM, and UTSC. Altogether Toronto holds 20% of the value of the national astronomy annual grants under NSERC GSC 17 (the next universities are under 10%). The Canadian PI for TMT, Carlberg, has been awarded $12M toward the detailed design (CFI, OIT, NSERC).

4.3.6 Leadership

As well as participating in many international review committees, telescope time assignment committees, advisory and publication boards, etc., our faculty have undertaken major leadership roles, heading recently, e.g., Board of the James Clerk Maxwell Telescope, Mid-Term Review of the Canadian Long Range Plan (LRP) for astronomy, Joint Committee for Space Astronomy (CSA and CASCA), CASCA, Board of Trustees of the Ontario Science Centre (vice-chair), Royal Astronomical Society of Canada, Commission on Variable Stars of the International Astronomical Union, and American Association of Variable Star Observers. With the strong and active support of the University, DAA members spearheaded the formation of the Association of Canadian Universities for Research in Astronomy (ACURA), which is now undertaking a major role in implementing the LRP, including the flagship project TMT, the next-generation 30-m optical telescope. TMT will enable detection of distant galaxies as they first form, and also characterization of extrasolar planets. With a total facility cost approaching $1B, Canada's goal of a "second-to-none" partnership clearly requires "big science" funding, but to quote the CFI's MAC, *"we can't afford not to do it."*

Another priority is to provide leadership within Canada to ensure that we develop and have access to next-generation facilities in space (to overcome the effects of the atmosphere: the blurring in the optical, and, more basically, the blocking of major parts of the electromagnetic spectrum, e.g., x-ray, infrared and submillimetre). Because each of these advanced facilities is so expensive, and there is such challenging lead time, forging international collaborations is essential. This is most readily accomplished on the basis of the high value that our researchers bring intellectually to each initiative.

4.3.7 Developing Canadian Networks and International Research Partnerships

Here there is deep experience through CITA, CIFAR Cosmology, Canadian Network for Observational Cosmology, and the Canadian Galactic Plane Survey. A most successful recent network is CFHLS which used 500 nights of CFHT time to tackle problems from cosmology to solar system debris. CFHLS spawned new activity in which the largest telescopes on the world were used to follow up newly discovered distant supernovae. RCS2 is using telescopes in both hemispheres to discover and study distant galaxy clusters. Another large collaboration (25 – 30 people), SpARCS, started by graduate student Muzzin (with Yee), is the world's largest/leading IR/optical search for $z>1$ clusters, using Spitzer/IRAC plus ground-based data. The Gemini Deep Deep Survey for the first time measured spectra of high redshift (1 – 2) galaxies. The Gemini Genesis Survey is poised to search for the earliest galaxies using F2T2 (tunable filter developed here) on the newly commissioned FLAMIGOS2. Development of novel infrared spectrographs for the world's largest telescopes is underway in collaboration with international partners.

Much new activity is devoted to exploitation of new facilities in space, as described above. Planck and Herschel were launched in May 2009, with our researchers playing active roles as Co- and Associate Investigators within three international instrument collaborations to develop the control and analysis software and the best scientific use of the missions. Complementary international campaigns led by us are using the Green Bank Telescope, the DRAO Synthesis Telescope, and the JCMT. Even JWST (launch 2013) is demanding a lot of attention by our three Science Team members for the Near Infrared Camera and the Fine Guidance System, a unique instrument in its own right with an imager behind a tunable filter.

An innovative site testing campaign on Ellesmere Island in the high Arctic is been carried out. Preliminary results for the few nights analyzed so far for image quality indicate that the site is exceptionally good – at the high standard of Mauna Kea, Hawaii.

5. INFRASTRUCTURE AND SPACE

5.1 Research Facilities

Research and teaching go hand in hand and so access to advanced facilities for our graduate students and postdocs is a must. DAA researchers work with the best facilities on forefront problems.

5.1.1 Telescopes and observatories

National and international telescopes. We use major optical and radio facilities at the finest sites in the world and space observatories, all through peer-reviewed competition. "National facilities," those to which Canada has contributed to the construction and operation, include CFHT, DRAO Synthesis Telescope, Gemini, JCMT, and through the NAPRA agreement the GBT and VLA of NRAO (and soon ALMA), and, in space, Herschel, MOST, and Planck (and eventually JWST). Other notable facilities used are Akari, Chandra, Hale, HST, Keck, Spitzer, and VLT.

Collaborations. We have an active experimental program using telescopes on long-duration stratospheric balloons telescopes for cosmological and Galactic research. The most recent was BLAST (Balloon-borne Large Aperture Submillimetre Telescope) and this is being followed by BLASTpol and Spider (a CMB experiment). Under an instrumentation development collaboration with the Carnegie Observatories we enjoy access to the du Pont 2.5-m at Las Campanas. An agreement re the Magellan 6.5-m telescopes has expired but similar agreements should be sought.

Private telescopes. For undergraduate major and specialist students, the 0.4-m Boller and Chivens reflector with SBIG spectrograph, on the roof of the McLennan Labs, and the 0.3-m Questar Maksutov telescope with FLI IMG1024S wide-field CCD camera, at UTSC, are used "hands on." They are also capable of automated, remote, and robotic operation to allow students to carry out observations from "warm rooms" or from home (www.astro.utoronto.ca/~stefan/images/index.html). A small 2-m radio telescope tuned to the 21-cm line of H I is also situated on the roof of the McLennan Labs, but is operated remotely too. The 60-cm Helen Sawyer Hogg Telescope (HSHT) formerly located at UTSO www.astro.utoronto.ca/~utso/ on Cerro Las Campanas in Chile had a remarkably productive record making many discoveries including the nearest and brightest supernova since 1604 and a pure helium star. HSHT is now located in Argentina on Cerro Burek at the Observatorio El Leoncito on permanent loan to the Argentine observatory, in return for which DAA has 25% of the observing time (remote observing from DAA being the goal). It has two new CCD detectors, both with larger format and increased sensitivity in the blue-violet. One is for direct imaging and the other for moderate-dispersion spectroscopy. The DDO with its 1.88-m telescope (the largest in Canada), equipped with a CCD grating spectrograph, has been sold.

Proposed teaching telescopes and a teaching planetarium are described above in Section 3.3.11.

5.1.2 Laboratories and shops

In the basement of the Astronomy Building are three new laboratories for optical/near-infrared instrumentation, including clean room, and a large assembly/integration area incorporating a modest mechanical shop.

Further renovation in the Astronomy Building will be needed in the startup phase of DI, but as was clear from the outset this building, in which we have temporary/interim occupancy, is inadequate both in size and access to meet the goals.

In a separate purpose-built building, the Stratospheric Telescope Integration Facility (STIF), there is a large specialized highbay and associated laboratories on two floors above.

DDO formerly provided shops for electronic and mechanical work. These will have to be replaced by modern facilities. This awaits the development of DI.

5.1.3 Computing

The department manages its own web servers, mail servers, name servers, switches, printers, electronic signage systems, and other IT services and equipment. The majority of computers are Linux based (mostly Red Hat Enterprise Linux and Fedora Core), with smaller numbers of Windows and Mac OS in the mix. There is an undergraduate computer lab with 10 Linux computers, overdue for an upgrade. The networks of DAA consist of two and a half subnets spread across three buildings, the Burton Tower (MP), the Astronomy Building (AB) and STIF. In addition, DI, co-occupying AB, has its own subnet. The total number of computers is well over 300.

DAA and CITA are recognized centres in numerical simulations for astrophysics. Various researchers have developed some of the most powerful numerical techniques in use today. Historically, DAA and CITA have installed a series of competitive machines, including a novel parallel computer (over 500 processors), at the time the fastest computer in Canada (38th in the world). This facility, used effectively to carry out large, hence more realistic, N-body and MHD simulations, has been replaced by a more powerful cluster (electricity costs and physical space were factors in shutting down the original one). Aggressive computation is also required for processing and modeling the enormous amounts of data acquired in modern observing campaigns and this has led to other major computing systems such as to support the Canada-France-Hawaii Legacy Survey (CFHLS). There will be a continuing need for such specialized facilities. It is also important to invest in more exploratory hardware at the cutting edge of new approaches to computing. A case in point currently is GPU-based computing. A small cluster is already in use at UTSC and a large facility is being implemented by CITA (managing space and power again being major issues).

For the largest needs in high performance computing, for modeling, simulations, and data analysis, DAA and especially CITA played an important role in establishing the UofT collaboration SciNet (www.scinet.utoronto.ca), now funded by CFI as a major national node. This has put in place the most capable computing facilities in Canada using a range of architectures optimized for various types of problems. One cluster with 30,000 processors was 16th on the recent world top-computers list and 3rd among universities.

5.1.4 Library

The primary mandate of the Astronomy Library (www.astro.utoronto.ca/AALibrary) is to serve the research and reference needs of faculty, graduate students, and senior undergraduates of DAA and CITA. This it has done admirably. As for all libraries, major issues include the explosion of the literature in both journals and books, and exploiting the dramatic change to publications on line. The DAA Library houses the largest astronomy and astrophysics collection in Canada –

indeed it is one of the best in North America. The collection consists of approximately 25,000 volumes and, although primarily devoted to astronomy and astrophysics material, it also includes physics, mathematics, computer science and other materials of interest to astronomers and astrophysicists. The Library is accessible 24 hours a day, 7 days a week to members of the department. The Astronomy Librarian is dedicated to developing and maintaining the specialized collection and to providing timely information and services that are aligned with the research and study of DAA and CITA and the broader international astronomical community. The Librarian feels it is especially important to assist the graduate students with their studies and to cater to the complexities of their research.

Having a dedicated Astronomy Library is a unique resource for a Canadian university. The physical collection of the DAA Library includes monographs, theses, conference proceedings, sky atlases and catalogues in both print and electronic media, scholarly journals, newsletters and publication series from observatories and astronomical institutions worldwide. The Astronomy Library monograph collection is strong in many astronomical subjects, i.e., galaxy formation and dynamics, star formation and evolution, origin and diversity of planetary systems, globular clusters, instrumentation and cosmology. The Astronomy Library collection is particularly noteworthy due to the extensive holdings of observatory publications from around the world, many of which are complete, going back to the first published volume. The Astronomy Library holdings also contain either print or full-text electronic versions of all the major Astronomy journals. Over the last few years, the monograph collection has seen increased utilization, not only by graduate students but by members of the faculty too.

The Astronomy Library not only provides a physical place that welcomes and contributes to research and learning, but the Librarian works proactively in partnership with members of the department and the larger university community to acquire or provide access to other essential information resources that support the research and scholarship of the department. The subject expertise that the Librarian provides is also a very specialized service. A critical role of the Astronomy Librarian is to set up, maintain and ensure continued access to the electronic publications and journals essential to the department's research and teaching missions, especially as fewer resources are being housed in print.

For several years, the Astronomy Librarian has been involved in teaching a class remotely on Physics and Astronomy Librarianship at the Graduate School of Library and Information Science at the University of Illinois, Urbana-Champaign. Students from these classes have undertaken projects such as redesigning the Astronomy Library website. The Astronomy Librarian has also supervised several student projects from the University of Toronto Faculty of Information and from Seneca College.

In the age of the internet and electronic resources, the traditional concept of a library and librarianship is being redefined as more and more research and scholarship are conducted online. This necessitates that the role of the library and indeed that of the librarian adapt and evolve as well to become more of an information manager. In conjunction with the Internet Archive Project, the *Publications of the David Dunlap Observatory (DDO)* have been digitized at high photographic resolution and been made available online. The *DDO Doings* are also being scanned and will be made available online.

The Librarian has served as the Head of the Standing Committee for the David Dunlap Observatory Astronomical Plate Legacy Project. In this role, the Librarian has undertaken several local digitization projects including making the DDO observing logbooks available online and is involved in a number of North American preservation initiatives.

The Astronomy Librarian is also a member of the Observational Data subcommittee of the American Astronomical Society's Working Group on Preservation of Astronomical Heritage (WGPAH), which is concerned with the preservation and digitization of the archive of ~3 million astronomical photographic plates world-wide. The legacy from DDO alone consists of ~70,000 photographic plates spanning 55 years of observations, incorporating spectrographic and wide-field images. Under the subcommittee's auspices, the Astronomy Librarian co-authored and analyzed a census of all astronomical photographic plate holdings in North America – a final report was issued to AAS in October 2008.

The Astronomy Librarian represented the DAA and DDO at the Workshop on Preserving Astronomical Plates held at the Pisgah Astronomical Research Institute in November 2007. The Astronomy Librarian also instigated and supervised a successful project to evaluate the suitability of commercial scanners to digitize spectral photographic glass plates. Following the workshop and the photographic plate census, the Astronomy Librarian co-edited a book published in October 2009 as an Astronomical Society of the Pacific Conference Series entitled "*Preserving Astronomy's Photographic Legacy: Current Status and the Future of North American Astronomical Plates.*"

There are several projects under way or being planned (external resources are needed) with the final goal of providing online access to the digitized plate images from the DDO photographic plate archives. Among these are projects that involve transcribing the information from the scanned observing logbooks into machine-readable database formats to provide online catalogue access, to finding suitable scanning technologies for the photographic plates, to consolidating existing electronic data.

5.2 Space/Housing

The shift over the years of the centre-of-mass of activities from DDO to the St. George campus, combined with the growth of DAA, accommodation of CITA, and inertia in any moves that involve other occupants of the McLennan Labs, have meant that space is at a premium and additional space had to be scrounged elsewhere. This is about to be exacerbated by the development of DI.

5.2.1 Dispersed space prior to 2006

The dispersion was particularly disadvantageous to our small department engaged in collaborative work and trying to maintain critical mass. UTM and UTSC faculty members are of course not at the St. George campus every day. In addition, there were four other sites:

- DAA and the graduate program are centred on the St. George campus, and occupied the 13th to 16th floors of the Burton Tower of the McLennan Labs (CITA was crowded into the 12th floor). The 13th floor contained offices for faculty and graduate students, the library, a modest seminar room, and the undergraduate computer lab. The 14th floor contained further offices for faculty, students, and administration, a lounge, and a mail/FAX/printing/photocopy room. The 15th floor (not accessible by elevator) contained a conference room, a storeroom, and overflow library space. The 16th floor (more stairs) provides access to the undergraduate observatories.
- Carlberg and the entire CFHLS team had to be housed temporarily in the Greenhouse Tower, in the next block on Russell St. (attached to the Earth Sciences Complex, specifically Geology).

- A unique Stratospheric Telescope Integration Facility was built next to (west of) the Greenhouse Tower. It houses a highbay and, on the upper floors, laboratories.
- At DDO, some 20 km north in Richmond Hill, we had offices, library overflow, catalog storage, data archives, computers, measuring engines, a small auditorium for seminars and public tours, and all of our shops.

5.2.2 Some relief: move to the Astronomy Building in August 2006

With Faculty and University planning support, some consolidation of space has been made in the Astronomy Building (aka the former Nursing building), next to the McLennan Labs. This also needs to accommodate the new Dunlap Institute in its early phase.

CITA moved to the 13th and 14th floor.

5.2.3 Dispersed space at present along Russell Street

The problem of dispersed space is still with us and although there is more space on the St. George campus, a similar amount of space was lost through closing DDO. The situation is:

- DAA occupies the Astronomy Building, sharing with DI
- DAA occupies offices on half of the 12th floor of McLennan
- The DAA library occupies parts of the 13th and 15th floors of McLennan
- The McLennan 16th floor still provides access to the undergraduate observatories.
- The Stratospheric Telescope Integration Facility is the prime home of Netterfield's group.

We have planned office assignments to keep graduate-postdoc-faculty research groups together as closely knit units and to provide undergraduates with dedicated space where they too can benefit first-hand from the ferment of ongoing research, optimizing their student experience. However, the split of the Department and the separation from CITA are major problems still to be addressed.

5.2.4 A new building for all of astronomy and astrophysics

A much-anticipated redevelopment on the nursing site could accommodate all of astrophysics (DAA, DI, CITA). This will require a major effort in advancement and with granting agencies like CFI. It is important that this plan be followed through.

6. ORGANIZATIONAL STRUCTURE AND GOVERNANCE

6.1 Administrative Structure

Historically, the DAA and the DDO have been under the direction and management of one individual, who was both the Chair of the DAA and the Director of the DDO. The incumbent Chair is Peter Martin, for his present term cross-appointed half-time from CITA. He is no longer the Director of DDO, which was closed in 2008, but since that time he has been Interim Director of the DI.

The Chair has ultimate responsibility for the budget, hiring/layoff, evaluation of faculty and staff performance, enrolment planning, the quality of the teaching programs and their delivery, and physical plant and research infrastructure. The Chair reports to the Dean of the Faculty of Arts and Science.

The Chair is assisted in the administration by two faculty members, an Associate Chair Undergraduate (Carlberg) and Associate Chair Graduate (Yee and now Abraham).

6.2 Support Staff

Our staff was restructured on addition of a new staff salary line during the present term of the Chair. An iterative refinement through partial reorganization about two years ago has produced an even more focused and productive administration. Of course, even with a perfect org-chart, the outcome in practice is dependent on the incumbents. In DAA we are fortunate to have dedicated individuals who are working hard towards a responsive and smoothly operating administration. Staff members improve their skills through courses, selected both with a view to fulfilling their job description and to becoming broader so as to cover other positions during vacations or emergencies and to improve their own career opportunities. Because of the small number of DAA staff (see Table 2.3 for comparison to cognate departments), there are not regular and obvious paths for advancement within DAA; one has to look to the broader university for that.

On the near horizon is the development of the DI which will create new needs for staff, in some cases overlapping with those needed in DAA. However, it has to be appreciated that DI is an independent academic unit with its own mandate and priorities. By deliberate and explicit proscription in its founding agreement, DI funds are not available simply to subsidize shortfalls in the FAS budget of DAA. Furthermore, because present DAA staff members are working flat out, any sharing of present DAA staff with DI would result in reduced service to DAA.

6.2.1 Academic program

There is an Associate Chair for each of the graduate and undergraduate programs and these are each assisted by a dedicated staff member. This line of reporting is in practice very effective and provides good service to both the students and the Associate Chairs. Because of the small size of the DAA staff, these two also provide a number of important services to the DAA more generally and can back one another up in emergencies and vacations. The new position mentioned is supporting the new tutorial system and huge TA load in our large breadth courses and is optimizing the use of the undergraduate observatories, our equivalent of laboratories, for experiential learning by all of our students.

6.2.2 Finance, HR, facilities

This is largely concentrated in the key position of the Department Manager assisted by the Financial Officer. This structure embodies the one-up monitoring, signing, and approvals authority needed in a responsible administration and required formally by audit. Because of the small size of the staff, there is no personal assistant to the chair, and so many of these activities (e.g., relating to tenure and promotion, annual performance reviews of faculty, academic planning) fall on the Department Manager along with normal duties like budget oversight, forecasting, physical plant, etc.

6.2.3 Technical staff

DDO had several technical staff. These salary lines were transferred to the DI to support its new mission. A significant outstanding issue therefore is that DAA is dependent on DI (still to be developed) and/or other units for technical services.

6.2.4 Computing

DAA has a full time Computing Facilities Manager who is aided by 50%-FTE part time students from engineering/computer science. This represents a service reduction from a skilled professional as full time assistant. Since they are responsible for managing all aspects of IT, this is a serious shortcoming, both in absolute terms and compared to our competitor peer departments. Given the centrality of IT, appropriate staffing is a matter of concern and deserves ongoing attention. Two undergraduate program students help out as audio-visual assistants for colloquia and G2000.

The user groups can be divided into undergraduates, graduate students, faculty, researchers, staff, and visitors. In general, the department enjoys a pleasant, powerful, and efficient computing environment. Nevertheless, given the central role of computing, this area should be recognized as under-resourced because of a tight budget. This is occurring at a time when computer hardware is cheaper, the number of computers is increasing dramatically, the complexity of the networks is escalating, and new web and IT services are required. However, the post-purchase costs, especially the costs associated with the support of these systems, are not fully budgeted by the research groups or the department. Researchers should focus on their research and students should focus on their studies, with system support and administration carried out by professionals. This desired culture is undermined in a tight budget situation, with either graduate students or researchers managing some computers. If this trend escalates due to inadequate funding, it will inevitably affect many things including research productivity, time to completion in the graduate program, and computer system security and the possibility of data loss.

These factors are rarely accounted for, missing the point that financial savings on one account have academic costs on another. It is a constant struggle to find the right balance. Therefore, an advisory computing committee is being struck to work with the Computing Facilities Manager. The mandate of the committee is policy oriented, though it is hard to completely separate policy, planning, direction, implementation, and coordination. While this and a comparative study of some similar-sized units within the university and beyond will help assess the appropriate level of IT staffing and support, it seems a foregone conclusion that more resources will be needed to remain competitive. As the DI enters full operation, it will generate its own demands for IT support. With deliberate planning an efficient and cost-effective model of IT support serving both DAA and DI might be established.

6.2.5 Web

The technical implementation of the hardware and software servers is under computing. We have a content management system (plone) that allows for distributed entry and updating by other members of staff, faculty members, and the librarian. This is functional, though hardly streamlined. Individuals manage their own research and course pages under a heterogeneous system with little help or guidance. With no common (or minimum!) standard, the result is a range from excellent to woefully out of date, or even non-existent. There are no resources or in-house capabilities for major redesign of the web site and related electronic signage, or even ongoing refinements (the DI web site was developed under a one-off contract with FAS personnel). This no doubt has an impact on all of the things for which the web is touted, including recruiting and outreach. However, since there are no direct metrics of any negative impact, these costs are well hidden and never addressed in a tight budget situation.

6.2.6 Research/contract staff

Not in Table 2.2 for the DAA administrative staff is a contract-funded employee working on the business aspects of implementing Canada's NSERC and CFI funding of the Detail Design Phase of the Thirty Meter Telescope (TMT). She is integrated in "administration alley" in the Astronomy Building but spends all of her time on the TMT. Historically, there have been non-academic staff members hired by professors to advance certain research projects, but there are none at present.

6.3 Governance

DAA is among the smaller departments, which offers advantages with respect to transparency, openness, and consultation in departmental decision making and general feelings of collegiality and inclusiveness. Faculty meetings offer an opportunity for dissemination of information, consideration of committee recommendations, and collective brainstorming on strategic, structural, and cultural issues. There have been a few standing committees and others are struck to meet particular needs. Quite a few initiatives are seeded at morning coffee and developed in meetings of the interested parties and via e-mail discussion. The Chair maintains an open door policy to attempt to be responsive. The Graduate Astronomy Students Association (GASA) sends two representatives to faculty meetings and has over the years initiated many positive changes in policy and practice. There are diverse opportunities for interaction: morning coffee, twice-weekly gatherings after the Department seminar and colloquium, astro tea, dim-sum lunch discussions, admin staff meetings, etc. Collegiality and inclusiveness are also engendered by Department social events: GASA parties (equinoxes), summer picnic, celebration of awards, receptions related to public lectures, the AstroGradNetwork dinner. The Department has a supportive relationship with undergraduates through the Physics and Astronomy Student Union (PASU) and the Astronomy and Space Exploration Society (ASX).

6.4 Relationship with UTM and UTSC, CITA and DI, and Engineering

In context of the graduate program, the faculty members from all three campuses link together in common enterprise under the graduate Chair of DAA, with activities largely at the downtown St. George campus. Tri-campus communication among faculty responsible for the graduate program is good. The communication is facilitated by formal meetings of the Department but also occurs informally (in the hallways, at coffee in the lounge, after colloquia, etc.) and by e-mail.

Otherwise, the UTM and UTSC faculty members maintain (potentially) distinctive undergraduate programs and are responsible to their chairs in the Department of Chemical and Physical Sciences (www.utm.utoronto.ca/~w3cps) and the Department of Physical and Environmental Sciences (www.utsc.utoronto.ca/%7Ephyssci), respectively.

The graduate Chair contributes to the tri-campus faculty performance evaluations annually. By university protocol, the graduate Chair is supposed to be consulted re academic planning and to participate in all search committees for which the candidate would be in the Astronomy and Astrophysics graduate department. This was the case for the *Stepping Up* plan and for the last two hires at UTSC, but with the many subsequent changes of administration at UTSC there has been a lapse and failure to implement the plan. There have been no recent searches at UTM. Faculty renewal at UTM is a critical issue too (see Section 2.1).

UofT astronomy and astrophysics is vibrant, with national leadership and international impact. A collapse of astronomy at UTM and UTSC, whether planned or by attrition, would put us in a diminished position, rather than consolidate our strengths, and so this issue should merit tri-campus consideration. It would of course be a pity for undergraduates at those campuses not to have the opportunity to be exposed to the dynamic field of astronomy and astrophysics. One does not have to be particularly inventive here, because there is a living model that has worked well over the past forty years, one that could be augmented and supplemented by adapting recent innovations and successes on the St. George campus.

CITA and DI. DAA has had close relations with CITA since helping to found it in 1984. Likewise, links with DI are expected to be strong. On a day to day basis, this involves interactions of students, postdocs, and faculty. These are spontaneous, through joint research, and through a plethora of colloquia, discussion groups, etc. (www.astro.utoronto.ca/events). Interactions are encouraged through varied social and athletic activities throughout the year.

Engineering. While there are no formal ties with the Faculty of Applied Science and Engineering, collaborations go back at least as far as the 1950s (see history in 1.2). Currently there are collaborations with UTIAS on BRITE, following the success of MOST. Undergraduate engineering students are engaged in research projects through the Professional Experience Year and through summer employment. Engineering students have had success in our graduate program. We collaborate on the exploitation of space through the UofT Space Program (www.research.utoronto.ca/u-of-t-space-program). Further engagement is expected through the Dunlap Institute.

7. ADVANCEMENT AND ALUMNI RELATIONS

7.1 Outreach www.astro.utoronto.ca/events/public-lectures-tours

Outreach, in its many aspects, is another area that DAA does exceptionally well, systematically and on a much larger scale relative to others in the Faculty. Several of our faculty members have created, organized, and/or delivered innovative outreach programs that have captured international attention. Our research findings have received worldwide media coverage on numerous occasions, and faculty members, graduate students, and postdocs are often invited as commentators by major media outlets (CBC TV and Radio, Globe & Mail, Toronto Star, NPR). Likewise, they are in high demand as speakers for senior alumni events and for public talks outside the University at astronomy clubs, in schools, and for life-long learning groups.

We regularly mount major public lectures of our own and with the outstanding and energetic student Astronomy and Space Exploration Society (ASX: asx.sa.utoronto.ca).

We also work closely with the Royal Astronomical Society of Canada (toronto.rasc.ca) and other local astronomy clubs and through the Education and Public Outreach Committee of the Canadian Astronomical Society (www.cascaeducation.ca/files/index.html). We participate in judging science fairs and special programs at the Ontario Science Centre. This has been a particularly busy year with the International Year of Astronomy (IYA).

Our graduate students have developed and run a successful public night program once a month (www1.astro.utoronto.ca/~gasa/public_talk/iWeb/Welcome.html). Thanks to both advertising and word-of-mouth, these now routinely draw capacity crowds into a 200 seat lecture hall in McLennan after which they visit the telescopes at the campus observatories and on the balcony. Over the year this program represents about $12,000 in volunteer person hours at TA rates (and postdocs and faculty members participate). The above-mentioned planetarium (Section 3.3.11) will be a major new facility for public outreach. The graduate students have been awarded US$2,500 from the Astronomical Society of the Pacific to help acquire a small planetarium system and they are eager to contribute their funds (which must be spent prior to September 2010) towards this larger and more capable facility. This planetarium could be moved to the main lobby of the Physics building for at least some of these events. The planetarium is about 26' feet in diameter and so for a standing crowd can accommodate about fifty people, who then are also free to come and go.

7.2 Alumni and donor relations

Through our AstroGradNetwork (www.astro.utoronto.ca/undergrad/agn) we keep in touch with our undergraduate program students, striving to keep a comprehensive database up to date. The main activity every year is a dinner in November. We also work with other physical science departments on activities at the time of Spring Reunion. This included a well-attended IYA-related lecture this year.

One thing we do not produce is a glossy self-promotional newsletter or annual report as has become common in larger units. This is not for lack of stellar material, but department members at all levels are so stretched delivering on other activities that this has not risen to high priority in the competition for scarce time and resources. Perhaps this has been short-sighted.

Over the years a number of scholarships, fellowships, and memorial awards and lectures have been established by donors. The Department endeavours to deliver on its commitments and provide good feedback to the donors on the effectiveness of their generous contributions.

We worked closely with the Dunlap family over the past decade to develop an ongoing legacy for the original gift by Jessie Donalda Dunlap which founded DDO. This has resulted in the endowment of the Dunlap Institute which future Self Studies should come to see as a landmark event.

Despite other ambitious goals and the dedicated support of staff in development and advancement in the Faculty and University, no gift such as an endowed chair or major support of a research or teaching initiative has been realized yet.

We will maintain good stewardship of the present donations and continue to develop mutually supportive relations with our alumni and potential benefactors. Outreach will remain a focus. A major goal in the immediate future is to develop a plan for a new building to consolidate the activities of DAA, DI, and CITA.

APPENDIX

Table A1. Graduate faculty (2009-10)

Faculty in the Department of Astronomy and Astrophysics

NAME	ACADEMIC RANK	RESEARCH AREA
Abraham, Bob (R. G.)	Professor	High redshift galaxies, the evolution and morphology of galaxies, observational cosmology
Carlberg, Ray	Professor	N-body modeling, galactic dynamics, cosmology
Jayawardhana, Ray	Associate Professor	Star formation, brown dwarfs, exo-planets
Matzner, Chris	Associate Professor	Theory of star formation, molecular clouds, interstellar medium, GRBs
Mochnacki, Stefan	Associate Professor	Binary stars, instrumentation, stellar spectroscopy
Moon, Dae-Sik	Assistant Professor	Instrumentation, supernova remnants, X-ray binaries
Netterfield, Barth (C.B.)	Professor (also 0.5 Physics)	Measurements of anisotropy in the Cosmic Microwave Background
van Kerkwijk, Marten	Professor	Compact objects, stars and binaries, their structure, formation and evolution, and inferring fundamental physical properties
Wu, Yanqin	Associate Professor	Planets: dynamics, interiors, protoplanetary disks, hydrodynamics, resonances; stars: structure, pulsation, nonlinear effects, tides, binaries, white dwarfs, neutron stars, supernova
Yee, Howard	Professor	Galaxy clusters – galaxy population, evolution, dynamics, surveys; high-redshift galaxies; planet searches

Faculty on Contractually Limited Term Appointments

NAME	ACADEMIC RANK	RESEARCH AREA
Marleau, Francine	CLTA Assistant Professor	Cosmology, cosmic microwave background, clusters
Reid, Michael	CLTA Assistant Professor	Star formation

Faculty at UTM and UTSC

NAME	ACADEMIC RANK	RESEARCH AREA
Artymowicz, Pawel	Professor UTSC	Stellar dynamics, extrasolar planet formation
Dyer, Charles	Professor UTSC	General Relativity, gravitational lenses, relativistic astrophysics, cosmology, algebraic computation
Lester, John	Professor UTM	Measurement of stellar spectral energy distributions and of stellar convection, high resolution spectroscopy, atmospheres
Lowman, Julian	Assistant Professor UTSC	Theory of planetary interiors

Faculty in CITA

NAME	ACADEMIC RANK	RESEARCH AREA
Bond, Dick (J. R.)	Professor	Astrophysics & Cosmology – Physics of the Very Early Universe; Origin and Evolution of Cosmic Structure; Cosmic Radiation Backgrounds; Dark Matter & Dark Energy Problems; Particle and Gravitational Theory.
Kofman, Lev	Professor (sadly deceased)	Cosmology, very early universe, inflation, large scale structure.
Martin, Peter	Professor	International Galactic Plane Survey, infrared imaging: HiRes, MSX and Spitzer, H II regions: Orion, structure, dynamics and chemical abundances, dust: interstellar polarization
Murray, Norm	Professor	Non-linear dynamics, planetary dynamics, solar physics, active galactic nuclei
Pen, Ue-Li	Associate Professor	Cosmology, n-body and hydro simulations, CMB, topological defects
Pfeiffer, Harald	Assistant Professor	Gravitational radiation, high energy astrophysics
Thompson, Chris	Professor	Astrophysical sources of high energy radiation (Soft Gamma Repeaters, Anomalous X-ray Pulsars, GRBs), relativistic fluids and magnetofluids, supernova core collapse, accretion flows; and, intermittently, the early universe.

Faculty Emeriti

NAME	ACADEMIC RANK	RESEARCH AREA
Bolton, Tom (C. T.)	Professor Emeritus	Stellar spectroscopy, binary and variable stars, atmospheres and winds of early type stars, and the solar-stellar connection
Clement, Christine	Professor Emerita	Variable stars in globular clusters and other stellar systems
Clement, Maurice	Professor Emeritus	Equilibrium and stability of rotating stellar models, circulation and mixing in stellar interiors
Fernie, Don (J. D.)	Professor Emeritus Director Emeritus	Variable stars, history of astronomy
Garrison, Bob (R.)	Professor Emeritus	Spectral classification, galactic structure, spectroscopy, peculiar stars, morphology of galaxies, instrumentation
Kronberg, Phil	Professor Emeritus UTSC	Radio astronomy, magnetic fields
Percy, John	Professor Emeritus UTM	Variable stars, pulsating variables, Be stars, supergiants, binaries, small amp. variables
Rucinski, Slavek	Professor Emeritus	Binary stars, stellar atmospheres, star formation and evolution
Seaquist, Ernest	Professor Emeritus Director Emeritus	Stellar radio emission, line and continuum radio emission from spiral and irregular galaxies and QSOs

End of Table A1. Graduate faculty (2009-10)

Table A2. DAA Postdoctoral Fellows (2009-10)

NAME	FACULTY ADVISOR	RESEARCH AREA
Bonavita, Mariangela	Jayawardhana	Direct imaging of exoplanets
Breton, Rene	van Kerkwijk	Neutron stars and pulsars
Geers, Vincent	Jayawardhana	Low-mass end of the initial mass function in young nearby star-forming regions
Janson, Markus	Reinhardt Fellow	Detection and characterization of extrasolar planets, brown dwarfs, and very low-mass stars in stellar systems
Lee, Ho-Gyu	Moon	Infrared astronomy and supernova remnants
Muzic, Koraljka	Jayawardhana	Brown dwarfs, bottom of the IMF
Siwak, Michael	Rucinski	Late-type spotted stars; T Tauri type stars
Yan, Renbin	Yee	Galaxy evolution, AGN, and cosmology

Table A3. Employment of former DAA Postdoctoral Fellows
F=faculty, S=professional staff, and for recent members, P=went on to another postdoc

NAME	APPOINTMENT DATE	PRESENT POSITION
Clarke, Jim	1978-1980	F, U Toronto (Computer Science)
Gilmore, Bill (W. S.)	1978-1980	unknown
Carlberg, Ray	1982-1983	F, U Toronto
Taylor, A. Russ	1982-1984	F, U of Calgary
Jeong, Jang Hae	1984-1986	F, Chungbuk National Univ., Korea
Odegar, Nils	1985-1987	F, SSAI, Washington
Stefl, Stanislav	1988	S, Ondrejov Obs., Czech Republic
Quinn, Tom	1986-1989	F, U Washington
Krogulec, M.	1989-1991	F, Univ. Gdansk, Poland
Couchman, Hugh	1987-1989	F, McMaster University
Tribble, Peter	1990-1991	S, RFC for Genomics Research
Ortiz, Patricio F.	1992	S, U Leicester
Ivison, R. J.	1992-1994	S, ATC, Edinburgh
Bietenholz, Michael	1992-1995	S, York University
Colin, Pedro	1995	F, UNAM
Golla, Goetz	1993-1997	P, Bochum
Schade, David	1995-1996	S, CADC, HIA Victoria
Frayer, David	1995-1997	S, Spitzer Science Center
Lin, Huan	1995-1998	S, Fermilab
Gao, Yu	1998-1999	S, Purple Mountain
Hudson, Mike	1998-1999	F, Waterloo
Birk, Guido	1998-1999	F, U Munich
Ensslin, Torsten	1999-2000	S, MPIA, Garching
Wade, Gregg	1998-2000	F, Royal Military College, Kingston
Fischer, Phil	2000-2001	industry
Hall, Pat	1997-2001	F, York University
Allen, Michael	2000-2002	F, Washington State
Hoekstra, Henk	2000-2002	F, Leiden
Lee, Siow-Wang	2000-2002	York District School Board
Zhu, Ming	2002-2003	S, JCMT
Scholz, Alexander	2005-2006	P, University of St. Andrews
Gilbank, David	2003-2007	P, University of Waterloo
Mori, Kaya	2003-2007	P, Columbia University
Sullivan, Mark	2003-2007	P, Royal Society Fellowship, Oxford

Brandeker, Alexis	2004-2007	S, Stockholms universitet
Howell, Dale	2003-2008	F, UC Santa Barbara
Conley, Alex	2005-2008	P, University of Colorado
Krasnopolsky, Ruben	2005-2008	P, ASIAA
Bundy, Kevin	2006-2008	P, University of California Berkeley
Pribulla, Theo	2007-2008	P, University of Jena
Attwood, Rhianne	2009	P, Cardiff University
Perrett, Kathy	2003-2009	federal civil service, Ottawa
Lafreniere, David	2007-2009	P, Montreal

End of Table A3. Employment of former DAA Postdoctoral Fellows

Table A4. DAA Graduate Students (2009-10)

Name	Advisor	Subject
Atkinson, Adam	First Year	
Battaglia, Nicholas	Bond	Non-thermal processes within the intracluster medium and their effects on using galaxy clusters for cosmology
Chou, Richard Chueh-Yi	Abraham & Moon	Observational Studies of Interacting Galaxies and the Development of a Wide Integral-field Infrared Spectrograph
Croll, Bryce	Jayawardhana & Murray	Exploring the diversity of planets in other solar systems
Damjanov, Ivana	Abraham	Dynamical and Structural Evolution of Galaxies from the Peak of the Star Formation Epoch
Farhang, Marzieh	Bond & Netterfield	Probing Early Universe and Reionization with the Balloon-borne SPIDER Experiment
Fissel, Laura	Netterfield	Probing the Role of Magnetic Fields in Star Formation with BLAST-pol
Fung, Jeffrey	First Year	
Gandilo, Natalie	Netterfield	Spider: A Suborbital Polarimeter for Inflation, Dust, and the Epoch of Reionization
Gonçalves, Daniela	Martin	Physical properties of dust and gas in high Galactic latitudes
Gonzalez, Santiago	Carlberg	Supernova Rates and Relations to their Progenitors
Harper-Clark, Elizabeth	Murray	Feedback from massive star clusters
Huang, Zhiqi	Bond & Kofman	Parameterizing and Constraining Dynamical Trajectories of Dark Energy
Kim, Daekwan	TBD	TBD (just beginning 2nd year)
Kratter, Kaitlin	Matzner	The role of gravitational instability in accretion disks
Lepo, Kelly	van Kerkwijk	Precise determinations of neutron-star properties
Lloyd, Emma	First Year	
MacDonald, Ilana	Pfeiffer	Binary black hole interactions, gravitational radiation, LIGO
Mentuch, Erin	Abraham	A search for high-z Lyα emitting sources with the narrowband tunable filter F2T2
Ngan, Wayne	First Year	
Ossokine, Serguei	First Year	
Paciga, Gregory	Pen	Epoch of reionization
Radigan, Jacqueline	Jayawardhana	Weather-induced variability in brown dwarf atmospheres
Rahman, Mubdi	Matzner & Moon	The effects of Massive Star Formation on the Global Galactic Environment
Rivera-Ingraham, Alana	Martin	Understanding the Pre-stellar Stages in Massive Star Formation

Roy, Arabindo	Martin	Probing into Massive Star formation region by Submm Observations
Shannon, Andrew	Wu	Formation and evolution of debris disks
Shariff, Jamil Aly	Netterfield	Instrumentation, stratospheric telescopes
Soler, Juan Diego	Netterfield	SPIDER: Balloon-borne CMB Polarimeter for Inflation, Dust and Epoch of Reionization
Stankovic, Marija	Seaquist	A New View at the Galactic Centre Region – Methanol Emission in the Sgr A* Environment
Tacik, Nick	First Year	
Taranu, Dan	Dubinski &Yee	Evolution and Mergers of Group and Cluster Galaxies
Viero, Marco	Netterfield	How Galaxy Formation Traces Large Scale Structure
Vujanovic, Gojko	Pen	Baryon Acoustic Oscillations: an Innovative Tool to study Dark Energy Dynamics
Yeh, Sherry Chia-Chen	Matzner & Seaquist	The Role of Star Clusters in Driving Large Scale Galactic Outflows

End of Table A4. DAA Graduate Students (2009-10)

Table A5. Employment of DAA Ph.D. Graduates

F=faculty, S=professional staff, and, for recent graduates, P=postdoctoral fellow

NAME	DATE	PRESENT POSITION
Hossack, William Ross	1953	deceased
Halliday, Ian	1954	S, NRC
Bakos, Gustav	1959	F, U Waterloo (deceased)
Demarque, Pierre	1959	F, Yale
Hogg, David	1962	S, NRAO Charlottesville
Morris, Stephen C.	1963	S, HIA Victoria
Innanen, Kimmo	1964	F, York University
Chow, Y. L. (EE)	1965	F, City University, Hong Kong
Demers, Serge	1966	F, U de Montreal
Hallgren, E. L.	1966	unknown
Hartwick, F. David A.	1966	F, University of Victoria
Seaquist, Ernest R.	1966	F, University of Toronto
Coutts, Christine M.	1967	F, University of Toronto
Crampton, David	1967	S, HIA Victoria
McClure, Robert D.	1967	S, HIA Victoria
Mitchell, George F.	1967	F, St. Mary’s University
Racine, Rene	1967	F, U de Montreal
Braun, L. D. (EE)	1968	F, Toronto (EE), presently unknown
Hube, Douglas Peter	1968	F, University of Alberta
Percy, John R.	1968	F, University of Toronto
Sackman, I. Juliana	1968	F (associate), Caltech
Clarke, Thomas	1969	S, Royal Ontario Museum
Fahlman, Gregory G.	1969	DG, HIA Victoria; F, UBC
Goodenough, David G.	1969	S, NRC (remote sensing)
Barnes, Thomas G.	1970	F, University of Texas
Naylor, Mark Dennis	1971	executive at Canadian Pacific
Bignell, Richard Carl	1972	S, NRAO Charlottesville
DuPuy, David L.	1972	F, Virginia Military Institution
Ross, Hugh Norman	1972	minister of religion
Dyer, Charles Chester	1973	F, University of Toronto
Vallee, Jacques P.	1973	S, HIA Victoria
Deupree, Robert Gaston	1974	F, St. Mary’s University
Evans, Nancy Remage	1974	S, SAO
Hagen (Harris), Gretchen	1974	F, University of Waterloo
Harris, William Edgar	1974	F, McMaster University
Herbst, William	1974	F, Wesleyan University
Madore, Barry F.	1974	F, IPAC Caltech
Winzer, John Ernest	1974	F, Georgian College
Bednarek, Theodore	1975	unknown
Hanes, David Alan	1975	F, Queen’s University
Pineault, Serge	1975	F, Laval University
Pritchet, Christopher J.	1975	F, University of Victoria
Campbell, Bruce	1976	P, HIA Victoria (unknown)

Chambers, Robert H.	1976	S, U Toronto (computing)
Gulliver, Austin F.	1976	F, Brandon University
Lake, Kayll William	1976	F, Queen’s University
Teillet, Phillippe Martin	1977	S, Mines & Forests, Ottawa
Irwin, Alan W.	1978	S, University of Victoria
Jakate, Shyam Manohar	1978	unknown
Shore, Steven Neil	1978	F, Universitàdi Pisa
Everson, Bjarne Lee	1979	P, Cambridge, Los Alamos
Maza, Jose	1979	F, University of Chile
Pedreros-Avendano, Mario	1979	F, U de Tarapacá, Chile
Simard-Normandin, Martine	1979	S, NRC Ottawa
Davis, Lindsey Elspeth	1981	S, NRAO Socorro
Fraquelli, Dorothy A.	1981	software development, Lockheed Aerospace
Lane, Mary C.	1981	computer industry
McAlary, Christopher	1981	P, NOAO (deceased)
Rogers, Christopher	1981	F (part-time), Okanagan College
Crabtree, Dennis Richard	1982	S, HIA Victoria
McGonegal, Richard John	1982	S, CFHT
Arellano-Ferro, Armando	1983	F, National University, Mexico
Clayton, Geoffrey C.	1983	F, Louisiana State University
Corbally, Christopher J.	1983	S, Vatican Observatory
Gauthier, Robert Paul	1983	Canada Centre for Remote Sensing
Grieve, Gerald R.	1983	S, U British Columbia (computing)
Wrobel, Joan M.	1983	S, NRAO, Socorro
Crowe, Richard Alan	1984	F, University of Hawaii Hilo
Duric, Nebojsa	1984	F, Wayne State (medical imaging)
Freedman, Wendy Laurel	1984	Director, Carnegie Observatories
Pedreros Avendano, Mario	1984	high school teacher, Richmond Hill
Gies, Douglas Russell	1985	F, Georgia
Noreau, Louis	1985	administrator at NRC
Welch, Douglas Lindsay	1985	F, McMaster University
Gray, Richard O.	1986	F, Appalachian State University
Richards, Mercedes	1986	F, Penn State University
Stagg, Christopher Russell	1986	F, U Calgary and Mount Royal College
Irwin, Judith Ann	1988	F, Queen’s University
Kim, Kwang Tae	1988	F, Chungnam National University, Korea
Leonard, Peter James	1988	S, NASA contractor SSA
Oattes, Lee Michael	1988	S, Toronto (computing)
Rusk, Raymond E.	1988	S, DRAO
Frail, Dale A.	1989	S, NRAO Socorro
Bietenholz, Michael F.	1990	S, York University
Fullerton, Alexander	1990	S, Johns Hopkins (FUSE)
Sasselov, Dimitar Dimitrov	1990	F, Harvard
Zhan, Yin	1990	computer systems manager
Zukowski, Edwin L. H.	1990	high school physics teacher
Dubinski, John Joseph	1991	F (adjunct), U Toronto
Harper, John Francis	1991	S, Toronto (computing)
Hill, Robert James	1991	S, NASA GSFC
Ortiz, Patricio F.	1992	S, Leicester University

Rouleau, Francois	1993	P, Leiden, MPI Jena
Ip, Peter Shun Sang	1994	S, U Toronto (computing)
Li, Gang	1994	medical imaging, Sunnybrook Hospital
Hudon, James Daniel	1995	freelance writer, teacher
Kim, Sang-Hee	1995	P, Korea NO; now patent expert in Seoul
Landry, Sylvie	1995	P, Laval University
Marleau, Francine R.	1995	F, Toronto (S, Spitzer; F, St. Mary's)
Short, Christopher Ian	1995	F, St. Mary's University
Sigut, T. A. Aaron	1995	F, University of Western Ontario
Shelton, Ian K.	1995	F, Mount Allison
Wiegert, Paul A.	1996	F, University of Western Ontario
Brown, James Patrick	1997	financial sector
Hendry, Paul A.	1996	industry
Huang, Siqin	1997	unknown
Lopez-Cruz, Omar	1997	F, INAOE-Tonantzintla, Mexico
Gravel, Pierre	1998	unknown
Kroeker, Teresa Lynn	1998	computing
Papadopoulos, Padeli Peter	1998	F, Athens
Wadsley, James	1998	F, McMaster University
Allen, Michael L.	1999	F, Washington State
Barrientos, Luis Felipe	1999	F, Catolica
Sawicki, Marcin	1999	F, St. Mary's
Clarke, Tracy E.	2000	P, Virginia (was Jansky Fellow)
Kerton, Charles Robert	2000	F, Iowa State
Mallen-Ornelas, Gabriela	2000	P, CfA, now PhD candidate in BME at USC
Verner, Ekaterina	2000	P, NASA GSFC
Hamilton, Devon	2001	S, Ontario Science Centre, Toronto
Zhu, Ming	2001	S, JCMT
Burns, Christopher, R.	2002	F (visiting), Swarthmore
Gladders, Michael David	2002	F, Chicago
Karr, Jennifer	2002	P, ASIAA
Shepherd, Charles	2002	F (temporary), U Toronto Scarborough
Webb, Tracy M. A.	2002	F, McGill
Barkhouse, Wayne Alan	2003	F, University of North Dakota
Reid, Robert	2003	P, DRAO
Zhang, Pengjie	2003	F, Beijing
Brodwin, Mark	2004	P, JPL
Trac, Hy	2004	F, Carnegie Mellon U.
Tycner, Christopher	2004	F, Central Michigan University
Attard, Allen	2005	software industry
Matsuyama, Isamu	2005	P, UC Berkeley
McClure, Megan	2005	P, Dalhousie
Blagrave, Kevin	2006	P, U of T (CITA)
Blindert, Kris	2006	P, Max-Planck-Institut für Astronomie
Durant, Martin	2006	P, Instituto de Astrofisica de Canarias
Bridge, Carrie	2007	P, Caltech
Lee, Brian	2007	P, Florida State University
Li, I-Hui	2007	P, Swinburne University

Mudryk, Lawrence	2007	P, U of T (Physics)
Muzzin, Adam	2007	P, Yale
Khavari, Parandis	2009	P, St. Mary's
Lu, Tingting	2009	Private sector
Nair, Preethi	2009	P, Bologna
Yao, Lihong	2009	S, NRAO
Fernandez, Rodrigo	2009	P, Institute for Advanced Study
Pena, Fernando	2009	P, St. Mary's
Neilson, Hilding	2009	P, Bonn
Nguyen, Duy	2009	P, University of Florida

End of Table A5. Employment of DAA Ph.D. Graduates

Table A6. Graduation Numbers with program types and totals, including average CGPAs for undergraduate programs

	Graduation Session						
	June 2005	**June 2006**	**November 2006**	**June 2007**	**November 2007**	**June 2008**	**November 2008**
Major	3	2		6	2	2	2
CGPA Average	2.72	2.09		2.79	2.99	2.44	2.29
Minor	1			1		1	
CGPA Average	3			2.36		3.9	
Specialist	6	6	1	7		3	
CGPA Average	3.1	2.98	3.01	3.2		3.09	
Total	**10**	**8**	**1**	**14**	**2**	**6**	**2**
CGPA Average	**2.98**	**2.76**	**3.01**	**2.96**	**2.99**	**3.01**	**2.29**

Re GPA, see
www.artsandscience.utoronto.ca/ofr/calendar/rules.htm#grading.

Table A7. CGPA Distribution of all students enrolled in POSts, by year

		2004			
Subject POSt Title		**Specialist**	**Minor**	**Major**	**Total**
ASTRONOMY & ASTROPHYSICS	**CGPA Average**		2.27	2.23	2.26
	Students		42	17	59
ASTRONOMY & PHYSICS	**CGPA Average**	2.79			2.79
	Students	42			42
PLANETARY SCIENCE	**CGPA Average**	2.14			2.14
	Students	5			5
CGPA Average		2.72	2.27	2.23	2.44
		47	42	17	106

		2005			
Subject POSt Title		**Specialist**	**Minor**	**Major**	**Total**
ASTRONOMY & ASTROPHYSICS	**CGPA Average**		2.43	2.15	2.21
	Students		12	50	62
ASTRONOMY & PHYSICS	**CGPA Average**	2.51			2.51
	Students	38			38
PLANETARY SCIENCE	**CGPA Average**	2.25			2.25
	Students	6			6
CGPA Average		2.47	2.43	2.15	2.32
		44	12	50	106

		2006			
Subject POSt Title		**Specialist**	**Minor**	**Major**	**Total**
ASTRONOMY & ASTROPHYSICS	**CGPA Average**		2.35	2.21	2.24
	Students		11	37	48
ASTRONOMY & PHYSICS	**CGPA Average**	2.49			2.49
	Students	33			33
PLANETARY SCIENCE	**CGPA Average**	2.41			2.41
	Students	4			4
CGPA Average		2.48	2.35	2.21	2.35
		37	11	37	85

Table A7 (continued)

		2007			
Subject POSt Title		**Specialist**	**Minor**	**Major**	**Total**
ASTRONOMY & ASTROPHYSICS	**CGPA Average**		2.65	1.98	2.18
	Students		15	36	51
ASTRONOMY & PHYSICS	**CGPA Average**	2.30			2.30
	Students	40			40
PLANETARY SCIENCE	**CGPA Average**	2.00			2.00
	Students	3			3
CGPA Average		2.28	2.65	1.98	2.23
		43	15	36	94

Re GPA, see
www.artsandscience.utoronto.ca/ofr/calendar/rules.htm#grading.

Table A8. Undergraduate Courses Drop Rates

a) Course level: 100

Course	Session	Sec	Course Title	Lecture Section Number	Drop Rate %	Drop Rate Enrolments
AST101 H1	20049	F	Sun & its Neighbours	0101	5.61%	44
AST101 H1	20059	F	Sun & its Neighbours	0101	8.40%	83
AST101 H1	20069	F	Sun & its Neighbours	0101	7.88%	84
AST101 H1	20079	F	Sun & its Neighbours	0101	5.76%	69
AST101 H1	20089	F	Sun & its Neighbours	0101	8.84%	106
AST121 H1	20051	S	Origin Evol Universe	0101	41.54%	54
AST121 H1	20061	S	Origin Evol Universe	0101	36.07%	44
AST121 H1	20071	S	Origin Evol Universe	0101	32.00%	40
AST121 H1	20081	S	Origin Evol Universe	0101	14.94%	23
AST121 H1	20091	S	Origin Evol Universe	0101	34.09%	45

b) Course level: 200

Course	Session	Sec	Course Title	Lecture Section Number	Drop Rate %	Drop Rate Enrolments
AST201 H1	20051	S	Stars & Galaxies	0101	8.32%	83
AST201 H1	20061	S	Stars & Galaxies	0101	13.72%	138
AST201 H1	20071	S	Stars & Galaxies	0101	7.52%	85
AST201 H1	20081	S	Stars & Galaxies	0101	7.94%	95
AST201 H1	20091	S	Stars & Galaxies	0101	12.58%	146
AST210 H1	20049	F	Astronomic Discovery	0101	9.79%	19
AST210 H1	20051	S	Astronomic Discovery	0101	5.10%	10
AST210 H1	20059	F	Great Moments in Ast	0101	7.65%	15

AST210 H1	20061	S	Great Moments in Ast	0101	6.67%	13
AST210 H1	20069	F	Great Moments in Ast	0101	12.72%	43
AST210 H1	20079	F	Great Moments in Ast	0101	0.35%	1
AST210 H1	20089	F	Great Moments in Ast	0101	9.84%	38
AST221 H1	20049	F	Solar/Stellar Astron	0101	32.08%	17
AST221 H1	20059	F	Solar/Stellar Astron	0101	30.43%	14
AST221 H1	20069	F	Solar/Stellar Astron	0101	30.77%	8
AST221 H1	20079	F	Stars and Planets	0101	28.13%	9
AST221 H1	20089	F	Stars and Planets	0101	40.54%	15
AST222 H1	20051	S	Galaxies & Cosmology	0101	9.09%	3
AST222 H1	20061	S	Galaxies & Cosmology	0101	18.18%	4
AST222 H1	20071	S	Galaxies & Cosmology	0101	6.67%	1
AST222 H1	20081	S	Galaxies & Cosmology	0101	12.50%	2
AST222 H1	20091	S	Galaxies & Cosmology	0101	0.00%	0
AST251 H1	20049	F	Life on Other Worlds	0101	24.55%	27
AST251 H1	20051	S	Life on Other Worlds	0101	13.14%	23
AST251 H1	20059	F	Life on Other Worlds	0101	17.53%	27
AST251 H1	20061	S	Life on Other Worlds	0101	22.67%	39
AST251 H1	20071	S	Life on Other Worlds	0101	9.94%	33
AST251 H1	20081	S	Life on Other Worlds	0101	6.36%	22
AST251 H1	20091	S	Life on Other Worlds	0101	15.64%	51
AST299Y 1	20049	Y	Rsch Opportunity Prg	0101	0.00%	0
AST299Y 1	20049	Y	Rsch Opportunity Prg	0201	0.00%	0
AST299Y 1	20059	Y	Rsch Opportunity Prg	0101	0.00%	0
AST299Y 1	20059	Y	Rsch Opportunity Prg	0201	N/A	N/A

AST299Y1	20059	Y	Rsch Opportunity Prg	0301	0.00%	0
AST299Y1	20069	Y	Rsch Opportunity Prg	0101	N/A	N/A
AST299Y1	20069	Y	Rsch Opportunity Prg	0201	0.00%	0
AST299Y1	20069	Y	Rsch Opportunity Prg	0301	0.00%	0
AST299Y1	20069	Y	Rsch Opportunity Prg	0401	N/A	N/A
AST299Y1	20079	Y	Rsch Opportunity Prg	0101	N/A	N/A
AST299Y1	20079	Y	Rsch Opportunity Prg	0201	N/A	N/A
AST299Y1	20089	Y	Rsch Opportunity Prg	0101	0.00%	0
AST299Y1	20089	Y	Rsch Opportunity Prg	0201	0.00%	0

c) Course level: 300

Course	Session	Sec	Course Title	Lecture Section Number	Drop Rate %	Drop Rate Enrolments
AST320H1	20051	S	Intro Astrophysics	0101	5.26%	1
AST320H1	20061	S	Intro Astrophysics	0101	N/A	N/A
AST320H1	20071	S	Intro Astrophysics	0101	7.14%	1
AST320H1	20081	S	Intro Astrophysics	0101	5.88%	1
AST320H1	20091	S	Intro Astrophysics	0101	7.14%	1
AST325H1	20049	F	Intro Practical Ast	0101	22.22%	2
AST325H1	20059	F	Intro Practical Ast	0101	16.67%	2
AST325H1	20069	F	Intro Practical Ast	0101	20.00%	1
AST325H1	20079	F	Intro Practical Ast	0101	0.00%	0
AST325H1	20089	F	Intro Practical Ast	0101	22.22%	2
AST326Y1	20049	Y	Practical Astronomy	0101	0.00%	0
AST326Y1	20059	Y	Practical Astronomy	0101	16.67%	2
AST326Y1	20069	Y	Practical Astronomy	0101	33.33%	3

AST326Y1	20079	Y	Practical Astronomy	0101	50.00%	3
AST326Y1	20089	Y	Practical Astronomy	0101	N/A	N/A

d) Course level: 400

Course	Session	Sec	Course Title	Lecture Section Number	Drop Rate %	Drop Rate Enrolments
AST420H1	20049	F	Topical Astrophysics	0101	0.00%	0
AST420H1	20059	F	Topical Astrophysics	0101	0.00%	0
AST420H1	20069	F	Topical Astrophysics	0101	7.14%	1
AST425H1	20049	Y	Astronomy Research	0101	0.00%	0
AST425H1	20059	Y	Astronomy Research	0101	0.00%	0
AST425H1	20069	Y	Astronomy Research	0101	N/A	N/A
AST425H1	20071	S	Astronomy Research	0101	0.00%	0
AST425Y1	20079	Y	Astronomy Research	0101	N/A	N/A
AST425Y1	20089	Y	Astronomy Research	0101	0.00%	0
PLN420H1	20079	F	Planet Sci Seminar	0101	0.00%	0
PLN420H1	20089	F	Planet Sci Seminar	0101	0.00%	0
PLN425H1	20049	F	Planet Sci Research	0101	N/A	N/A
PLN425H1	20059	Y	Planet Sci Research	0101	0.00%	0
PLN425H1	20069	Y	Planet Sci Research	0101	N/A	N/A
PLN425H1	20071	S	Planet Sci Research	0101	0.00%	0
PLN425H1	20079	Y	Planet Sci Research	0101	0.00%	0
PLN425H1	20089	Y	Planet Sci Research	0101	0.00%	0

End of Table A8. Undergraduate Courses Drop Rates

Table A9. Student Satisfaction: Teaching in undergraduate courses

ASSU Student Survey Results – "All things considered, performs effectively as a university teacher"

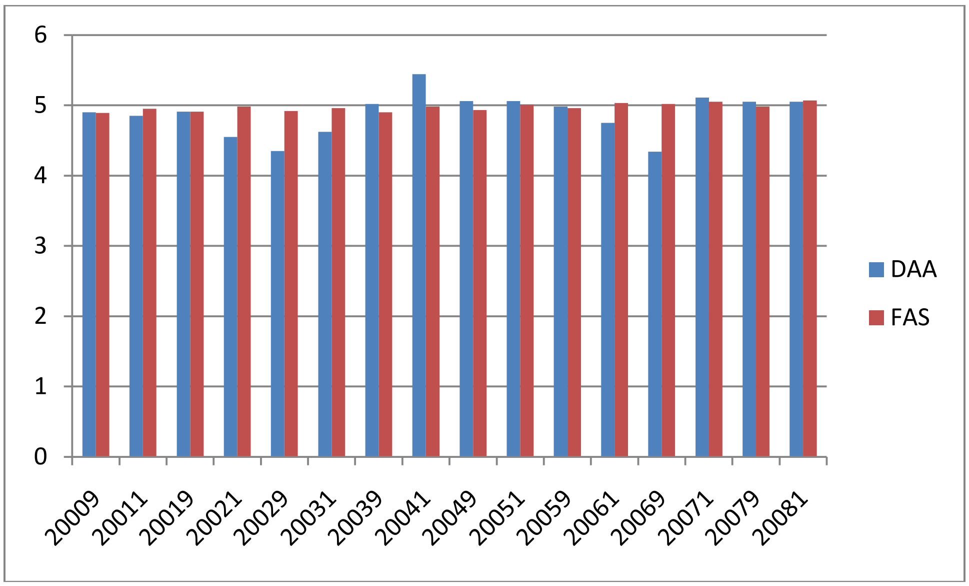
Rating: 1 – Extremely Poor
2 – Very Poor
3 – Poor
4 – Adequate
5 – Good
6 – Very Good
7 – Outstanding

Session	Average Rating	# of Students Responding	FAS Sessional Average	Difference
20009	5.78	502	5.47	0.31
20011	5.56	522	5.59	-0.03
20019	5.70	507	5.56	0.15
20021	5.00	423	5.55	-0.56
20029	5.02	448	5.55	-0.53
20031	5.20	408	5.62	-0.42
20039	5.64	694	5.48	0.16
20041	6.01	575	5.64	0.37
20049	5.66	583	5.60	0.07
20051	5.65	529	5.63	0.02
20059	5.62	478	5.61	0.02
20061	5.34	429	5.68	-0.34
20069	5.09	341	5.66	-0.57
20071	5.58	473	5.70	-0.12
20079	5.74	432	5.66	0.08
20081	5.66	376	5.76	-0.10

Table A10. Student Satisfaction: Learning experience in undergraduate courses

ASSU Student Survey Results – "The value of the overall learning experience is:"

Rating: 1 – Extremely Poor
2 – Very Poor
3 – Poor
4 – Adequate
5 – Good
6 – Very Good
7 – Outstanding



Session	Rating	StDev	# of Students Respon.	1.96*StDev	Sqrt Count	*Standard Error - +*	FAS Sessional Average	Difference
20009	4.90	1.139	399	2.234	19.97	*0.112*	4.89	0.01
20011	4.85	1.235	423	2.421	20.56	*0.118*	4.95	-0.11
20019	4.91	1.189	405	2.331	20.12	*0.116*	4.91	0.00
20021	4.55	1.393	333	2.730	18.24	*0.150*	4.98	-0.43
20029	4.35	1.269	351	2.487	18.73	*0.133*	4.92	-0.57
20031	4.62	1.280	333	2.509	18.24	*0.138*	4.96	-0.33
20039	5.02	1.185	386	2.322	19.64	*0.118*	4.90	0.13
20041	5.44	1.131	344	2.217	18.54	*0.120*	4.98	0.47
20049	5.06	1.222	348	2.396	18.65	*0.128*	4.93	0.13
20051	5.06	1.223	335	2.397	18.30	*0.131*	5.01	0.04
20059	4.98	1.150	281	2.255	16.76	*0.135*	4.96	0.01
20061	4.75	1.192	264	2.337	16.24	*0.144*	5.03	-0.28
20069	4.34	1.375	175	2.696	13.22	*0.204*	5.02	-0.68
20071	5.11	1.270	247	2.490	15.71	*0.158*	5.05	0.06
20079	5.05	1.167	218	2.287	14.76	*0.155*	4.98	0.06
20081	5.05	1.355	214	2.657	14.62	*0.182*	5.07	-0.02

Table A11. Student Satisfactions: Retake for undergraduate courses

ASSU Student Survey Results: “Considering your experience with this course, and disregarding your need for it to meet program or degree requirements, would you still have taken this course?”

Session	Response	# of Students Responding	Retake
20009	yes	397	**82.19%**
	no	86	
20011	yes	377	**76.47%**
	no	116	
20019	yes	381	**77.91%**
	no	108	
20021	yes	259	**65.90%**
	no	134	
20029	yes	264	**63.16%**
	no	154	
20031	yes	271	**69.49%**
	no	119	
20039	yes	345	**77.01%**
	no	103	
20041	yes	331	**83.38%**
	no	66	
20049	yes	322	**83.20%**
	no	65	
20051	yes	310	**81.15%**
	no	72	
20059	yes	257	**78.83%**
	no	69	
20061	yes	239	**75.63%**
	no	77	
20069	yes	120	**60.30%**
	no	79	
20071	yes	233	**83.21%**
	no	47	
20079	yes	196	**78.40%**
	no	54	
20081	yes	193	**78.78%**
	no	52	

Table A12. Graduate Recruitment

*Completed admissions applications & paid the application fees

Period	# of Applications*	PhD		Masters	
		# of Admitted	# of accepted offered	# of Admitted	# of accepted offer
2006-2007	70	24	7	0	0
2007-2008	48	11	6	3	1
2008-2009	40	15	7	0	0
2009-2010	48	8	4	2	2

Table A13. Graduate Enrolment

Period	Total Enrolment (Based on Nov 1 count)	Enrolment - PhD		Enrolment - Masters	
		Domestic	International	Domestic	International
2005-2006	32	17	15	1	0
2006-2007	33	17	16	0	0
2007-2008	32	16	16	0	0
2008-2009	37	20	17	0	0

Table A14. Financial Support for Graduate Students

Year	Measure	No Income in at Least 1 Session	Award Income	Employment Income	Research Stipend	All Income
2006/07	Funding Received	$ -	$ 517,571	$ 200,719	$ 203,771	$ 922,062
	Average Income per Student	$ -	16,174	$ 7,168	$ 9,262	$ 27,941
	Student Count	0	32	28	22	33
	Student Count with 'Funded Cohort = Y'	0	28	25	18	28
2007/08	Funding Received	$ -	$ 526,675	$ 172,397	$ 223,083	$ 922,156
	Average Income per Student	$ -	16,989	$ 6,385	$ 8,580	$ 28,817
	Student Count	0	31	27	26	32
	Student Count with 'Funded Cohort = Y'	0	29	25	22	29
2008/09	Funding Received	$ -	$ 515,158	$ 153,245	$ 264,308	$ 932,712
	Average Income per Student	$ -	15,151	$ 5,108	$ 9,789	$ 25,208
	Student Count	10	34	30	27	37
	Student Count with 'Funded Cohort = Y'	8	30	25	21	31

Table A15. Financial Support – External

Period	# of students in funded cohort	Unit's average UTF	External Support from Federal Council (NSERC)		External Support from Provincial Government (OGS & OGSST)	
			# of students	Total Amount	# of students	Total amount
2005-2006	27	$203,749	4	$73,300	5	$75,000
2006-2007	28	$284,862	3	$59,500	5	$75,000
2007-2008	28	$248,335	3	$65,000	5	$75,000
2008-2009	31	$260,118	5	$113,800	4	$40,000

Table A16. Degree Awarded and Time to Completion

Year	Degree	Number of Graduates	Mean Time to Completion
2004-05	MSc	1	3.00
	PhD	2	4.17
2005-06	MSc	3	1.56
	PhD	3	5.89
2006-07	MSc	2	0.67
	PhD	4	5.42
2007-08	MSc	1	2.33
	PhD	4	5.17
2008-09	PhD	2	7.17

Table A17. Student Experiences
Graduate & Professional Student Survey Results 2005 & 2007

See scanned tables on following pages.

Office of Graduate Education Research
School of Graduate Studies, University of Toronto

Canadian Graduate & Professional Student Survey (Spring 2005)

Results for the Department of Astronomy and Astrophysics (AST)

Fall 2005

I. Survey Participants

AST	Registered	Surveyed	%
Doctoral students	26	16	62%
Research Master's students	1	1	100%
Professional Master's students	0	0	0%
Total	27	17	63%

II. Satisfaction with Program, Quality of Interaction, and Coursework

1. Please rate the following dimensions of your program:

	Excellent %		Very good %		Good %		Fair/Poor %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
1. The intellectual quality of the faculty	41.2	42.1	47.1	42.4	11.8	12.5	0.0	3.0
2. The intellectual quality of students	0.0	23.2	52.9	47.2	41.2	24.1	5.9	5.6
3. The relationship between faculty and graduate students	5.9	14.7	52.9	37.2	23.5	30.9	17.7	17.2
4. Program's ability to integrate recent developments in my field	23.5	20.8	64.7	38.0	11.8	26.8	0.0	14.4
5. Program space and facilities	5.9	11.2	35.3	25.2	47.1	30.3	11.8	33.3
6. Overall quality of graduate level teaching by faculty	0.0	15.5	29.4	40.2	52.9	29.9	17.7	14.4
7. Amount of financial support	0.0	8.0	41.2	19.2	23.5	27.8	35.3	44.9
8. Quality of academic advising and guidance	11.8	13.8	41.2	28.0	23.5	31.7	23.5	26.5
9. Helpfulness of staff members in my department/program	11.8	21.8	64.7	35.4	11.8	28.0	11.8	14.8
10. Assistance in finding employment	0.0	4.1	26.7	16.8	46.7	35.6	26.7	43.4
11. The opportunity to interact across disciplines	0.0	8.5	12.5	21.6	50.0	31.0	37.5	38.9
12. Academic standards in my program	6.3	19.2	56.3	41.9	31.3	29.2	6.3	9.6
13. Overall program quality	0.0	14.1	58.8	46.2	35.3	29.6	5.9	10.1

2. To what extent do you agree or disagree with each of the following statements?

	Strongly agree %		Agree %		Ambivalent %		Disagree/Strongly disagree %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
1. Students in my program are treated with respect by faculty.	11.8	28.5	58.8	52.2	11.8	13.6	17.7	5.9
2. Faculty members are willing to work with me.	35.3	26.8	41.2	53.1	23.5	15.4	0.0	4.8
3. Rapport between faculty & students in my program is good.	5.9	20.0	64.7	54.3	11.8	19.3	17.7	6.4
4. My own relationships and interaction with faculty are good.	23.5	31.0	52.9	52.2	11.8	13.4	11.8	3.4
5. There are tensions among faculty that affect students.	0.0	8.9	17.6	19.4	11.8	28.0	70.6	43.6
6. Financial support for students in my program is distributed fairly.	17.6	6.4	58.8	34.1	17.6	36.6	5.9	22.9
7. Students in my program are collegial.	17.6	18.5	41.2	54.4	11.8	20.9	29.4	6.1
8. My relationships & interaction with other students in my program are good.	17.6	29.0	52.9	56.6	29.4	11.4	0.0	3.1
9. Overall, the climate of my program is positive.	23.5	21.2	47.1	56.6	11.8	14.9	17.6	7.3
10. Program activities foster a sense of intellectual community.	5.9	16.3	47.1	49.0	29.4	22.5	17.6	12.2
11. Program content supports my research/professional goals.	17.6	18.8	58.8	51.3	17.6	19.5	5.9	10.3
12. Program structure encourages student collaboration or teamwork.	5.9	14.9	23.5	36.1	41.2	26.3	29.4	22.7
13. Program structure provides opportunities to take coursework outside my own department.	5.9	16.8	41.2	38.8	29.4	23.9	23.6	20.4
14. Program structure provides opportunities to engage in interdisciplinary work.	5.9	15.1	23.5	37.8	47.1	28.4	23.5	18.7
15. Amount of coursework seems appropriate to the degree.	6.3	16.1	43.8	56.7	31.3	15.8	18.8	11.3

3. General Satisfaction

	Definitely %		Probably %		Maybe %		Probably/ Definitely Not %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
1. If you were to start your graduate/ professional career again, would you select this same university?	17.6	37.2	64.7	37.3	17.6	14.5	0.0	10.9
2. If you were to start your graduate/ professional career again, would you select the same field of study?	52.9	50.6	23.5	29.1	5.9	12.9	17.7	7.4
3. Would you recommend this university to someone considering your program?	41.2	43.3	41.2	31.4	17.6	16.5	0.0	8.8
4. Would you recommend this university to someone in another field?	11.8	30.6	52.9	37.3	35.3	26.6	0.0	5.5

III. Program/Department Support

1. Research Experience

Have you	Yes % AST	Yes % UofT	No / n/a % AST	No / n/a % UofT
Conducted independent research since starting your graduate program?	70.6	72.1	29.4	27.9
Received training before beginning your own research?	31.3	41.5	68.7	58.5
Received faculty guidance in formulating a research topic?	81.3	75.4	18.8	24.6
Conducted your research in collaboration with one or more faculty members?	82.4	46.9	17.6	53.1
Assisted faculty in writing a grant proposal?	23.5	18.7	76.5	81.3
Attended national scholarly meetings?	67.7	68.1	33.3	31.8
Delivered papers or presented a poster at national scholarly meetings?	72.7	67.7	27.3	32.3
Co-authored in refereed journals with your program faculty?	33.3	55.2	66.7	44.8
Published as sole or first author in a refereed journal?	40.0	51.8	60.0	48.2

2. For each of the following statements, indicate the extent that it describe the behavior of your dissertation advisor or chair. (Doctoral students only)

My dissertation advisor:	Strongly agree % AST	Strongly agree % UofT	Agree % AST	Agree % UofT	Disagree % AST	Disagree % UofT	Strongly disagree % AST	Strongly disagree % UofT
a. was knowledgeable about degree requirements.	45.5	45.3	45.5	43.6	9.1	9.4	0.0	1.7
b. served as my advocate when necessary.	60.0	52.0	30.0	41.0	10.0	5.7	0.0	1.3
c. helped me secure financial support for my graduate work.	54.5	43.3	27.3	40.2	18.2	11.3	0.0	5.2
d. considered me a source of labor to advance his/her research.	25.0	14.1	33.3	24.0	0.0	32.3	41.7	29.7
e. gave me constructive feedback on my work.	50.0	46.9	33.3	44.0	16.7	7.2	0.0	1.9
f. returned my work promptly.	36.4	42.6	36.4	42.6	9.1	10.5	18.2	4.3
g. promoted my professional development.	33.3	41.0	50.0	43.5	8.3	12.0	8.3	3.5
h. provided information about multiple career paths.	14.3	16.4	28.6	33.4	28.6	38.4	28.6	11.8
i. would support me in any career path I might choose.	10.0	38.9	70.0	46.7	0.0	10.2	20.0	4.1
j. assisted me in my search for employment.	50.0	27.0	0.0	35.3	25.0	27.6	25.0	10.0
k. overall, performed the role well.	46.2	43.8	30.8	46.2	15.4	7.8	7.7	2.2

3. How helpful was/were your advisor(s) for each of the following activities? (Doctoral students only)

	Very helpful %		Somewhat helpful %		Not very helpful %		Not at all helpful %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
Preparing for written qualifying exams	33.3	38.4	44.4	42.7	11.1	13.9	11.1	5.0
Preparing for oral qualifying exams	28.6	39.9	57.1	43.4	7.1	12.0	7.1	4.7
Finding a dissertation topic	64.3	51.8	28.6	36.4	7.1	8.5	0.0	3.3
Writing a dissertation prospectus or proposal	50.0	46.1	21.4	39.5	28.6	11.6	0.0	2.9
Doing research for the dissertation	35.7	42.2	57.1	41.1	0.0	11.8	7.1	4.9
Writing the dissertation	22.2	41.0	66.7	44.3	11.1	11.0	0.0	3.8

4. How satisfied are you with each of the following?

	Very satisfied %		Generally satisfied %		Generally dissatisfied %		Very dissatisfied %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
Training in research methods	17.6	17.9	58.8	61.3	17.6	16.6	5.9	4.2
Professional relationship with my thesis/dissertation supervisor	46.7	49.7	40.0	39.9	6.7	7.4	6.7	3.0

IV. General Assessment

1. Rate the extent to which the following factors are an obstacle to your academic progress.
Respondents who rate the factors "a major obstacle" to their academic progress

AST	%
Course scheduling	6.7
Availability of faculty	6.7
Family obligations	6.7
Work/financial commitments	0.0
Program structure or requirements	0.0
Immigration laws or regulations	0.0

2. Overall, how would you rate the quality of

	Excellent %		Very good %		Good %		Fair/Poor %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
your academic experience at this university?	20.0	23.6	40.0	42.5	33.3	23.9	6.7	10.1
your student life experience at this university?	13.3	11.1	26.7	30.9	26.7	33.5	33.3	24.5
your graduate program at this university?	13.3	21.7	46.7	38.0	26.7	26.7	13.3	13.6
your overall experience at this university?	13.3	17.5	46.7	40.3	26.7	29.6	13.3	12.6

Office of Graduate Education Research
School of Graduate Studies, University of Toronto

Canadian Graduate & Professional Student Survey (Spring 2007)

Results for the Department of Astronomy and Astrophysics (AST)

Responses of Doctoral and Research Master's Students

Fall 2007

Note: The results from 2005 and 2007 are not fully comparable, as some questions were removed from the 2007 version. Only comparable results are presented below. In addition, the wording of some questions and/or response options changed in 2007. The tables in this report use the questions from 2007 and differences from 2005 are indicated, where applicable. U of T values only include responses from doctoral and research master's students.

I. Survey Participants

AST	Registered	Surveyed	%
Doctoral students	32	12	38%
Research Master's students	0	0	0%
Total	32	12	38%

II. Satisfaction with Program, Quality of Interaction, and Coursework

1. Please rate the following dimensions of your program:

	Excellent %		Very good %		Good %		Fair/Poor %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
1. The intellectual quality of the faculty	41.7	54.2	41.7	35.5	0.0	8.0	16.7	2.2
2. The intellectual quality of my fellow students	25.0	31.3	50.0	46.4	16.7	17.6	8.3	4.7
3. The relationship between faculty and graduate students	8.3	18.6	25.0	39.0	33.3	26.8	33.3	15.6
4. Overall quality of graduate level teaching by faculty	0.0	18.4	16.7	41.5	33.3	26.6	50.0	13.5
5. Quality of academic advising and guidance	8.3	16.4	41.7	31.8	25.0	28.5	25.0	23.2
6. Helpfulness of staff members in my program	33.3	27.3	33.3	35.3	16.7	24.0	16.7	13.4

Note: In 2005, the wording of #6 was slightly different; students were asked about the "helpfulness of staff members in my department/program."

2. Please rate the following dimensions of your program

	Excellent %		Very Good %		Good %		Fair/Poor %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
1. Relationship of program content to my research/ professional goals	16.7	18.4	41.7	35.7	25.0	28.8	16.7	17.0
2. Opportunities for student collaboration or teamwork	25.0	14.1	33.3	28.6	25.0	29.8	16.7	27.5
3. Opportunities to take coursework outside my own department	0.0	20.8	8.3	31.3	58.3	28.5	33.3	19.4
4. Opportunities to engage in interdisciplinary work	0.0	19.0	16.7	27.9	25.0	30.1	58.3	22.9
5. Amount of coursework	0.0	11.1	50.0	34.3	41.7	39.7	8.3	14.9

Note: In 2005, these questions were phrased slightly differently. Students were asked to rate their agreement to statements that mentioned program content in #1 (e.g., "Program content supports my research/professional goals") and program structure in #2 to #4 (e.g., "Program structure encourages student collaboration or teamwork"). In addition, the wording of #5 was different; in 2005, students rated the statement "Amount of coursework seems appropriate to the degree". Please also note there was a difference in response categories between 2005 and 2007 (2005 response categories: "Strongly Agree", "Agree", "Ambivalent", "Disagree"/"Strongly disagree").

3. General Satisfaction

	Definitely %		Probably %		Maybe %		Probably/ Definitely Not %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
1. If you were to start your graduate/professional career again, would you select this same university?	41.7	41.0	33.3	40.3	8.3	12.6	16.7	6.1
2. If you were to start your graduate/professional career again, would you select the same field of study?	50.0	48.9	33.3	31.4	8.3	12.5	8.3	7.1
3. Would you recommend this university to someone considering your program?	50.0	50.9	25.0	31.2	8.3	12.1	16.7	5.8
4. Would you recommend this university to someone in another field?	25.0	29.7	33.3	39.7	16.7	27.1	25.0	3.5

III. Program/Department Support

Note: Results in this section include only those respondents who answered "yes" to the question, "Does your program include a thesis, dissertation or research paper?"

1. Research Experience

How would you rate the quality of support and opportunities you received in these areas?	Yes %		No %		N/A %	
	AST	UofT	AST	UofT	AST	UofT
1. Conducting independent research since starting your graduate program	100.0	94.5	0.0	2.5	0.0	3.0
2. Training in research methods before beginning your own research	91.7	92.3	0.0	3.7	8.3	4.0
3. Faculty guidance in formulating a research topic	100.0	97.1	0.0	1.2	0.0	1.7
4. Research collaboration with one or more faculty members	91.7	82.6	0.0	8.4	8.3	9.0
5. Collaboration with faculty in writing grant proposals	75.0	56.5	8.3	24.0	16.7	19.5
6. Attended national scholarly meetings	66.7	71.3	33.3	28.7		
7. Delivered papers or presented a poster at national scholarly meetings	77.8	69.8	22.2	30.2		
8. Co-authored in refereed journals with your program faculty	71.4	56.9	28.6	43.1		
9. Published as sole or first author in a refereed journal	60.0	55.5	40.0	44.5		

Note: In 2007, participation was calcuated by excluding the percentage of respondents answering "Not applicable" or "Did not participate" from the pool of valid cases. In 2005, students were asked directly whether or not they had participated in activities described in items #1 to #5. Questions were also worded slightly differently, with the greatest difference in item #2 (i.e., in 2005, students were asked "[Have you] received training before beginning your research?"). In addition, although response categories did not change in 2007, please note that "No" and "N/A" responses are presented separately above.

2. For each of the following statements, indicate the extent that it describes the behavior of your dissertation advisor (Doctoral students only)

My dissertation advisor:	Strongly agree %		Agree %		Disagree %		Strongly disagree %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
1. Was knowledgeable about formal degree requirements	58.3	43.2	33.3	47.9	8.3	6.9	0.0	1.9
2. Served as my advocate when necessary	66.7	50.8	25.0	42.0	8.3	5.3	0.0	1.9
3. Gave me constructive feedback on my work	66.7	51.0	25.0	41.2	0.0	5.6	8.3	2.2
4. Returned my work promptly	50.0	46.5	41.7	39.8	0.0	9.8	8.3	3.9
5. Promoted my professional development	66.7	47.2	25.0	40.1	0.0	9.7	8.3	3.0
6. Overall, performed the role well	58.3	48.8	33.3	41.3	0.0	7.2	8.3	2.7

Note: Please note there was a difference in response categories between 2005 and 2007 (2005 response categories: "Very helpful", "Somewhat helpful", "Not very helpful", "Not at all helpful").

3. For each of the following statements, indicate the extent that it describes the behavior of your dissertation advisor (Doctoral students only)

	Strongly agree %		Agree %		Disagree %		Strongly disagree %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
1. Was very helpful to me in preparing for written qualifying exams	57.1	39.5	28.6	41.6	0.0	13.7	14.3	5.2
2. Was very helpful to me in preparing for the oral qualifying exam	55.6	38.1	33.3	43.9	0.0	14.2	11.1	3.8
3. Was very helpful to me in selecting a dissertation topic	45.5	42.0	45.5	43.8	0.0	11.1	9.1	3.1
4. Was very helpful to me in writing a dissertation prospectus or proposal	28.6	39.7	57.1	45.1	0.0	11.9	14.3	3.3
5. Was very helpful to me in writing the dissertation	28.6	40.3	57.1	42.7	0.0	12.3	14.3	4.7

Note: In 2005, respondents were asked, "How helpful was/were your advisor(s) for each of the following activities?" Although the question structure changed only slightly, please note there was a difference in response categories between 2005 and 2007 (2005 response categories: "Very helpful", Somewhat helpful", "Not very helpful", "Not at all helpful").

IV. General Assessment

1. Rate the extent to which the following factors are an obstacle to your academic progress.
Respondents who rate the factors "a major obstacle" to their academic progress

	%
Availability of faculty	8.3
Program structure or requirements	8.3
Work/financial commitments	8.3
Course scheduling	0.0
Family obligations	0.0
Immigration laws or regulations	0.0

2. Overall, how would you rate the quality of

	Excellent %		Very good %		Good %		Fair/Poor %	
	AST	UofT	AST	UofT	AST	UofT	AST	UofT
1. your academic experience at this university?	25.0	34.0	50.0	39.5	0.0	19.1	25.0	7.4
2. your student life experience at this university?	33.3	15.7	16.7	32.4	25.0	30.9	25.0	21.0
3. your graduate program at this university?	25.0	28.6	41.7	40.6	8.3	19.8	25.0	11.1
4. your overall experience at this university?	25.0	23.8	41.7	41.8	16.7	24.0	16.7	10.5