Department of Astronomy & Astrophysics External Review
January 10-11, 2005

February 28, 2005

Introduction: The Review Process and Overview

The External Review Committee (ERC) was composed of Alyssa Goodman (Dept. of Astronomy, Harvard University), Lyman Page (Dept. of Physics, Princeton University), and A. Russell Taylor (Dept. of Physics and Astronomy, The University of Calgary). The ERC met January 10 and 11, 2005 at the University of Toronto Department of Astronomy and Astrophysics (DAA). We spoke with representatives of all elements of the department.

Our predominant observation is that the DAA is in very good shape. There have been impressive scientific results from the department over the past few years; the importance of education at all levels is embraced by the faculty; and the responsibility of sharing scientific discovery with the public is part of the fabric of the DAA, being practiced by faculty, graduate students, and undergraduates alike. The department has a warm, congenial, and positive spirit. The department has enormous potential that we hope continues to be fostered by the University and by the next generation of leadership.

Throughout the world, interest in space based science, astronomy, astrophysics, and cosmology has never been greater. Canadian achievements in astrophysics are highly regarded and are deeply woven into humankind's conception of Nature. The ERC believes that these efforts represent the most important components of the physical sciences in Canada. The combination of CITA and the DAA squarely places the UT as Canada's preeminent home for astrophysical research. The ERC would rank CITA as one of the top two or three institutes in the world for astrophysical research (we do not know of a better institute in cosmology); the department is rapidly approaching the levels of the top US graduate programs (our parochialism results from our current associations!).

As a mark of the new interest in the US, there are three new Kavli centers devoted to astrophysics (Stanford, Chicago, MIT), there are expansion plans at Harvard as part new development in the science faculty, and a large number of universities are targeting astrophysics as a growth area.

Peter Martin's leadership of the DAA over the past five years has been excellent. He was uniformly praised by his colleagues. By external measures, the department is much

stronger than it was just five years ago. The new faculty are of high quality, there is a spirit of cooperation between the faculty with whom we spoke, and much of the ground work has been done to enable an exciting new initiative: the David Dunlap Institute.

Bill Clarke and Christine Clement have shepherded the graduate and undergraduate programs for many years, and can take substantial credit for the excellent reputation of the teaching program at the DAA within Canada and abroad.

In the following we point out areas where we think there could be improvement, keeping in mind that the overall picture is very healthy.

Faculty

It is a pleasure to talk with a diverse group of faculty and hear virtually no grumbling. The junior faculty did not raise any worries; no one felt unfairly treated. The group is writing highly cited papers. Many of the younger faculty are dedicated to high quality teaching at both the undergraduate and graduate levels in addition to their ambitious research programs.

The goal of hiring a strong experimentalist/instrumentalist is endorsed by the ERC.

Overview: Quality of Research Activities

The quality of the research at the University of Toronto ranges from very good to outstanding. The following is limited to the faculty in the DAA. These include Profs. Abraham (c), Bolton, Carlberg (c), Clarke (c), Clement (c), Dubinski, Jayawardhana (c), Martin (c), Matzner, Mochnacki (c), Netterfield (c), Seaquist, van Kerkwijk (c), Wu (c), and Yee (c). The people with whom we spoke are denoted with a (c).

The research on the extra galactic universe involves at least four faculty members and is outstanding. For example, virtually every astronomer in the world has heard of BOOMERanG, the CFHT legacy survey, and the RSCS survey to name just a few projects represented in the department. The community awaits the most recent developments from these projects, as well as new results from BLAST, ACT, Planck, and Magellan related projects. The DAA has found a winning formula here and should foster this core of excellence and leadership. The STIF is one example of infrastructure that will keep the DAA at the cutting edge. New initiatives in computation and the DDI are other important components.

Closer to home, the DAA's role in the International Galactic Plane Survey was strongly appreciated. The observational and theoretical work on star formation, molecular clouds will integrate well into the scientific capabilities and priorities of ALMA.

The research on planets and planetary system is just getting up to speed and developments at the DAA could mesh well with the plans at UTM. This is a growing field and the DAA is off to a great start with the the recent hire of Prof. Wu.

Recruitment and Retention of Junior Faculty

The junior faculty uniformly assert that the DAA is a dynamic, energetic research environment. Over the past several years the department has been very successful in recruiting

active and internationally respected researchers who promise to be leaders in the next generation of discovery. However, the growth in astronomy and astrophysics in North America is probably slightly ahead of the supply of highly talented researchers. Thus, UT will have to be on guard to continue to make the DAA an attractive place. There are three elements to this: 1) Maintain a strong congenial and intellectual environment; 2) Do not overload the faculty with teaching responsibilities or administrative burden; 3) Give the faculty the support it needs to carry out research. Our experience is that even if one grows an excellent department like the DAA, one has to "pay" to maintain it.

Intellectual Environment

The intellectual environment in the DAA/CITA is as strong as anywhere and that is perhaps the most important element for maintaining the DAA's strength.

Teaching/Administrative load

Undergraduates take the DAA courses because they are well taught and delivered by experts, e.g., "the three tenors." Majors stay in the department because they can learn astronomy from experts in the field who are at the research forefront. Graduate students come to UT because the research is excellent. The common element is that the department is strong when its members are experts, excited about their research. There is a fine balance between getting faculty to teach more and giving them the time to maintain their research expertise. The nominal UT teaching load is three classes per year. At peer US institutes, the teaching load is two or less per year. To maintain some kind of parity, Peter Martin has deftly reduced the teaching load of many of the faculty through a few mechanisms at his disposal and external awards. It is important that these efforts be sustained and supported by the administration.

In other sections of this report, we make recommendations about teaching and courses. In following these recommendations, it is important that the net teaching load is not significantly increased. We note that peer US institutions have fewer undergraduate courses and more graduate courses. If the net teaching load were significantly larger, especially for younger faculty, other institutions would look more attractive.

The current levels of administrative burden seems reasonable. However, with the dual retirement of Profs. Clarke and Clement, the burden on the rest of the department will increase. Add to that the necessary replacement of the teaching and advising time devoted to the department by these two and it seems clear that department members should anticipate spending more time on non-research activities. While some increase in load is not unreasonable, the administration should be careful to ensure that DAA members have a healthy amount of research time.

Support

To do research in any subfield of astronomy requires a computer. To submit, process, and serve grants, not to mention other activities, requires administrative/secretarial assistance. To do experimental/instrumental work requires facilities (machine shops, electronics shops, a high bay). The DAA is walking a tight rope on the first two issues. With the Physics

Department shops and the construction of the STIF, there is a healthy level of facilities support, which the DDI will enhance even further.

Though issues of support are discussed elsewhere, we bring them up here because it is often the frustration associated with the lack of support or facilities that drives faculty to entertain alternative positions elsewhere.

Before leaving the question of retention and recruitment, we note that outside of the lack of space the faculty did not express to us any sentiments of undue burdened or unhappiness. This, again, is testament to the wonderful leadership over the past few years.

Undergraduate Education

The department teaches a large number of students with a general interest in astronomy. In many ways this introductory class is its face to the University. Realizing that students learn as much in a class of 200 as 1000, a number of years ago the department redesigned its approach to the class. It now uses young energetic teachers in a group teaching format. Based on course evaluations and the fact that enrollment increases after the first week, we believe this experiment is working. However, this class should be carefully monitored to ensure its continued health.

We had a long conversation with over a dozen undergraduate specialists. We observed that the breadth of Astronomy courses offered to undergraduates is large. (Unusually so by U.S. standards, for example.) We also found that the Department offers skills courses in important areas like Numerical Methods and Practical Astronomy, which give students excellent preparation to go on in either Astronomy or any other technical field.

The range of student preferences as to the mix of Physics and Astronomy required for an Astronomy degree is wide. The optimal phasing of Physics, Math, and Astronomy courses during the undergraduate experience is not clear to the students, and is likely to be different for different kinds of students (e.g., those more vs. less mathematically prepared upon entrance). For example, at some schools physics and math dominate the second year astronomy requirements.

The amount of advising offered to undergraduates is inadequate. In response to these findings, **the committee recommends that the (existing) Undergraduate Curriculum Committee be rejuvenated, and that this Committee meet several times over the coming year to discuss**:

- A new advising plan for students.
- Student and faculty concerns about course content.
- The timing of courses that would allow students to normally graduate within 4 years.

A possible plan for advising undergraduates would be to enhance and advertise the role of the Undergraduate Coordinator for the younger (year 1 and 2) students, and to assign individual faculty mentors (advisors) to the older (year 3 and 4) students. After this initial set of revisions, we suggest that the Undergraduate Curriculum Committee meet once per year to hear student concerns, and then revisit the whole curriculum every 4 or so years. The Committee itself should also have student members.

Graduate Education

The DAA Graduate program has a large affect on Canadian astronomy, nearly 40% of its most recent graduates are hold faculty positions in Canadian universities or professional staff positions at Canadian institutes. Recently the graduate program has undergone restructuring and the future of the graduate program is under internal discussion. The faculty is responsive to the needs of the graduate students and is trying to improve their experience. The students felt the faculty approachable. The ERC made a number of observations:

- We did not get the sense that the majority of the graduate students were as motivated as the faculty. Steps should be taken to increase expectations.

  There is a department-wide discussion on how graduate students should be taught. The opinions vary from a minimalist approach in which students jump right into research and learn from the experience, to a prescriptive approach with a set of eight courses. The level and openness of the discussion appears healthy.

  ¿From our discussions with the students and faculty, we got the feeling that too many of the graduate students did not have a broad knowledge of astrophysics. For the less motivated students, it is too easy to take the minimal number of courses and then to focus too narrowly on a thesis project. **We recommend the introduction of additional academic challenges that take place on or before the end of the second year.** This could take the form of more courses (possibly along the lines of the "Collaborative Program"), a more difficult oral exam over a broader range of subjects, a written exam, or some combination.

  The graduate students report that the teaching quality varies from excellent to fair. This is probably no different than elsewhere. The mini-courses are well received. These considerations should be taken into account for planning the future of the program.

  Regarding the question of motivation, we are impressed by the extent to which the graduates self organize to make public presentations. These efforts exceed similar activities in our departments. We came away wondering how we could inculcate a similar feeling in our students.

- The graduate students would benefit from more guidance and mentoring. Soon after new students arrive, there is a meeting with three faculty members. This new practice is appreciated. The students wished that it happened sooner after their arrival and was repeated at the beginning of the second semester.

  A model that works well other places is that students have a graduate committee with whom they can speak and seek advice. We believe this is preferable to having one appointed position or mixing advice with course work. In discussions with the faculty we got the sense that there were more opportunities available to the students than they took advantage of. **We recommend holding an "open house" with the graduate students to discuss/get suggestions on the advising process.**

- With the world class faculty, we expect that its reach in recruitment and of graduate students could be more international. A clear association of the DAA with CITA in

its recruitment information might leverage the international reputation of CITA in recruitment.

- Even though almost half the graduate students we spoke with were drawn to UT because of CITA, they were still somewhat intimidated by CITA. There was no question that the graduate students were welcome at CITA, but the interaction between the DAA graduate program and CITA is not all it could be. Perhaps the solution to this issue is as simple as having a rotation through CITA for first year students, or for CITA to host social events aimed at graduate students.

- The international character of the graduate body is impressive. We do not think that enough of the world knows of UT's attractiveness. We recommend spreading the word about the grad school throughout Europe, the Middle East, and China. Many efforts are made to recruit US students. We do not know for sure but imagine the comparatively low stipend is a factor in the unsuccessful recruiting rate there.

- The bookkeeping on the number of students that applied and the fraction accepted was not consistent between the department and the Dean's office. The discrepancy was tracked to the difference between electronic and paper applications. There was also an effect having to do with the department's generously sympathetic (and appreciated) approach to applicants who could not afford the application fee. As these records inform the relation between the department and administration, they should be straightened out.

- There are plans to increase the graduate students body by up to 50%. We saw no reason not to do this as long as there is enough space for them. We had complete faith that the faculty would maintain high standards and only accept qualified students.

Relation to Other Units

The balance between CITA and the DAA is healthy. This is a case where one plus one is much greater than two. Outside of increasing the interactions with graduate students and solving issues of space, we would not suggest altering a winning formula.

Interactions with the Department of Physics are present but limited. The University of Toronto is among a very few Departments of Astronomy in North America. At most universities, astrophysics is merged with physics in Departments of Physics and Astronomy. A close interaction with physics is beneficial to undergraduate and graduate students. In the DAA the strongest link with Physics appears to be among faculty involved in instrumentation development, e.g., Netterfield. The development of the David Dunlap Institute may provide an additional opportunity to foster a closer level of interaction with Physics.

The relation to astrophysics research and teaching programs at the other campuses is not clear. We met with Professors Dyer and Percy. Undergraduate programs at UTM and UTSC are independent of the DA. There does not appear to be strong coordination of programs at the research and graduate school level. Planning for planetary science research at UTM

appears to be largely independent of research planning at the DAA. While there is a potential missed opportunity for a more cohesive and integrative approach to planning and hiring, this diversity is not seen as significantly detrimental to the DAA.

Department Administration

Peter Martin's stewardship of the DAA has successfully placed it on a phenomenally rising trajectory. An extrapolation of this trajectory would take the Department to a level comparable with the best Astronomy departments in the U.S. Therefore, leadership of the DAA is especially critical of the coming few years. The committee does not find an obvious successor to Prof. Martin amongst the existing DAA faculty. It may be that an external search for a Chair would be best. The DAA, as a rising star on the academic astronomy scene, and its association with CITA would already be enough to attract top-notch candidates for such a position. When the impending formation of the DDI is factored into the mix, it seems that shepherding the DAA becomes quite the plum job for an ambitious established astronomer seeking an important leadership role within our community. In any case, it appears that the selection of a leader for the DAA at this juncture is an unusually critical decision.

The retirements of Profs. Clarke and Clement, both to happen in the coming year, also present an administrative challenge. Prof. Clarke has been serving as Graduate Coordinator in the DAA and Prof. Clement as Undergraduate Coordinator a very long time. Both have done very well in these roles, and the institutional knowledge residing in these two faculty members is immense. A strategy for ensuring continuity of service in these roles should be a high priority.

The committee feels that many of the more administrative tasks currently carried out by the Undergraduate and Graduate Coordinators could be passed on to an administrative staff member (see below). The more academic (advising) aspects of the jobs should be carried out by a faculty member. We discuss issues around the advising of students elsewhere in this report.

In order to add administration of the undergraduate and graduate programs to the tasks of the current DAA administrative staff, an expansion in staffing seems required. Even without these new duties, it appeared to the committee that the current highly-efficient staff were already overtaxed by their current duties. Of particular concern was IT support. Only one person, plus a 10-hour-per-week student helper, now support(s) the DAA's 200 computers. In industry, the norm is 1 sys-admin per 30 computers. We realize that a public university cannot meet this standard, but 1-per-200 means that faculty are spending a fair amount of time on system administration, which does not seem an effective use of their time.

Enhanced IT support would also allow for an expansion/enhancement of the DAA's web presence, and for more courses to include an on-line component. Both of these areas seem to have been pushed to the back burner purely for lack of time on the part of both the faculty and the (IT) staff.

Facilities and Support Staff

Office Space

The lack of available office/lab space significantly impedes the DAA from realizing its full potential. Every faculty member, post doc, and graduate student commented on this limitation, most without being asked. For example due to a lack of office space, the CFHT group was located two buildings away from the DAA and CITA. The effect is to isolate the post docs and graduate students from the rest of the DAA and CITA. Given the large overlap between their scientific goals this is unfortunate. Other examples of the impact of the lack of space for the DAA include: making it a second choice as a meeting space for collaborations, limiting the number of short term visitors to the department, and limiting the abilities to host sabbaticals. More space would also foster interactions between the postdocs and graduate students.

Our primary recommendation is that the University, DAA, and CITA should meet and plan a method to grow the available space. The plan should be implemented as soon as possible. This expansion should be considered in light of the increasing visibility of astrophysics around the world and the increasing standing of the DAA.

Library

The library is in good shape. In scientific research, electronic journals are the primary source of information. Collections of journals and books, while important, are used less. Libraries are increasingly becoming conduits to information as opposed to sources of information. It may be efficient to combine more of the department IT activities with library activities.

Quality interaction space is also important to foster communications among faculty and students and enhance the collegial environment. The Library could play a role in this capacity.

Future Directions

While committee members will file a separate report on the DDI, it seems important to comment here on the expected and potential effects the DDI would have on the DAA (and on CITA). In short, if the current DDO could be transformed into a new Institute on-campus, hosting the kind of instrumentation effort under discussion as a first emphasis, the DAA's output and reputation can be expected to be dramatically enhanced in several ways. Canada's entire commitment to the TMT would be on firmer ground, and the breadth of work within the DAA (+CITA) would extend to cover all important areas of endeavor in astrophysics (observation + computation + theory + instrumentation). The potential effects of the DDI are complex, in that they depend in detail on its exact staffing plan and emphasis. We only comment here that close cooperation between DDI planners, all members of the DAA, and the long-term members of CITA seems essential for maximizing the DDIs near- and long-term future impact, and for minimizing the potential to fracture astronomy efforts in Toronto into too many pieces.

SCHEDULE FOR THE EXTERNAL REVIEW
OF THE DEPARTMENT OF ASTRONOMY AND ASTROPHYSICS

Unless otherwise mentioned, all meetings will take place in the Conference Room, 15th Floor, Burton Tower

MONDAY, 10 JANUARY 2005

	Time	Location	Notes
Morning			
	7:30	Hotel Inter-Continental Signatures Restaurant (main floor)	**Breakfast meeting** with Dean Pekka Sinervo and Acting Vice-Dean Jonathan Freedman (reservations made in Dean Sinervo's name)
	9:00	Room 1402, 14th Floor, McLennan Labs	Peter Martin, Chair
	9:50	Conference Room	Bill Clarke, Associate Chair and Graduate Coordinator
	10:20		**Coffee break, in camera**
	10:30		John Percy (Professor, UTM)
	11:00		Ray Jayawardhana
	11:30		Barth Netterfield
	11:50	Stratospheric Telescope Integration Facility	(tour re BLAST: Netterfield, Martin)
	12:10	2nd floor Greenhouse Tower	Ray Carlberg (tour re CFH Legacy Survey activities)
	12:45	4th Floor Lab, STIF	**Lunch with post-docs**
Afternoon:	1:50	Conference Room	in camera opportunity
	2:00		Yanqin Wu
	2:30		Charles Dyer (Chair, Department of Physical and Environmental Sciences, UTSC)
	3:00		GASA (Graduate Astronomy Students Association)
	3:30		GASA, **coffee on the fly**
	4:00		Christine Clement, Undergraduate Coordinator
	4:30		Stefan Mochnacki (tour re undergraduate observatories)
	5:00		Undergraduate Students
	5:45		(end) (according to protocol, the committee is on its own for **dinner**)

TUESDAY, 11 JANUARY 2005

			(according to protocol, the committee is on its own for **breakfast**)
Morning	8:30	13th floor library	Lee Robbins, Librarian (tour of library, ending on15th floor)
	9:00	Conference Room	Administrative Staff DAA -- Angela Choi, Toni Young, Hugh Zhao
	9:30		Bob Abraham
	10:00		**Coffee break, in camera**
	10:15		Slavek Rucinski
	10:45		~~Tom Bolton~~
	11:15		Marten van Kerkwijk
	11:45		Howard Yee
	12:15-2:00		**Lunch with some faculty** (host Peter Martin)
Afternoon	2:00		Dick Bond, Director, CITA
	2:30-4:00	Room 2008, Sidney Smith Hall 100 St. George Street	Reviewers prepare draft Review Report
3:30	~~4:00-5:30~~	Room 1005, Sidney Smith Hall 100 St. George Street	Debriefing meeting with Dean Sinervo and Acting Vice-Dean Freedman