

# **DUNLAP INSTITUTE FOR ASTRONOMY AND ASTROPHYSICS**

## **Proposal for the establishment of an EDU B in the Faculty of Arts & Science**

### **1. VISION**

As a renewal of the memorial that founded the David Dunlap Observatory (DDO), the Faculty of Arts & Science proposes the establishment of the Dunlap Institute for Astronomy and Astrophysics as an EDU B. Creation of the Dunlap Institute presents a unique opportunity to ensure that the Dunlap name continues to be recognized internationally as a defining indicator of excellence in astronomy and astrophysics.

When the David Dunlap Observatory opened in 1935, it housed the second largest telescope in the world; research at DDO has underpinned the University's strong international reputation in astronomy and astrophysics, and personnel trained at DDO have branched out to advance the discipline within Canada and internationally. Likewise, the goals of the revitalized Dunlap legacy are set very high. Funded through the endowment created from the sale of DDO, the Dunlap Institute intends to become a major player on the world scene and through its programs and its alumni/ae to have a lasting impact on the discipline in the profound way that has come to be associated with the Dunlap name. The Dunlap Institute's academic program in astronomy and astrophysics, coupled with strong outreach to the public, exemplifies this vision. The program will build upon the principle of bringing strong research leaders together with top students and postdoctoral researchers and state-of-the-art facilities.

This is an opportune time for such an initiative. There is intense public interest in astronomy and a thirst for discovery and understanding – witness the public outcry at the demotion of Pluto's planetary status. Indeed observational advances are being made almost daily, and this pace seems certain to continue as the next generation of telescopes now being built or planned (both on Earth and in space) come into operation. These new observatories will be optimized to study the very fundamentals, nothing less than the structure and evolution of planetary systems, stars, galaxies, and the universe. Complementary efforts in astrophysics, both on underlying basic theory and on modeling/numerical simulation using high performance computers, will be essential to an understanding of these observational advances.

The University of Toronto is well positioned to participate vigorously in these initiatives based on its investments in personnel and related infrastructure in the Department of Astronomy and Astrophysics (DAA) and the Canadian Institute for Theoretical Astrophysics (CITA), leadership in the Cosmology and Gravity Program of the Canadian Institute for Advanced Research (CIFAR), and creation of a cluster of chairs under the Canada Research Chair (CRC) program. The stimulus provided by the establishment of the Dunlap Institute will enhance and consolidate the University's work in astronomy and astrophysics within the top tier internationally, and the Institute will complement these existing resources.

## **1.1 Mandate of the Dunlap Institute**

The Dunlap Institute will provide leadership in and support of astrophysical research of international prominence. The Dunlap Institute may engage in and support each of the several approaches to research – computational, experimental, instrumental, observational, and theoretical – with a holistic outlook, combined with advanced training and effective outreach.

The Dunlap Institute’s commitment will be to enrich the astronomy and astrophysics research enterprise at the University of Toronto, complementing, adding new dimensions to, and growing beyond what is already possible through DAA and CITA.

To accomplish this, the Dunlap Institute will mount its own programs/projects or work to build programs in collaboration with local, Canadian, or international researchers. Programs will normally be of finite duration, clearly defined at the outset, and will have strong review requirements. It will be most effective for the Institute to search out opportunities and then focus its resources through particular research projects to ensure a recognized impact on answering the big questions. Preference will be given to programs that seed new activity or leverage additional contributions.

## **1.2 Scope of this Document**

This document presents a vision and long-term mission for the Dunlap Institute. Because the Institute will be endowed, its activities will extend and continue into the foreseeable future. In many aspects this document is like a charter, with the tone intentionally permissive rather than prescriptive. The document also addresses practical details of implementation.

## **1.3 External Review**

An independent peer review of the Department of Astronomy and Astrophysics was carried out in 2005 by three internationally-recognized experts: Alyssa Goodman (Department of Astronomy, Harvard University), Lyman Page (Department of Physics, Princeton University), A. Russell Taylor (Department of Physics and Astronomy, University of Calgary). In addition, they considered the draft mission statement for the Institute, strongly endorsing those plans. They write that “The vision for the Dunlap Institute is inspired,” and that “We cannot imagine a better way to carry on the Dunlap legacy.”

## **2. MISSION AND GUIDING PRINCIPLES**

The Dunlap Institute is intended to assume a prominent leadership position in research, teaching and advanced training, and public outreach. The original gift of the David Dunlap Observatory placed the University of Toronto among the first rank of institutions in the world. The initiative made possible through this revitalization of the legacy will help ensure the premier status of the University in astronomy and astrophysics.

## 2.1 Objectives

Specific objectives of the Institute are:

- to be an international centre of research excellence where fellows and visitors will conduct and promote scholarly research in astronomy and astrophysics;
- to promote fruitful interaction between astronomers engaged in observations, experimentation, simulation, and theory;
- to provide the leadership and core strengths to create major national and international research collaborations;
- to promote advanced training opportunities for graduate students, postdoctoral fellows, and research associates;
- to organize and host international scientific workshops and meetings;
- to explore and exploit the use of new technologies in advancing research in astronomy and astrophysics;
- to provide a primary means for channeling information on astronomy and astrophysics to the general public.

Features of the Dunlap Institute that will be important for achieving these objectives include:

- leadership, provided by the involvement of faculty of international stature;
- a stimulating environment provided by the close interaction of all levels of the research staff: chair-holders and cross-appointed faculty, research associates and postdoctoral fellows, graduate students and undergraduate specialists, and national and international visitors;
- an active visitors program, including specialized workshops and scientific meetings;

and more specifically, from the point of view of technology:

- an instrumentation development fund;
- leading-edge computing equipment;
- workshops and laboratories;
- technical personnel.

Astronomy and astrophysics research has an increasingly international reach; the Dunlap Institute must be engaged internationally. Research personnel will be a key focus, and the Institute's goal will be to create an international centre of excellence where fellows and visitors will join faculty and students to conduct and promote scholarly research in astronomy and astrophysics. The Institute will take an integrative approach in its programs, promoting fruitful interactions among astronomers pursuing different approaches to research and providing the foundation for creating major national and international research collaborations.

The stimulating milieu of the Dunlap Institute will be ideal for inspiring and enriching the best young minds in astronomy and astrophysics, be they research associates, postdoctoral fellows, graduate students, or senior undergraduate specialists. Just as personnel trained at the David Dunlap Observatory have fanned out into influential positions across Canada and internationally, alumni/ae of the Dunlap Institute will be

expected to have a profound impact on the development of astronomy and astrophysics world wide.

Technology plays many roles in advancing this science. Dedicated experiments and more general-purpose scientific instrumentation are both valuable. The Dunlap Institute will participate in such experiments and in the design, fabrication, and implementation of scientific instrumentation for well-defined and strategically-chosen research projects on world-class ground and space-based observatories.<sup>1</sup> In addition, the use of computers, both for simulations of complex phenomena and for analyzing massive amounts of data, has been revolutionary, and among new developments will be data mining in the era of virtual observatories. Thus a broad range of computational activities is expected to be of interest to the Institute. The exploitation of any technology requires skilled people. While people resources should be paramount, achieving the most effective balance with technology will be central to the success of the Dunlap Institute.

The mission of the Institute will remain unfulfilled unless the results of research are brought with passion to the general public. Not only is public interest high, but astronomy is formally part of the elementary and secondary school curricula in most provinces, and there is need for pre-service and in-service teacher education. There is already an existing informal network in the Greater Toronto Area, linking the University with the Royal Astronomical Society of Canada, the Mississauga Astronomical Society, the Royal Ontario Museum, the Ontario Science Centre, and York University. With the continuity of dedicated leadership in outreach, the Dunlap Institute will be an effective main node in the cross-Canada astronomy public education network and will be plugged into international networks as well. For outreach and broader education in the public sector, links to the Ontario Institute for Studies in Education in the university (OISE/UT) will be valuable.

## **2.2 A Responsive and Adaptable Ethos**

The fundamental ethos of the Dunlap Institute must be to be responsive and adaptable. It should be recognized that not all of the specific programs and activities illustrated below need be in place simultaneously. Indeed, the range of possibilities will no doubt outstrip the available core funding, and so it will be incumbent on the Institute to identify new opportunities, to set priorities, to optimize its programs, and to leverage its resources to achieve the highest impact. When it comes to personnel, the Institute must have programs and policies that engender responsiveness and flexibility, and for any permanent/continuing appointments must attract exceptional researchers and technical staff who both as individuals and as part of the team embody these criteria.

A corollary is that as an organizational strategy the Institute will adopt a project focus, at any given time being engaged in a limited number of specific programs targeted explicitly to achieving success on particular challenging questions.

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<sup>1</sup> Canada's current decadal Long Range Plan (LRP) for astronomy and astrophysics gives as its highest priority for universities *the creation of laboratories for experimental astrophysics*, pointing to the *disappearance of university instrumentation laboratories as a potential point of critical failure in Canadian astronomy*. It is essential for our graduate students to be trained in the development of first rank hardware for the next generation of international and world observatories.

## 2.3 Dynamic Links to Other Academic Units

In addition to close interactions with DAA and CITA, the Dunlap Institute will benefit both itself and the University by establishing interdisciplinary and/or cross-disciplinary links to other academic units/activities in the Faculty of Arts & Science as well as across the University. Perhaps the more obvious links are to physics<sup>2</sup> (whence the name “astrophysics” after all), but bridges to other physical and life sciences will be explored vigorously too.<sup>3</sup> On the technology side there is much to gain as well through interactions with the physical sciences and the Faculty of Engineering.<sup>4</sup> Astronomical investigations have very demanding requirements and present many exciting challenges across a range of disciplines. Modern technical shops are becoming increasingly expensive, both in the sophisticated equipment required and in the skilled personnel to run them. Thus attention will be given to a possible tiered structure with both local resources and resources shared across several disciplines in, for example, joint high-level physical sciences technical services.

## 3. IMPLEMENTATION

### 3.1 Governance

The Dunlap Institute will be headed by a Director, appointed by the Dean of the Faculty of Arts & Science under the University’s *Policy on the Appointment of Academic Administrators*. The Director will report to the Dean of the Faculty of Arts & Science. Control over the Institute’s programs and projects will rest with an internal Steering Committee, drawn from faculty actively involved in the Institute’s work, and chaired by the Director.

There will also be an Advisory Committee for the Institute. Up to two descendants of Jessie Donalda Dunlap will be members of that Committee in perpetuity or so long as there are descendants available and willing to act. The Committee will meet at least annually to receive the report on the management of the endowment and the expenditure of the income there from and it shall have such other advisory functions as may be prescribed by the Vice-President and Provost of the University in accordance with its Statement on the Role of Advisory Bodies.

### 3.2 EDU Status and Relationships with other Units

The Dunlap Institute for Astronomy and Astrophysics is the renewal of the memorial that founded the David Dunlap Observatory. As described in the vision and mandate, the themes and programs pursued by the Institute will be chosen to complement, build upon, and consolidate the strengths already embodied in the national theory institute CITA and in the DAA, for example by engaging in advanced astronomical instrumentation. There are many opportunities to enhance interactions within the University and indeed nationally and internationally, and for interdisciplinary initiatives. To further its

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<sup>2</sup> Current examples would include particle astrophysics (SNO and SNOLab and dark matter detection) and gravity-wave detection (LIGO and LISA).

<sup>3</sup> Emergent areas include astrobiology, astrochemistry, bioastronomy, cosmochemistry, ...

<sup>4</sup> For example, aerospace and satellite technology (UTIAS); material science, MEMS, and nanotechnology (electrical engineering, Emerging Communications Technology Institute, mechanical engineering, physics, chemistry); light interactions with materials (Institute of Optical Sciences); structural design (civil engineering).

interdisciplinary programs, the Institute may establish collaborative graduate programs with cognate Departments and Faculties. With the real prospect of endowed faculty positions, the Institute will be established with the status EDU B so that it can hold minority faculty appointments.

### **3.3 Academic Personnel**

The strategy for bringing the Dunlap Institute to high international stature is rooted in the research and advanced education carried out by the faculty associated with the Institute. The opportunities created through the Dunlap Institute will attract top-ranked astronomers and astrophysicists to Toronto, and the appropriate engagement and support of such personnel will be a significant focus and commitment.

#### **(i) Expert Faculty, Distinguished Chairs, Research Professorships**

It is important that the Dunlap Institute benefit from expert faculty members attuned to the particular goals on which the Institute chooses to focus from time to time. These faculty members will bring critical expertise to themed research fields<sup>5</sup> in which the Institute is determined to make an impact through specific programs. They will provide leadership in these areas both directly and through their teaching and supervision of research fellows and graduate students, and will guide the development and teaching of astronomy and astrophysics throughout Canada and internationally.

There are a number of effective arrangements that can be contemplated. For example, as resources permit, the Institute will create distinguished endowed chairs with either career (more normal) or limited-term (more flexible) appointments. In addition, commitments will be formalized for specific terms or projects by cross-appointment (status only) from the Department of Astronomy and Astrophysics and from cognate departments as appropriate.

#### **(ii) Research Associates and Postdoctoral Fellows**

As demonstrated by the success of CITA, a continually changing pool of talented individuals with three to five year postdoctoral or research associate appointments will enable the Dunlap Institute to respond rapidly to changing research themes in astronomy and astrophysics. Young researchers are approaching their productive best and have the freedom to focus on their research; as such they are a cost-effective investment.<sup>6</sup> The Dunlap Institute will create focused teams for concerted attacks on particular scientific problems or targeting development of specific instrumentation or experiments.

The stimulating environment of the Dunlap Institute will be a magnet for postdoctoral scholars with their own funding (e.g., postdoctoral fellowships from the Natural Sciences and Engineering Research Council [NSERC], the Canadian Space Agency, International Awards from the US National Science Foundation, etc.). In some cases, such as the current NSERC fellowships, the basic award will need to be supplemented in the form of

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<sup>5</sup> Broadly defined these will encompass fields of long standing and healthy maturity (relatively speaking at the time, e.g., currently observational cosmology), as well as others more recently developed (e.g., star and planet formation), and those rapidly emerging (e.g., astrobiology).

<sup>6</sup> As emphasized in Canada's current decadal Long Range Plan (LRP) for astronomy and astrophysics, Canada presently offers relatively few opportunities for funding people at this level, making this aspect of the Dunlap Institute all the more compelling.

a prestigious Dunlap fellowship to be competitive. This is an example of the leverage that would characterize the Dunlap Institute strategy.

### **(iii) Students**

Students will also gravitate to the Dunlap Institute, drawn by the prospect of close interactions with senior personnel. The Institute need not develop an accredited PhD graduate program of its own. Graduate students will register in the Department of Astronomy and Astrophysics or in one of the cognate departments<sup>7</sup> as appropriate and will be supervised by faculty in the Dunlap Institute with appropriate cross-appointments. The Institute anticipates establishing collaborative MSc graduate programs with cognate Departments and Faculties as appropriate to furthering its programs, for example in astronomical instrumentation.

The high-quality students that will be attracted to the Dunlap Institute will usually arrive with their own scholarship funding, e.g., from NSERC, provincial governments, or foreign equivalents. But given the intense competition for the best students, the prestige of Dunlap scholarships as a supplement to these awards will be a valuable recruiting tool.

Likewise, senior undergraduate specialists in astronomy and astrophysics, planetary sciences, engineering, etc. will benefit from close one-on-one interactions. With its emphasis on research productivity, and exploitation of modern technologies in instrumentation, experimentation, and computation, the Dunlap Institute will provide a rich training ground for all of these exceptional students.

### **(iv) Visitors Program**

A sign of a healthy and influential institute is its strong ties to the international community. The Dunlap Institute will be a key node on the international circuit that active researchers will want to visit, in order to exchange new observations, ideas, and theories, and to plan new initiatives. Visitors will come for various periods of time, from a few days to deliver a colloquium, to a term or more (e.g., on sabbatical leave) to engage in collaborative work at the Dunlap Institute.

## **3.5 Administrative and Technical Support and Library Facilities**

The scientific, technical, management, and outreach activities of the Institute will demand expert support from dedicated staff, some continuing staff-appointed and others on contract. These areas of service will include: personnel; business (budget, finance, procurement, and grants); project management; engineering and design; electrical, optical, and machine shops; computing; web and other organizational and outreach services. The balance among these areas will depend on the specific directions chosen and priorities established by the Institute from time to time.

The Department of Astronomy and Astrophysics has developed a library of international stature that owes much of its quality to its long association with the David Dunlap Observatory. This library, increasingly providing services in electronic form, will be a

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<sup>7</sup> Including Chemistry, Computer Science, Geology, Mathematics, Physics, and departments in the Faculty of Applied Science and Engineering.

major asset to the Dunlap Institute, as it has been to CITA.

### **3.6 Resources**

The Dunlap Institute will be underwritten in large part by the expendable income from the new endowment. There are other complementary resources historically associated with the David Dunlap Observatory that, through the metamorphosis of the memorial, the University intends will accrue to the Dunlap Institute.

The Dunlap Institute is also expected to enhance its influence several fold by using its funding as the critical lead contribution to build strategic collaborations and to exploit matching and leveraging opportunities on a time-limited, project basis. In this way Dunlap Institute personnel could develop and/or gain access to, for example, the most advanced instruments, the largest telescopes, and/or the fastest computers.

### **3.7 Budget**

In advancing its mission in astronomy and astrophysics, major categories of expense for the Dunlap Institute will include but will not be limited to:

- salaries and stipends for personnel at various levels to carry out research;
- scholarships and fellowships;
- research expenses;
- visitors program;
- scientific workshops and meetings;
- administrative services;
- workshops, laboratories, and related technical services;
- instrumentation and new technology – both the subject of research and to enable research – including computing equipment;
- outreach.

Relative priorities and distribution will change from time to time and will be set by the Director and Steering Committee.

### **4.7 Space**

The University will provide space for the Institute on the St. George campus, in close proximity to the DAA, CITA, and the Department of Physics, which physical presence for the Institute will distinguish it prominently amidst these surroundings.

As a first step, FAS has arranged that the Dunlap Institute will be housed in the Astronomy and Astrophysics Building at 50 St. George Street. This will provide space for beginning a wide range of activities: offices for scientific personnel, administrative and technical support, laboratories and workshops, computing services, and interaction areas like small classrooms, (video-)conference rooms, and lounge.

The other main occupant of 50 St. George Street, also on an interim basis, is the Department of Astronomy and Astrophysics which also occupies space in the McLennan Physical Laboratories along with CITA and the Department of Physics. It is ultimately desirable to house together all of the astronomy and astrophysics activities represented in



the Dunlap Institute, DAA, and CITA. Among the possibilities is complete redevelopment of Site 9 within an expanded building envelope. New capital funding will have to be identified.

#### **4. SUMMING UP**

The creation of the Dunlap Institute for Astronomy and Astrophysics presents a unique opportunity to ensure that the Dunlap name continues to be recognized internationally, closely associated with excellence in astronomy and astrophysics. Renewal of the Dunlap memorial in the form of a world-class institute is a very exciting prospect for the University of Toronto. It is a privilege that requires careful stewardship. The vision and plans presented here illuminate the path ahead.