2019 Pre-Budget Consultation

Submission of the Coalition for Canadian Astronomy

August 2018

Coalition for Canadian Astronomy
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Recommendations

- Create an official entity for funding applications for big science projects.

- Provide the above with sufficient funding for Canadian researchers to take advantage of international collaboration opportunities on big science projects.

- Establish a new vision for the Canadian Space Agency that includes space science, with annual funding of $100 million to support competitions for small, medium and large space missions.

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Introduction

The Coalition for Canadian Astronomy is composed of:

- Academia: represented by the Association of Canadian Universities for Research in Astronomy (ACURA) and its 20 member universities;
- Professional astronomers: represented by the Canadian Astronomical Society (CASCA);
- Industry: represented by Canadian companies involved in major astronomy projects.

The Coalition is united behind the Long-Range Plan for Astronomy and Astrophysics (LRP), a decadal plan first launched in 2000 and renewed in 2010, with a view to sustaining Canada's international leadership in this field. The LRP process, backed by Coalition support, has created a legacy of success, with astronomy consistently ranking as Canada's top science and Canadians continuing to be at the forefront of this field globally. At the same time, Canadian astronomy is becoming increasingly diverse as it moves towards a better understanding of career barriers facing certain groups.

However, two significant and related challenges require urgent attention. First, for ground-based astronomy, there is still no official funding mechanism for big science projects, like international telescope collaborations, which are critical to maintaining Canada's international leadership. Second, the same problem exists for space-based astronomy, though here the Canadian Space Agency (CSA) is the logical home, but it is not presently constituted for that purpose.

Our submission offers recommendations to address both challenges, but first provides background on the scientific and economic success story of Canadian astronomy and how it relates to Canada's future economic growth and competitiveness and deepening relationships with important trading partners.

Canadian Astronomy and Astrophysics: A Scientific and Economic Success Story

In standard analyses of per capita impact, Canada is ranked #1 in the G7 in Astronomy and Astrophysics. Within Canada, the field has a higher world impact than any other science or engineering research area.

The Council of Canadian Academies and a report by Hickling, Arthurs & Low to the National Research Council have documented this success, from which all astronomy stakeholders have benefited. For example, the number of universities with graduate programs in astronomy has grown from 3 in the 1960s to 20, and the population engaged in astronomy research in Canada doubles every decade. The membership of CASCA has more than tripled. Meanwhile, Canadian industry has reaped hundreds of millions of dollars in direct astronomy support work and resulting spin-offs, with new industries and companies created – and with more to come.

None of this happened by chance; it is the outcome of the LRP and Coalition approach. The LRP calls for Canadian participation in a carefully crafted portfolio of next generation projects and is renewed each decade based on extensive consultation with the astronomy community and external peer review.

While fundamental scientific research has always been the primary goal, we are also proud of the resulting economic benefits. Things like WiFi, laser eye surgery, high-resolution x-ray imaging and even the technology being used to search for Ebola and Zika vaccines are spin-offs from astronomy research. The priority projects identified in the LRP for future investments offer great

potential in new technology areas like optical science, high speed data networking, remote sensing, space technology and large-scale computation. That is why Canadian industry has always been a partner in the Coalition, along with our scientists and universities.

Funding Mechanism for Big Science Projects

Like most scientific disciplines, astronomy is moving to next generation facilities, or what are commonly known as "big science" projects: facilities with huge price tags, multiple international partners, long planning and construction cycles, and even longer operational lifetimes.

While this applies to both ground- and space-based astronomy, this section focuses on the former since there is a logical home for funding big science in space, namely the CSA. For ground-based astronomy, the lack of an official big science funding mechanism means scientists are forced to spend time away from their research lobbying for financial support as a decision on engaging in a project lands at the political level and requires a commitment outside existing budget planning, which is a huge challenge and creates uncertainty with project partners.

The Coalition has previously recommended the establishment of a big science fund or funding mechanism, a view that was echoed by the report on the Fundamental Science Review. We were hopeful such a mechanism would emerge from a recently announced consultation on a new $275 million Tri-Council Fund focused on international, interdisciplinary and high-risk research activities, but it does not appear designed for this purpose.

Furthermore, the proposed Tri-Council Fund is insufficient to keep Canada at the forefront of global big science. To put it in perspective, the $275 million for the new fund is over five years. However, the flagship project of Canadian astronomy, the Thirty Meter Telescope (TMT), received a financial contribution from the Federal Government of $243.5 million in 2015. In other words, had astronomy been directed to this fund when Canada's TMT commitment was due, it would have consumed 89% of its five-year funding. However, this is the level of investment required for Canada to have a "second to none" role in such projects and the opportunity for Canadian industry to supply key components.

Therefore, Canada still needs a formal entity to which applications for big science projects can be made, and the funding needs to be of a sufficient scale to take advantage of opportunities for international scientific collaborations. To determine what that number should be, the Government should consult with disciplines on their emerging priorities. For astronomy, for example, with our decadal plan we can project infrastructure and operational costs on a long-term basis with a reasonable degree of accuracy. If all disciplines had a similar approach the Government would have some ability to plan financially over a long timeframe for potential big science projects.

Recommendation #1: Create an official entity for funding applications for big science projects.

Recommendation #2: Provide the above with sufficient funding for Canadian researchers to take advantage of international collaboration opportunities on big science projects.

A New Vision for the Canadian Space Agency

Canada's leadership in ground-based astronomy is largely due to exceptional collaboration between universities, industry and government. That same potential exists in space – including the very real possibility of leading an international space mission – but the key partner that has been missing is the government, as currently embodied by the CSA. While the CSA works diligently to support human spaceflight, it is not resourced to support and reap the benefits of an active space-based science portfolio.

The solution lies in a reconstituted CSA that has a vision for space astronomy and funding to support regular space missions. Because missions take more than a decade to plan, a sustained government commitment is necessary. A $100 million annual investment would allow for regular competitions for small, medium and large space projects, including Canadian leadership of a flagship space exploration mission. This money would flow to high technology industry-university partnerships and leverage entry into technology markets hundreds, if not thousands, of times larger. The $100 million figure represents a per capita investment in space astronomy that is roughly half the scaled per capita astrophysics budget of NASA.

This annual investment would cover the existing and emerging opportunities for Canadian space astronomy (see below), and a portfolio of around a dozen other projects that would realize Canada's potential to be a space leader while growing the industries that support space science. Conversely, if Canada does not invest, the scientific and industrial expertise currently housed here will go elsewhere.

Recommendation #3: Establish a new vision for the CSA that includes space science, with annual funding of $100 million to support competitions for small, medium and large space missions.

Economic Benefits

Space is the window into everything happening on our planet and beyond. Technologies that allow us to look out to the Universe beyond also help to look down and understand problems closer to home. Climate change, communications, natural resource management and national defence owe many advances to space science and exploration. The countries that best appreciate the value of space will reap the benefits. Centuries ago those countries that pushed the boundaries of exploration on the earth's surface became the world's dominant economic powers. Today that next frontier is space.

Investing in space science would stimulate vigorous interaction between scientists and aerospace companies, building on Canada's already strong reputation for industrial work to support space projects. These are investments in industries of the future. Past investments in space science have generated and advanced technologies like fine guidance sensors, metrology systems, digital frequency multiplexing readout systems, while imaging Fourier transform spectroscopy and wavefront sensor technology, which have both ground- and space-based applications, are about to energize export markets.

Looking ahead, the market for the space industry is projected to grow from $350 billion to $1-2.7 trillion by the 2040s. For example, the market for industrial metrology is projected to be $13 billion by 2023, and for intersatellite communications $5 billion by 2025. Space science is an investment in Canada's future economic competitiveness and diversity.

Space Opportunities for Canada
There are two near-term space missions that offer enormous economic and scientific potential for Canada.

Wide Field InfraRed Survey Telescope (WFIRST): This NASA observatory is designed to settle essential questions about the nature of dark matter, dark energy and gravity itself, and to obtain images and spectra of exo-planets around nearby stars. WFIRST images will as sharp as those of the Hubble Space Telescope, but at over 100x the area. This allows it to survey the astronomical sky with speed and accuracy, uncovering millions of galaxies. This is NASA's next major flagship observatory and it is currently in formulation phase, with launch expected in 2024.

Canadian companies involved in WFIRST include COM DEV, ABB, NuVu Cameras and many others. However, in June 2018, a lack of funding forced Canada to exit the mission. While potential opportunities remain, windows of opportunity are short and our international reputation has suffered.

Cosmological Advanced Survey Telescope for Optical and Ultraviolet Research (CASTOR): CASTOR is a proposed Canadian-led mission that would make a unique, powerful and lasting contribution to astrophysics by providing panoramic, high-resolution imaging in the UV/optical spectral region. This versatile and innovative 'smallSAT'-class mission would far surpass any ground-based optical telescope in terms of angular resolution and provide the highest resolution UV/optical survey ever taken over an area 1/8th of the entire sky.

While simultaneously breaking new ground in science areas such as galactic archaeology, quasar monitoring, star formation and stellar astrophysics, it would also provide ultra-deep imaging in three broad filters to supplement longer-wavelength data from planned international dark energy missions. CASTOR would combine the largest focal plane ever flown in space with an innovative optical design that delivers quality images over a field two orders of magnitude larger than Hubble. No planned or proposed astronomical facility would exceed CASTOR in its potential for discovery at these wavelengths.

Conclusion
Almost any day of the week Canadians will see reports about major astronomy discoveries, many involving Canadian researchers. Canada's global leadership in ground-based astronomy is something to be proud of and can be used to stimulate the next generation to pursue a career in the STEM fields. That same potential exists with space, including the incredibly exciting prospect of Canada leading a space mission. However, both are contingent upon establishing funding mechanisms that allow Canada to take advantage of the opportunities presented as a result of our current world leadership.

Finally, in sustaining that scientific leadership, the Government can also stimulate the hundreds of companies that support astronomy work, with enormous – and proven – spinoffs that create jobs and position Canadian industry for the economy of the future.

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