

**House of Commons  
Standing Committee on Finance  
2006 Pre-Budget Hearings**

**Canada's Place in a Competitive World**

**Submission by  
the Coalition for Canadian Astronomy**

**Tuesday, September 5, 2006**

## Executive Summary

The Coalition for Canadian Astronomy believes that the Federal Government should continue investing strategically in scientific research, thereby ensuring Canada remains competitive and prospers in the global, knowledge-based economy. Strategic scientific investment is just as important, if not more so, than government investments in traditional manufacturing or resource industries. Such funding has to be seen as an investment in Canada's economic future and a public good, as vital to our economy as roads and ports or other types of infrastructure.

We understand that the Government cannot, and should not, invest in everything. Resources should be focused where results are proven and returns are the greatest. Astronomy is at the top of that list, since it has a proven track record of delivering concrete benefits to the economy and our universities, industries and workforce.

Astronomy is marketable scientific research, meaning Canada not only benefits from the scientific achievements and discoveries resulting from that research, but also from the economic opportunities generated through the knowledge gained in developing the tools and equipment needed for astronomy projects.

The Coalition has both a short-term and a long-term recommendation. In the short term, the Coalition is seeking the Government's continued financial support for the Long Range Plan for Astronomy and Astrophysics (LRP). Through the Federal Government, the National Research Council, and the Canada Foundation for Innovation, the LRP has received nearly \$90 million since 2000. **Approximately an additional \$225 million is required over the next seven years to complete the priority projects identified in the Plan**, including the construction of the world's largest telescope (see appendix 1).

Long term, the Government needs to adapt its funding mechanisms to suit the realities of globalized scientific research. The future lies in major international projects with costs in the hundreds of millions and lifespans in decades. Canada's astronomy community has adapted to this changing reality. We selected our project priorities after a detailed assessment of which would most enhance our position in international astronomy.

Unfortunately, government funding mechanisms have not adapted to the changing realities, with no long-term funding capability, nor a coordinated plan to focus resources on our areas of greatest strength. Canada can be middle of the pack in several disciplines, or world leader in a few. We believe the latter delivers more benefits to Canadian science and the economy.

Therefore, long term, **we recommend that the Federal Government re-examine its approach to scientific funding to ensure that those disciplines with a proven track record of success are given priority for project funding**. Our Coalition model should serve as a model for other disciplines, offering a coordinated approach to scientific research that involves all relevant stakeholders.

Canadians want a better future for their children. That is only possible if Canada can keep up with the rest of the world. Scientific investment is critical to that.

## **Introduction**

The Coalition for Canadian Astronomy is pleased to make the following submission to the House of Commons Standing Committee on Finance for the 2006 Pre-Budget Consultation. We will address head-on the question that most people will automatically ask: what does astronomy have to do with a Federal Government Budget focusing on *Canada's Place in a Competitive World*.

We will demonstrate that investments by the Federal Government in astronomy have paid huge dividends to the Canadian economy, providing hundreds of jobs, hundreds of millions in business revenue and, of particular note, technological advances and expertise that have helped establish Canadian industry as world leaders in fields as diverse as telescope design and construction, the design of sophisticated theme park rides, and computer visualization and video production.

The Coalition for Canadian Astronomy feels strongly that **strategic investments in marketable scientific research are critical to ensuring Canada's long-term economic competitiveness in the global, knowledge-based economy**. Moreover, our Coalition approach serves as a model for the efficient and productive use of scientific investment funds that the Government can use to determine how future resources should be allocated.

In short, when carried out in a strategic and coordinated way, Federal Government investment in scientific research will not only ensure Canada can take a leadership role in specific disciplines, but will also further our international competitiveness and our ability to adapt to rapid technological change. Furthermore, these investments will help Canadians acquire the skills needed to seize new market opportunities the world over. As we will demonstrate, this is already happening thanks to prior investments in astronomy research.

## **Who We Are**

The Coalition for Canadian Astronomy was formed in 2000 and is unprecedented in the Canadian science community. For the first time, we brought together representatives from the astronomical community, academia and industry to chart a course for scientific excellence in the field of astronomy.

The Coalition was our response to the challenges posed by the internationalization of astronomy. The engineering scale and technological sophistication of next generation telescopes requires the intellectual and financial resources of the world astronomy community to plan and construct them. Canadian astronomers had to make a conscious effort to be a part of this new era.

After lengthy debate and discussion within the astronomical community, a set of priorities was identified that formed the basis of the Long Range Plan for Astronomy and Astrophysics: *The Origins of the Structure in the Universe*, or LRP. The LRP vision document was created by a Blue Ribbon Panel to chart a course for Canadian astronomy over this decade and beyond. It calls for Canadian participation in the next generation of global astronomy projects, coupled with investments in technology development in Canada, the training of young Canadian scientists and engineers, and intellectual leadership in the planning and operation of facilities by Canadian astronomers.

By developing the LRP, the astronomical community forced itself to focus on a select few projects through which Canadian astronomers could make an impact. There were many projects that the community chose not to pursue. The community's ability to come together and agree on these projects is essential to our success. Once the astronomy community agreed upon its priorities, all stakeholders were needed to work towards its goals – and academia and industry were immediately identified and the Coalition was born.

On the academic side, the Association of Canadian Universities for Research in Astronomy, or ACURA, was formed at the very senior levels of university administration, bringing together 22 Canadian universities with astronomy programs.

A partnership with industry was also sought, since so many of our projects require highly specialized design, with price tags often into the hundreds of millions of dollars. Canadian firms that engaged in the LRP stood to benefit greatly from the projects identified therein.

We are now half way through the LRP and a mid-term review completed earlier this year validated our efforts to date and established the funding required to complete the Plan. Our achievements are detailed in the next section.

However you measure it – scientifically, academically or economically – astronomy is a Canadian success story. Astronomy is Canada's top exported science and we are consistently ranked among the top three nations in the world in astronomical research. Our success was even noted in the *New York Times*, which commented wryly on a recent citation study that showed Canada ranked first among 62 nations in a measure of research impact in astronomy. **Better yet, our successes in astronomy have delivered concrete benefits to the Canadian economy.**

We credit our tremendous success to our truly extraordinary Coalition relationship. We are aware of no other sector where a scientific community, academia, and industry work so well together to ensure the success of a plan.

## **Why Invest in Astronomy?**

The simple scientific answer to the question above is to further our understanding of the origins of the structure of the universe. However, we are well aware that those concerned with fiscal matters may be looking for more tangible (and economic) reasons. For this consultation process, the Committee wants to know how investing in astronomy will make Canada more competitive. The Coalition is equally proud of its scientific achievements as we are of the economic benefits we have delivered to Canadians. **We believe astronomy is marketable scientific research, meaning we not only benefit from the scientific achievements and discoveries resulting from that research, but also the economic opportunities generated through the knowledge gained in developing the tools and equipment needed for astronomy projects.**

Outlined below are three primary areas in which astronomy research is contributing to the economy and ensuring Canada remains competitive globally: through the contracts awarded to Canadian firms, the spin-offs technologies developed from working on astronomy projects, and the skills developed in the workforce and in our universities in doing so.

### *Contracts Awarded*

As mentioned earlier, astronomical research today involves projects that cost into the hundreds of millions of dollars. An example is Canada's involvement in the Thirty-Metre Telescope, which is currently in the design phase and when completed will be the world's largest. Building this telescope is a massive and costly undertaking. Canada is one of the international partners in this project and a Canadian company, AMEC, is poised to win a \$100 million contract to design and build the enclosures and structure for this telescope. To date, Canada's partnership in this project has only cost \$6 million. By any measure, that is an incredible return on investment – through jobs created, new skills learned, and tax revenue.

Designing and building telescopes is an area of expertise developed by AMEC starting in the 1970s when Canada became a partner in the Gemini Twin Eight-Metre telescopes. That initial investment led to a \$44 million contract for AMEC to build the domes for these telescopes. AMEC's structural design expertise generated through the involvement with this project and the Canada-France-Hawaii telescope has now grossed over \$300 million, not including the pending \$100 million contract for the Thirty-Metre Telescope.

Through its work on the development and construction of astronomical facilities, AMEC now supports a large cluster of companies throughout Western Canada who are subcontracted to develop and maintain various elements of these projects.

There are several other examples of Canadian companies being awarded contracts to support LRP projects. For several of these companies, it is the first time they have ever been involved in astronomical pursuits:

- INO of Sainte-Foy has been contracted to study development of the advanced, super-durable coatings needed for the Thirty-Metre Telescope mirrors and is participating in the conceptual design for an extreme adaptive optics return.
- Teraxion (formerly DiCos) of Sherbrooke was selected to provide the Master Laser System for the Atacama Large Millimetre Array (ALMA) in Chile.
- Nanowave Technologies of Toronto is providing low noise amplifiers for Band 3 software development for the Thirty-Metre Telescope.
- Breconridge in Kanata, Ontario, was contracted to provide a \$100,000 feasibility study for work on the Square Kilometre Array, positioning it for downstream contracts.
- Contracts to support space astronomy have been awarded to EMS Technologies Inc., ComDev, Dynacon Inc. and Routes Inc., all Ontario-based companies.

These contracts translate into jobs and income for Canadians. However, these contracts will only continue to flow to Canadian companies if we continue to partner in international astronomy projects.

**Canada has received a two-to-one direct return for every dollar invested by the Federal Government in astronomy research thus far.** This return on investment is even more impressive when you consider the businesses that are getting contracts to support our astronomical research. All are in the high-tech field, providing Canadian companies an opportunity to distinguish themselves in this advanced sector.

Without Federal Government investment in astronomy, these opportunities would not have presented themselves.

### *Spin-off Technologies*

The second benefit of astronomy funding to the competitiveness of the Canadian economy comes from spin-off technologies generated from knowledge gained supporting astronomy projects. While the two-to-one direct return on investments in astronomy is impressive, **the return generated from the development of spin-off technologies is estimated to be as high as ten-to-one.** When working on projects, the Coalition uses a “smart procurement” model in which contractors are introduced to problems faced by the astronomical community during project design and development. Canadian industry is then tasked with finding creative solutions. The knowledge gained in solving these problems leads to new business opportunities in sectors far removed from astronomy as those technological developments are spun-off into other applications.

Listed below are examples of spin-off technologies developed from astronomical research:

- the development of image reconstruction techniques and sensitive microwave receivers that are used for analysis of CAT scans, magnetic resonance imaging (MRI) and breast cancer scans;
- the precursors of the detectors that scan baggage at airports;
- the technology for the Netscape web program;
- digital cameras;
- synthetic aperture radar technology, employed by RADARSAT to map the earth in high detail and;
- the creation of Softimage, a software company which has now grown into an industry leader in computer visualization and video production (developed by two researchers from the Observatoire Mont Megantic in Québec).

In one of the most unique examples, AMEC parlayed its work experience with observatory enclosures and telescopes into becoming a world leader in the design of theme park rides.

All this happened because the Government made an investment in astronomy research. Not only is this research increasing our scientific knowledge and generating a direct economic return through contracts and jobs, but it is also delivering huge benefits as Canadian companies develop spin-off technical expertise that offers tremendous marketing and business development potential.

### *Skills Development*

The Pre-Budget consultation document correctly notes that the future is rapidly changing and we must be prepared and proactive in developing the skills needed to seize market opportunities and maximize our potential as a nation. The previous section already detailed how Canadian companies, through the skills developed by their employees working on astronomy projects, have created new business opportunities.

Equally important, however, is the continued development of skilled labour to sustain Canada's emerging scientific and industrial strengths. We currently enjoy a privileged position near the top of the global astronomy community. To stay there, we need to ensure we are developing the next generation of astronomers. The benefits currently being enjoyed by Canadian industry will only continue to flow if we have top-level astronomers in this country.

To that end, the Coalition's success has generated an explosion of interest in astronomy at the university level. There are now 22 universities involved in astronomical research, a significant increase since the Coalition's beginning. The number of graduate students and post-doctoral fellows involved in astronomy research within these universities has increased from 213 in 1999 to 345 in 2004, a 62% increase in only five years. There are now also 23 Canada Research Chairs in astronomy.

This growth in interest is easy to explain. Canada's involvement in some of the world's leading astronomy projects is providing students and faculty with a chance to work on them. This not only stimulates interest in astronomy; it gives the next generation of Canadian astronomers the skills and experience needed to keep us at the forefront of this field.

### **An Industrial Strategy for Science or No Strategy at All?**

This is an important question. We are not blind to the fact that a range of scientific interests will be seeking government funds for a host of different priorities. However, we are the only discipline that has a clear plan for achieving scientific excellence, bringing together Canada's scientific, academic and industrial resources. Our Long Range Plan clearly defines our project priorities and our financial needs for the next seven years. We have identified the domestic support structures needed to maintain those priorities. And perhaps most important of all, we are pursuing these priorities in a coordinated way that brings together all Canada's astronomy stakeholders.

The Coalition's plan is not only advancing Canada's scientific knowledge and international standing, but it is doing so in a way that is delivering concrete benefits to our universities and our economy. Investments in astronomy are encouraging research and development of new technology, helping build a skilled workforce, and providing jobs and income to Canadians.

It is because of all this that we believe our plan and our Coalition approach serve as a model for a science-based industrial strategy. This is a position we have argued in the past before the Finance and Industry Committees of the House of Commons.

Not to dwell on the negative, but serious questions have to be asked if the Federal Government chooses not to fund further astronomy research. First and foremost, if the Government is not going to fund its top science, what are its scientific priorities? Science is a key driver in closing the technological gaps and ensuring a competitive society.

There is also the question of why the Government would make a significant initial investment in astronomy, let it build up to such a strong position, and then walk away? The initial funding allowed us to begin work on major international projects, but we are now scrambling to find resources to continue our participation. We cannot overstate how serious a blow it would be to Canada's competitive nature and to our international scientific reputation if we were forced to withdraw from signed international agreements because of a lack of funding.

Third, how does Canada expect to attract top scientific talent if that talent loses the ability to work on major international projects? Finally, these questions do not even begin to address the lost benefits to Canadian industry.

We have presented a model for strategic scientific investment. We hope that your Committee endorses it.

## **Recommendations**

### *Short Term*

**The Coalition recommends that the Federal Government provide approximately \$235 million over the next seven years to complete the remaining elements of the LRP.** We have attached a detailed, yearly cost breakdown for our funding request. This stems from a mid-term review of our Long Range Plan conducted by third party experts from our field.

Without that funding, Canada's partnership in several international projects is put in doubt. Ideally, we would like a commitment for the full seven years. That would avoid us having to return to the Hill year after year requesting money. We would much rather spend that time conducting our research. We fully understand the concern with accountability, however, and always welcome the opportunity to keep Parliamentarians fully up to date on how taxpayer money is being spent. Furthermore, as discussed below, we recognize the Government lacks a mechanism to provide such long term financing.

### *Long Term*

Science has changed. Just like most other aspects of the economy and society, scientific pursuits are now international – and they are big. Canada has to be a player in this global scientific context to have any success. In astronomy, we have adapted to this new reality. Unfortunately, government funding mechanisms have not.

There is no single agency that can fund our projects, forcing us to deal with myriad agencies with different mandates and reporting requirements. When the Coalition has received funding, it is often short-term and piecemeal. This is not conducive to long term planning, especially with international partners. Furthermore, funding seems to lack focus. Canada should focus its resources on our areas of greatest strengths, rather than try to be all things to all people.

However, if the Government is going to change its approach, we recognize that the scientific community must do so as well. We offer our Coalition and our detailed plan for excellence as a model. A strategic government approach to scientific investment, coupled with focused, coordinated planning within disciplines, will greatly enhance Canada's scientific standing, our economy and our competitiveness.

## **Relationship to Canada's Place in a Competitive World**

The Pre-Budget consultation document asks four questions regarding how we can ensure our nation's competitiveness. Our response to those questions is below, in the context of our seven-year, \$235 million funding request.

*What specific federal program spending measures should be implemented in the upcoming budget to ensure that our citizens have the right skills for their own benefit and for the benefit of their employers?*

Scientists will locate where the best opportunities present themselves. Right now, Canada is a priority destination for astronomers. This is an exciting place to be. We have strong university astronomy programs and departments and access to world-leading projects. On the industrial side, skilled workers can stay in Canada and further their careers here. Scientists and highly-skilled workers are perhaps two of the most mobile occupational groups. The Coalition for Canadian Astronomy is proud of the opportunities that have been presented to Canada as a result of our success.

Canada's partnership in world-leading astronomy projects provides our astronomers, our students and Canadian industry with opportunities to continually learn new techniques and processes that keep them at the forefront of their field.

*What specific federal program spending measures should be implemented in the upcoming budget to ensure that our businesses are competitive?*

Canada's astronomy investments have a proven track record in delivering benefits to the economy. Canadian companies have become world leaders in several fields as a result of their work on astronomy projects. That skill development is a direct result of government investment. As mentioned earlier, these investments are perhaps more productive than ones in traditional manufacturing or resource industries. These are investments into the knowledge-based economy, which is a reality now. That will keep Canadian business competitive.

*What specific program spending measures should be implemented to ensure that our nation has the infrastructure required by citizens and businesses?*

This is an interesting question, and the answer depends on how you define infrastructure. We firmly believe that a country's scientific knowledge- base is as important a piece of infrastructure in today's economy as roads, ports or railways. If Canada wants to compete in this economy, the Government must have a science strategy that creates the knowledge infrastructure to make that happen. That knowledge is a public good.

*What specific federal actions should be taken to ensure that the Government is able to afford the spending measures needed to ensure that Canada's citizens and businesses can prosper in the world of the future?*

As mentioned throughout this document, investments in science must be strategic. First, the Government has to recognize that it cannot fund every scientific project that comes along. Each discipline has to come to that same conclusion – like we did with astronomy. Disciplines should be encouraged to come up with their own plans to achieve excellence, prioritizing their project pursuits. We believe our Long Range Plan for Astronomy provides such a model. If all disciplines take such an approach, it will ensure a productive, efficient use of financial resources.

Second, priority can be given to those disciplines with a proven track record of delivering returns to the economy. We have that in astronomy. For every dollar invested thus far by the Federal Government, there has been a two-to-one direct return and a ten-to-one indirect return. Therefore, not only is the Government making an important investment in our ability to compete in the world, it is receiving a direct dividend.

## **Conclusion**

To return to our original question, why should funding for astronomy be included in a Budget focused on Canada's place in a competitive world? We believe the answers are self-evident.

We have clearly shown that investments in astronomy allow Canada to remain competitive through the development of new technology, the creation of a skilled workforce, and the emergence of a strong future generation of astronomers in our universities. Canada is perfectly positioned to maintain its world leadership position in astronomy, along with all the economic and competitive dividends that flow from it.

This is only possible, however, if the Federal Government continues to invest in astronomy research. If Canada wants to establish itself as a world leader in scientific research and reap the benefits, the Government must provide the financial investment.

Research, development and innovation are at the heart of competitive country. Science, academia and industry working together encourage all three. Our Long Range Plan, if funded, will continue to deliver economic returns to Canada and ensure our place in a competitive world. This is not a request for speculative purposes. It is a clearly defined and tightly coordinated plan, which, as we noted earlier, provides a model for an industrial strategy for science.

The Coalition strongly recommends that the Government continue to fund this sort of strategic scientific research. Investments to date have more than paid for themselves. We thank the Committee for its consideration. We hope that you will see the link between science funding, the Canadian economy, and a competitive Canada.

**Recommended Expenditures for the Period 2006-2012 (millions of dollars)**

Ground-based

<b>World scale facilities</b>	
ALMA	22.00
SKA	24.50
VLOT/TMT	125.00
Subtotal	171.50
<b>Intermediate scale projects</b>	
Gemini/JCMT/CFHT	21.30
Receiver/Correlator Groups	2.00
DAO Telescopes	0.25
Subtotal	23.55
<b>Highly qualified personnel</b>	
HIA research scientists	4.30
Herzberg Fellowships	3.20
NSERC Fellowships	1.60
Experimental astronomy labs	4.90
Research grants	3.50
Subtotal	16.10
<b>Computing facilities</b>	
CVO	3.00
HPC	15.00
Equipment grants	3.50
Subtotal	21.50
<b>Education &amp; Outreach</b>	3.00
<b>TOTAL</b>	<b>235.65</b>