Presentation by
The Canadian Coalition for Astronomy

To the
House of Commons
Standing Committee on Industry, Science and Technology

by

Dr. Russ Taylor and Mr. Peter Janson

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Good Morning, and thank you for inviting my colleagues and I to present a national vision for the future of Canadian astronomy.

My name is Dr. Russ Taylor. I am the president of the Canadian Astronomical Society/ Societe canadienne d'astronomie, and a Co-Chair of the Canadian Coalition on Astronomy.

With me is Peter Janson, who is the Chair and CEO of AMEC and another of the Coalition's Co-Chairs.

I am also joined by Dr. Rene Racine; a prominent Canadian astronomer, former director of the Canada France Hawaii Telescope, and currently a member of the council of NRC.

Canadian astronomers have developed a 10-year plan for astronomy in Canada. This Long Range Plan builds on the strength of Canadian science and technology on the international stage. It provides opportunities for Canadian high-tech industry, and our young scientists and technologists, to participate in the development of new technologies and innovations, and it maintains Canadian leadership in the international advance of the frontier of knowledge about the nature of our Universe.

Today, we want to give you an overview of Canada's Long Range Plan for Astronomy and Astrophysics, and discuss with you why it is important for this country's future that Canada continues to support this key area of scientific research.

To begin, I would like to give you a sense of the state of the discipline internationally and Canada's prominent role on the world stage.

Advances in the power of technology over the past few decades, many pioneered by Canadians, have brought the field of astronomy to the brink of charting a complete history of the time. Our most powerful telescopes, such as the Hubble Space Telescope show us the universe at half its present age. We are now poised to observe even further back in time; to answer fundamental questions that have engaged the curiosity of human beings for ages.

How did the highly structured Universe we see around us come into being? When was the dawn of first light, and the birth of stars and galaxies? How has the Universe evolved and what is its ultimate fate? When do the building blocks of life arise? Does life, and civilization, exist elsewhere in the Universe? How does humanity fit into this cosmic history?

These and many other questions drive the development of the next generation of ground and space-based telescopes. These telescopes will be so powerful and push current technologies so hard that no individual country has the resources to develop them on their own.

Astronomy is moving into an era of internationalization; where groups of developed countries work together and combine their resources to develop and build facilities that redefine the cutting edge.

Canada is an important player in these international efforts. Many Canadians know that this country is a world leader in science and technology. Across all scientific disciplines, Canada does about 5% of the world's research. The relative impact of a discipline on the international stage is measured by the number of citations to published research (i.e. use of the published results by other researchers). Within Canadian science and technology, astronomy leads all other disciplines in international impact – followed by medicine and chemistry.

The impact per-astronomer of Canadian astronomy makes this country the third most important player in this area of study, behind only the United States and the United Kingdom, and ahead of other major science and technology supporting countries. This despite the fact that Canada has the lowest per-capita funding level for astronomy among our G7 partners. Seven times less than the US and five times less than the UK.

By any measure, Canada is among the world leaders in astronomy and astrophysics. Canadian research and discoveries have directly contributed to moving astronomy forward to its current position. Some of the discoveries made by Canadian astronomers over the past decades include:

- The invention of techniques to measure ultra precise motions of stars now used to detect the presence of planets around other stars.

- The development of adaptive optics techniques to remove the distortions in optical images caused by the Earth's atmosphere

- Canadian theorists have used computers to develop predictions of the structure of the Universe before the dawn of light - predictions that will be tested by the next-generation of radio telescopes.

- Canadian scientists have used measurements of the motions of galaxies in space to measure the density of the universe.

- Canadian scientists have identified the missing link in the evolution of matter from the primordial state outside galaxies to the complex state needed to form the building blocks of life.

One of the most important factors in bringing Canada to this high standing in the international astronomical community has been the relationship between the University sector and the National Research Council of Canada.

The NRC has the parliamentary mandate to operate national facilities for Canadian astronomy. The NRC continues to play key roles in developing international partnerships and negotiating agreements to jointly develop new telescopes. The NRC also maintains domestic telescopes and laboratories within Canada where advanced technologies are developed and young Canadians are trained.

Despite our great success in astronomy, as the international community ramps up to develop the new world observatories, Canada is in danger of being sidelined. The stakes are changing.

The Long Range Plan for astronomy and astrophysics, or the LRP as we call it, has one overarching goal – to ensure that Canada remains a key player in this new era of internationalism and that we reap the scientific and economic benefit of the new developments in astronomy. It is a goal that is both affordable because of the direct economic benefit to Canada of the investment, and attainable, because of Canada's current leadership position in international astronomy.

The Plan was developed by an expert panel, and reflects the consensus and support of the entire astronomical community. It builds on our natural scientific and technical strengths to continue Canada's international leadership in astronomy.

It also has been publicly endorsed by all major stakeholders including: the Presidents of all the government agencies involved in providing funding for astronomy – the National Research Council, the Canadian Space Agency, and the National Sciences and Engineering Research Council; the Presidents of all Canadian Universities engaged in astronomical research; leaders of Canadian industry, and leaders in the field of public awareness of science.

The Long Range Plan calls for an investment in technology development, infrastructure, and people over the next 10 years. Approximately $200 million would be spent on development of Canadian technologies for key international space astronomy missions and for the new generation of ground-based world observatories.

In Space, Canada will become partners in the **Next Generation Space Telescope**, which will replace the Hubble Telescope around 2010 to observe further back in the history of the Universe to the first formation of Galaxies, the **FIRST** and **Planck** missions which will probe the relic radiation from the Big Bang, and a next generation space mission to probe the Universe for supermassive black holes.

On the ground, Canada will provide key technologies for the **Atacama Large Millimetre Array**, including specialized high speed digital electronics devices to convert the faint signals received by the telescopes into images of radiation from dust and gas in the early Universe. Plans for Canadian partnership in the Atacama Large Millimetre Array have been formalized as part of an agreement between the U.S. National Science Foundation and the National Research Council.

We will develop an innovative Canadian radio telescope concept, the **Canadian Large Adaptive Reflector** and construct the world's largest telescope in Canada, as part of the technology development for the **Square Kilometre Array**, which will probe the dark era of the Universe, before there was light. This technical innovation by Canadian scientists will allow construction of giant radio telescopes at a tenth of their current cost.

We will also develop new approaches to fabrication of optical telescopes as part of an international program to design a **Very Large Optical Telescope** on the ground that will be used to measure the properties of planets around nearby stars.

All of these technology developments are carried out in partnership with Canadian industry. Another $64 million will be used for people, infrastructure and training within Canada.

A Canadian investment of $264 million over the next 10 years buys Canada the opportunity to participate in over $ 4 billion dollars worth of the new generation of observatories. It will develop new expertise for Canada's technology and knowledge industries, and enables Canadian companies to compete for billions of dollars worth of contracts.

The space-based components of the LRP ($100 million) will be funded by the Canadian Space Agency. These funds have been committed. The Canadian Coalition for Astronomy is now seeking a commitment by the Federal Government for the remaining funds, $16.4 million dollars per year for ten years for the land-based components of the Plan.

This investment will secure Canadian scientists access to the new world observatories, and enable Canadian technology and engineering companies to compete for work designing, developing, building, and maintaining these facilities.

Money invested in astronomy is a direct investment in Canada's economy. Over the last two decades funds invested by the government in industry-based research and development for astronomy has returned at least two-fold in direct return to Canadian high-tech industry through the development of expertise that enables them to compete internationally. Technologies such as advanced optical components, innovative structural design, high-speed digital signal processing, telecommunications, control systems engineering, information technologies,... The list goes on.

Peter Janson's company – AMEC – is an excellent example of the impact astronomy can have on the Canadian economy. I would now like to ask him to share some of his experiences and observations with you.

Thank you Russ.

Madam Chair, Parliamentarians, Ladies and Gentlemen, thank you for inviting us to meet with you.

As Dr. Taylor said, the Coalition for Canadian Astronomy members are working together to advance Canada's Long Range Plan for Astronomy and Astrophysics. We are seeking a new investment of $16.4 million dollars per year for the next decade to make this Long-Range Plan a reality.

Canada is a world leader in Astronomy. In the recent election campaign, the Liberal government stated its commitment to a massive increase in basic R&D. One of the stated goals is to enhance Canada's prestige in science and technology.

There are a lot of reasons why an investment of this kind makes sense. In many respects, we are at the same kind of critical crossroads that Canada faced in 1989/90 when Canada's participation in Gemini was decided. Then, private enterprise also committed to the Keck program. Today's large projects demand a different model.

International agreements to which Canada is a signatory were reached in January. The time is fast approaching for Canada to commit funds to fulfill our part of the deal. If we are not soon at the table, Canada's potential to shape the projects outlined in the Plan will diminish, and Canadian technology and expertise may be sidelined by other countries that are ready to proceed.

Dr. Taylor has outlined many of the reasons why, from a scientific perspective, this investment makes sense. I would like to offer the business case.

Canada currently invests about $22 million annually in astronomy, a per capita investment of 98 cents per year. Our investment is several times smaller, per capita, than in the USA and typically five times smaller than in European Countries with similar GDPs.

Yet, with that small investment, the National Research Council maintains 3 major offshore facilities through international partnerships. Canadian engineering has been at the foundation of these impressive observatories.

They include:

- the twin 8 metre Gemini Telescopes; (one in Hawaii and one in Chile)
- the Canada-France-Hawaii Telescope (CFHT) (Maunea Kea, Hawaii) and the
- James Clerk Maxwell (JCMT) radio telescope. (Maunea Kea, Hawaii)

I would like to highlight the Gemini telescopes to demonstrate the excellent value that Canada receives through this focused investment.

Canada invested $38 million to buy its partnership in the Gemini twin 8-meter telescopes. My company, AMEC Dynamic Structures (formerly known as AGRA Coast) built the Gemini domes. Our contract for the construction alone was worth $44 million. Our ongoing work on telescopes has now resulted in gross revenue of $150 million.

Canadian enterprises competed for an additional $8 million in contracts for sophisticated electronic equipment installed at Gemini. These projects returned even more to Canada as spin off benefits from that original investment of $38 million.

More than 80 high tech and engineering companies across Canada involved in astronomy projects would not have been eligible to compete for the work they are doing in this field if Canada had chosen not to participate in Gemini.

Because of AMEC's experience in astronomy structures, we are now placed at the forefront of another sector, the multi-billion dollar international amusement ride industry. AMEC has become the contractor of choice, providing turnkey solutions to some of North America's largest amusement park companies and international theme park builders.

Economic activity generated from the construction and operation of major astronomical facilities has a broad impact. Even a very conservative reckoning would show that for every dollar Canada invests in astronomy projects, Canadians are getting at least double their money back through the spin-offs and the work that Canadians are uniquely positioned to do.

If we fully implement this Plan, not only will we preserve Canada's leadership position in world astronomy, but our designs will influence and form the foundation for other countries to follow. With Gemini, we bid to construct structures to specifications. Implementing the LRP will mean Canada actually writes the specifications that others will bid to. It can be everything. Developed in Canada by Canadians for the world.

One thing is for sure, if we do not invest in the new round of projects outlined in the LRP, Canadian technology will not be a part of them, and Canadian companies will not be able to compete for the work.

Make no mistake; these projects will be built, with or without Canadian participation. The business members of the Coalition want to compete, and win so that Canada can win. Whether as engineers, technicians, graduate students or advanced researchers, Canadians want to continue to play a prominent role in the unraveling of the mystery of the origins of our universe. We ask you to share in that vision.

[Back to Dr. Taylor]

As you have seen, an investment in Canadian Astronomy can bring a high, positive economic return to the Canadian economy through direct spending on high-tech Research and Development, and through developing highly valuable expertise in private industry.

Many spin offs from astronomical research have had an impact on our daily lives.

For example:

- The technology for now world encompassing Netscape web program was invented for computational astrophysics work.

- Image reconstruction techniques developed for astronomy are used for analysis of CAT scans and Magnetic resonance imaging (MRI).

- Sensitive microwave receivers, another astronomical development in radio astronomy, are used for breast cancer scans.

- The precursors of the detectors that scan baggage at airports were developed for X-ray satellites.

- Synthetic aperture radar technology, such as used by RADARSAT to map the earth in high detail, uses the technique of aperture synthesis first developed by radio astronomers to make detailed images of the sky.

- Two students from Ecole Polytechnique started a small company Matrox in 1979 to produce electronic cards for storing images from the Observatoire Mont Megantic in Quebec. Today Matrox is a world leader in video cards for personal computers with export sales in excess of $200 million annually.

- From the same observatory two researchers developed a computer display system for astronomical images. The software company Softimage resulted, and has grown into an industry leader in computer visualization and video production.

What new products and processes will be derived from continuing to challenge the imagination of Canadian scientists, technologists, and engineers through astronomy? That remains to be seen, but we do know there will be real and lasting benefits.

In Summary:

Implementing the Long Range Plan for Astronomy and Astrophysics will help maintain Canadian leadership in a high-profile area of science, and enhance Canada's reputation as a leader in scientific research and high technology research and development.

It develops expertise within Canadian industry that gives us a competitive advantage in the international community of high technology and returns the investment many-fold.

It will excite Canadian youth and help us keep a generation of our best and brightest young scientists at home where they belong.

And perhaps most exciting, it will give Canadians a lead role in a new, historic era of cosmic exploration. As a nation, Canadians will share in the excitement of discovery, and will share in the national pride that comes with helping push back the frontiers of knowledge.

I urge the Standing Committee on Industry, Science and Technology to champion the Long-Range Plan for Astronomy and Astrophysics. It is right for Canada.

When the Minister of Industry spoke to you last week he responded to a question from Mr. Manning about what criteria would be used to decide what proposals get funded.

The LRP is consistent with the Minister's criteria. We are not asking for an exception, or exemption in any way.

Minister Tobin indicated the following:

He said that he wanted to resist funding a shopping list of projects, but instead wanted to rely on "expert panels" for advice.

The Long-Range Plan packages that you have before you include a report of an International Blue Ribbon panel that reviewed the Plan and fully endorsed it. Moreover, the NRC-NSERC long-range planning panel, which compiled and wrote the LRP, was itself a panel of experts. The Astronomical community in Canada stands behind this plan.

Minister Tobin also said his priority was to invest in "research excellence", "merit", and "where we get the most effective investment for our moneys."

Canadian astronomers are world leaders in research citations and have the highest productivity in astronomy in the OCED with the lowest funding levels. Within Canada the science of astronomy has the highest impact on world research.

As Coalition Co-Chair, Peter Janson demonstrated, investments in astronomy yield large returns to Canada's high technology, construction and engineering industries.

The Long-Range Plan is coherent. It makes sense. It has broad-based support among astronomers, academia and industry. And it meets all of the Minister of Industry's stated criteria for support.

We are seeking a way to fund the ground-based component of the coherent 10-year national program embodied in the Long Range Plan. There is broad consensus that the LRP is good for Canada. Yet because of internal constraints and funding formulas in programs like the CFI or Networks of Centres of Excellence, there is not yet a coherent funding source for the Plan. The National Research Council, which has the mandate and experience to negotiate for Canada internationally, and to construct and operate astronomical facilities on behalf of Canadian scientists, is the logical funding stream.

Ms. Torsney put the question to the Minister last week with reference to the LRP. She asked if there is a way to get everyone to the table to find innovative ways to move forward because, as she put it, " A pocket here and a pocket there and a pocket the other way does not an international commitment over 10 years make?"

The Canadian Astronomical community has achieved great things in the past. Discovering the origins and structure of the universe are close at hand.

We want to continue the tradition of Canadian excellence and participate in the discovery. We hope that you will help us, by encouraging the Government to commit to funding Canada's Long-Range Plan for Astronomy and Astrophysics.

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