

Canadian Astronomy Funding

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Introduction

Canada's funding of astronomy originates mostly from the Federal Government. They support the Herzberg Astronomy & Astrophysics Research Centre (HAA), as well as providing funds to the National Science and Engineering Research Council (NSERC) and the Canada Foundation for Innovation (CFI). The Provincial Governments fund the universities and pays the salaries of their faculty members.

There is no cohesive program for funding large-scale science infrastructure in Canada. The funding of each new major facility is taken on an ad hoc basis. The community has been creative in tapping into existing funding sources to do the early design work and the building of both national and international support for these facilities.

This report will examine the current funding of astronomy in Canada and the trends since the last LRP (or longer).

NSERC Discovery Grants

As stated on the NSERC website the "Discovery Grant Program assists in:

- promoting and maintaining a diversified base of high-quality research capability in the natural sciences and engineering in Canadian universities;
- fostering research excellence;
- providing a stimulating environment for research training."

Discovery Grants (DGs) are the most significant source of research funds for most Canadian faculty members. DGs are available to adjunct faculty members for the sole purpose of supporting graduate student training. This allows, for example, HAA staff members to provide support to graduate students. While NSERC considers DGs to be "grants in aid" of research, the reality is that for most Canadian faculty members the DGs are the sole source of funding.

NSERC has an online awards database that allows a look at all NSERC awards back for over 20 years. I have mined this database for data on various A&A awards to understand historical trends.

Individual Discovery Grants

There are several categories of Discovery Grants but the most significant and relevant is the Individual Discovery grant. Figure 1 shows the historical data from 1997 – 2018 (year of application). The total amount awarded increased significantly through approximately 2005 when the rate of growth declined and the total amount almost flattened. The total amount awarded in 2018 was 2.6 times that awarded in 1997. However, when one looks at the inflation corrected amount, the increase was only a factor of 1.8.

If one looks at the mean amount of the awards, the increase is much smaller. The mean award in 2018 is only 1.26 times that of the average amount awarded in 1997 and 1998 (I averaged these two years as there is a significant jump between 1997 and 1998). When one looks at the inflation corrected amount, the mean award in 2018 was only 0.86 that awarded in 1997/1998. Research support from the Individual Discovery Grant Program is lower than 20 years ago. This decrease in the inflation corrected mean award amount has been occurring since 1999 with a few upwards bumps along the way.

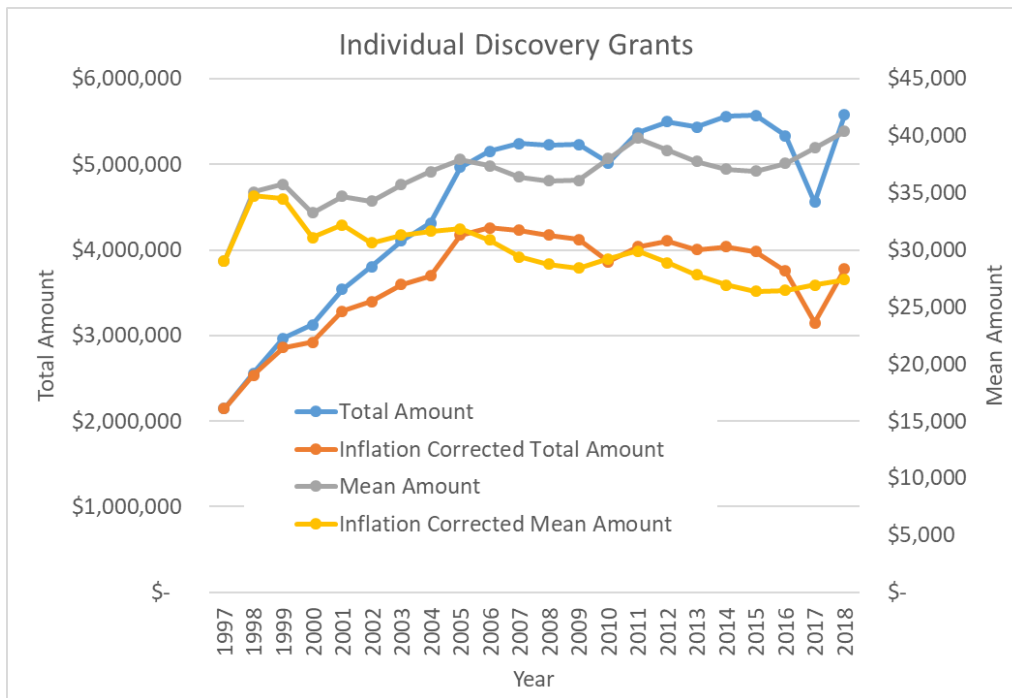


Figure 1 Total and Mean Amounts of Individual Discovery Grant Award

There are other categories of Discovery Grants such as the Accelerator Supplements (introduced in 2008). Figure shows the total award value of all Discovery Awards as well as the inflation corrected amounts. Again, we see that the Discovery Awards are not keeping up with inflation.

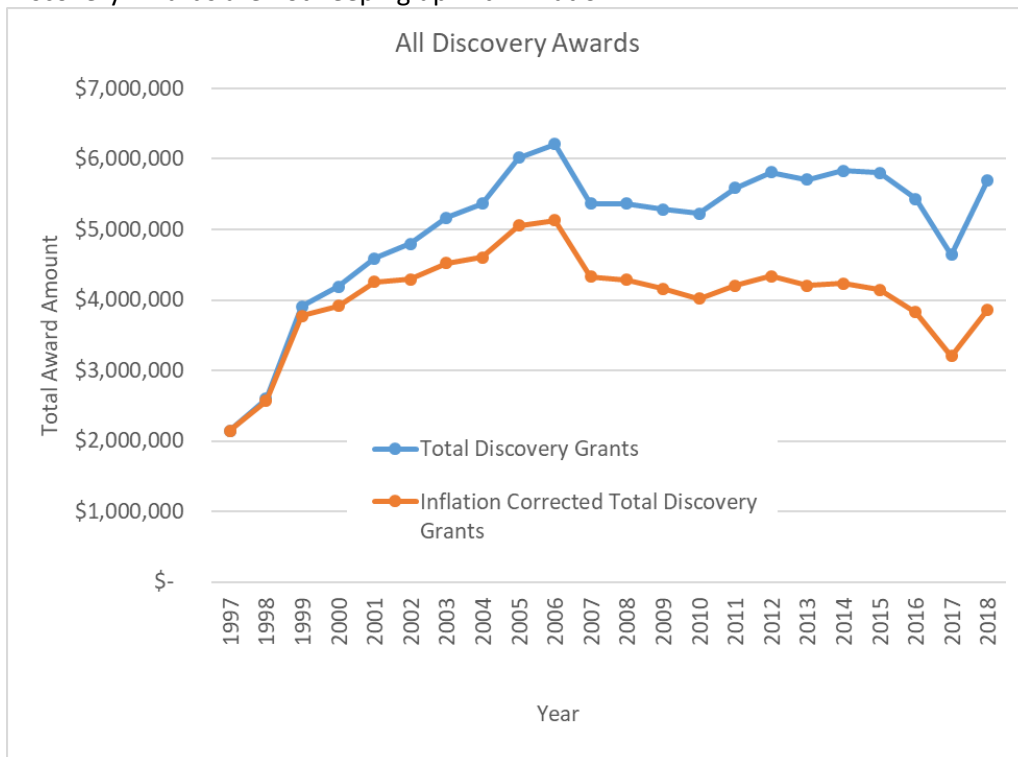


Figure 2 Total Award Amounts for all Discovery Awards

Research Chairs

There are two Research Chair Programs from which astronomy has received awards; Canada Research Chairs (CRC) and Canada 150 Research Chairs (150 CRC). The CRC program has been in place since 2000 while the 150 CRC program started in 2017. Figure 3 shows the total amount of the awards to astronomy from these two programs, and the percentage of awards (value) to astronomy compared to all fields.

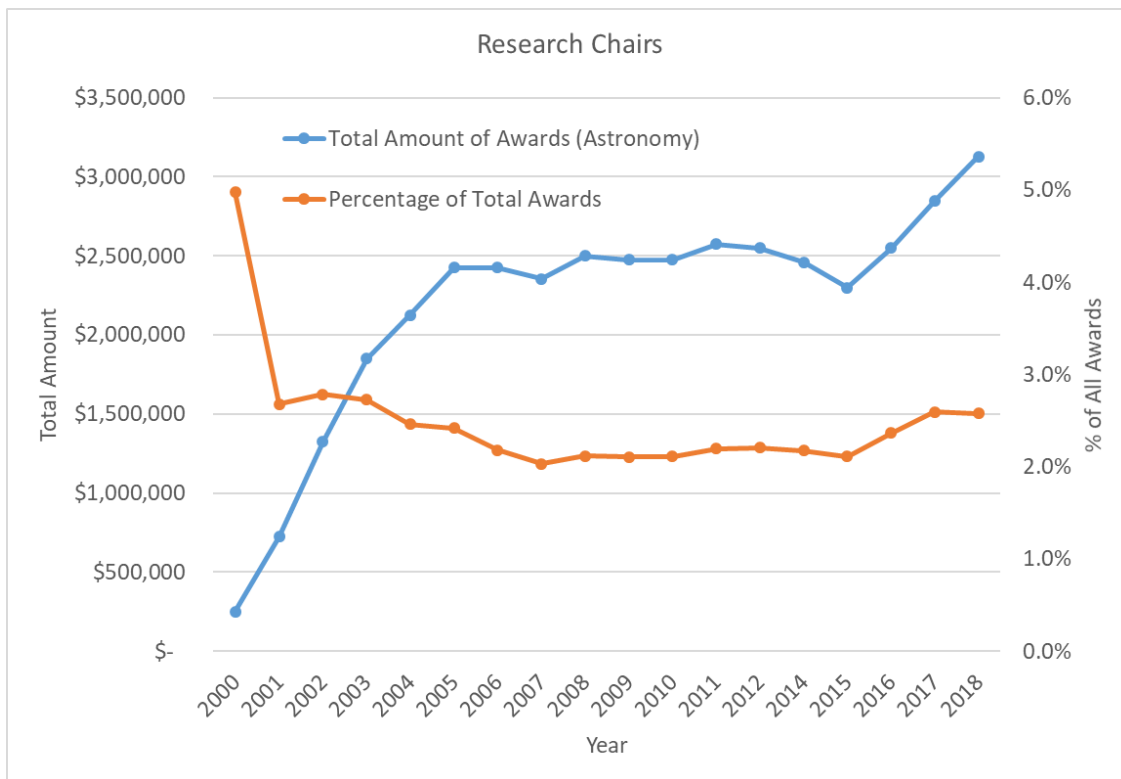


Figure 3 Research Chair Awards

Scholarships and Fellowships

NSERC also awards a wide range of scholarships and fellowships. The total value of these awards is shown in Figure 4. The inflation corrected total awards value is also shown. While the inflation corrected awards value has increased from 1997, it has probably not increased at the same rate as the size of the community.

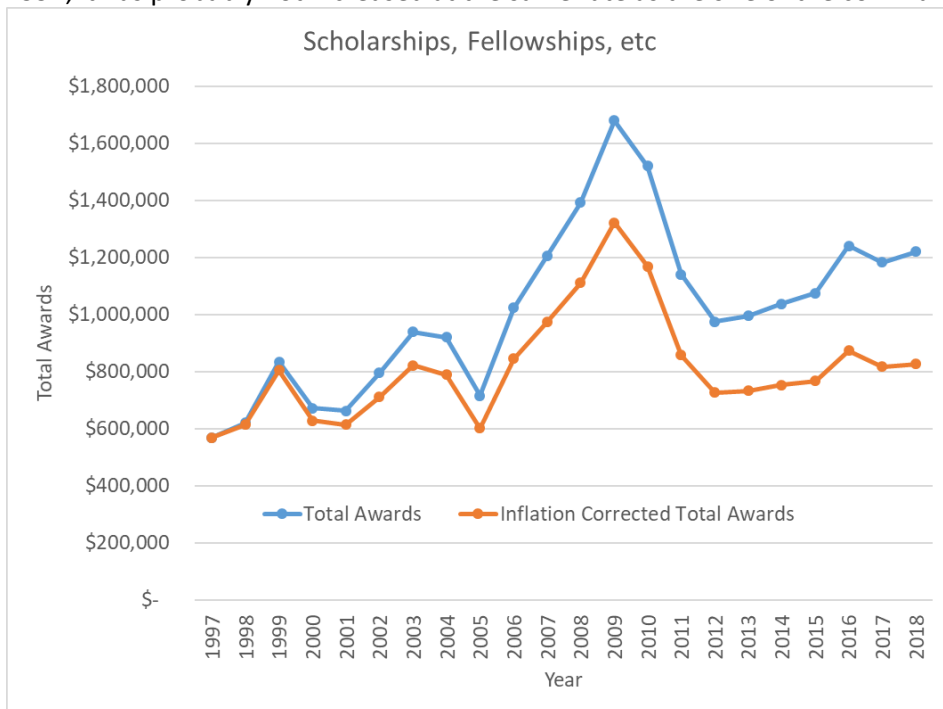


Figure 4 Value of scholarships and fellowships awarded by NSERC

Total NSERC Awards

The total amount over all NSERC Awards is shown in Figure 5. The inflation corrected total value in 2018 is 20 percent lower than the peak value in 2008. There has been a steady decline in total NSERC funding of astronomy in 1997 with 2018 seeing an uptick.

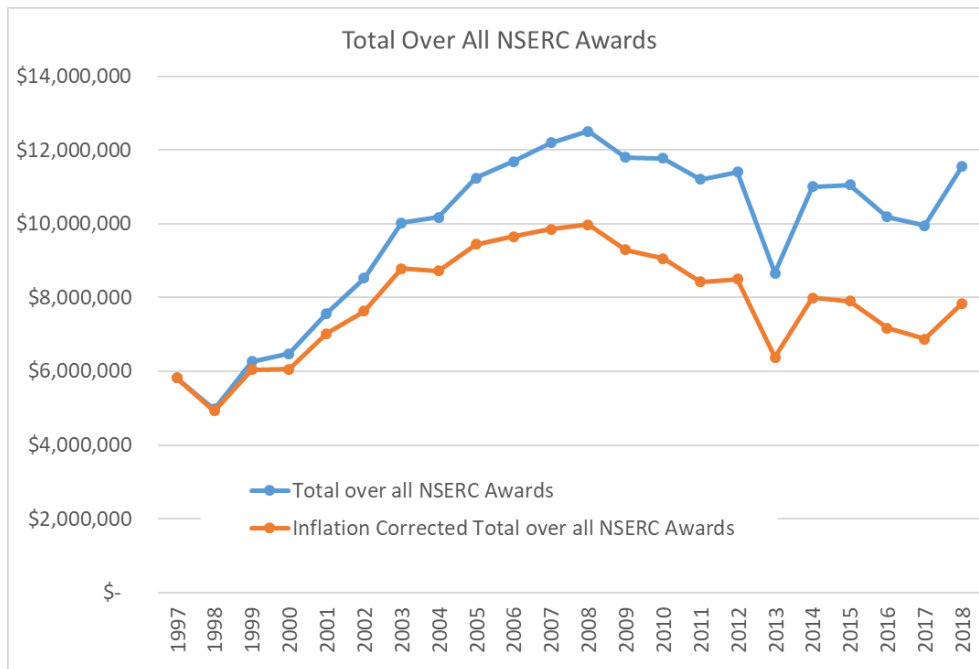


Figure 5 Total NSERC funding for astronomy

Canada Foundation for Innovation (CFI) Funding

CFI was created in 1997 with a \$500M endowment from the Federal Government, and was charged with investing in Canada's research infrastructure. More than 20 years later, CFI is firmly established in the Canadian research funding landscape.

Astronomy has been successful in receiving CFI funds from the very first round of awards. Figure 6 shows the cumulative amount of CFI funds awarded to Canadian astronomy. Significant awards over this period are identified by arrows. Canadian astronomy has received almost \$70M from CFI. For most (all?) of its awards, CFI only awards 40% of the total value of the project. This means that approximately \$175M has flowed into astronomy for CFI-related projects.

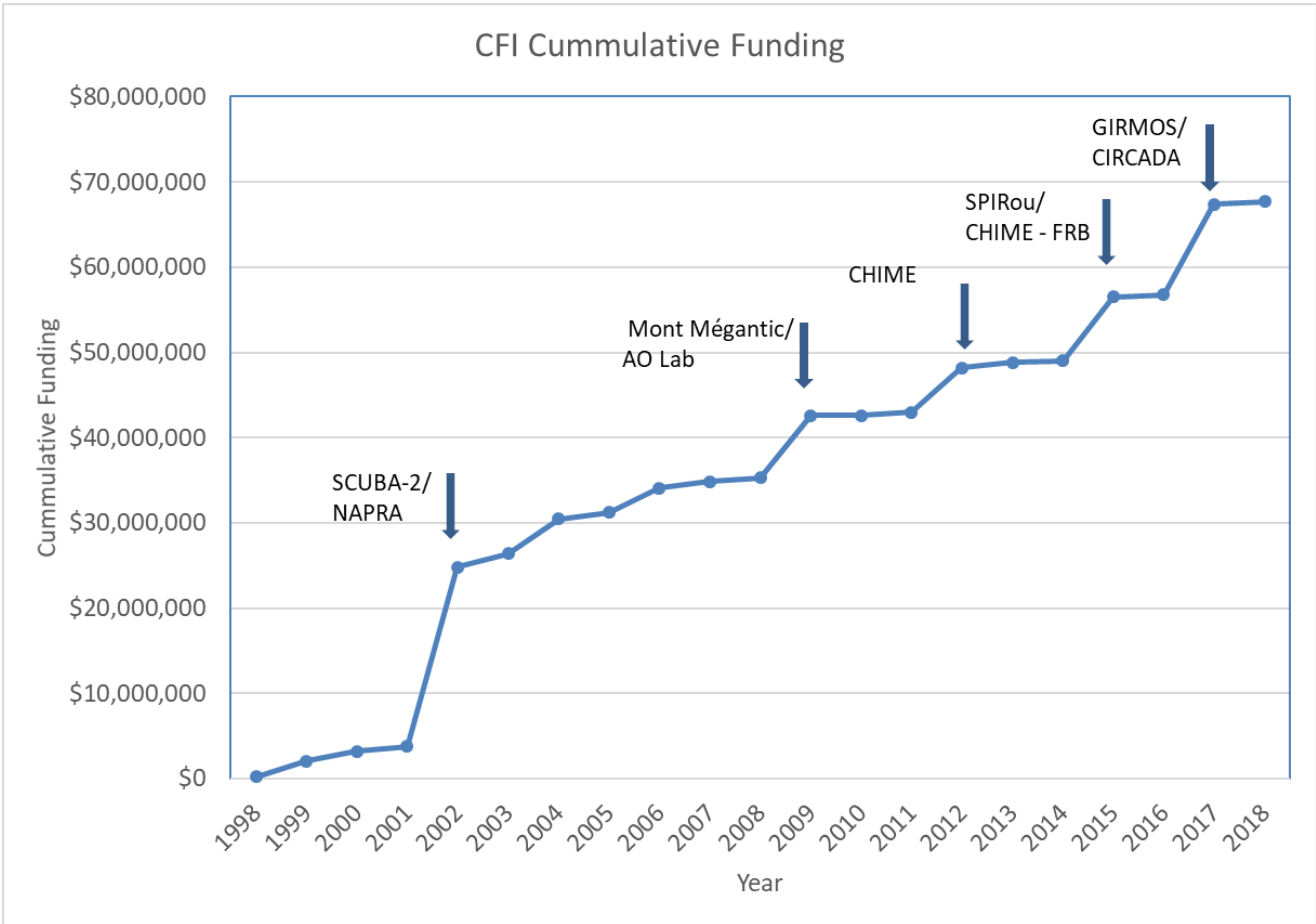


Figure 6 Cumulative CFI Funding from 1998 - 2018

Table 1 Breakdown by year and program of CFI funding for astronomy

Year	Canada Research Chairs Infrastructure Fund	CFI Career Awards	Innovation Fund	International Access Fund	John R. Evans Leaders Fund	Leaders Opportunity Fund	Leading Edge Fund	New Opportunities Fund	Regional/ National Facilities	Total
1998								\$197,400		\$197,400
1999									\$1,880,000	\$1,880,000
2000	\$117,500		\$711,080					\$333,680		\$1,162,260
2001	\$553,335									\$553,335
2002	\$312,239		\$79,000	\$20,273,952				\$343,145		\$21,008,336
2003	\$577,685	\$182,300						\$849,905		\$1,609,890
2004			\$4,000,000					\$79,942		\$4,079,942
2005	\$303,963	\$113,442						\$305,056		\$722,461
2006					\$200,000		\$2,708,912			\$2,908,912
2007					\$479,997	\$232,825				\$712,822
2008					\$444,455	\$30,263				\$474,718
2009						\$187,456	\$7,113,220			\$7,300,676
2010										
2011						\$379,895				\$379,895
2012					\$210,231	\$36,031	\$4,985,372			\$5,231,634
2013					\$635,040					\$635,040
2014					\$150,000	\$29,600				\$179,600
2015			\$7,304,368		\$200,000					\$7,504,368
2016					\$250,000					\$250,000
2017			\$10,502,524		\$59,593					\$10,562,117
2018							\$371,316			\$371,316

Total of CFI and NSERC Funding

The funding of both NSERC and CFI are shown in Figure 7. The figures are not inflation corrected. Since 1998 astronomy has received \$372M in funding from NSERC and CFI (including matching funds). This includes all the programs NSERC offers as well as the matching funds required by CFI.

One aspect of funding that is significant is that used to support faculty members in astronomy. While salary information is not publicly available, one can use an estimate for the mean salary of faculty members multiplied by the number of faculty in Canada to achieve the funding used to support university researchers. Using a mean salary of \$130K, a total of \$22.4M in funding to support Canadian astronomy faculty.

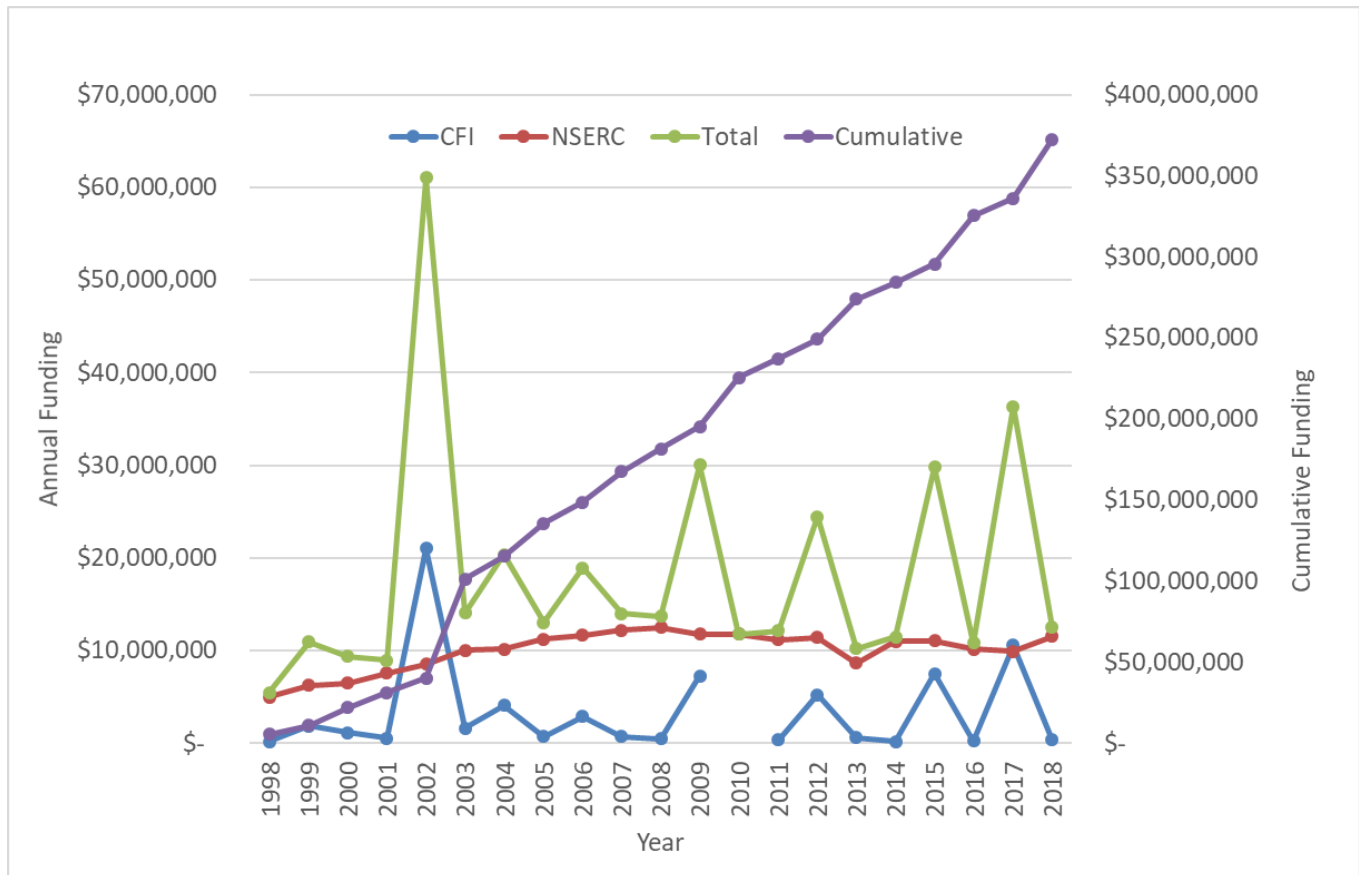


Figure 7 NSERC and CFI funding for astronomy.

Comparison with Australia

It is tricky to compare funding levels across different countries as the different funding sources don't match and each country has its own funding culture.

Australian astronomy is very similar in size and strength to Canada, making Australia a good comparison. Funding for astronomy in Australia flows through the Australian Research Council (ARC). The role of ARC in funding astronomy in Australia is very similar to the combined role of NSERC and CFI in Canada.

The cumulative funding for Canada and Australia from 2002 onward is shown in Figure 8. The amounts are shown in Canadian and Australian dollars with adjustment for exchange rate. The year 2002 corresponds to the year of SCUBA-2 and NAPRA funding from CFI which gives Canada a bit of kickstart in this figure. Canada's funding was on a steeper slope until 2011 when ARC awarded over \$20M for CAASTRO (ARC Centre of Excellence for All-sky Astrophysics). The Australian funding rate resumed at a slightly higher rate than before 2011 and then received two large inputs of money for the Centre of Excellence for All Sky Astrophysics in 3 Dimensions and the ARC Centre of Excellence for Gravitational Wave Discovery. Overall, Canada and Australia received very similar amounts of funding via NSERC and CFI (Canada), and ARC (Australia).

I have excluded the funding provided by ARC for major projects. Likewise, the Canadian amounts do not show the major funding awarded for TMT. Over the 2002 – 2018 period ARC awarded a total of \$585M for the projects noted in Table 2 Canada awarded \$243.5M for the TMT in 2015, and we are hopeful a large award for the SKA soon.

Table 2 ARC Awards for major projects

Name	Funding (\$M)	Period
ESO	129	2018-2027
ASKAP	111	2007-2019
SKA	294	2016-2025
MWA-1	51	2007-2011

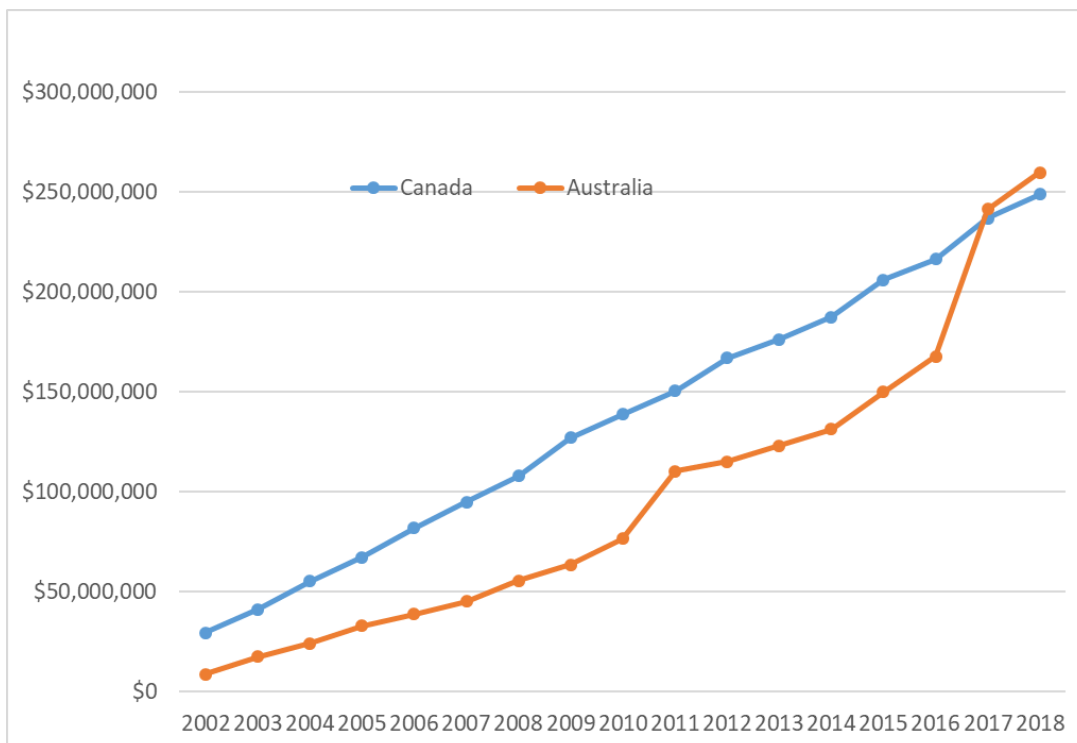


Figure 8 Cumulative funding for Canada and Australia

Appendix

The NSERC awards database can be used to summarize awards by University. This data was downloaded and synthesized for fiscal years 2009-2010 through 2018-2019.

The total amount awarded to each university for the last 10 fiscal years is shown in Table 3. The University of Toronto numbers were adjusted by removing the funding for CITA. These funding numbers as a percentage of the total are shown in Table 4 and graphically in Figure

Table 3 Total NSERC awards for universities for 2009-2010 to 2018-2019

University	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
University of Alberta	208,214	253,214	268,133	318,633	222,909	243,500	331,000	332,500	332,000	388,500
University of Calgary	599,392	940,796	243,720	395,169	234,000	163,500	163,500	162,500	145,000	171,000
University of Lethbridge	48,675	57,675	69,000	69,000	69,000	204,500	204,500	288,453	256,381	258,500
University of British Columbia	831,177	792,445	1,065,487	951,991	518,125	775,300	878,800	863,697	693,300	1,052,976
University of Victoria	974,832	989,995	1,049,370	977,008	762,500	835,000	860,500	836,800	954,800	1,198,800
University of Manitoba	220,955	190,955	231,303	158,803	146,803	217,000	217,000	246,000	209,000	137,500
Mount Allison University	23,560	23,560	23,560	23,560						41,500
Université de Moncton	17,730	17,730	22,000	22,000	26,500	22,000	22,000	22,000	22,000	26,500
Dalhousie University				60,000	99,500	64,500	69,000	77,500		63,500
Saint Mary's University	587,736	527,665	490,598	493,759	176,500	350,000	312,000	388,500	480,500	475,000
McMaster University	621,874	589,511	517,380	658,652	547,472	403,733	449,275	837,000	742,500	623,000
Queen's University	251,455	289,555	289,555	229,266	172,500	251,500	202,000	201,500	186,000	169,000
Royal Military College of Canada	26,595	51,137	99,042	94,542	66,042	41,500	37,000	69,000	64,500	64,500
Trent University	34,400	29,900	42,000	28,000	28,000	32,500	28,000	37,500	42,000	42,000
University of Guelph	16,688	16,688	15,000	15,000	15,000	15,000	15,000		17,500	
University of Toronto	2,356,742	2,043,254	2,087,424	2,121,557	2,615,961	2,063,273	2,284,011	2,131,100	2,380,677	1,973,923
University of Waterloo	311,613	333,413	334,413	518,821	469,868	511,500	370,500	968,250	302,000	428,500
University of Western Ontario	584,042	684,578	762,078	768,078	460,972	860,472	756,500	718,000	828,000	893,249
York University	151,319	91,756	46,280	103,746	111,500	169,560	199,000	323,500	209,500	304,000
Bishop's University	73,725	28,225	28,225	23,725	22,500	27,000	31,500	22,500	122,500	154,000
McGill University	1,077,785	1,118,460	943,761	927,336	828,276	1,095,000	963,567	968,250	638,506	1,718,882
Université de Montréal	789,061	768,461	761,264	685,391	593,675	814,467	822,500	718,000	757,000	1,007,500
Université Laval	457,104	458,304	363,500	342,103	176,500	370,500	347,000	323,500	269,000	118,000

Table 4 Total NSERC funding by University as a percentage of the total amount awarded each fiscal year

University	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
University of Alberta	2.0%	2.5%	2.7%	3.2%	2.7%	2.6%	3.5%	3.2%	3.4%	3.4%
University of Calgary	5.8%	9.1%	2.5%	4.0%	2.8%	1.7%	1.7%	1.5%	1.5%	1.5%
University of Lethbridge	0.5%	0.6%	0.7%	0.7%	0.8%	2.1%	2.1%	2.7%	2.7%	2.3%
University of British Columbia	8.1%	7.7%	10.9%	9.5%	6.2%	8.1%	9.2%	8.2%	7.2%	9.3%
University of Victoria	9.5%	9.6%	10.8%	9.8%	9.1%	8.8%	9.0%	7.9%	9.9%	10.6%
University of Manitoba	2.2%	1.9%	2.4%	1.6%	1.8%	2.3%	2.3%	2.3%	2.2%	1.2%
Mount Allison University	0.2%	0.2%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
Université de Moncton	0.2%	0.2%	0.2%	0.2%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%
Dalhousie University	0.0%	0.0%	0.0%	0.6%	1.2%	0.7%	0.7%	0.7%	0.0%	0.6%
Saint Mary's University	5.7%	5.1%	5.0%	4.9%	2.1%	3.7%	3.3%	3.7%	5.0%	4.2%
McMaster University	6.1%	5.7%	5.3%	6.6%	6.5%	4.2%	4.7%	7.9%	7.7%	5.5%
Queen's University	2.4%	2.8%	3.0%	2.3%	2.1%	2.6%	2.1%	1.9%	1.9%	1.5%
Royal Military College of Canada	0.3%	0.5%	1.0%	0.9%	0.8%	0.4%	0.4%	0.7%	0.7%	0.6%
Trent University	0.3%	0.3%	0.4%	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%	0.4%
University of Guelph	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.0%	0.2%	0.0%
University of Toronto	23.0%	19.8%	21.4%	21.2%	31.3%	21.6%	23.9%	20.2%	24.7%	17.5%
University of Waterloo	3.0%	3.2%	3.4%	5.2%	5.6%	5.4%	3.9%	9.2%	3.1%	3.8%
University of Western Ontario	5.7%	6.6%	7.8%	7.7%	5.5%	9.0%	7.9%	6.8%	8.6%	7.9%
York University	1.5%	0.9%	0.5%	1.0%	1.3%	1.8%	2.1%	3.1%	2.2%	2.7%
Bishop's University	0.7%	0.3%	0.3%	0.2%	0.3%	0.3%	0.3%	0.2%	1.3%	1.4%
McGill University	10.5%	10.9%	9.7%	9.3%	9.9%	11.5%	10.1%	9.2%	6.6%	15.2%
Université de Montréal	7.7%	7.5%	7.8%	6.9%	7.1%	8.5%	8.6%	6.8%	7.8%	8.9%
Université Laval	4.5%	4.5%	3.7%	3.4%	2.1%	3.9%	3.6%	3.1%	2.8%	1.0%

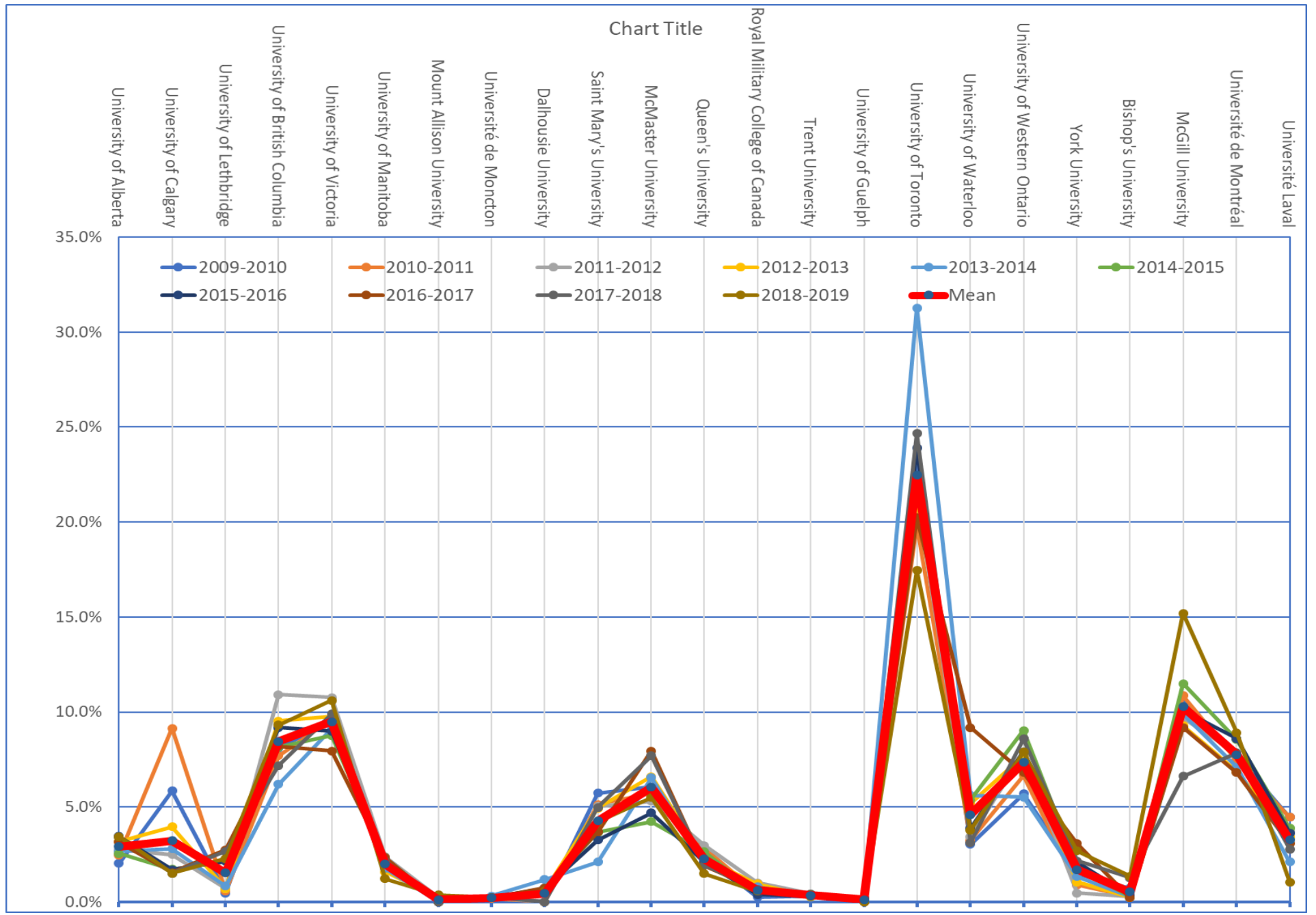


Figure 6 Total NSERC funding by University as a percentage of the total amount awarded each fiscal year with mean for the 10-year period shown as the thick red line