DEMOGRAPHIC SURVEY OF AUSTRALIAN ASTRONOMY

Report to the National Committee for Astronomy
for the Australian Astronomy Decadal Plan 2016-2025
Working Group 3.1 January 2015

CONTENTS

Image: 'Southern Cross' (ESO/Yuri Beletsky)

SUMMARY

Some key features of the demographic survey of the Australian astronomical community, compared to the decadal review in 2005 and 1995, are summarised by the following points:

1. The total size of the Australian astronomical community has grown by ~25% in the past decade, increasing from 417 FTE in March 2005 to ~527 FTE in January 2014. (The size of community was relatively steady for the previous decade, with ~420 FTE reported in 1995.) The astronomy research effort has also increased substantially in the past decade, from 111 FTE in 2005 to 349 FTE in 2014.
2. Of those staff involved in astronomy research, 36% are in ongoing positions while 64% are in fixed-term positions. This compares to 32% of research astronomers in 2005 in ongoing positions, representing a small improvement in the long-term job prospects for astronomy researchers over the past decade.
3. There has been no change in the overall percentage of (non-student) women in Australian astronomy over the past decade. Women comprise 21% of Australia's astronomy researchers (~22% of fixed-term and 19% of ongoing research positions), and 20% of the entire astronomical community (including non-research active support staff). In 2005, women made up 20% of the entire community.
4. There has been a large turnover of staff over the past 5 years. This staff movement is dominated by fixed-term positions, which represent 91% of the new positions and 86% of departures. The influx of astronomers to Australia from overseas in the past two decade has increased overall, as have the number of departures from Australia, with an overall increase in the size of the community. In the 5-year periods 1990-1994, 2000-2005 and 2009-2014, 48 versus 84 versus 166 people commenced Australian astronomy jobs from overseas, while 28 versus 39 versus 70 people left Australian astronomy for positions overseas.
5. Detailed employment history statistics have been gathered for the first time for over 300 individual astronomy staff. They suggest some divergences in career trends between fixed-term and ongoing employees, and between male and female astronomers.
6. The current number of PhD students has increased dramatically over the past decade, from 157 PhD students reported in 2005 to 266 in 2014. A better measure, however, of PhD students are the numbers of graduates. In the 5-year period from 2009-2013, 159 people graduated with Australian PhDs, almost double the number in the 5-year period 2000-2004. The number of women PhD graduates has dropped a little in the past decade, from 37% female in 2000-2004 to 33% in 2009-2013 (though well above the 15% reported in 1995). There has also been a 17% increase in the number of Honours graduates over the past decade.
7. Australia continues to be very active in hosting conferences and workshops, participating in international organisations, and receiving awards and honours.
8. The community continues to be very active in public outreach at every level.
9. The areas of astronomy that receive the greatest proportion of research effort have remained relatively unchanged since 2005 (dominated by extragalactic astronomy, instrumentation, galactic astronomy, and stellar astronomy). Extragalactic astronomy remains the most popular astronomy research area, especially amongst ongoing staff. With regards to research techniques, computational astrophysics contnued its 1995-2005 growth trend and was the most popular technique used in 2014.

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PART 1. INTRODUCTION

The Australian astronomical community carries out a formal strategic planning process on a 10-year time scale, along with a mid-term review. This process is run by the National Committee for Astronomy (NCA) and provides the opportunity for Australian astronomy to carry out a stocktake of its capabilities, assess its impact both nationally and internationally, provide a vision for the future and to set priorities and develop strategies on how that vision might be implemented.

The resultant Decadal Plan can then be used as a highly influential document to present our vision to key stakeholders outside the research sector. This includes Australian Astronomy's key stakeholder, the Commonwealth Government, as well as industry and research partners both nationally and internationally.

The period spanned by the previous Decadal Plan was 2006-2015, with a mid-term review in 2010. This decadal planning process is for the next ten-year period: 2016-2025.

The NCA's Demographics Working Group (WG3.1) conducted two extensive community surveys (see Appendices A and B) to collect and collate the information necessary to quantise and assess the total astronomy effort within Australia. Unlike the previous Decadal Plan demographics stocktake, WG 3.1 designed two surveys to obtain a census of both Australian astronomers and astronomy institutions:

1. The first survey (entitled 'Australian Astronomy Census 2014 – Individual', hereafter "Individual Survey") was open to *every person working in Australian astronomy*, incorporating a number of questions covering personal demographics, research areas and techniques, and employment history.

2. The second survey ('Australian Astronomy Census 2014 – Institutional', hereafter "Institutional Survey") was sent to *each Australian institute involved in astronomy*. The Institutional survey focused on staff numbers and movement, postgraduate student details, institute funding and research quality, community and industry engagement, and education programs.

The Individual Survey was sent out to astronomers via the Astronomical Society of Australia's mailing list, as well as via Head of Departments to their own astronomy groups. Just under 500 Australian astronomers, including postgraduate students, researchers, academics, technical and support staff, completed the Individual Survey. The Institutional Survey was sent to 18 institutes (listed in Table 1) and completed by department heads or their nominated representatives.

In order to retain consistency of survey responses, we asked that all relevant statistics be reported as of 31 January 2014. The material requested as part of the Institutional Survey was typically tied to the most recent five-year period – i.e., 2009-2013 inclusive – although some questions asked about current data to simplify reporting.

Since the completion of the 2006-2015 Decadal Plan ("New Horizons A Decadal Plan for Australian Astronomy 2006 – 2015"), four groups no longer considered themselves active: Queensland University of Technology (QUT), the University of Wollongong, the Perth Observatory and James Cook University (JCU). At QUT there is just one academic in the physics department working on astronomy education, who was not included in the survey. Similarly at the University of Wollongong there is one academic in the centre of medical radiation physics

who was not included in the survey. The Perth Observatory, while still a functioning public observatory, ceased astronomical research in March 2013. The JCU Centre for Astronomy was established in 2004, just prior to the last decadal plan survey, but closed at the end of 2012. It is included in the Institutional Survey, providing data from 2009 through until 2012. The Australian Centre for Astrobiology, which was reported in the last decadal plan, is now part of the University of New South Wales (UNSW) and is included with UNSW data.

Institutions included in this decadal plan that were not included in the previous 2005 survey include Curtin University, which has grown substantially in the past decade, and University of Western Sydney, which has remained a small but active group. It should also be noted the Australian National University (ANU) institutional survey responses include staff and students from the Research School of Astronomy and Astrophysics (RSAA), the Planetary Science Institute (PSI) and the Mathematical Sciences Institute (MSI).

Table 1. Institutional Survey Primary Contacts.

Institute	**Primary contact**
Australian Astronomical Observatory (AAO)*	Andrew Hopkins
Australian National University (ANU)	Milica Symil
CSIRO Astronomy & Space Science (CASS)†	Nic Svenson
Curtin University	Steven Tingay
James Cook University (JCU)	Andrew Walsh
Macquarie University	Amanda Manypeney
Monash University	John Lattanzio
Swinburne University of Technology	Sarah Maddison
University of Adelaide	Roger Clay
University of Melbourne	Rachel Webster
University of New South Wales	Chris Tinney
University of New South Wales-Canberra (UNSW-Can)‡	Warrick Lawson
University of Queensland (UQ)	Holger Baumgardt
University of Southern Queensland (USQ)	Brad Carter
University of Sydney	Peter Tuthill
University of Tasmania	Imogen Jones
University of Western Australia (UWA)	Renu Sharma
University of Western Sydney (UWS)	Miroslav Filipovic

Some questions in the Institutional Survey were prepared in consultation with or specifically for some of the other Working Groups. These include: WG 3.2 Educations, Training & Careers; WG 3.3 Industry; and WG 3.4 Research Funding. Some survey results are presented here (in sections 2.6 and 2.7 for WG 3.2, section 2.5 for WG 3.3 and section 2.3 for WG 3.4), with more details and specifically analysis in the reports of those respective Working Groups.

* In the previous decadal plan, the AAO was called the Anglo-Australia Observatory. It became the Australian Astronomical Observatory in 2010 when UK involvement in the AAO ceased.

† In the previous decadal plan, CASS was listed as the Australia Telescope National Facility (ATNF).

‡ In the previous decadal plan, UNSW-Canberra was listed as the Australian Defence Force Academy (ADFA).

PART 2. INSTITUTIONAL SURVEY RESULTS

2.1 STAFF DEMOGRAPHICS

The data collected on the staff and students in each institution was collected in a slightly different manner from the previous surveys due to the fact that two surveys were run (Institutional and Individual). Institutions were asked to report on their current total number of staff, separated by gender as well as separated by contract type (fixed-term or ongoing/tenured), who were doing astronomy for any part of their time. Movement of research staff was also tracked over the past 5 years (2009-2013) by asking for the number of new staff as well as departing staff over that time period, separated by contract type (fixed-term or ongoing/tenured) as well as by movement within and outside of Australia.

A total of 387 staff currently spend some of their time on astronomy research in Australia, with a full-time equivalence (FTE) of 349. Only 36% of Australian astronomy researchers are in ongoing positions, with 64% of researchers in fixed-term positions. 21% of Australia's astronomy researchers are women, with a slightly higher percentage of women in fixed-term than ongoing positions. Table 2 shows the distribution of staff across the 18 institutions.

Table 2. Current staff involved in astronomy research, listed by contract type (fixed-term or ongoing), percentage of women, and full-time equivalence (FTE).

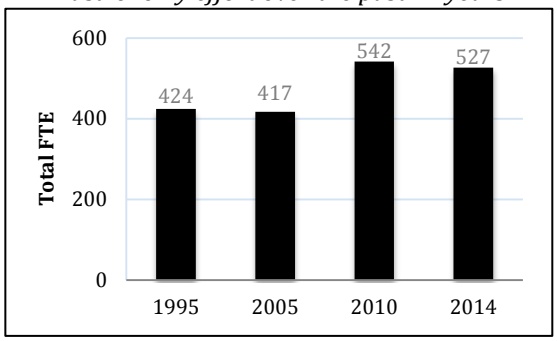
	Staff		Gender		Full time equivalence (FTE)	
Institution	**Fixed-term**	**Ongoing**	**Women FT (%)**	**Women ong. (%)**	**Fixed-term**	**Ongoing**
ANU	34	30	7 (20.6%)	4 (13.3%)	34	29.29
AAO	15	5	5 (33.3%)	0 (0%)	12.5	3
CASS	20	19	8 (40%)	6 (31.6%)	18	10.2
Curtin	27	4	4 (14.8%)	1 (25%)	26	4
JCU	0	0	-	-	0	0
Macquarie	14	4	2 (14.3%)	1 (25%)	11	3.7
Monash	8	13	3 (37.5%)	3 (23.1%)	7.5	12.5
Swinburne	23	14	2 (8.7%)	3 (21.4%)	23	13.6
U.Adelaide	4	5	0 (0%)	0 (0%)	2.6	4.5
U.Melbourne	13	3	2 (15.4%)	1 (33.3%)	12.8	3
UNSW	6	8	3 (50%)	2 (25%)	6	8
UNSW-Canberra	2	1	0 (0%)	0 (0%)	1.1	1
UQ	2	3	1 (50%)	1 (33.3%)	2	3
USQ	1	5	0 (0%)	1 (20%)	0.2	5
U.Sydney	33	8	4 (12.1%)	2 (25%)	32.5	6.3
U.Tasmania	16	5	6 (37.5%)	0 (0%)	9	5
UWA	30	8	7 (23.3%)	1 (12.5%)	29.2	6.5
UWS	0	4	0 (0%)	0 (0%)	0	3
Total	**248**	**139**	**54 (21.8%)**	**26 (18.7%)**	**227.4**	**121.6**
	total staff:	**387**	**total women:**	**80 (20.7%)**	**total FTE:**	**349.0**

In the 2005 demographic study, a complete census of all staff at each institute was conducted, including staff who contribute to astronomy that are not directly involved in astronomical research for any part of their time. Such a census was not carried out this year. However, the main institutes which have substantial numbers of technical support and administrative staff who contribute to the Australian astronomy effort are the two national facilities – the AAO and CASS – as well as the instrumentation group at ANU. The data in Table 2 for AAO includes research astronomers (AAT Science and AusGO) and research instrumentation scientists; the ANU data includes astronomers plus technical and engineering personnel; while the CASS data includes only research astronomers.

If we include the additional staff at AAO who support Australian astronomy, including operations, (non-research) instrumentation, administration and IT, this adds an extra 64 people, bringing the total AAO staff to 84 (24% women). Similarly, if we include the non-research CASS staff who support Australian astronomy, in technical support, administration, management and other roles, this adds an extra 178 people, bringing the CASS staff total to 217 (32% women)[§]. With these additional support staff included, the total current Australian astronomical workforce increases to approximately 629 people, 20% of whom are women.

It is difficult to directly compare the evolution of staff numbers with previous decadal plan surveys where all numbers were reported in FTE rather than people. If we assume the same "FTE rate" of the additional AAO and CASS support staff as their respective research staff FTE rates (which may not be the case) we get an approximate total astronomy effort FTE for 2014 of 527 FTE. Figure 1 compares the FTE with previous decadal plans and the 2010 mid-term review snapshot survey.

Figure 1. Evolution of the FTE Australian astronomy effort over the past 20 years.



In terms of staff movement, institutions were asked to report the number of fixed-term and ongoing (research) staff both arriving from and departing to positions outside of and within Australia over the past 5 years.

- In total, 311 staff commenced new positions (282 fixed-term and 29 ongoing) and there were 169 staff departures (145 fixed-term and 24 ongoing).
- Comparing the number of staff arrivals versus staff departures, we can see that there was a substantial overall growth in the total number of positions in Australian astronomy over the past 5 years in. There was a clear spike in new positions in 2011 resulting from the ARC Super Science Fellowships[**], which funded 31 new astronomy positions commencing 2012 and 2011.
- While the total increase in ongoing staff over the past 5 years has only increased by 4 positions, over the past decade the number has increased from 107 to 139, with substantial increases in the number of ongoing research staff at Monash, Swinburne, ANU and UWA, and with ongoing staff numbers at Curtin and USQ also on the rise. Over the past decade it is very encouraging to see the percentage of women in tenured positions increase from 10% to nearly 19%.
- Of the staff arrivals over the past 5 years, 42% of the 282 fixed-term positions were taken up by people from within Australia, while 58% of the new staff came from overseas. Of the 29 new ongoing positions, 41% of the staff came from overseas.
- Of the staff departures in the past 5 years, 56% of the fixed-term positions moved to other Australian positions, while 44% took up positions overseas. 75% of staff who left ongoing positions moved to other Australian positions and 25% moved overseas. Overall, 41% of staff departures left the country. (It should be noted that data was not collected on the type

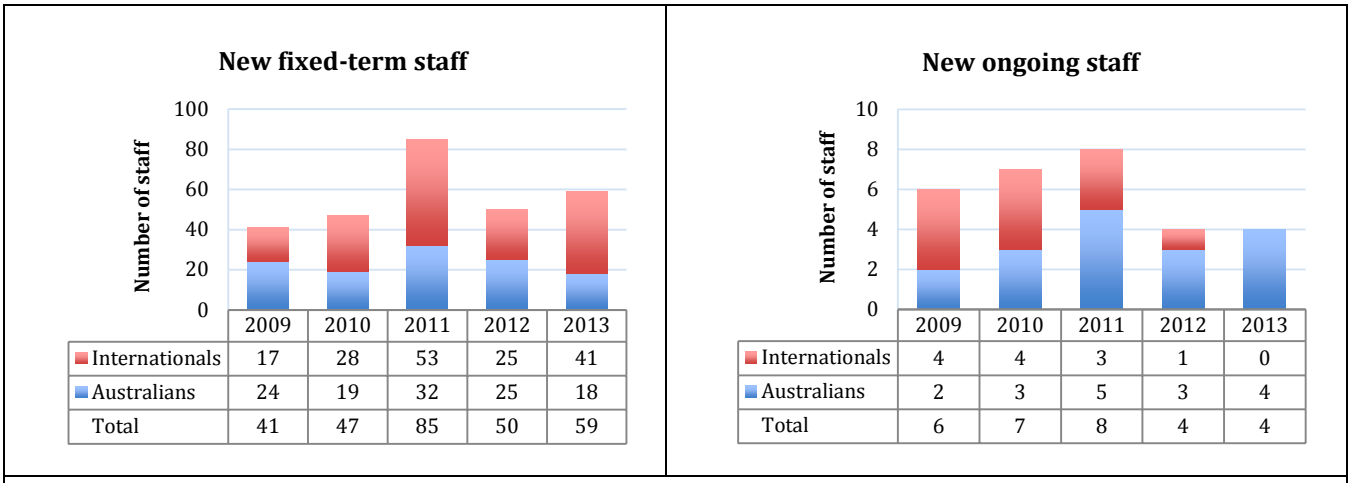
[§] These additional CASS numbers do not include the 88 staff of the Canberra Deep Space Communications Complex since only a small portion of their time goes to supporting the ATNF component of the Tidbinbilla facility

[**] http://www.arc.gov.au/ncgp/ssf/ssf_outcomes.htm

of jobs departing staff moved to, though anecdotally the majority of people moved to other astronomy jobs.)

- The influx of astronomers to Australia from overseas over the past two decades has increased overall, as have the number of departures from Australia, with an overall increases in the size of the community. Comparing the 5 years periods 1990-1994, 2000-2005 and 2009-2014, 48 versus 84 versus 166 people commenced Australian astronomy jobs from overseas, while 28 versus 39 versus 70 people left Australian astronomy jobs for positions overseas.
- The largest growth of research effort has come from Perth, which contributes nearly 18% of Australia's astronomy research, similar in number to Melbourne (19%) and Canberra (17%) which percentage-wise have both remained steady over the past decade. Sydney remains the highest concentration of astronomical research, representing 35% of the nation's effort.

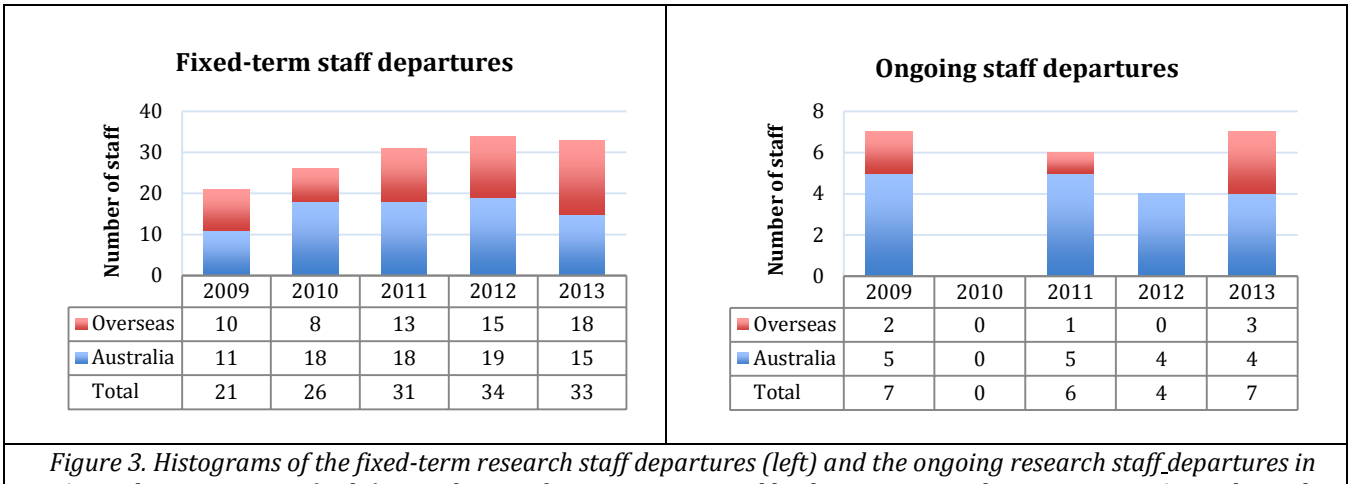
Figure 2 shows the overall numbers of new staff positions, while Figure 3 shows the staff departures for fixed-term and ongoing positions. Table 3 lists staff movement per institution.



	2009	2010	2011	2012	2013
Internationals	17	28	53	25	41
Australians	24	19	32	25	18
Total	41	47	85	50	59

	2009	2010	2011	2012	2013
Internationals	4	4	3	1	0
Australians	2	3	5	3	4
Total	6	7	8	4	4

Figure 2: Histograms of the new fixed-term research positions (left) and the new ongoing research positions (right) in Australian astronomy over the past five years, separated by arrivals from within Australia and from overseas.



	2009	2010	2011	2012	2013
Overseas	10	8	13	15	18
Australia	11	18	18	19	15
Total	21	26	31	34	33

	2009	2010	2011	2012	2013
Overseas	2	0	1	0	3
Australia	5	0	5	4	4
Total	7	0	6	4	7

Figure 3. Histograms of the fixed-term research staff departures (left) and the ongoing research staff departures in Australian astronomy (right) over the past five years, separated by departures to other positions in Australia and overseas.

Table 3. Research staff movement per institution over the past 5 years for fixed-term and ongoing positions.

Institution	New fixed-term staff						New ongoing staff						Departing fixed-term staff						Departing ongoing staff					
	09	10	11	12	13	Total	09	10	11	12	13	Total	09	10	11	12	13	Total	09	10	11	12	13	Total
AAO	3	6	9	4	6	28	1	1	1	1	0	4	3	2	4	3	4	16	1	0	0	0	0	1
ANU	7	9	9	>10	7	42	1	0	1	2	0	4	5	3	3	6	4	21	5	0	5	1	3	14
CASS	2	4	8	4	6	24	0	2	0	0	0	2	5	3	4	3	5	20	1	0	0	0	1	2
Curtin	5	3	8	2	4	22	0	0	1	0	1	2	0	1	1	1	0	3	0	0	0	0	0	0
JCU	1	0	1	0	0	2	0	0	0	0	0	0	0	1	0	3	0	4	0	0	0	1	0	1
Macquarie	1	1	5	5	1	13	2	0	1	0	0	3	0	0	0	1	2	3	0	0	0	0	0	0
Monash	0	0	4	1	0	5	0	0	0	1	0	1	1	1	3	0	1	6	0	0	0	0	1	1
Swinburne	5	3	10	2	8	28	0	0	0	0	0	0	2	5	3	3	4	17	0	0	0	0	0	0
U.Adelaide	0	0	1	0	1	2	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1
U.Melbourne	3	2	4	5	3	17	0	0	0	0	0	0	2	0	3	2	1	8	0	0	0	0	0	0
UNSW	2	2	3	1	2	10	0	0	0	0	1	1	1	2	4	0	3	10	0	0	1	0	0	1
UNSW-Canberra	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
UQ	0	1	2	0	1	4	1	1	0	0	0	2	0	0	0	0	2	2	0	0	0	0	0	0
USQ	0	0	0	0	1	1	0	0	1	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0
U.Sydney	5	5	>10	7	5	32	0	1	0	0	0	1	2	5	5	3	4	19	0	0	0	1	0	1
U.Tasmania	1	1	0	3	4	9	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0
UWA	5	>10	>10	5	10	40	0	2	1	0	0	3	0	3	1	8	2	14	0	0	0	0	0	0
UWS	1	0	1	0	0	2	1	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
	41	47	85	50	59	282	6	7	8	4	4	29	21	26	31	34	33	145	7	0	6	4	7	24

2.2 STUDENT DEMOGRAPHICS

Institutes were asked about the current numbers of Honours and postgraduate students; the number of Honours and postgraduate graduations over the past 5 years (and the demographics and destination of their graduates); the number of postgraduate scholarship applications received and postgraduate commencements; as well as some general questions about future expectations in terms of graduate students. Postgraduate training programs are run by 16 of the 18 institutions. The two national facilities, AAO and ATNF, are strong contributors to student research training but are not degree awarding institutions.

A snapshot of the current number of students and total number of graduates over the past 5 years is as follows:

Degree	Honours	Masters	PhD
Current students	40	24	266
Graduates (5 yrs)	167	25	159

2.2.1 POSTGRADUATE STUDENTS

Summary of some key trends in the postgraduate student data include:

- The current number of astronomy PhD students within Australia is 266, a substantial increase compared with the 157 PhD students reported in 2005. See Figure 4 for a comparison of PhD student numbers per institute over the past decade.
- The number of PhD completions in the recent 5-year period between 2009-2013 was 159, a significant increase compared to the 2000-2004 numbers (83) and the estimated numbers from 1990-1994 (98). See Figure 5 for a comparison of PhD completions over the past decade by institution.
- The gender balance amongst the PhD graduates have dropped a little over the past decade. Of the astronomy PhD graduates in the past 5 years, 33.3% were women, compared with 37.3% in the years 2000-2004 (which was a great improvement over the 15% women PhD graduates in the 1995 census).

- As well as PhD students, there are also 24 students currently enrolled in a Masters by research (excluding those at Melbourne University, who are included here with the Honours student data in the next section), and there have been 25 MSc students graduate over the past 5 years, of which 20% were women. If we combined the PhD and MSc students to consider the total number of postgraduate astronomy students in Australia, the total current number is 290 and the total number of graduations in the past 5 years is 184 (of which 31.5% were women).
- Institutes with postgraduate training courses (and the two national facilities that are active in research training) were asked to give a qualitative assessment of their expectations for the future of graduate training at their institution. 50% expected the quality to increase, 44% expected the quality to remain the same, while 6% expected the quality to decrease. They were also asked if they believed that the number of future postgraduate students would increase, which 67% agreed to, while 33% believe the numbers would remain the same.

Figure 4. Comparison of PhD student enrolment in January 2014 and March 2005 by institution.

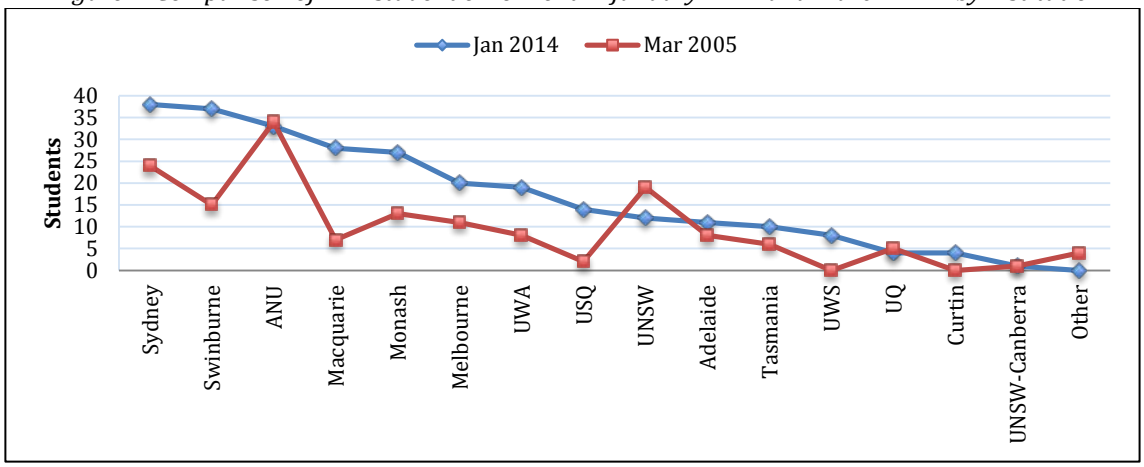


Figure 5. Comparison of the number of PhD graduates over the recent 5 year period 2009-2013 and that a decade ago from 2000-2004 by institution.

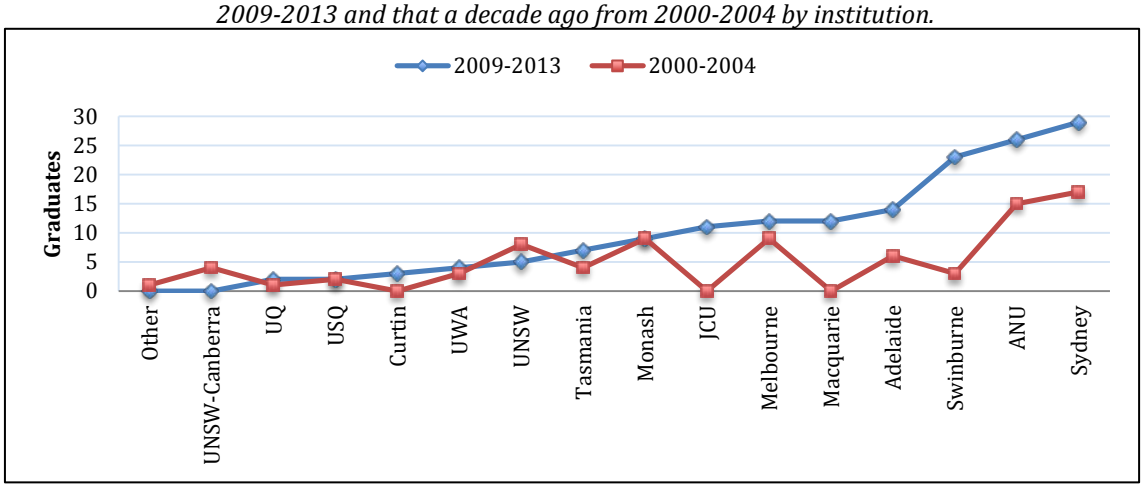


Figure 6 shows the number of PhD graduates per year over the past 5 years, and Table 4 shows the current number of students and graduates over the past 5 years (including contributions from AAO and CASS to postgraduate training, though these students tallied in the total numbers since these institutes do not award degrees).

Figure 6. Number of astronomy PhD graduates per year over the past 5 years.

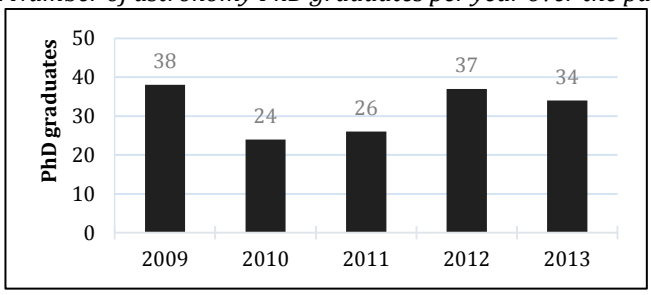
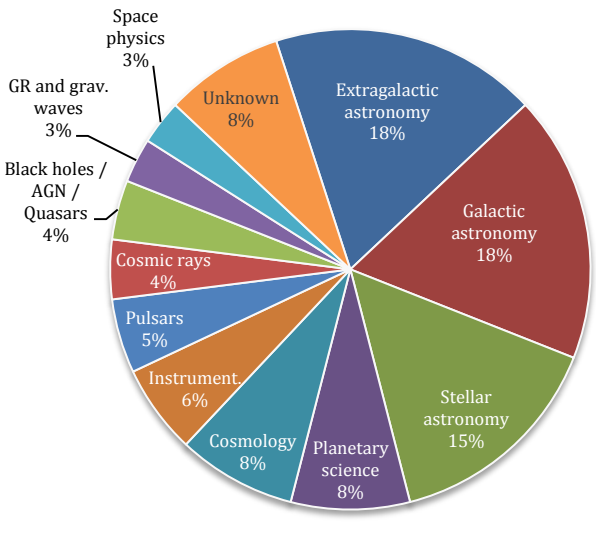


Table 4. Postgraduate student data per institute, including current student numbers and total number graduates (and number of those whom were female, F) over the past 5 years.

Institute	Current students		Graduates (2009-2013)			
	MSc	PhD	MSc	F	PhD	F
ANU	1	33	0	0	26	9
Curtin	3	4	1	1	3	0
JCU	0	0	1	0	11	2
Macquarie	6	28	3	1	12	5
Monash	0	27	0	0	9	4
Swinburne	1	37	0	0	23	9
U.Adelaide	2	11	6	2	14	1
U.Melbourne	2	20	2	0	12	6
UNSW	3	12	1	0	5	1
UNSW-Can	1	1	0	0	0	0
UQ	0	4	1	0	2	1
USQ	1	14	3	1	2	1
U.Sydney	3	38	3	0	29	10
U.Tasmania	0	10	1	0	7	2
UWA	1	19	3	0	4	2
UWS	0	8	0	0	0	0
AAO	*3*	*26*	*n/a*		*n/a*	
CASS	*1*	*34*	*n/a*		*n/a*	
TOTAL	24	266	25	20.0%	159	33.3%
Grad students	290		184 (31.5%)			

In Figure 7 we show the distribution of primary research area and primary technique of the PhD graduates over the past 5 years. Note that we have combined several areas: "planetary science" includes both exoplanets and planet formation; "galactic astronomy" includes galactic astronomy and galaxy formation; "space physics" include space physics and high-energy space physics; and "stellar astronomy" includes stellar astronomy, star formation and the Sun. Some thesis topics were difficult to classify, including those on radio transients (which included non-stellar sources) and those related to astronomical code development and high performance computing.



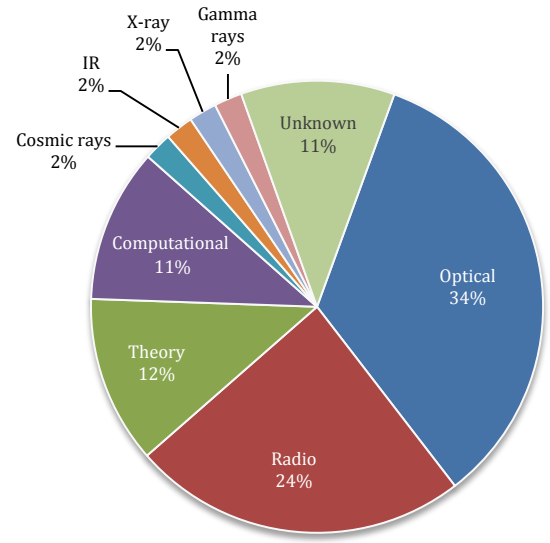


Figure 7. Distribution of research area (left) and research technique (right) of the astronomy PhD graduates over the past 5 years.

Institutes were asked about the post-degree employment destination of their graduates, if known, by type (academic, teaching, industry), area (astronomy, other science) and location (Australia, international). 59% were known to continue in academia, with 49% known to get jobs in astronomy. 18% of graduates went straight into industry or teaching. Note that the employment outcomes of about a quarter of graduates was unknown. The results are shown in Figure 8.

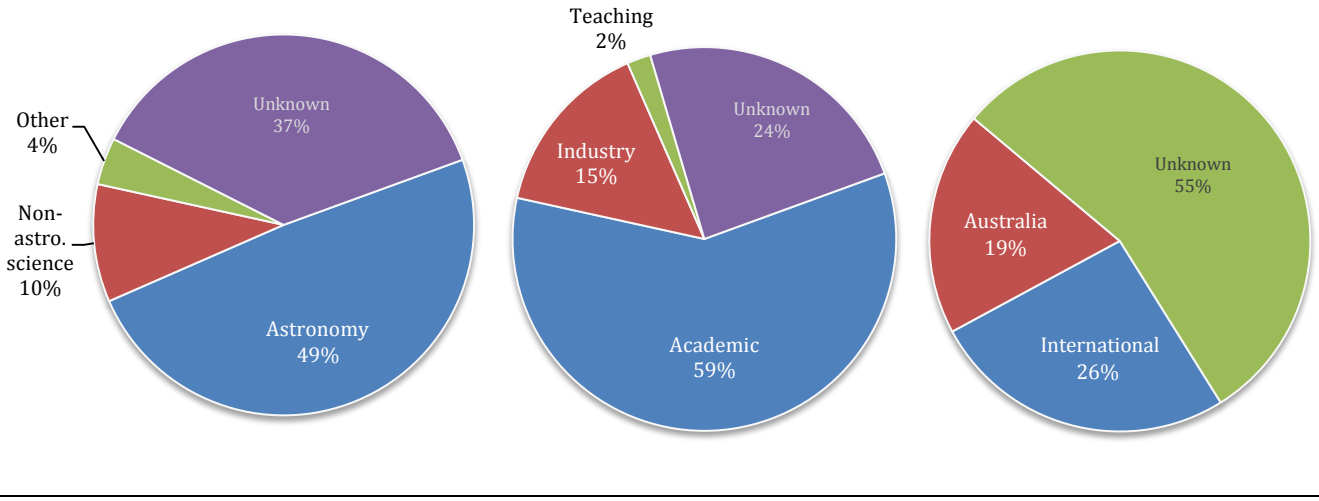
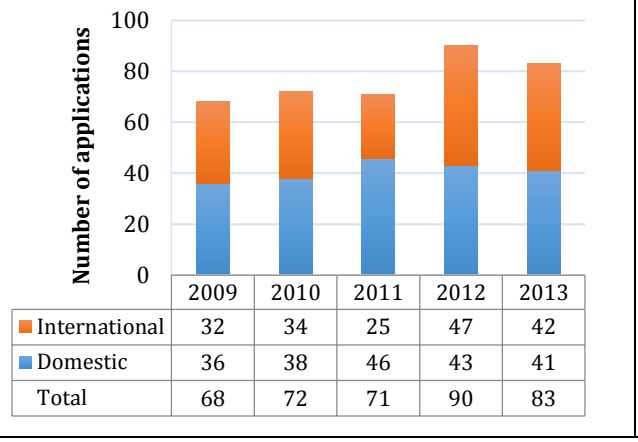
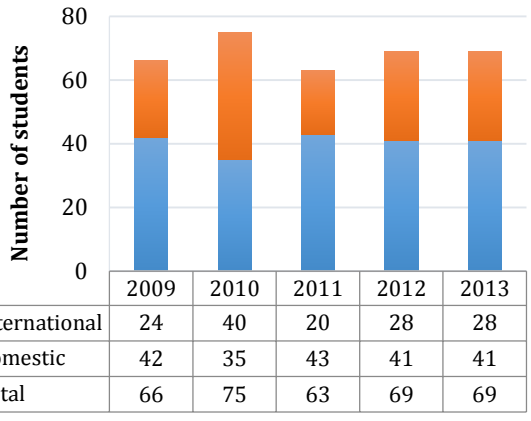


Figure 8. Post-PhD employment type (left), area (middle), and location (right).

Finally, institutes were also asked to report on the number of postgraduate scholarship applications they have received over the past 5 years, along with the number of commencements. In total there were 384 scholarship applications of which 47% were from international applicants, and 342 commencements, of which 41% were international students (see Figure 9 for more details).



	2009	2010	2011	2012	2013
International	32	34	25	47	42
Domestic	36	38	46	43	41
Total	68	72	71	90	83



	2009	2010	2011	2012	2013
International	24	40	20	28	28
Domestic	42	35	43	41	41
Total	66	75	63	69	69

Figure 9. Number of postgraduate scholarship applications over the past 5 years (left) and number of postgraduate commencements over the past 5 years (right).

2.2.2 HONOURS STUDENTS

Of the 18 institutes, 14 have an Honours programs. (The two national facilities, AAO and CASS, don't have teaching programs, and neither Swinburne nor UNSW-Canberra offered Honours in astronomy over the past 5 years. JCU did have an honours program before their astronomy

centre closed.) As of 31 January 2014, there were 47 Honours students†† enrolled at 11 institutes, though this number almost certainly rose once the semester began in March 2014. Over the past 5 years there have been 167 astronomy Honours graduates (see Figures 10 and 11).

Figure 10. The total number of Honours students graduated in past 5 years by institute.

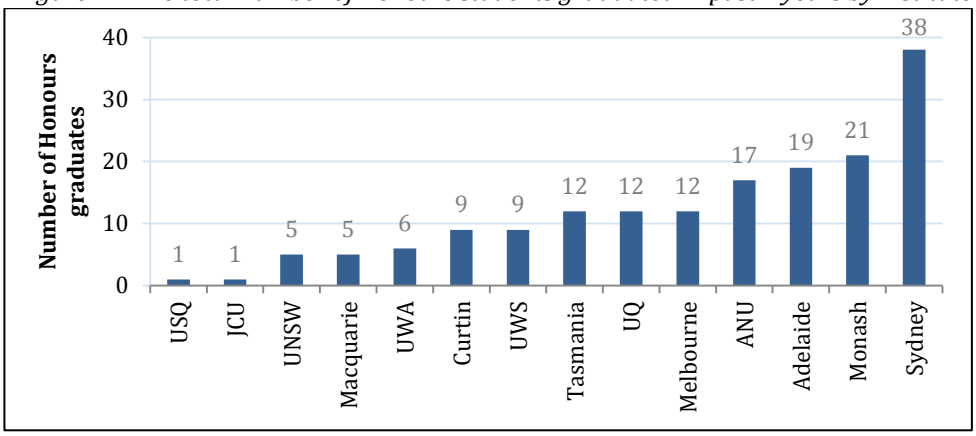
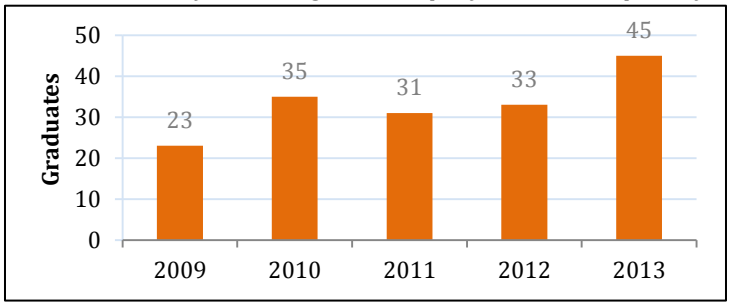


Figure 11. Number of Honours graduates per year over the past 5 years.



Institutes were asked to provide the following information of their Honours graduates: gender; their pre-Honours origin (what institute they came from); whether they continued on to postgraduate studies; and their employment outcomes. It was reported that:

- The number of Honours graduates has been increasing over the past 5 years (see Figure 11), and there has been a 17% increase in the number on Honours graduates compared to the 5 year period tracked in the last decadal study (167 students versus 143 students). The largest increases in Honours graduates over the past decade were seen at UQ, Adelaide, Sydney and Curtin, with the largest drop in Honours numbers at UNSW.
- Over that past 5 years 30% of the Honours graduates were women, compared to 37% a decade ago. This drop in the number of women graduating from Honours is cause for concern.
- Overall Australian students do not like to move institutes to do their Honours degree, with the majority of students staying in the same institutes where they completed their Bachelors degree. Only 7% of students come from another Australian institute and 2% from overseas. (See Figure 12, noting that the pre-honours origin of 27% of the graduates was unknown.) The nationality of the graduates was not collected.

†† Note that with the introduction of the "Melbourne Model" in 2008, the University of Melbourne moved to the Bologna model of a 3+2 degree. This replaced the traditional 3 year Bachelors + 1 year Honours with a 3 year Bachelors + 2 year Masters with research training. Thus the Melbourne Honours students listed here are in fact Masters students.

- After completing their Honours, 71% of the graduates continued on to postgraduate studies. Of those students who continued with their studies, 89% remained at the same institute, while 7% and 4% moved to other Australian and international institutes respectively. See Figure 12.
- Of those 31% of Honours graduates who did not continue on to postgraduate studies, knowledge of their employability outcomes are quite limited. However, there is data showing that 5 graduates went into industry, 6 into teaching and 2 into government.

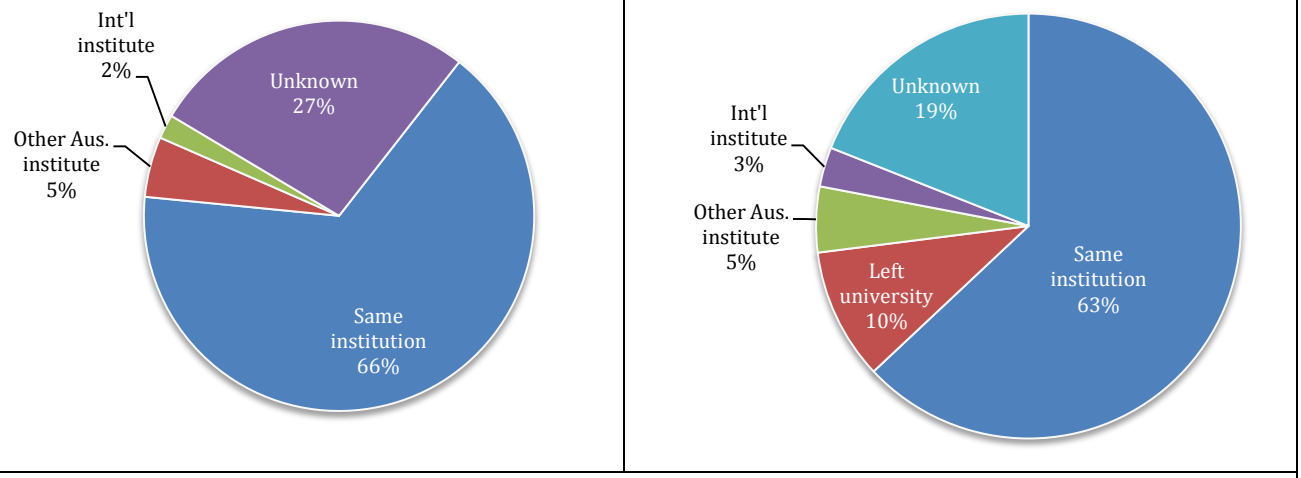
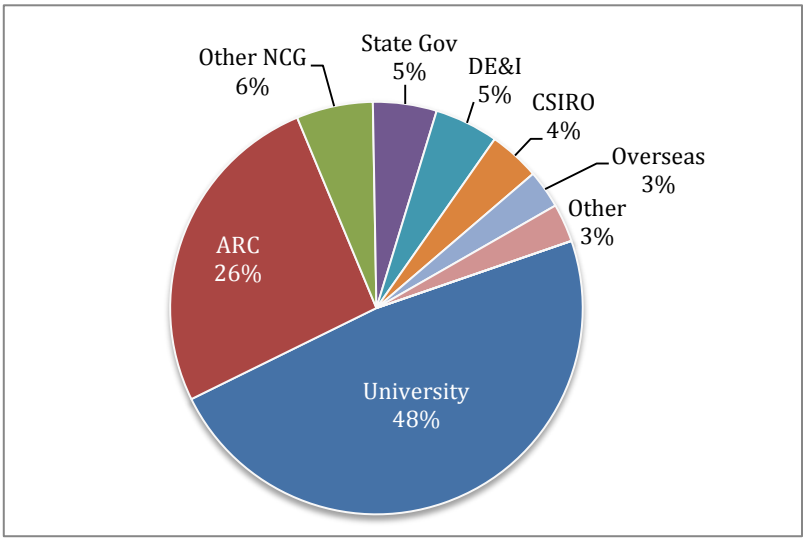


Figure 12. Pre-Honours origin of graduates over past 5 years (left), and proportion that went on to postgraduate studies (right).

2.3 FUNDING & GROWTH

Institutes were asked to indicate the percentage of their current budget (including salaries) that came from difference sources. Categories included: university; ARC; other national competitive grants (NCG) funding; Department of Education & Industry (ED&I); CSIRO; State or Territory Government (State Gov.); industry, overseas; private (including endowments, donations, charitable trusts etc.); and other. From Figure 13, we see that the majority of funding comes from universities and ARC (48.1% and 25.6% respectively), followed by a mix of other NCG funding, State government, Department and CSIRO funding. Almost 90% of the CSIRO funding that supports astronomy goes to CASS, with a small percentage of institute funding (generally < 5%) to Tasmania, UWA and Macquarie from CSIRO. The majority of the Department of Education & Industry funding that supports astronomy goes to AAO (74%), with contributions to Adelaide, Sydney, Macquarie, UWS and CASS (generally at the <5% level). Private funding and industry funding both contribute just 0.3% to Australian astronomy funding, comprising less than 3% of the overall budgets of Sydney, UNSW and ANU in the case of private funding, and Swinburne, CASS and ANU in the case of industry funding. Of the "Other" category, sources included visitor centres and ATO tax credits (CASS), DIISRTE (Tasmania), instrumentation contracts (26% of AAO's funding), interest and rent (12% of ANU's funding), as well inter-institute support.

Figure 13. Percentage of institutional budgets from a range of funding sources.



Institutes were asked what they felt about their current level of research funding, which the majority felt was adequate, while 33.3% felt was inadequate. Asked whether institutes felt that their research effort (in terms of both funding and staff) was currently expanding, steady or shrinking, almost 90% felt their situation was positive – see Table 5.

Table 5. Response to questions related to adequacy of research funding and current research efforts.

Adequacy of overall research funding		**Current research effort**	
More than adequate:	16.7%	Expanding:	50.0%
Inadequate:	33.3%	Steady:	38.9%
Just adequate:	50.0%	Shrinking:	11.1%

In terms of total expenditure contributing to astronomical teaching and research over the 5-year period from 2009-2013, the combined total expenditure across the 16 institutes that provided total budget information was almost $510M, while the average and median across the 16 institutes were $31.8M and $9.1M respectively. It should be noted, however, that the ANU and CASS budgets accounted for 60% of the total $510M.

Finally, institutes were asked to estimate the proportion of their annual budgets expended on teaching, research and other activities over the previous 5 years. Averaging over all 17 institutes, and over the 5 year period, approximately 30% of expenditure was on teaching-related activities, 55% on research activities, and 15% on other, where "other" included astronomy outreach programs, administration and telescope support.

2.4 RESEARCH QUALITY

The Australian community plays an active role in hosting both major international conferences and smaller, more focussed workshops. These all contribute to the high profile the Australian astronomical community enjoys internationally. In addition, Australians are active in executive positions, both nationally and internationally. Over the past 5 years, Australian astronomy has hosted just under 50 major conferences and over 100 workshops, and served on 102 international executive committees as well as 123 national executive committees. In those same 5 years, Australian astronomers have been awarded over 330 National Competitive grants, including over 130 non-ARC grants – see Table 6.

The quality of the research community has also been recognised by major awards, which include the Nobel Prize in physics, the Gruber prize for cosmology, two Prime Minister's Prize for Science awards, the Prime Minister's Malcolm McIntosh Prize for the Physical Sciences, and three Australian Academy of Science's Pawsey Medals. Two astronomers were also recognised as citation laureates, 4 astronomers have been awarded ARC Laureate Fellowships, 7 have become Fellows of the Australian Academy of Science, one became a Fellow of the Royal Society of London, and 2 astronomers were awarded Public Service Medals by the Commonwealth of Australia. Many other astronomers have been recognised by medals and awards from other countries and prestigious visiting positions. In addition, Australian astronomers hold senior positions in major international organisations and collaborations such as the International Astronomical Union, the Square Kilometre Array and the Giant Magellan Telescope, and serve on a range of committees for many of the major international observing facilities.

Table 6. Conferences, executive positions, awards & prizes and major national competitive grants (NCGs) awarded to each institute over the past 5 years.

Institute	Major Conferences	Local Workshops	International Exec Postions	Exec Positions	Awards & Prizes	ARC grants	Other NCGs
AAO	6	>10	3	10	11	4	1
ANU	2	3	16	13	21	23	0
CASS	8	>10	22	13	7	6	8
Curtin	3	>10	3	9	2	3	4
JCU	2	2	0	1	0	3	0
Macquarie	3	10	0	0	1	17	5
Monash	5	>10	7	7	0	14	0
Swinburne	2	5	12	8	5	24	>30
U.Adelaide	1	2	6	0	2	7	2
U.Melbourne	0	1	1	10	4	11	2
UNSW	3	3	7	9	4	>30	>30
UNSW-Canberra	0	0	0	0	0	1	0
UQ	1	5	1	6	5	5	0
USQ	0	0	1	1	0	0	2
U.Sydney	6	>10	11	20	10	>30	7
U.Tasmania	1	1	2	5	0	5	5
UWA	6	>10	10	11	4	20	>30
UWS	0	1	0	0	0	0	2
Totals	**49**	**>100**	**102**	**123**	**76**	**>200**	**>130**

2.5 INDUSTRY ENGAGEMENT & COMMERCIALISATION

Four institutes have implemented Integrated Project Teams with staff from both industry and research for projects including telescope instrumentation (AAO), telescope development (Curtin for the Murchison Widefield Array) and new technology development (UWA and ANU). Other commercial projects include the first Australian 3D IMAX movie (Swinburne), astrophotonics (Macquarie) and telescope infrastructure projects (CASS).

Institutes were asked how developed their skills were to successfully exploit commercial opportunities, industry capabilities and IP management, to which 3 (17%) responded 'very developed'. Asked whether it was felt that there is sufficient coordination within the Australian astronomy community to develop the flow of commercial products into and IP out of astronomy, one institute (6%) answered 'yes'. See Figure 14 for results.

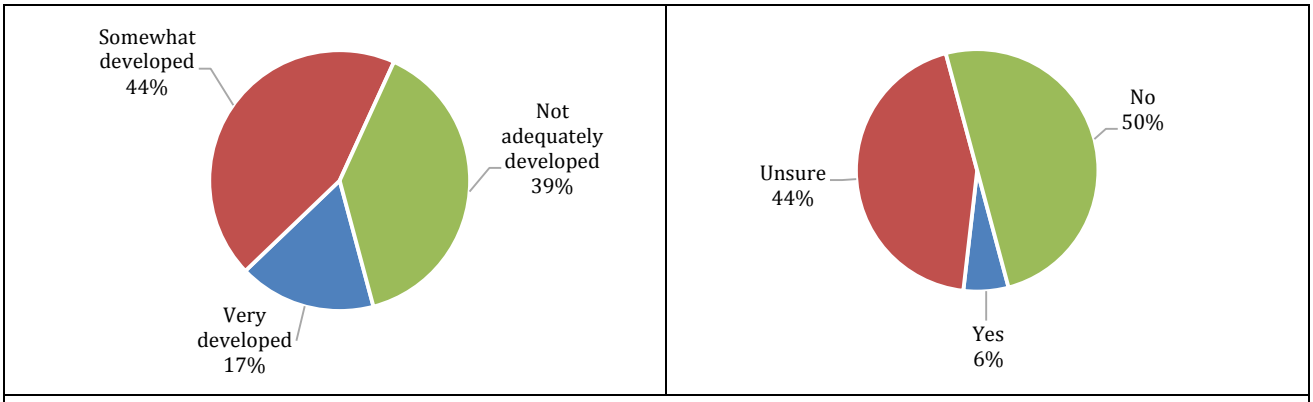


Figure 14. Institute responses to their level of skill at exploiting commercial opportunities (left), and whether they felt the community was sufficiently coordinated to develop the flow of astronomy commercialisation (right).

2.6 OUTREACH AND BENEFIT TO THE COMMUNITY

The Australian astronomical community is engaged with a wide range of outreach activities for students (primary, secondary and university), special interest groups and the general public. Of the 18 institutes: 17 offer public lectures; 8 have visitor centres; 15 have open days, night sky viewings and day/solar viewings; 16 institutes have visits to schools while 15 institutes host school group visits to institutes; and 12 institutes offer a range of other activities.

Over the past 5 years, there have been over 7,800 outreach activities across the 18 institutes attended by over 1.34 million people (see Figure 15). The Parkes visitor centre dominates the participant numbers, with over 890,000 visitors in the last 5 years. This number of activities and participants increased enormously compared to the previous decade (510,000 visitors in a 5 year period), no doubt helped by the 2009 International Year of Astronomy.

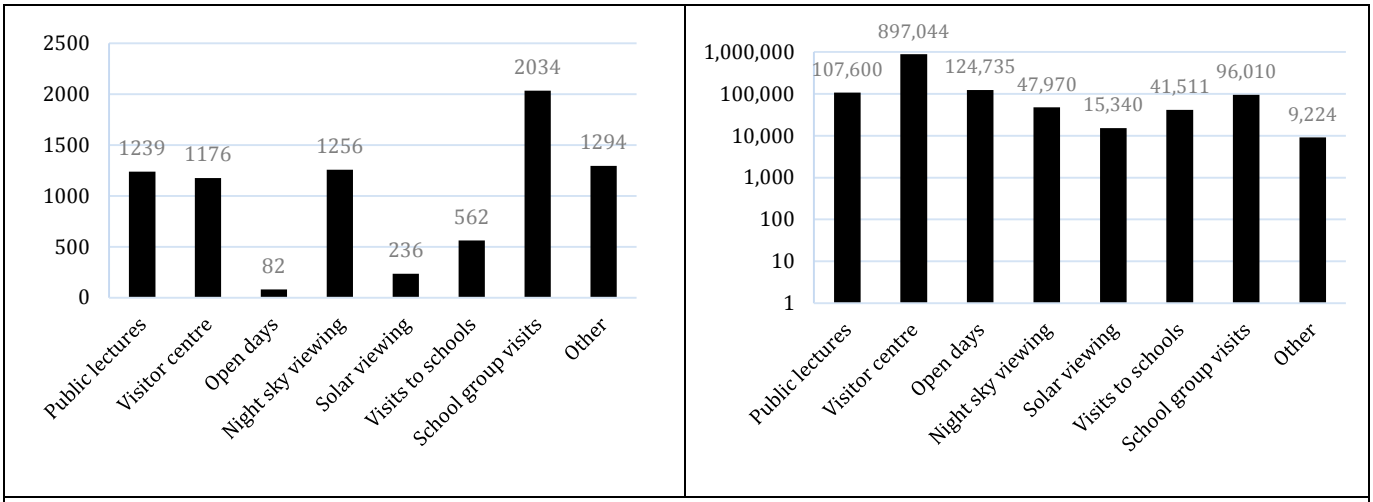


Figure 15. The number of outreach activities hosted in the past 5 years by the Australian astronomical community (left), and the number of participants to each outreach activity (right, with logarithmic scale).

Sixteen of the institutes have been involved in at least 500 collaborative outreach activities over the past 5 years: 7 institutes collaborate with other astronomy institutes; 12 institutes collaborate with amateur societies; 8 institutes collaborate with professional teachers associations; and 6 institutes collaborate with other groups that include Astronomers Without Borders, Questacon, Scienceworks, Australian Museum, Scitech, Victorian Space Science Education Centre, Australian Network for Art and Technology, and schools. Six institutes also offer teacher-training programs, attended by over 3,300 teachers in the past 5 years.

Eleven institutes have funding specifically for outreach activities, ranging from a few $100 to a few $100,000 per year, with a median amount of $10,000 per year. Three institutes run their outreach activities on a cost-recovery basis, and several institutes note that their outreach costs do not include salaries. Most university outreach activities are run on a volunteer basis and/or are an expected part of academic/student duties.

Australian astronomers have produced 26 popular books and over 300 popular astronomy articles over a range of formats in the past 5 years, including: amateur astronomy/science magazines, dedicated journals and magazines (such as university research magazines), newspaper articles, website articles, as well as blogs, newsletters and an online encyclopaedia of astronomy.

2.7 TEACHING AND EDUCATION

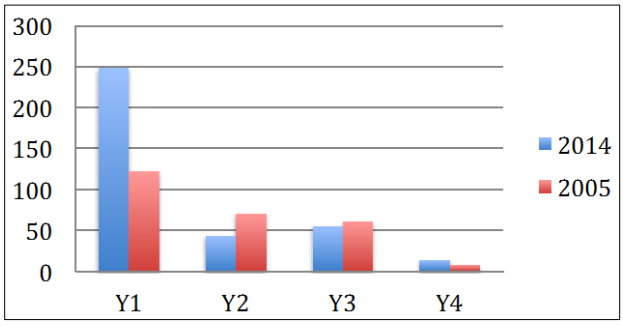
2.7.1 UNDERGRADUATE TEACHING

Most universities teach astronomy and astrophysics as part of the physics and/or mathematics subjects in the bachelor degrees, generally BSc, so students generally take astronomy subjects as a fairly small part of their undergraduate degree. Eleven institutes provided data on their undergraduate astronomy subjects (defined as units with 'astronomy' or 'astrophysics' in the title and/or >50% astronomy and/or astrophysics component in the syllabus for on-campus students). On average over the past 5 years, the community has taught astronomy to 2837 undergraduates (35% women), with a teaching load of almost 350 EFSTU‡‡ – see Table 7. This represents a 1.3 fold increase in undergraduate astronomy taught load compared to a decade ago, mainly due to the increase in astronomy first year enrolments – see Figure 16.

Table 7. Astronomy lecture courses taught (averaged over the past 5 years) in EFSTU.

Institute	Year 1 students	Year 2 students	Year 3 students	Year 4 students	Year 5 students
ANU	0	0	6.75	0	0
JCU	9.375	0	0	0	0
Macquarie	51.875	1.375	3.125	0	0
Monash	50	15	21.25	0	0
U.Adelaide	16.25	2.5	3.125	8	0
U.Melbourne	15	0	3.75	0	1.25
UNSW	60.625	3.75	2.8125	0	0
UNSW-Canberra	0	2.5	0	0	0
UQ	0	6.25	3.125	0	0
U.Sydney	25	11.5	8.75	3.125	0
UWA	19.5	0	2.25	0.75	0.25
Total	247.625	42.875	54.9375	11.875	1.5

Figure 16. Undergraduate astronomy taught load ETFSU in 2014 and 2005. (The 2014 Year 4 and Year 5 are combined as Y4).



‡‡ EFTSU = effective full-time students. Note that Honours (and Masters) research projects are not included in the EFTSU calculations.

Another significant part of training undergraduate students, and providing early experience in astronomical research, is through summer vacation programs. Fifteen of the 18 institutes offer vacation programs, supervising 333 students (40% women), of which 61 (18%) went on to do PhD at that same institute – see Table 8. Note that AAO and CASS offer summer scholarships but do no award PhDs. Anecdotally it appears that many summer vacation students go on to do PhDs in astronomy and other fields at different institutes, though this data was not recorded.

Table 8. Summer vacation student data over the past 5 years.

Institutes	Total # students in past 5 years	% women	# continued to PhDs
AAO	40	60	0
ANU	26	40	5
CASS	35	38	5
Curtin	40	30	0
Macquarie	10	50	2
Monash	15	30	5
Swinburne	45	37	5
U.Adelaide	10	50	5
U.Melbourne	10	50	5
UNSW	8	38	0
UQ	15	50	0
U.Sydney	38	31	17
U.Tasmania	20	25	7
UWA	19	20	3
UWS	2	50	2
Total	333	40	61

2.7.2 ONLINE & DISTANCE EDUCATION

Three institutes offer (or offered) fully online or distance degree programs in the past 5 years: Swinburne, USQ and JCU. Swinburne has been running their online postgraduate astronomy program for 15 years. The JCU Centre for Astronomy, established in 2004, specialised in distance learning postgraduate degrees that included a Master of Astronomy, a Doctor of Astronomy and a PhD. All JCU programs ceased at the end of 2012 when the Centre was closed. USQ commenced its online postgraduate programs in 2013 and has been running a distance BSc in physical science program since 2011. Over the past 5 years, these three institutes have taught 296 postgraduate students (26% women and 54% international on average) – see Table 9.

Table 9. Online and distance education data over the past 5 years.

Institute	Degree	Ave. # students	% female	% international	O=online, D=distance
Swinburne	Graduate Certificate of Science (Astronomy)	21	21	34	O
Swinburne	Graduate Diploma of Science (Astronomy)	15	11	28	O
Swinburne	Master of Science (Astronomy)	122	19	51	O
USQ	Bachelor of Science (Physical Sciences)	20	40	0	D
USQ	Graduate Certificate of Science (Astronomy)	10	60	0	O
USQ	Master of Science (Astronomy)	10	10	50	O
USQ	Doctor of Philosophy	14	15	85	O
JCU	Graduate Certificate of Astronomy	15	30	70	D/O
JCU	Graduate Diploma of Astronomy	15	30	70	D/O
JCU	Master of Astronomy	35	30	70	D/O
JCU	Doctor of Astronomy	22	30	70	D/O
JCU	PhD	17	30	70	D/O
		296	26	54.3636364	

2.7.3 EDUCATIONAL FUNDING

Institutions were also asked whether funds were available to support teaching initiatives: 15 institutions responded that they have funding sources available for education and teaching grants. However 10 institutions believe that overall funding for education is inadequate, 6 institutions believe it is just adequate, and 2 institutions believe that funding for education is more than adequate. Thirteen groups had been awarded over 45 education-related grants in the past 5 years, of which about 54% were funded internally.

PART 3. INDIVIDUAL SURVEY RESULTS

Just under 500 people working in Australian astronomy, including postgraduate students, researchers, academics and technical and support staff, completed the 2014 Individual Survey.[§§] This survey requested personal information from the participants, including their age, nationality and gender, which provides important demographic data on the Australian astronomical community. Additionally, this survey sought to create an overview of participants' research efforts by requesting breakdowns of their functional workload distribution, research areas and research techniques. Finally, participants were asked about their educational and employment history, ranging from their studies to fixed-term positions, through to tenured positions. This data provides information about the career stages of the astronomy workforce.

The data on these topics was collected in a different manner from the 2005 Demographic Study Survey due to the fact that two distinct surveys were run in 2014 (Institutional and Individual). The 2005 Survey collected data on all non-student astronomy staff at relevant astronomy institutes, and this data was provided by an institutional representative after consultation with their constituency. By contrast, the 2014 Individual Survey collected data on the basis of voluntary participation from all people working in Australian astronomy. This included postgraduate students but tended to exclude technical support staff due to the way the survey was distributed (see Part I above). The demographic, research and career progression data obtained from the 460+ participants who elected to respond to sections of this Individual Survey can therefore only serve as an indicative – rather than definitive – comparison to the trends observed in the 2005 Survey. Where such an analysis would be informative and has not already been covered by the 2014 Institutional Survey, data obtained from student participants has been removed to allow for a closer inspection of trends over the last decade.

As noted in Part I above, the 2014 Individual Survey also drew on a somewhat different subset of the Australian astronomy community compared to the 2014 Institutional Survey. Not all staff who informed the Institutional Survey elected to respond to the Individual Survey. At the same time, the Individual Survey included people not included in the Individual Survey, either due to their role (e.g. non-research active staff outside of AAO/ANU/CASS) or their institution (e.g. Sydney Observatory, Manly Astrophysics, etc.). As such, the subsets of the Australian astronomy community engaged by the two 2014 surveys do not completely overlap. The subset of astronomy research-active non-students in the Individual Survey is approximately 40% smaller than the size of the research-active astronomical workforce investigated by the Institutional Survey. The subset of students in the Individual Survey is approximately 58% smaller than the total number of postgraduate astronomy students enrolled in 2014 as measured by the Institutional Survey.

For these reasons, the main focus in the analysis of the results of the 2014 Individual Survey will be on percentage statistics (response count as a proportion of all respondents to the question) and breakdown comparisons (response trends within respondent sub-groups). Since no significance testing has been performed for the latter statistics, such comparisons are again indicative rather than definitive. Unless otherwise indicated, percentage values (along with the total number of respondents) will be provided in all Figures and Tables.

[§§] The number of respondents to each question varied throughout the survey, but was generally between 467 and 495. Respondent numbers will be provided for each question for the Individual Survey.

3.1 INSTITUTIONAL AFFILIATION

Participants were asked to elect their principal Australian institutional affiliation, and whether or not they are members of either the ARC Centre of Excellence for All-sky Astrophysics (CAASTRO) or the International Centre for Radio Astronomy Research (ICRAR). Figure 17 presents the responses obtained. Those grouped as 'Other' include respondents from Astronomy WA, Charles Sturt University, CSIRO CMSE and CESRE, Manly Astrophysics, Museum Victoria, Sydney Observatory, UNSW-Canberra, USQ, and UWS.

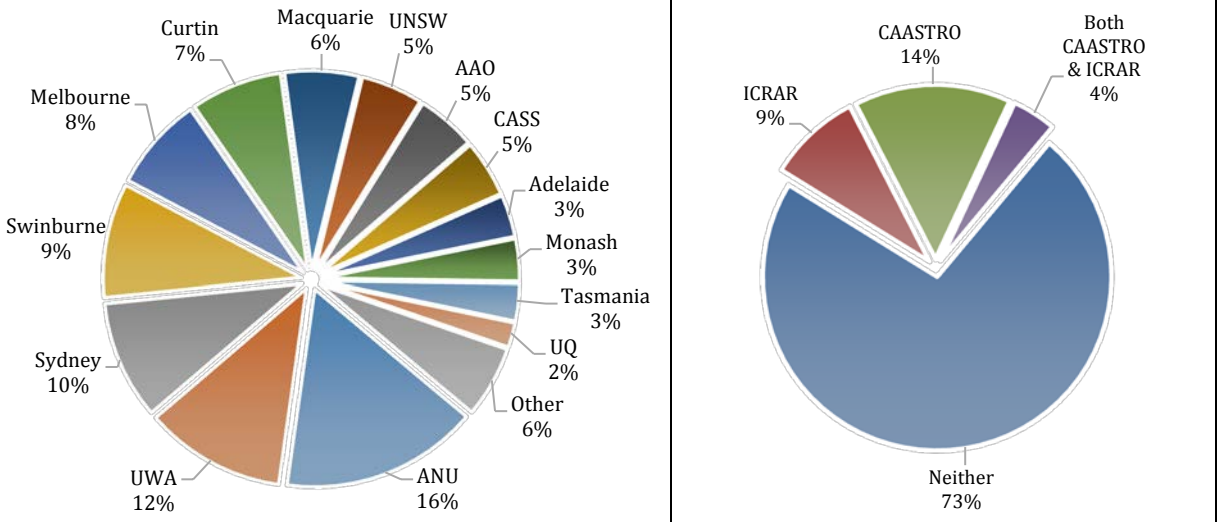


Figure 17. Distributions of principal Australian institutional affiliation (left; N=495) and CAASTRO/ICRAR membership (right; N=495).

3.2 EMPLOYMENT TYPE AND FULL TIME EQUIVALENCE

Participants were asked to indicate their employment type within four possible options: ongoing/continuing contract, fixed-term contract, postgraduate student, or casual work. Of the 467 respondents to this question 28% were ongoing staff, 39% were fixed-term staff, 7% were casual staff, and 26% were postgraduate students. These statistics should be seen as complimentary to the Institutional Survey employment data (section 2.1).

Investigating employment type trends by gender reveals that:

- Male respondents were proportionally more likely than female respondents to be employed in ongoing positions, while female respondents were proportionally more likely than male respondents to be students (see Figure 18).
- The overall male-female ratio within the group of ongoing staff was 78:22 (see Table 10). This indicates a substantial levelling of the 90:10 male-female ratio of ongoing staff from the 2005 Survey. This result should be taken as a complimentary comparison to the breakdown found in the 2014 Institutional study (81:19).

Figure 18. Employment type: trends within gender groups (121 female, 346 male).

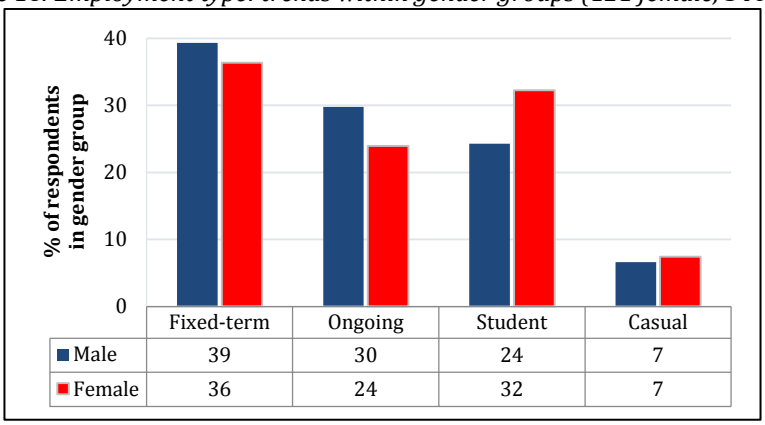


Table 10. Gender proportions within employment type groups.

	Male	Female	Group n=
% of ongoing respondents	78	22	132
% of fixed-term respondents	76	24	180
% of casual respondents	72	28	32
% of student respondents	68	32	123

Survey participants were also asked to provide the percentage of full time equivalence that they were employed at their principal Australian institution. 81% of the 467 respondents to this question chose '81-100% FTE'. 8% of respondents selected '0-20% FTE', 1% selected '21-40% FTE', 6% selected '41-60% FTE', and 4% selected '61-80% FTE'.

3.3 COMMUNITY DEMOGRAPHICS

Participants were requested to provide their age, nationality, gender and whether they have any dependents for which they have carer responsibilities.

3.3.1 AGE

The median age of all participants was 35, however as Figure 19 shows the age distribution is skewed towards younger age groups. The median age for non-student respondents was 42, which is unchanged from the 2005 Survey. However, the age distribution of non-student respondents under 40 has shifted since 2005.

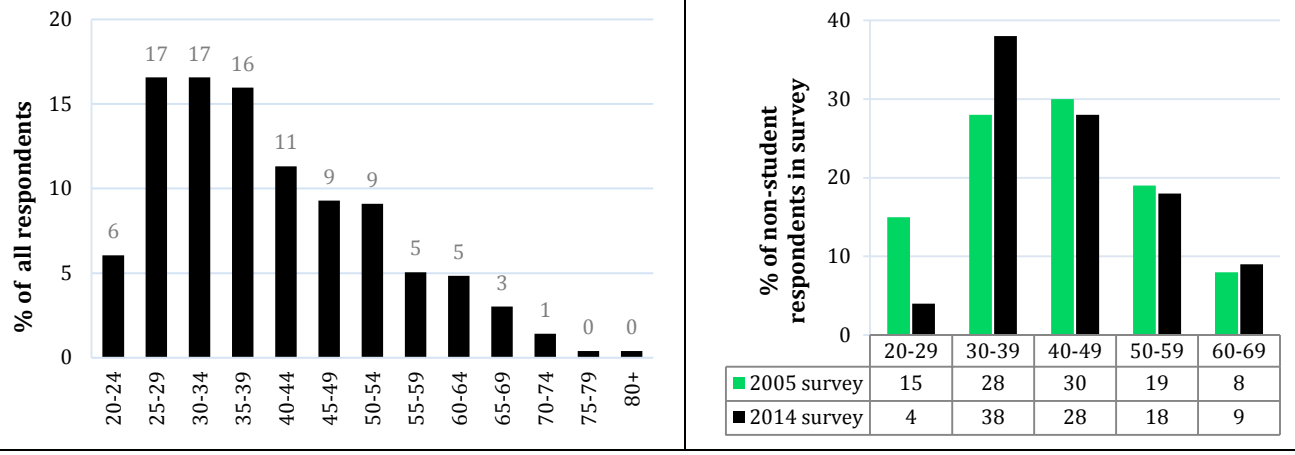
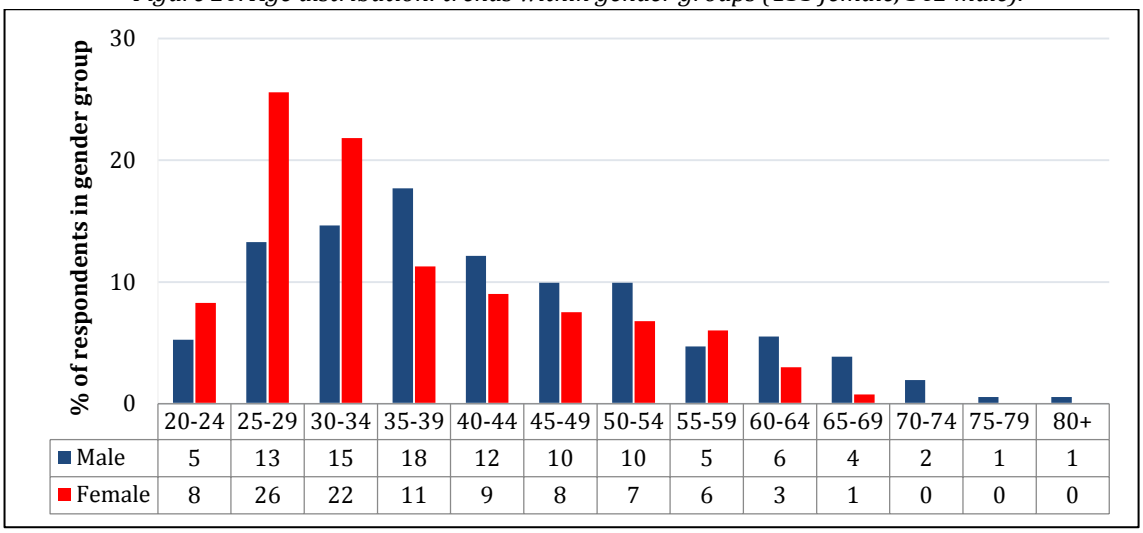


Figure 19. 2014 age distribution (left; N=495) and comparison of age distribution of non-student respondents between 2005 and 2014 (right).

Analysis of age distributions by gender and employment type shows:

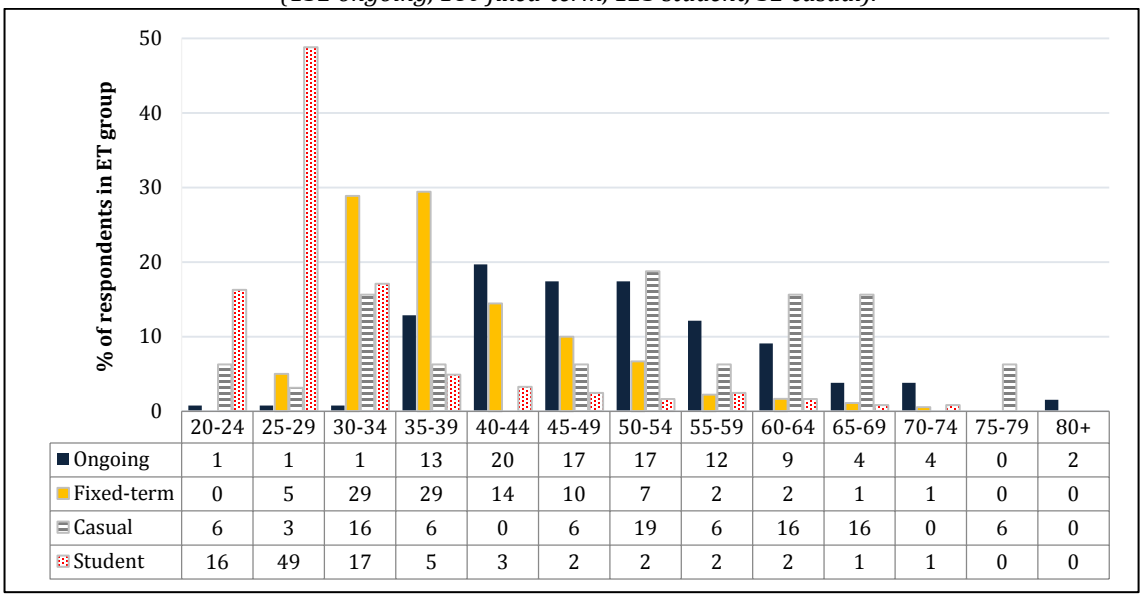
- Female participants were proportionally more likely than males to be aged below the overall median age of 35 (Figure 20), with a median age for female respondents of 33 compared to 39 for the male respondents.
- Students and fixed-term staff were over-represented in the <40 year old categories compared to ongoing staff (Figure 21).
- The proportion of ongoing staff aged <40 was 15%, which is similar to the proportion found in the 2005 Survey (18%). The proportion of ongoing staff aged 40-49 is also almost unchanged between the two surveys (39% in 2005, 37% in 2014).
- The median age for ongoing staff was 48, compared to 37 for fixed-term staff, 28 for student respondents, and 52 for casual staff (which included several semi-retired, honorary and emeritus staff).

Figure 20. Age distribution: trends within gender groups (133 female, 362 male).



	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
Male	5	13	15	18	12	10	10	5	6	4	2	1	1
Female	8	26	22	11	9	8	7	6	3	1	0	0	0

Figure 21. Age distribution: trends within employment type (ET) groups (132 ongoing, 180 fixed-term, 123 student, 32 casual).

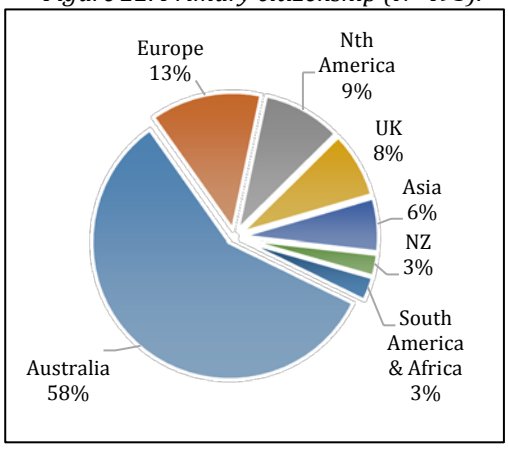


	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
Ongoing	1	1	1	13	20	17	17	12	9	4	4	0	2
Fixed-term	0	5	29	29	14	10	7	2	2	1	1	0	0
Casual	6	3	16	6	0	6	19	6	16	16	0	6	0
Student	16	49	17	5	3	2	2	2	2	1	1	0	0

3.3.2 NATIONALITY

Respondents were asked to identify their primary, secondary and tertiary citizenships. As the grouped data in Figure 22 shows, the majority of respondents selected Australian primary citizenship. In total, 63% of all respondents were of Australian primary or secondary citizenship. Amongst all non-student respondents 65% were of Australian primary or secondary citizenship.

Figure 22. Primary citizenship (N=495).



In terms of demographics, respondents with Australian primary citizenship had a median age of 43 years, substantially higher than the median age of non-Australian respondents (35). The gender split within Australian and non-Australian groups was almost identical and did not substantially deviate from the overall gender ratio (see below).

3.3.3 GENDER

Of the 495 respondents to this question, 73% identified as male and 27% identified as female. Breakdowns in relation to employment type and age are given in Table 10 and Figure 20 above.

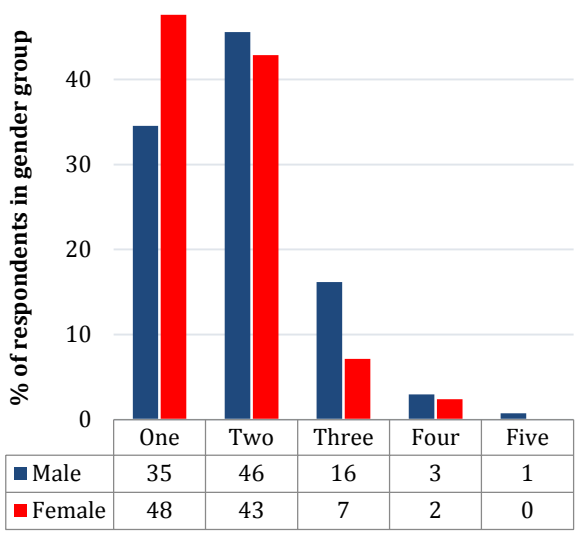
While the 2005 survey indicated an 80:20 male-female ratio across all non-student astronomy staff, non-student respondents from the 2014 survey had improved slightly to 76:24.

3.3.4 CARER RESPONSIBILITIES

Participants were asked to provide the number of dependents that they supported if they had carer responsibilities. Of the 495 respondents to this section of the survey, 178 (36%) provided a non-zero answer to this question. Of these 178 respondents, 38% indicated having one dependent, 45% had two dependents, 14% had three dependents, and 3% had four or more dependents.

Analysis by gender shows that:

- 32% of all female Individual Survey participants and 38% of all male Individual Survey participants indicated having at least one care dependent.
- Males with dependents were proportionally more likely to have more than one care dependent compared to females with dependents (see Figure 23 - left).
- When looking at all 495 respondents of the Individual Survey, a greater proportion of males <40 years old had care dependents than females in the same age range (see Figure 23 - right). This trend is reversed amongst older age groups.
- Male respondents with care dependents were proportionally more likely to be employed 81-100% FTE compared to female respondents with care dependents (76% of males vs. 56% of females; see Figure 24).



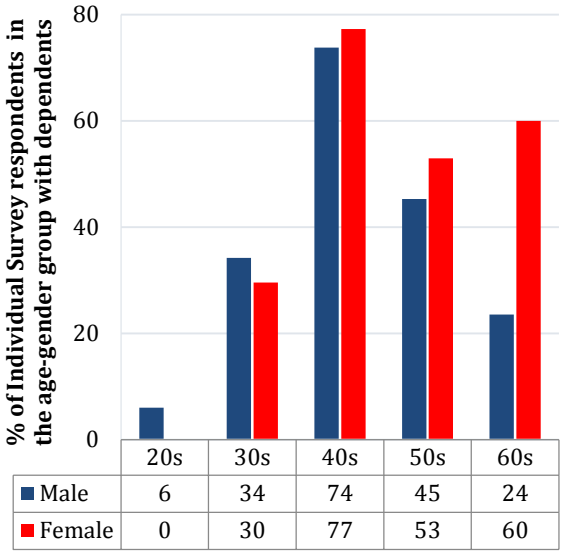
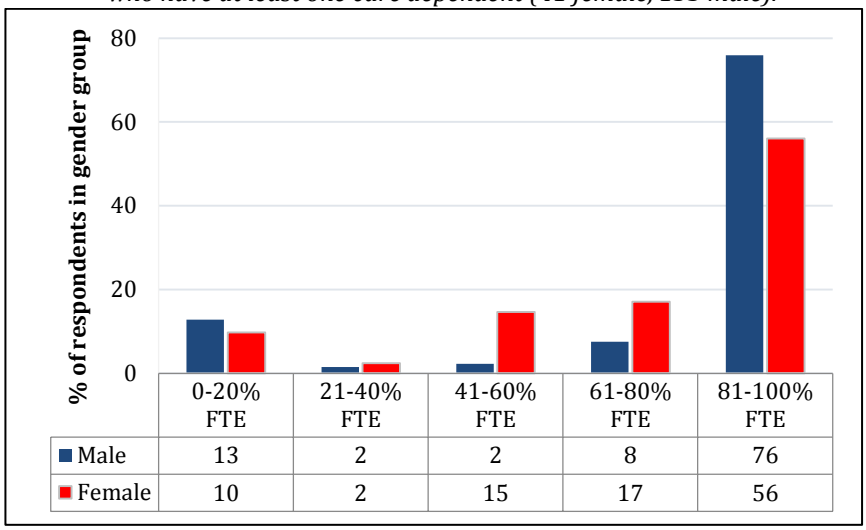


Figure 23. Gender trends for number of dependents for those with carer responsibilities (left; 42 female and 136 male) and proportion of all Individual Survey participants within age-gender groups that have at least one dependent (right).

Figure 24. FTE: trends within gender groups for respondents who have at least one care dependent (41 female, 133 male).



Breakdowns of data from all respondents to the Individual Survey by employment type and primary citizenship reveal that:

- 50% of all ongoing staff, 43% of all fixed-term staff, 28% of all casual staff, and 17% of all student respondents had at least one care dependent.
- 34% of all ongoing staff, 27% of all fixed-term staff, 16% of all casual staff, and 8% of all student respondents had more than one care dependent.
- 37% of all Australians and 34% of all non-Australians had at least one care dependent.
- 25% of all Australians and 18% of all non-Australians had more than one care dependent.

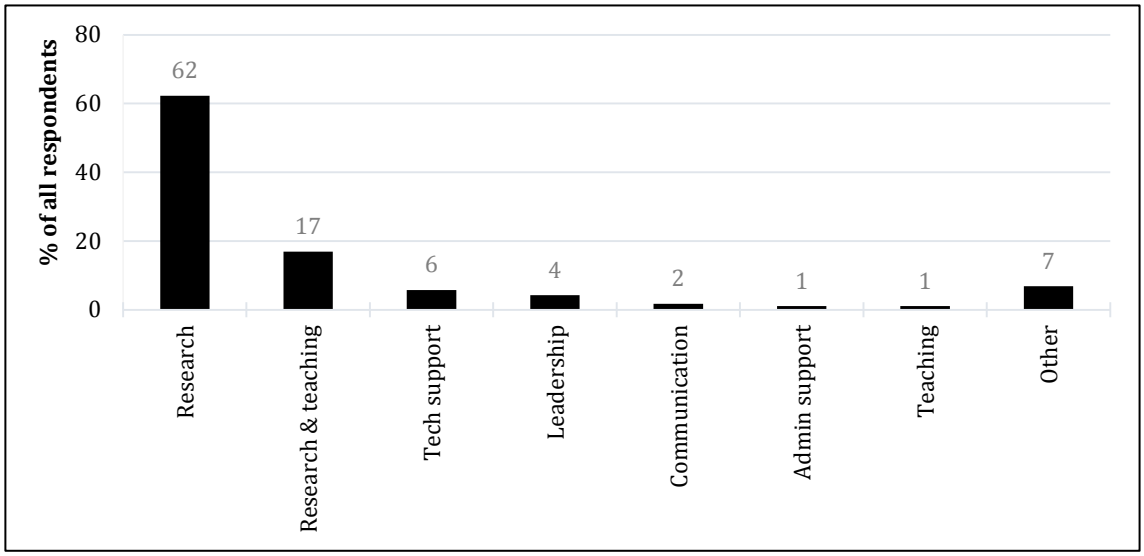
3.4 RESEARCH EFFORT

Survey participants were asked to provide a range of information concerning their work roles, workload distribution, research area focus and research technique use. This constitutes a substantial overview of current trends in the Australian astronomy community's research effort. In total 467 respondents participated in this section of the Individual Survey.

3.4.1 RESEARCH EFFORT: PRIMARY ROLE

Participants were asked to designate their primary role in Australian astronomy from a number of choices. As Figure 25 shows, the majority of respondents indicated that 'research' was their primary role (62%), followed by 'research & teaching' (17%). Of those that selected 'Other' (7%), several stated that they were in honorary roles or retired, or involved in project management or astronomy education.

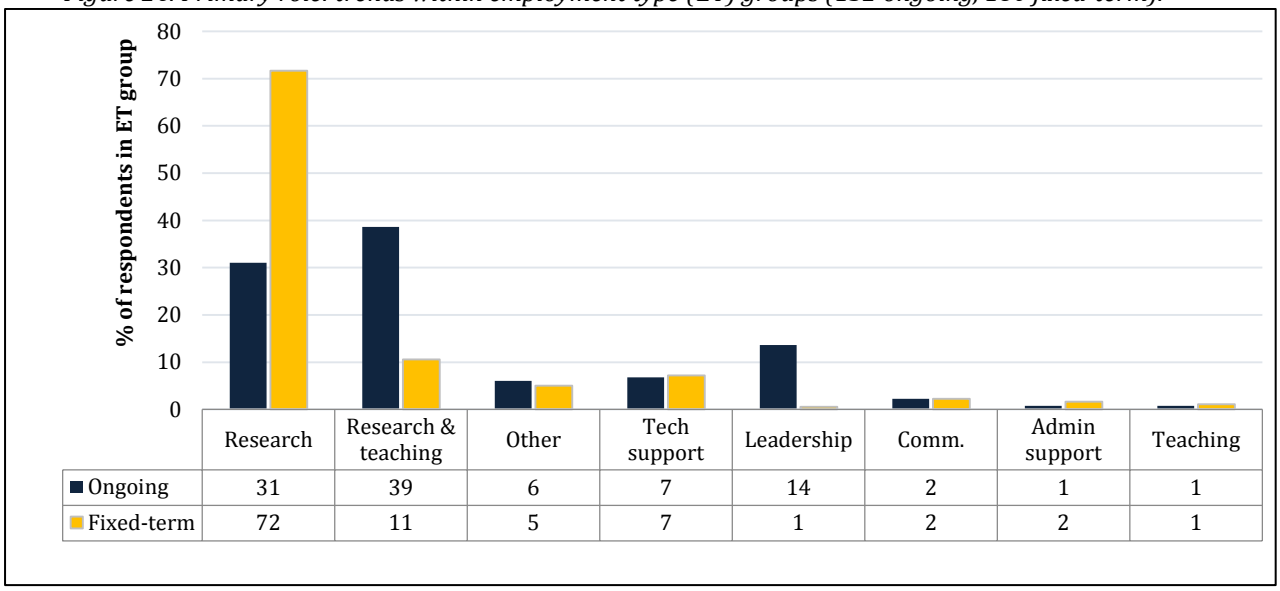
Figure 25. Primary role in Australian astronomy (N=467).



Comparing these responses by gender and employment type shows:

- There were only negligible differences between genders in the breakdown of role types.
- Notable differences were evident between ongoing versus fixed-term staff (see Figure 26). In particular, ongoing staff were proportionally more likely to be primarily engaged in 'research & teaching' (39% of ongoing staff) or 'leadership' (14% of ongoing staff) than fixed-term staff (11% and 1% of fixed-term staff respectively).
- Furthermore, 72% of fixed-term staff and 90% of students nominated pure 'research' as their primary role in Australian astronomy, compared to 31% of ongoing staff. This is not surprising given that many fixed-term positions are held by research-only post-docs.

Figure 26. Primary role: trends within employment type (ET) groups (132 ongoing, 180 fixed-term).

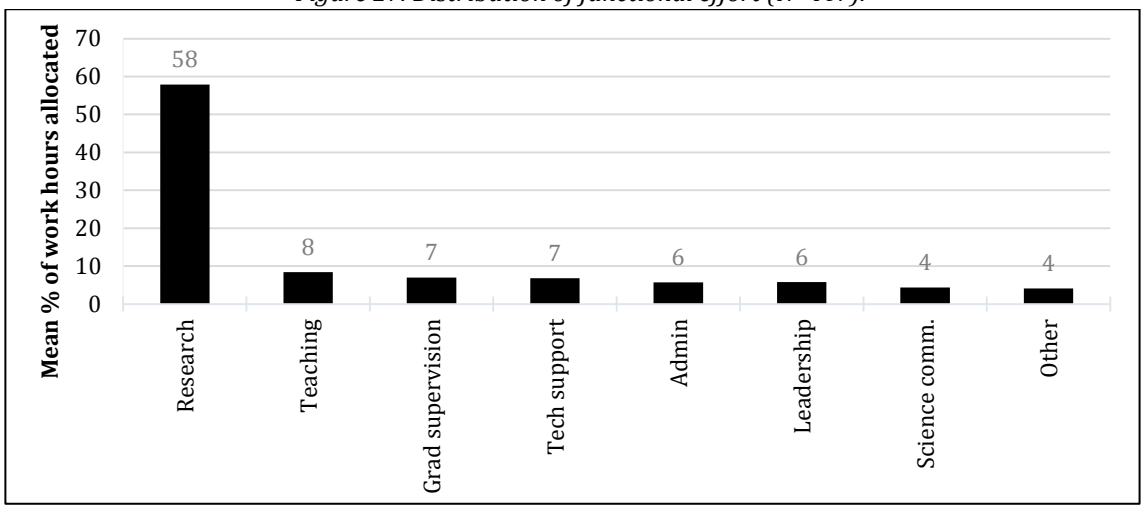


	Research	Research & teaching	Other	Tech support	Leadership	Comm.	Admin support	Teaching
Ongoing	31	39	6	7	14	2	1	1
Fixed-term	72	11	5	7	1	2	2	1

3.4.2 RESEARCH EFFORT: DISTRIBUTION OF FUNCTIONAL EFFORT

467 survey participants provided an estimate of how they distributed working hours across a variety of tasks: research, teaching, graduate supervision, technical support, administration, leadership, science communication, and 'other'. The mean values provided by respondents indicate that research is the overwhelming work focus for all participants (average of 58% of work hours allocated; see Figure 27). The responses do not indicate substantial differences between men and women in the distribution of functional effort. The 'other' tasks that respondents most commonly engage in are management, education/outreach, non-astronomical research, and grant/funding application.

Figure 27. Distribution of functional effort (N=467).



Due to the much greater number of technical/administration support staff who formed part of the 2005 Survey and the consequent predominance of research staff in the 2014 Individual Survey, a direct comparison of workload distribution between surveys is difficult. Even after removing the data of those institutes who had a large number of non-research support staff participate in the 2005 Survey (AAO, ATNF, and ANU-RSAA), a comparison with the 2014 results could not be interpreted in a way that identified meaningful trends.

3.4.3 RESEARCH EFFORT: RESEARCH AREAS

Survey respondents were asked to indicate the percentage of their individual research effort that they dedicate to specific areas of astronomy[***]. To attain an overall mean research effort percentage for an area all individual response values for the area were summed and then divided by the total number of respondents to this question (467).[†††] This percentage therefore represents the proportion of the total research effort of all Individual Survey participants that is dedicated to each area of astronomy. As shown in Figure 28, extragalactic astronomy received the highest overall mean percentage (20% of total research effort dedicated). Instrumentation attained the second-highest overall mean (13%), with the relative difference between consecutively lower-scoring areas being more gradual.

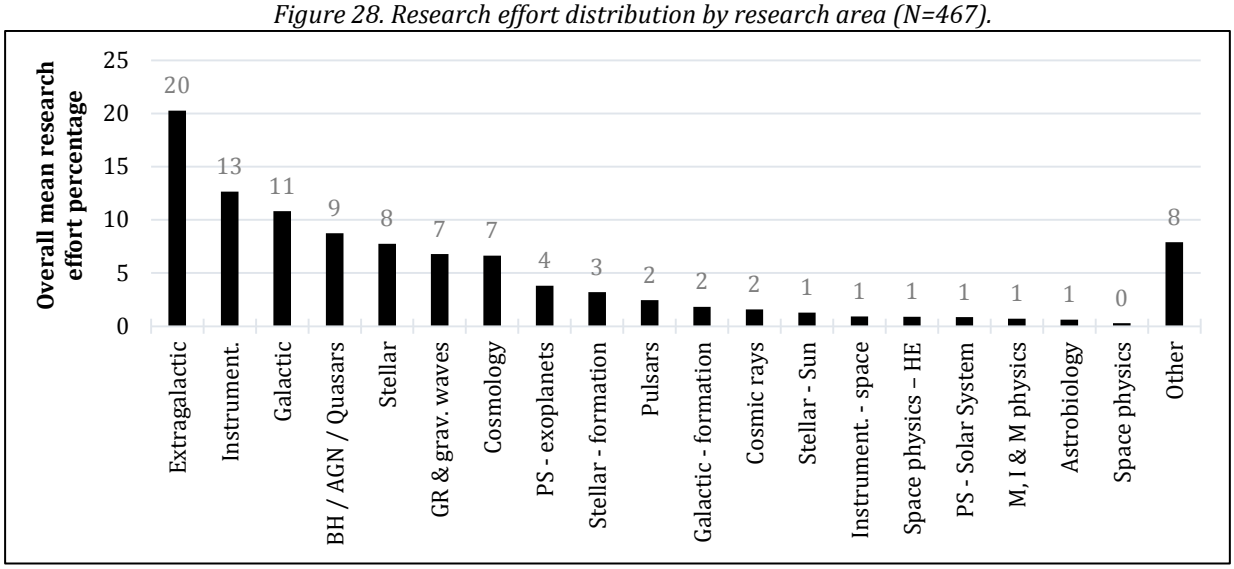
In addition to deriving the overall mean research effort percentage, there are ways of aggregating individual responses to this question on the basis of respondent and response types. Additional analyses performed for this question include:

- Calculating the mean research effort percentage within each gender group rather than within the group of all Individual Survey respondents. Females dedicated a higher proportion of their combined research effort to extragalactic astronomy (26%) than males (18% of combined male research effort). Males dedicated a higher proportion of their combined research effort to instrumentation (14%) than females (7%).
- Comparing the Individual Survey distribution of research effort for postgraduate students to the aggregated PhD graduate data from section 2.2.1 of the Institutional Survey (while keeping in mind the differences in survey respondent subsets – see section 3). A comparison of the top six astronomy areas (with subdivided research areas re-combined) shows overall similarities between PhD graduates from 2009-2013 and postgraduate students enrolled in 2014.
- Investigating the number of researchers active in each area, rather than calculating the overall mean research effort percentage dedicated to that area. It was found that extragalactic astronomy had the greatest number of active researchers (with 42% of all 467 respondents to this question indicating doing at least some research in this area). The second most popular area for research was instrumentation (including space instrumentation), in which 33% of all 467 respondents were research active.
- Looking at how researchers active in a particular area spread their research effort across other areas of astronomy. It was found that researchers active in gravitational waves and general relativity were the least diversified in their research interests, with on average only 44% of their research effort dedicated to other areas of astronomy. Researchers active in extragalactic astronomy were the second least diversified group, with on average 52% of their research effort being dedicated to other areas of astronomy. The most diversified group were those engaged in astrobiology, who on average dedicated 86% of their effort to other research areas.

[***] Some broader areas, such as stellar astronomy, were sub-divided into distinct areas. The areas listed were: astrobiology; black holes (BH) / AGN / Quasars; cosmic rays; cosmology; extragalactic astronomy; galactic astronomy; galactic astronomy - formation; general relativity (GR) and gravitational waves; instrumentation; instrumentation - space; mesospheric, ionospheric and magnetospheric (M, I & M) physics; planetary science (PS) - exoplanets; planetary science (PS) - solar system; pulsars; space physics; space physics – high energy (HE); stellar astronomy; stellar astronomy - formation; stellar astronomy - Sun; and 'other'/'none of the above'.

[†††] Respondents were required to provide a breakdown of individual research effort for each astronomy area, even if it was zero.

Figure 28. Research effort distribution by research area (N=467).



The 2005 Survey provided breakdowns of research area effort for two groups: non-student respondents and ongoing respondents. A comparison of the 2005 data to the 2014 data with sub-divided research areas re-combined is presented in Figures 29 and 30.‡‡‡ This shows that:

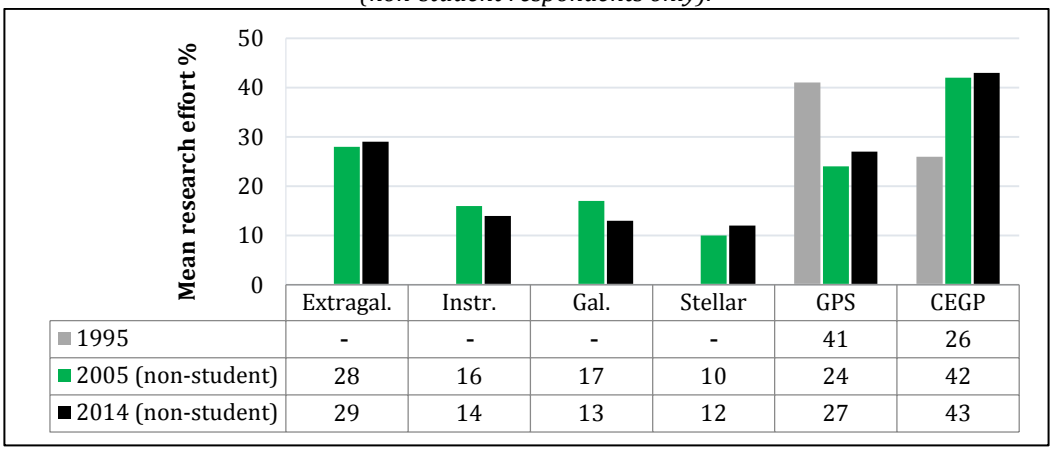
- In 2014 non-student respondents dedicated approximately the same proportion of their combined research effort to the top four area groups (extragalactic, instrumentation, galactic, and stellar) as in 2005.
- One of the largest shifts in research area groups from 1995 to 2005 for non-student respondents was the move away from the 'Galactic/Magellanic Clouds/pulsar/stellar' (GPS) area group. This has stabilised from 2005 to 2014. §§§
- The other major shift in research area groups from 1995 to 2005 for non-student respondents has also stabilised, namely the shift towards the 'cosmology/ extragalactic/gravitational physics' (CEGP) area group.****
- While in 2005 ongoing staff dedicated the largest proportion of their combined research effort to instrumentation (25%), by 2014 this had fallen to 13%. Replacing it at the top, extragalactic astronomy has increased its proportion of combined ongoing staff research effort from 19% in 2005 to 28% in 2014. Concurrently, the proportion of combined ongoing staff research effort of the CEGP group has increased from 27% in 2005 to 39% in 2014. Note that these changes were not mirrored in the group of all non-student respondents, and so must have been offset by trends amongst fixed-term staff. It is also possible that instrumentation staff were less likely to have elected to participate in the 2014 Individual Survey (see discussion in section 3 above).

‡‡‡ Note that the listings of research areas changed somewhat in the 2014 Survey to better reflect journal keyword areas. For the following comparisons the 2005 galactic group was combined from both 'Galactic/Magellanic Clouds' and 'ISM' research areas from the 2005 Survey. The 2014 extragalactic group was combined from both 'extragalactic' and 'BH/AGN/Quasars' research areas from the 2014 Survey. The 2014 instrumentation, galactic, stellar and planetary science groups were combined from all relevant subdivisions of each area (e.g. stellar = 'stellar' + 'stellar – formation' + 'stellar – Sun') from the 2014 Survey.

§§§ The 2005 GPS group was composed from the 'Galactic/Magellanic Clouds', 'stellar', and 'pulsar' research areas from the 2005 Survey. The 2014 GPS group was composed from the 'Galactic', 'Galactic – formation', 'pulsar', 'stellar', 'stellar – formation' and 'stellar – Sun' research areas from the 2014 Survey.

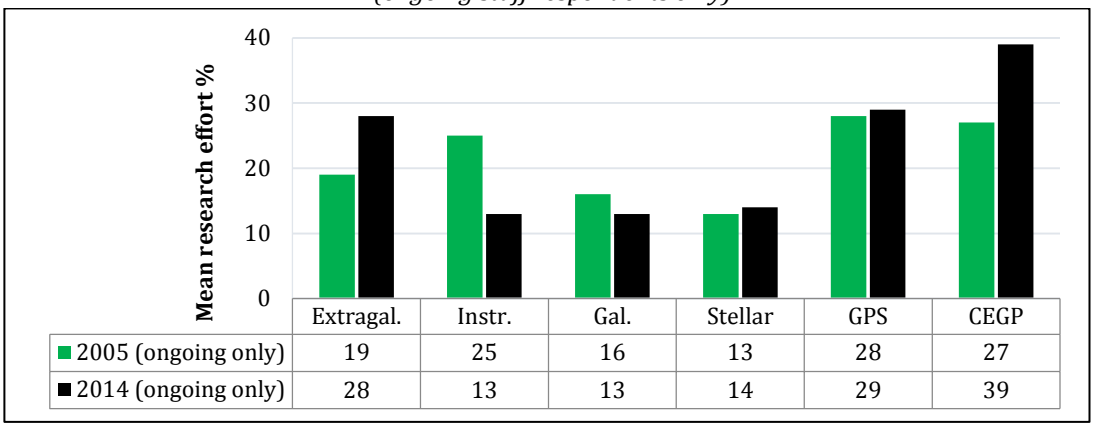
**** The 2005 CEGP group was composed from the 'cosmology', 'extragalactic' and 'gravitational physics' research areas from the 2005 Survey. The 2014 CEGP group was composed from the 'cosmology', 'extragalactic', 'BH/AGN/Quasars' and 'GR & gravitational physics' research areas from the 2014 Survey.

Figure 29. Comparison of research effort distribution by research area from 1995 to 2014 (non-student respondents only).



	Extragal.	Instr.	Gal.	Stellar	GPS	CEGP
1995	-	-	-	-	41	26
2005 (non-student)	28	16	17	10	24	42
2014 (non-student)	29	14	13	12	27	43

Figure 30. Comparison of research effort distribution by research area from 2005 to 2014 (ongoing staff respondents only).



	Extragal.	Instr.	Gal.	Stellar	GPS	CEGP
2005 (ongoing only)	19	25	16	13	28	27
2014 (ongoing only)	28	13	13	14	29	39

3.4.4 RESEARCH EFFORT: RESEARCH TECHNIQUES

Participants were asked to indicate the techniques that they made use of in their astronomical research. Respondents could select as many options as applied from the following list: computational, cosmic rays, infrared, optical, radio, theory, x-ray, and 'other'.

Of the 467 respondents to this question, 423 selected at least one option other than 'do not conduct astronomical research'. For these 423 'research respondents' the four most popular research techniques were computational astrophysics (67% of research respondents), optical astronomy (58%), theoretical astronomy (47%) and radio astronomy (46%) (see Figure 31). Gender analysis shows that the largest divergences were in the use of theoretical and radio astronomy as research techniques. Female research respondents were proportionally more likely to use these techniques than male research respondents (see Figure 32).

Figure 31. Technique use in astronomical research (N=423).

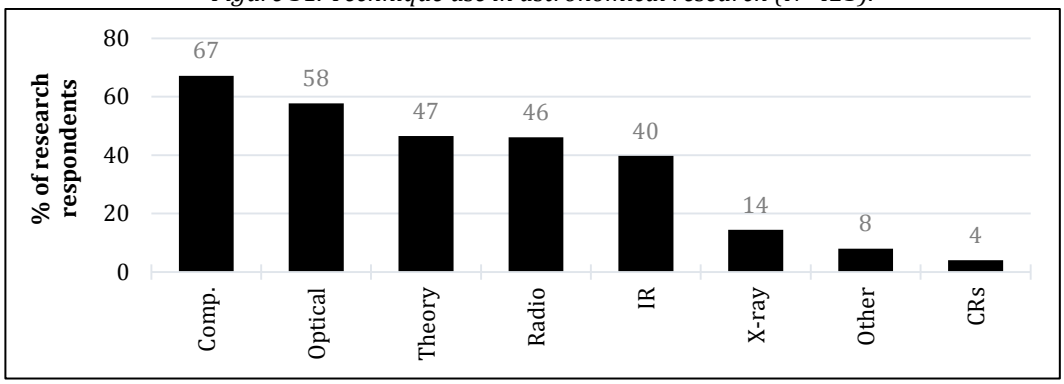
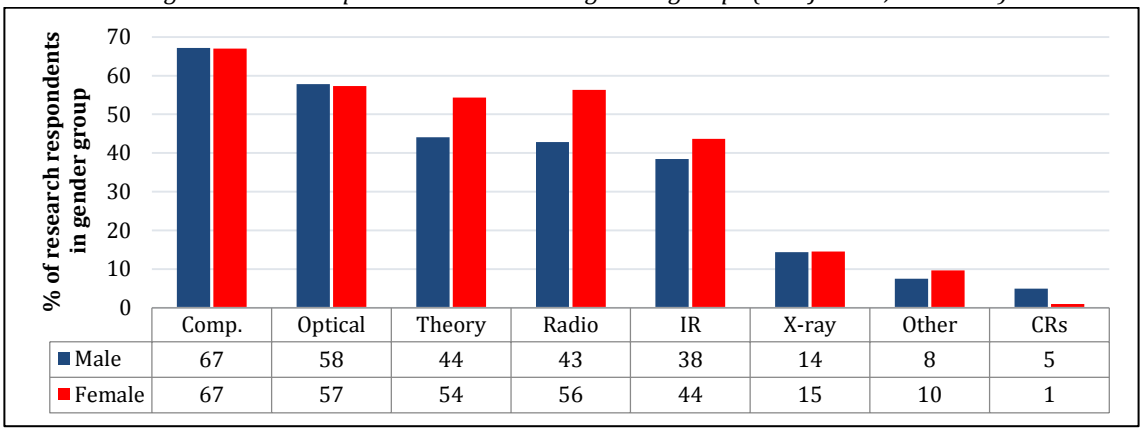


Figure 32. Technique use: trends within gender groups (103 female, 320 male).



	Comp.	Optical	Theory	Radio	IR	X-ray	Other	CRs
Male	67	58	44	43	38	14	8	5
Female	67	57	54	56	44	15	10	1

Since the 2005 Survey looked at the distribution of technique use as a proportion of the total FTE research effort (rather than simply whether or not respondents made any use of a technique at all), a direct comparison between the two surveys is impossible. However, the top five research techniques for non-student respondents in 2005 were found to be radio, computational and optical, theory, and infrared. While these five remain the most popular techniques used amongst non-student respondents in the 2014 Individual Survey, their relative rankings have changed (see Table 11). In particular, computational astrophysics cemented its trend of having the largest growth of any research technique from 1995-2005 (11% in 1995 to 21% in 2005), and was the most popular technique in 2014. As in 2005, the research techniques used by ongoing staff very closely mirror those used by the entire non-student cohort.

Table 11. Comparison of 2005 and 2014 research technique use.

	2005 Survey *(% of total non-student research effort)*	2014 Survey *(% of non-student research respondents who make any use of this technique)*	2005 rank	2014 rank
Computational	21	63	=2	1
Optical	21	61	=2	2
Radio	31	51	1	3
Theory	14	45	3	4
Infrared	8	42	4	5
X-ray	2	16	5	6
CRs	3	4	6	8

Two types of breakdowns are also available to investigate research technique use by Australian state/territory. Table 12 shows the contributions to overall technique use (as in Figure 31) that came from each state. Table 13 shows the distribution of technique use within each state across only research respondents from that state (i.e. the relative predominance of techniques within each state).

Table 12. Technique use: overall use split by state groups (highest row values in bold).

	% of all research respondents (N=423)							
	NSW	WA	VIC	QLD	SA	TAS	ACT	Total
Computational	**20**	11	19	3	2	1	10	67
Optical	**22**	9	11	2	0	1	12	58
Theory	14	7	**15**	2	0	1	7	47
Radio	**19**	10	8	1	1	**2**	4	46
Infrared	**19**	3	7	0	0	1	8	40
X-ray	**8**	1	2	0	1	0	2	14
Other	**2**	**2**	1	0	1	0	1	8
Cosmic rays	1	0	0	0	**2**	0	1	4

Table 13. Technique use: trends within state groups (highest column values in bold).

	% of research respondents in state						
	NSW	WA	VIC	QLD	SA	TAS	ACT
Computational	56	**64**	**85**	**100**	**64**	36	69
Optical	**62**	49	47	69	14	36	**84**
Theory	39	37	68	77	14	21	48
Radio	55	59	37	23	43	**64**	24
Infrared	53	19	31	15	14	43	56
X-ray	22	8	8	15	21	7	15
Other	6	12	4	0	43	14	6
Cosmic rays	2	1	1	0	57	7	5
Group n=	148	75	95	13	14	14	62

3.5 EDUCATIONAL HISTORY

Participants were asked to nominate the highest degree that they have completed, and the year and country in which they completed that degree. Overall, 61% of respondents indicated that they had achieved a PhD (see Figure 33). Amongst non-student respondents this figure rose to 85%. Fixed-term staff were just as likely as ongoing staff to have completed a PhD (see Figure 34). The proportion of ongoing staff that had not completed a PhD (12%) is almost identical to the proportion observed in the 2005 Survey (11%).

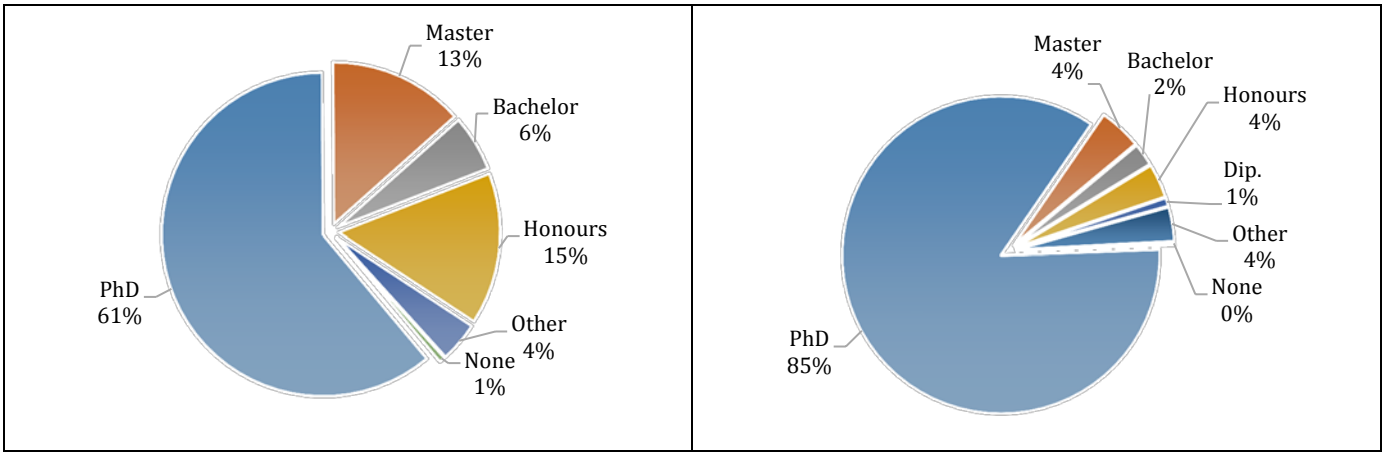
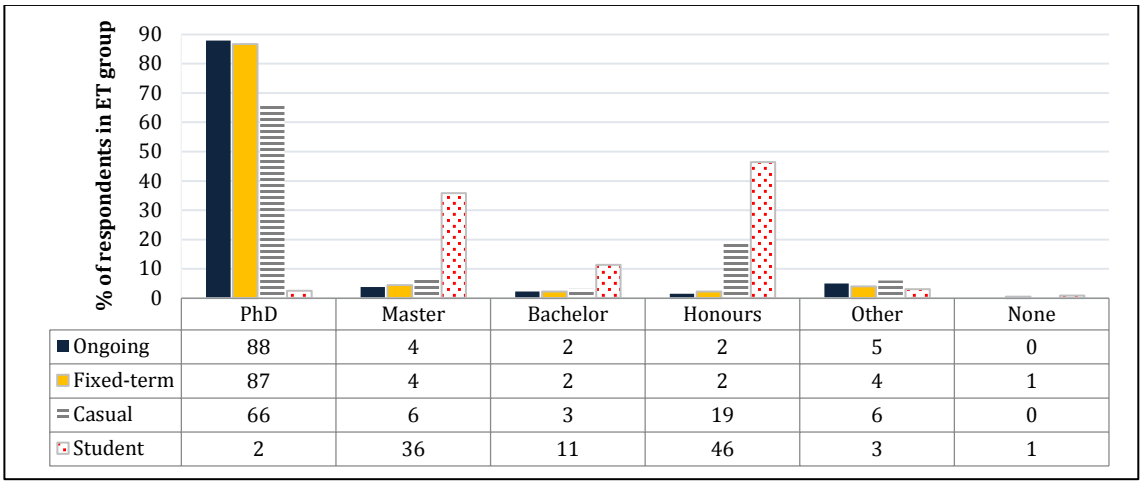


Figure 33. Distribution of highest degree completed (left; N=495) and highest degree completed for non-student respondents (right; N=344).

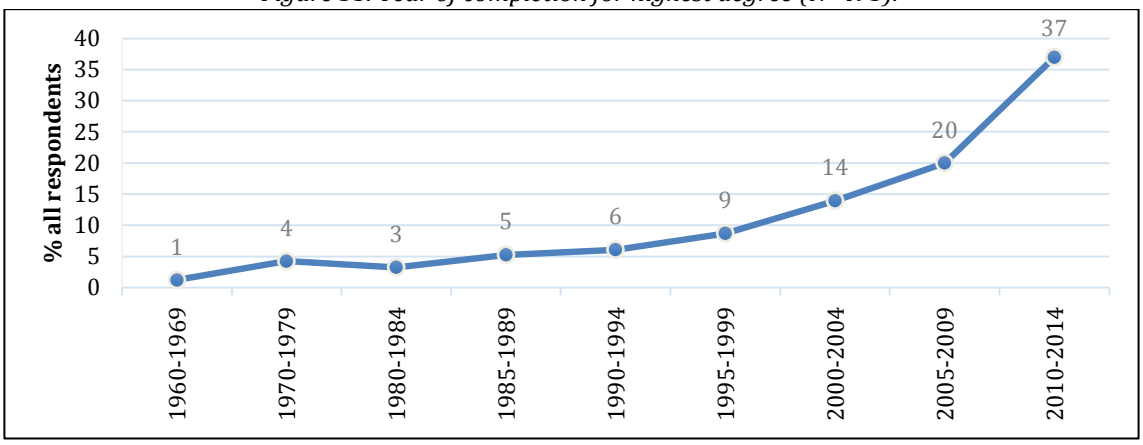
Figure 34. Highest degree completed: trends within employment type (ET) groups (132 ongoing, 180 fixed-term, 32 casual, 123 student).



	PhD	Master	Bachelor	Honours	Other	None
Ongoing	88	4	2	2	5	0
Fixed-term	87	4	2	2	4	1
Casual	66	6	3	19	6	0
Student	2	36	11	46	3	1

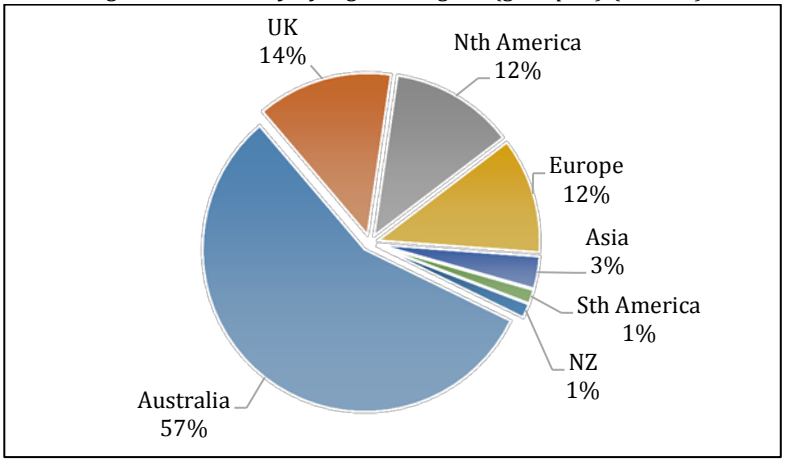
The response data for the year of completion for the highest degree is presented in Figure 35. The median year of completion for all respondents was 2007, while for non-student respondents it was 2003. The median year of completion for ongoing respondents was 1995, while for fixed-term respondents it was 2007.

Figure 35. Year of completion for highest degree (N=495).



As Figure 36 shows, Australia was the country of highest degree completion for the majority of respondents (57%). Additionally, the number of ongoing staff who have PhDs from non-Australian institutions (39%) remained almost unchanged since the 2005 Survey (37%). This is lower than the proportion of fixed-term staff with PhDs from non-Australian institutions in the 2014 survey (49%).

Figure 36. Country of highest degree (grouped) (N=495).

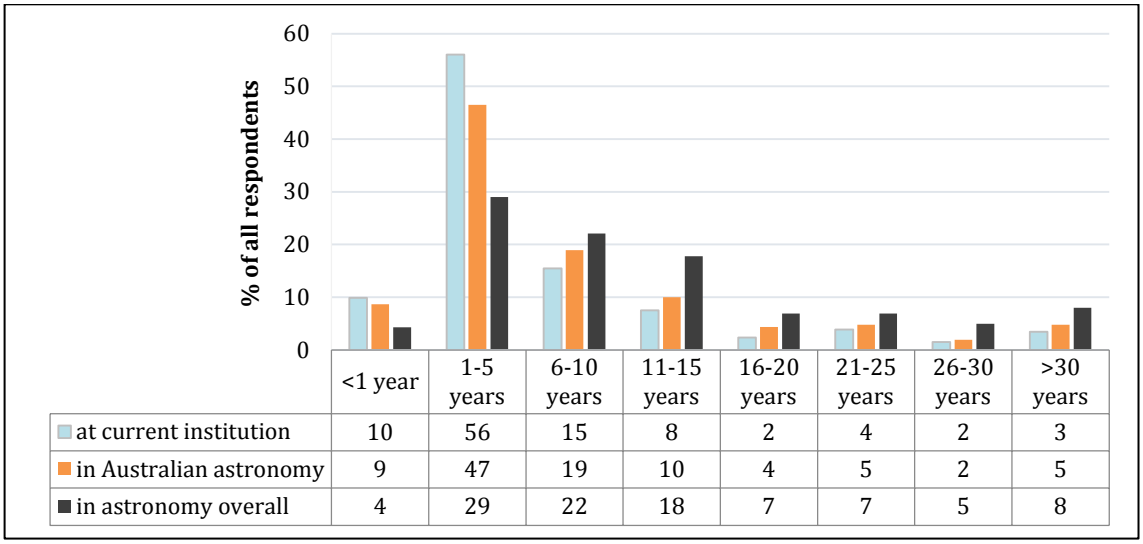


3.6 EMPLOYMENT HISTORY

3.6.1 YEARS WORKED IN ASTRONOMY

Participants were asked to approximate the number of calendar years for which they have worked in three domains: at their current principal Australian institution; in Australian astronomy generally; and in astronomy overall. Figure 37 shows the responses grouped into 5-year blocks. For each of these domains, the largest group of respondents indicated that they had worked 1-5 calendar years.

Figure 37. Years worked at current institution (N=466)/ in Australian astronomy (N=460)/in astronomy overall (N=462).



	<1 year	1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years	>30 years
at current institution	10	56	15	8	2	4	2	3
in Australian astronomy	9	47	19	10	4	5	2	5
in astronomy overall	4	29	22	18	7	7	5	8

Within gender and employment type groups:

- Females were proportionally more likely to have worked 1-5 years in each of the three domains (63%/55%/39% of female respondents) compared to males (54%/44%/25% of male respondents).
- Males were proportionally more like to have worked more than 15 years in each of the three domains (13%/18%/31% of male respondents) compared to females (6%/9%/16% of female respondents).
- There were major divergences in work histories between employment type groups, as can be seen from Table 14. In particular, ongoing staff respondents have worked substantially longer in each domain. 39% of ongoing respondents had worked ≤10 calendar years in Australian astronomy, compared to 84% of fixed-term respondents.

Table 14. Median calendar year work histories for employment type groups.

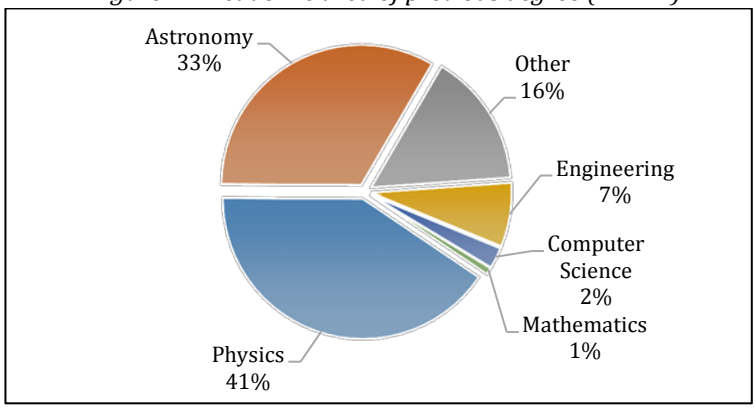
	Ongoing respondents	Fixed-term respondents	Student respondents	Casual respondents
Current institution	11	3	2	7
Australian astronomy	13	4	3	10
Astronomy overall	22	9	4	13

3.6.2 STUDENT HISTORY (STUDENT RESPONDENTS ONLY)

Participants who nominated 'postgraduate student' as their employment type were diverted to a separate section of the survey, which asked them to provide their current degree type and the academic area of their previous degree. Of 123 student respondents, 90% indicated that they were currently studying a PhD as opposed to a Masters degree (10%).

As presented in Figure 38, physics was the most common area for students' previous degrees (41%). The most common responses entered as 'other' (16%) were double-degrees combining two of physics/astronomy/engineering/maths.

Figure 38. Academic area of previous degree (N=123).



3.6.3 EMPLOYMENT HISTORY (FIXED-TERM RESPONDENTS ONLY)

Participants who nominated 'fixed-term contract' as their employment type were diverted to a separate section of the survey, which asked them to provide details of their current and past employment contracts in astronomy, their work location history, and their supervision load. There were 180 fixed-term respondents in total (76% male, 24% female).

In relation to their current fixed-term contract, respondents had overwhelmingly commenced in the period 2010-2013 (86% in total), with a median commencement year of 2012 (see Figure 39). The main divergence between gender groups in this regard was over the period 2011-2013, where 86% of fixed-term females commenced their current contract compared to 71% of fixed-term males (see Figure 39).

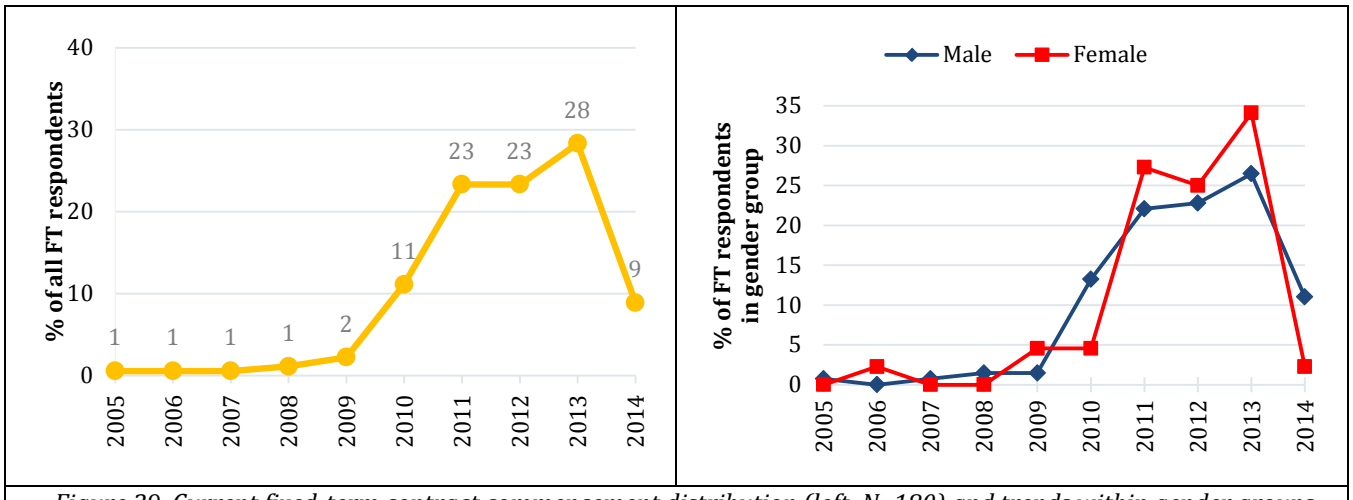


Figure 39. Current fixed-term contract commencement distribution (left; N=180) and trends within gender groups (right; 44 female, 136 male).

With regards to previous employment in astronomy, overall fixed-term respondents displayed an almost equal tendency to have had either none, one or two fixed-term contracts preceding their current contract (see Figure 40). Parity on this issue broke down within gender groups, with males proportionally more likely than females to have held more than one previous fixed-term contract (56% of male fixed-term respondents vs. 38% of female fixed-term respondents; see Figure 41). Fixed-term female respondents that had held exactly one previous fixed-term contract were 71% of non-Australian primary citizenship and had worked a median value of 3 calendar years in Australian astronomy. By contrast, fixed-term male respondents that had held exactly one previous fixed-term contract were 56% of non-Australian primary citizenship and had worked a median value of 5 calendar years in Australian astronomy.

Figure 40. Number of previous fixed-term contracts in astronomy (N=180).

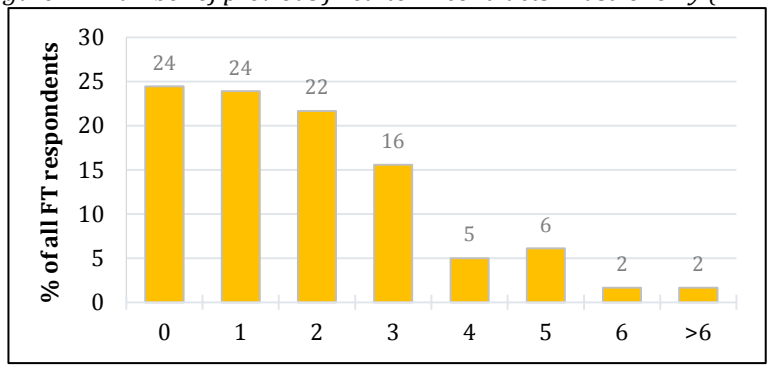
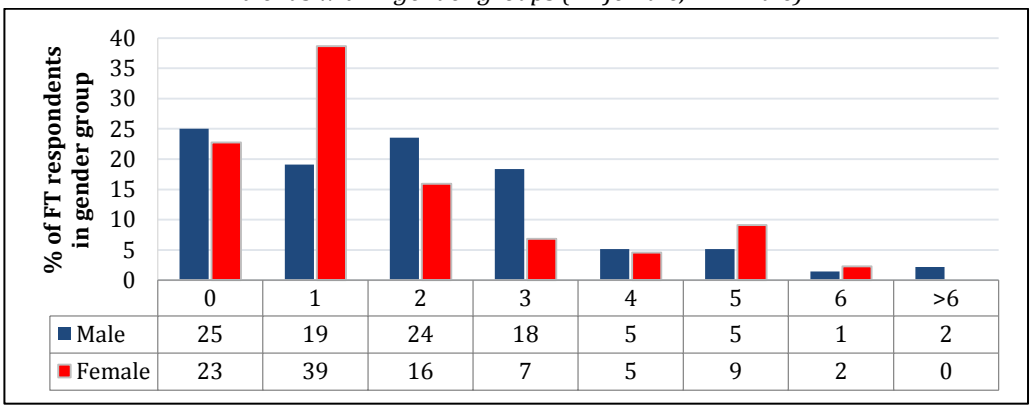


Figure 41. Number of previous fixed-term contracts in astronomy: trends within gender groups (44 female, 136 male).



	0	1	2	3	4	5	6	>6
Male	25	19	24	18	5	5	1	2
Female	23	39	16	7	5	9	2	0

Fixed-term respondents were also asked if they had previously held ongoing contracts. The vast majority indicated having held no previous ongoing contracts (83%), while 14% had held one and 3% had held two or more. There was no discernible difference across gender groups.

A majority of fixed-term respondents were employed on a fixed-term contract prior to taking up their current contract (63%; see Figure 42). However, a gender breakdown (Figure 43) shows that:

- Proportionally more females than males were employed on a fixed-term contract prior to taking up their current fixed-term contract (73% of fixed-term females vs. 60% of fixed-term males, with a median of 3 calendar years worked in Australian astronomy for the former group and 9 years for the latter group).
- Proportionally more males than females had been employed as students prior to taking up their current fixed-term contract (23% of male respondents vs. 7% of female respondents, with a median of 3 calendar years worked in Australian astronomy for the former group and <1 calendar years for the latter group).

- For those respondents who had been employed on an ongoing contract prior to taking up their current fixed-term contract (14% of all fixed-term respondents), the median number of calendar years worked in Australian astronomy was 3 for both males and females.

Figure 42. Previous employment type for fixed-term respondents (N=180).

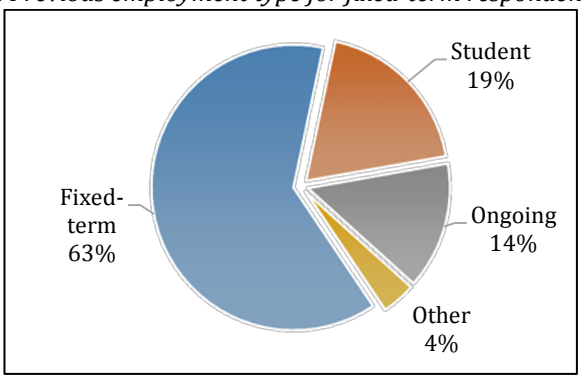
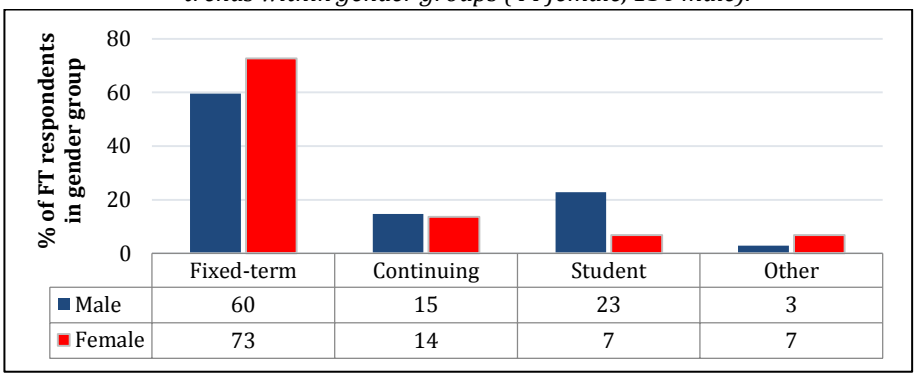


Figure 43. Previous employment type for fixed-term respondents: trends within gender groups (44 female, 136 male).



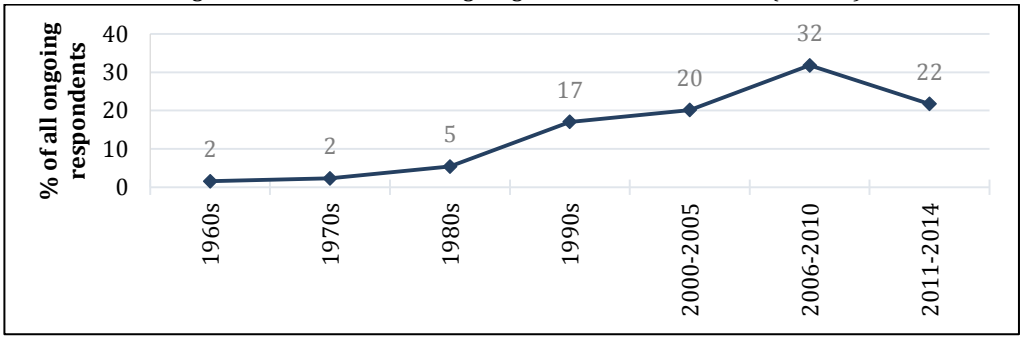
	Fixed-term	Continuing	Student	Other
Male	60	15	23	3
Female	73	14	7	7

3.6.4 EMPLOYMENT HISTORY (ONGOING RESPONDENTS ONLY)

Participants who nominated 'ongoing contract' as their employment type were also diverted to a separate section of the survey, which asked them to provide details of their current and past employment contracts in astronomy, their work location history, and their supervision load. 129 ongoing respondents participated in this section of the survey (79% male, 21% female).

With relation to their current ongoing contract, respondents indicated a large range of commencement years (see Figure 44). The overall median commencement year was 2006. The median commencement year for female ongoing respondents was 2009, while for male ongoing respondents it was 2006.

Figure 44. Year current ongoing contract commenced (N=129).



With regards to previous employment, 71% of ongoing respondents had held fewer than four fixed-term contracts in astronomy (Figure 45). This trend was stronger for females (89% of female ongoing respondents) than for males (66% of male ongoing respondents; see Figure 46). The median number of calendar years worked in Australian astronomy for ongoing females with fewer than four previous fixed-term contracts was 8, while for ongoing males with fewer than four previous fixed-term contracts it was 13.

Figure 45. Number of previous fixed-term contracts in astronomy (N=129).

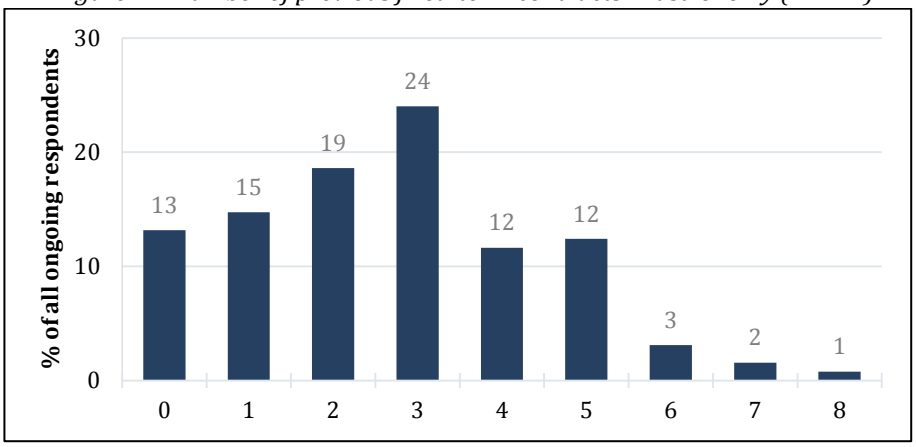
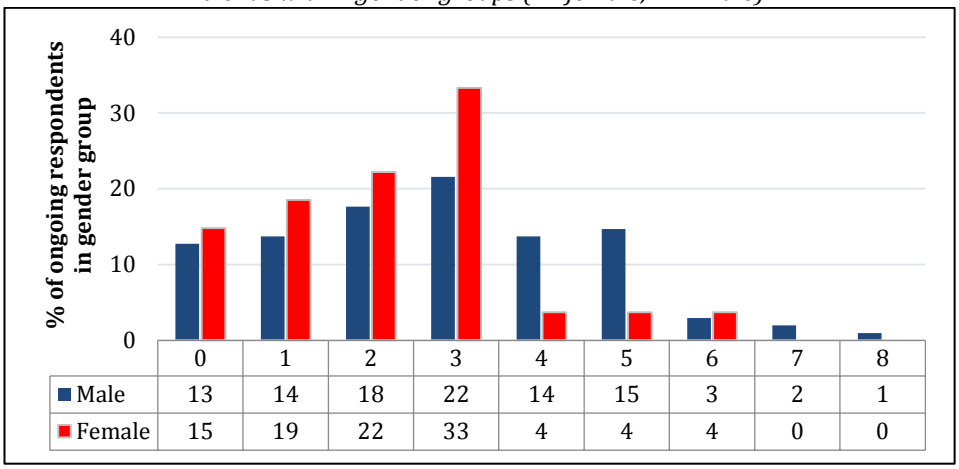
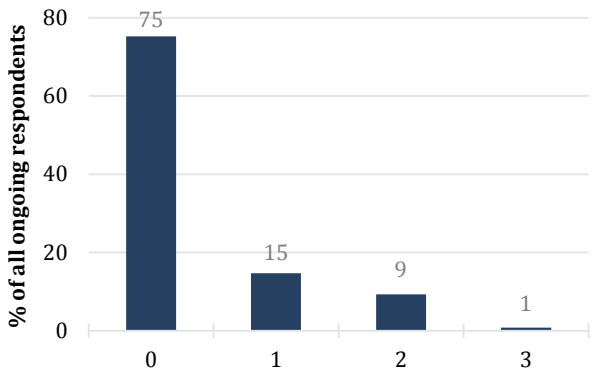


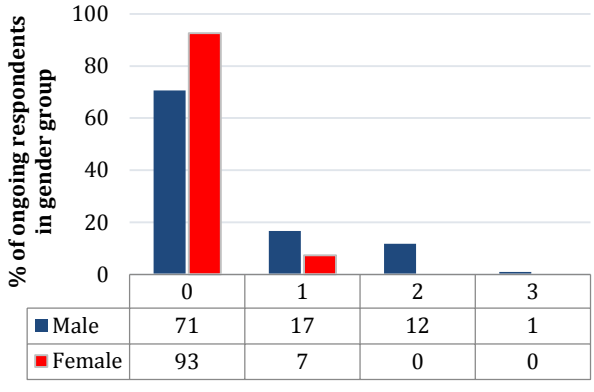
Figure 46. Number of previous fixed-term contracts in astronomy: trends within gender groups (27 female, 102 male).



	0	1	2	3	4	5	6	7	8
Male	13	14	18	22	14	15	3	2	1
Female	15	19	22	33	4	4	4	0	0

Ongoing respondents largely indicated having held no previous ongoing contracts in astronomy (75%; see Figure 47). This was again a stronger trend for females (93% of ongoing female respondents) than for males (71% of ongoing male respondents; see Figure 47).

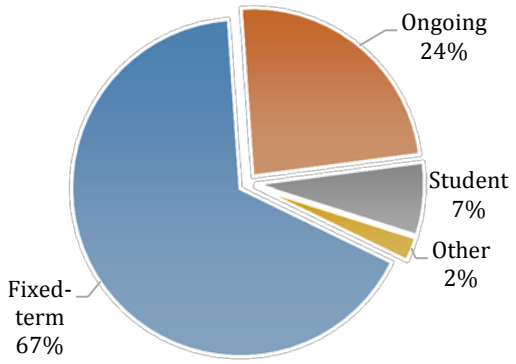




	0	1	2	3
Male	71	17	12	1
Female	93	7	0	0

Figure 47. Distribution of number of previous ongoing contracts in astronomy (left; N=129) and trends within gender groups (right; 27 female, 102 male).

The majority of ongoing respondents were employed on a fixed-term contract prior to commencing their current contract (67%). Ongoing females were proportionally less likely than ongoing males to have been employed on an ongoing contract prior to taking up their current contract. Ongoing females were also proportionally more likely than ongoing males to have been students prior to taking up their current contract (see Figure 48).



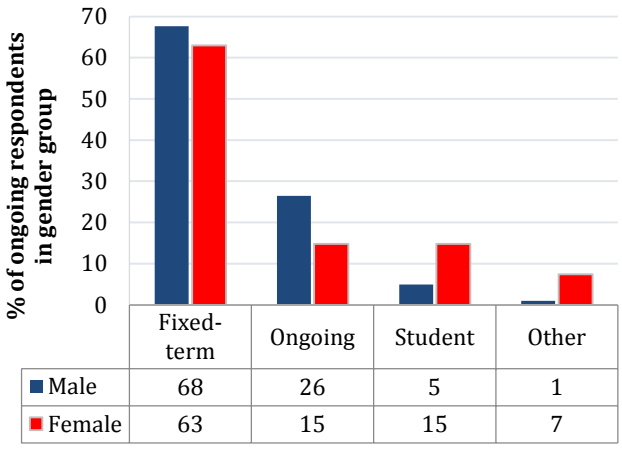
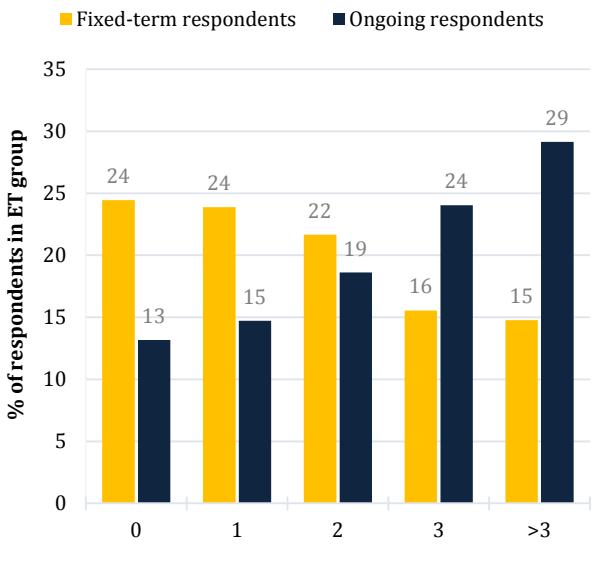


Figure 48. Previous employment type distribution for ongoing respondents (left; N=129) and trends within gender groups (right; 27 female, 102 male).

3.6.5 EMPLOYMENT HISTORY (COMPARING ONGOING AND FIXED-TERM RESPONDENTS)

Since both ongoing and fixed-term respondents answered similar questions in relation to their employment histories, an overall comparison between the two groups can be summarised:

- The median year of commencement for 'current' (2014) contracts was 2006 for all ongoing respondents and 2012 for all fixed-term respondents.
- Ongoing respondents were proportionally more likely than fixed-term respondents to have previously held several fixed-term contracts in astronomy (see Figure 49 - left). This trend was also evident (albeit in a weaker form) when it came to the number of previous ongoing contracts in astronomy (see Figure 49 - right).
- Compared to ongoing respondents, fixed-term respondents were proportionally more likely to have been employed as students immediately prior to taking up their current contract (see Figure 50).
- From the combined group of all employed respondents (whether fixed-term or ongoing in 2014) that had been students immediately prior to their 2014 contract, 79% had become employed on a fixed-term contract in 2014 and 21% had become ongoing staff. This again suggests that postgraduate students are significantly more likely to gain a fixed-term contract (e.g. a post-doc position) than an ongoing position immediately after their PhD. These statistics should be taken as complimentary to the PhD transition data obtained in the Institutional Survey (section 2.2.1).
- From the combined group of all employed respondents (whether fixed-term or ongoing in 2014) that had been in a fixed-term contract immediately prior to their 2014 contract, 57% had moved to another fixed-term contract. By contrast, 43% had become employed as ongoing staff by 2014.



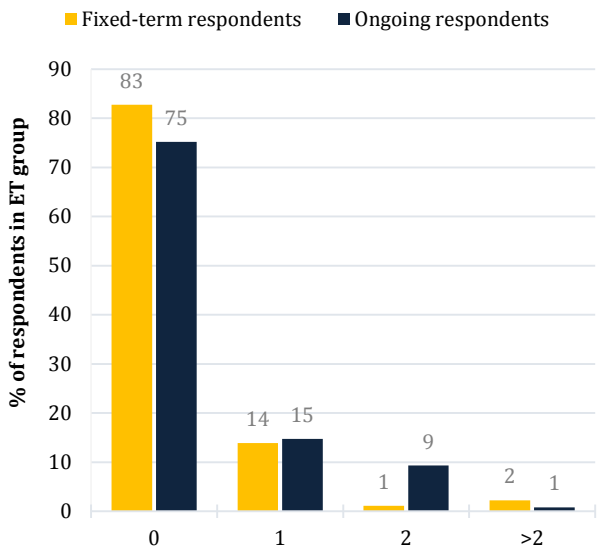
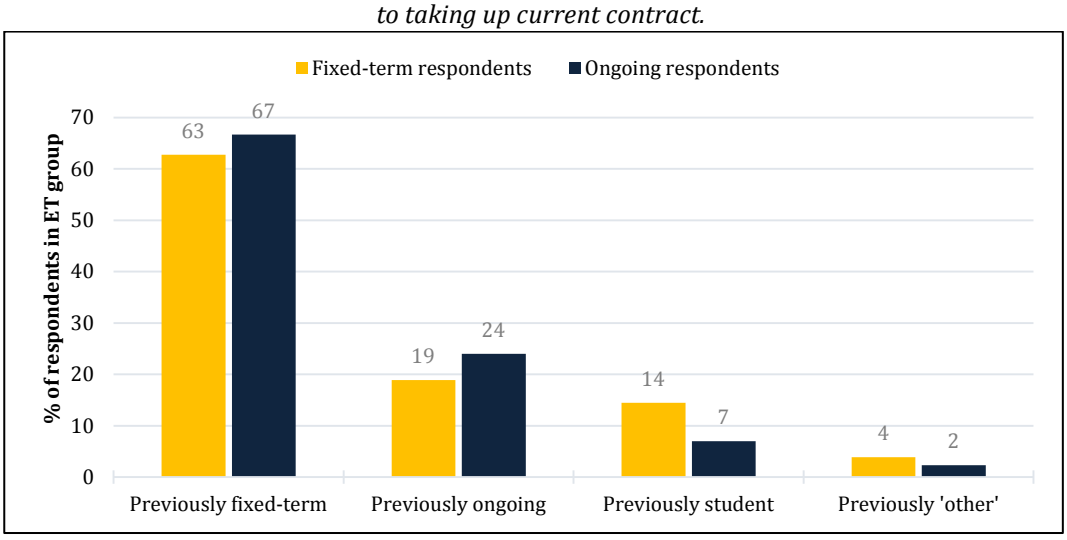


Figure 49. Comparison of ongoing (N=129) vs. fixed-term (N=180) respondents for number of previous fixed-term contracts in astronomy (left) and number of previous ongoing contracts in astronomy (right).

Figure 50. Comparison of ongoing (N=129) vs. fixed-term (N=180) respondents for employment type prior to taking up current contract.



The combined set of all ongoing and fixed-term respondents can also be divided into career stage groups on the basis of the number of years they have spent working in Australian astronomy. A summary of the employment history statistics for three career stages of this combined set of respondents is presented in Table 15. A gender-based breakdown of the same summary data is presented in Table 16.

The summary data below and the analyses provided for individual questions throughout the survey suggest a number of trends in relation to employment history. For example, the data seems to indicate that PhD students were more likely to gain a fixed-term contract rather than an ongoing contract immediately after completing their doctorates. It also appears that males gained fixed-term employment more readily than females after completing their PhDs, and were more likely to move between ongoing positions. In order to properly substantiate these claims, the employment history trends reported for individual questions and the career stage data summarised below require further analysis, additional synthesis with the staff and student movement data from the Institutional Survey, and significance testing.

Table 15. Comparison of employment history for all ongoing/fixed-term respondents split by calendar years worked in Australian astronomy.[††††]

	Currently FT	Currently ongoing	# previous FT contracts		# previous ongoing contracts		Were on a FT contract prior to current contract	Were on an ongoing contract prior to current contract	Were students prior to current contract
			Mean	*Median*	*Mean*	*Median*			
0-5 years *(N=136)*	84%	16%	1.6	1	0.2	0	58%	15%	22%
6-10 years *(N=63)*	56%	44%	2.6	3	0.2	0	73%	16%	8%
>10 years *(N=107)*	25%	75%	3.1	3	0.4	0	66%	23%	7%

Table 16. Gender breakdown of comparison of employment history for all ongoing/fixed-term respondents split by calendar years worked in Australian astronomy.

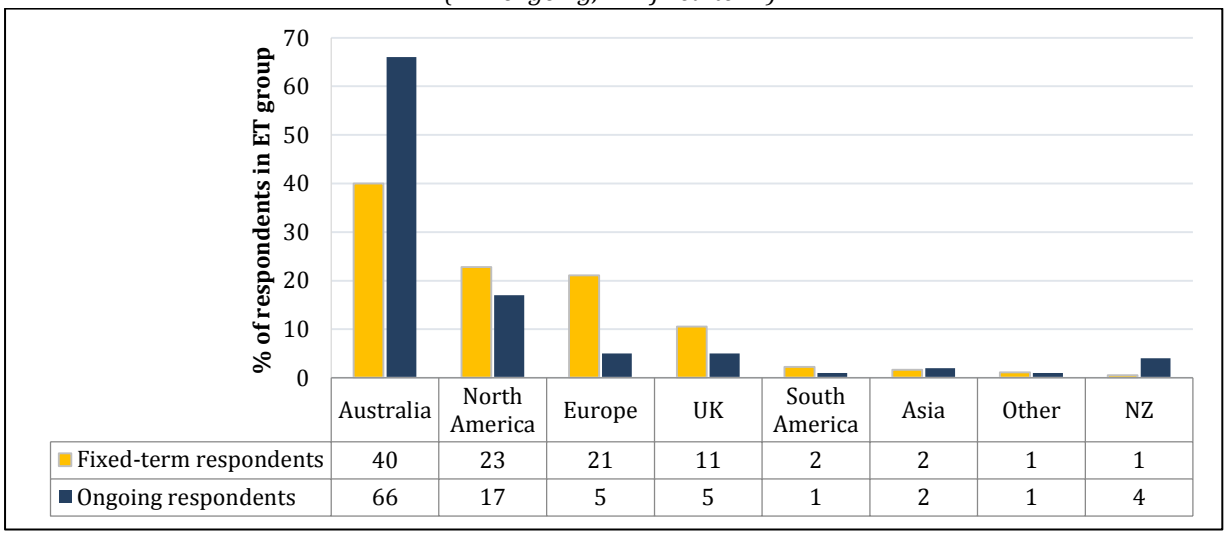
		Currently FT	Currently ongoing	# previous FT contracts		# previous ongoing contracts		Were on a FT contract prior to current contract	Were on an ongoing contract prior to current contract	Were students prior to current contract
				Mean	*Median*	*Mean*	*Median*			
0-5 years	**Male** *(n=100)*	85%	15%	1.8	1	0.2	0	56%	16%	25%
	Female (n=36)	81%	19%	1	1	0.1	0	64%	11%	14%
6-10 years	**Male** *(n=51)*	59%	41%	2.5	3	0.2	0	73%	16%	10%
	Female *(n=12)*	42%	58%	2.7	2.5	0.1	0	75%	17%	0%
>10 years	**Male** *(n=83)*	22%	78%	3.1	3	0.5	0	65%	27%	6%
	Female (n=24)	38%	63%	2.7	3	0.2	0	71%	13%	8%

[††††] Where the final three columns do no sum to 100%, some respondents in the group have answered 'other' for the question of contract type prior to current contract. Most of these respondents noted 'casual work' as the 'other' type of contract. Since no employment history statistics were collected from the group of casual staff respondents, they have not been included in this comparison. There were 8 casual staff in the 0-5 year category (5 female, 3 male); 12 casual staff in the 6-10 year category (4 female, 8 male); and 11 casual staff in the >10 year category (0 female, 11 male).

3.6.6 WORK LOCATION HISTORY (FIXED-TERM AND ONGOING RESPONDENTS)

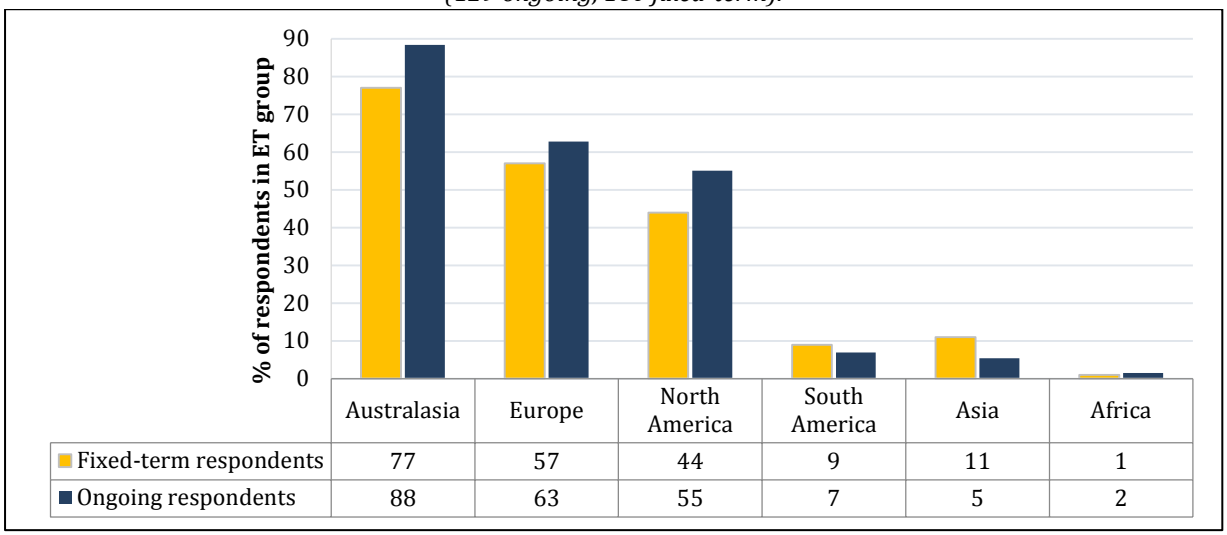
With regards to work location history, both fixed-term and ongoing respondents reported an overall tendency to have worked in Australia, followed by Europe or North America (see Figures 51 and 52 for location of previous contract and all continents worked on respectively).

Figure 51. Location of previous employment: trends in employment type (ET) groups (129 ongoing, 180 fixed-term).



	Australia	North America	Europe	UK	South America	Asia	Other	NZ
Fixed-term respondents	40	23	21	11	2	2	1	1
Ongoing respondents	66	17	5	5	1	2	1	4

Figure 52. Continents worked on: trends in employment type (ET) groups (129 ongoing, 180 fixed-term).

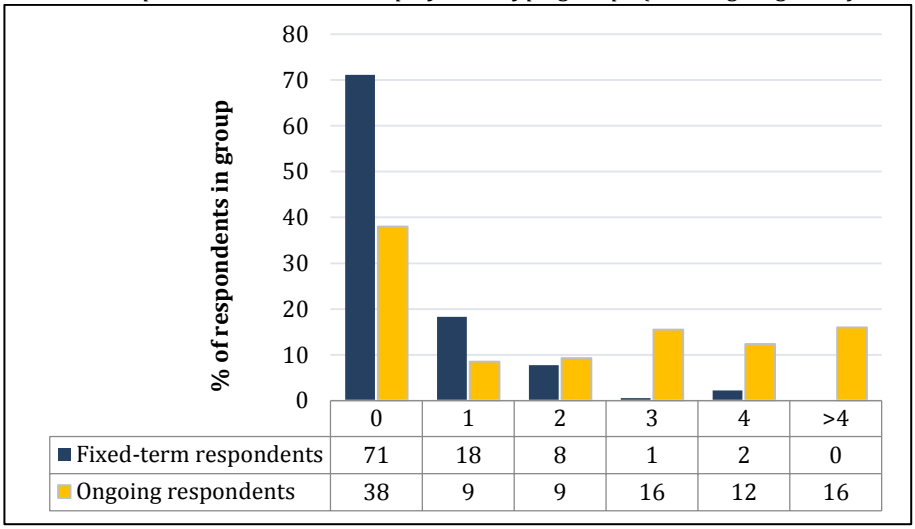


	Australasia	Europe	North America	South America	Asia	Africa
Fixed-term respondents	77	57	44	9	11	1
Ongoing respondents	88	63	55	7	5	2

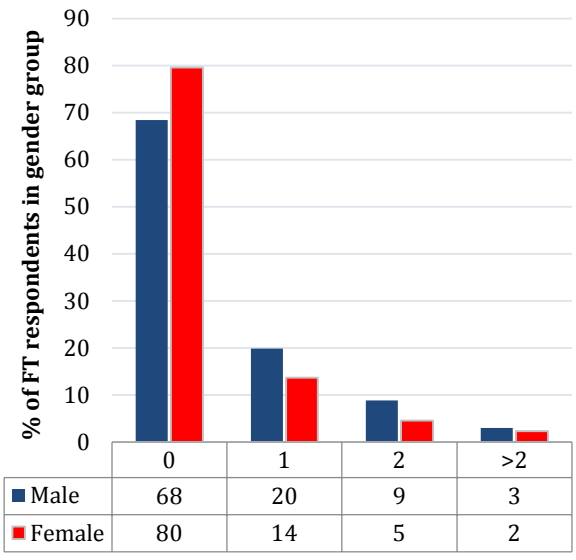
3.7 STUDENT SUPERVISION

Both fixed-term and ongoing respondents were asked to provide information about their student primary supervision loads. Both groups of respondents overwhelmingly supervised no Honours students (87% and 75% respectively) or Masters students (96% and 83% respectively). This is not surprising given that Honours programs are only run at a small number of institutes, and the number of astronomy Masters by research students in Australia is very low. The two employment type groups were quite distinct, however, in their supervision trends with relation to PhD students (see Figure 53). While only 29% of fixed-term respondents were supervising at least one PhD student, the proportion amongst ongoing respondents was 62%. This result was also expected, given that primary PhD supervisors are generally required to have ongoing contracts to ensure that they are present throughout the student's PhD candidature. Male respondents were proportionally more likely than female respondents to supervise at least one PhD student within both fixed-term and ongoing employment groups (see Figure 54).

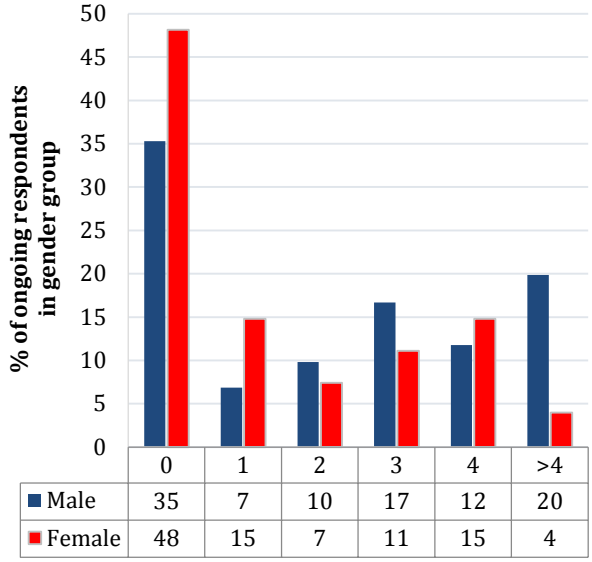
Figure 53. PhD supervision: trends in employment type groups (129 ongoing, 180 fixed-term).



	0	1	2	3	4	>4
Fixed-term respondents	71	18	8	1	2	0
Ongoing respondents	38	9	9	16	12	16



	0	1	2	>2
Male	68	20	9	3
Female	80	14	5	2



	0	1	2	3	4	>4
Male	35	7	10	17	12	20
Female	48	15	7	11	15	4

Figure 54. Gender trends in PhD supervision within the group of fixed-term respondents (left; 44 female, 136 male) and within the group of ongoing respondents (right; 27 female, 102 male).

APPENDIX A: INSTITUTIONAL SURVEY TEXT

Institution Identification‡‡‡‡

*** 1. Which Australian institution are you currently principally affiliated with?**

▼

Employee numbers

*** 1. How many people currently work at your institution, doing astronomy with any part of their time?**

Fixed-term contracts

Continuing contracts

*** 2. How many full-time equivalence (FTE) astronomy employees currently work at your institution? (Please adjust for part-time work)**

Fixed-term contracts

Continuing contracts

Research Staff Movement

*** 1. Please list the number of fixed-term and continuing staff that have arrived at your institution from either outside of or within Australia in the last 5 years.**

	Total number of new fixed-term staff	# new fixed-term staff who arrived from outside of Australia	Total number of new continuing staff	# new continuing staff who arrived from outside of Australia
2009	▼	▼	▼	▼
2010	▼	▼	▼	▼
2011	▼	▼	▼	▼
2012	▼	▼	▼	▼
2013	▼	▼	▼	▼

*** 2. Please list the number of fixed-term and continuing staff that have departed from your institution to positions either outside of or within Australia in the last 5 years.**

	Total number of fixed-term staff departures	# fixed-term staff who left Australia	Total number of continuing staff departures	# continuing staff who left Australia
2009	▼	▼	▼	▼
2010	▼	▼	▼	▼
2011	▼	▼	▼	▼
2012	▼	▼	▼	▼
2013	▼	▼	▼	▼

‡‡‡‡ '*' indicates compulsory questions.

Student Departures – PhD and MSc

Please fill in the details for all PhD or MSc students that have been awarded astronomy degrees from your institution in the last 5 years.

*** 1. How many students have graduated from your institute with PhD or MSc (by research) majoring in astronomy/astrophysics in the past 5 years? Please provide as accurate an answer as possible.**

2. Please complete the appropriate details for each PhD/MSc graduated.

	Degree	Year	Gender	Primary Research Area	Secondary Secondary Area	Main Research Technique	Employment Type Post-degree	Employment Area Post-degree	Location
1									
2									
3									
4									
5									

[Up to 30 students could be entered using the response table; additional student details could be entered in comma-separated format in a text box.]

Student Departures – Honours

Please fill in the details of students who have been awarded as Honours astronomy degrees (or physics or maths but majoring in astronomy) from your institution in the last 5 years.

*** 1. How many students have graduated from your institute with an Honours degree majoring in astronomy/astrophysics in the past 5 years? Please provide as accurate as answer as possible.**

2. Please complete the appropriate details for each Honours graduate.

	Year	Gender	Pre-Honours Origin	Continued Postgraduate Study	Employment
1					
2					
3					
4					
5					

[Up to 30 students could be entered using the response table; additional student details could be entered in comma-separated format in a text box.]

Postgraduate student numbers

*** 1. How many astronomy students are currently at your institution?**
(Please answer as of 31 January 2014.)

Honours students	
Masters students	
PhD students	

*** 2. In the future, does your institution expect postgraduate numbers to:**

- ○ increase
- ○ remain the same
- ○ decrease

*** 3. In the future, does your institution expect postgraduate quality to:**

- ○ increase
- ○ remain the same
- ○ decrease

4. How many astronomy postgraduate scholarship applicants did your institution receive in the last 5 years?

	Domestic (APA-eligible)	Internationals
2009	▼	▼
2010	▼	▼
2011	▼	▼
2012	▼	▼
2013	▼	▼

*** 5. How many astronomy postgraduate students have commenced studies at your institution in the last 5 years?**

	Domestic (APA-eligible)	Internationals
2009	▼	▼
2010	▼	▼
2011	▼	▼
2012	▼	▼
2013	▼	▼

Funding and Growth

*** 1. Please indicate what percentage of your institution's current budget (including all salaries) is contributed by different funding sources.**

ARC	
Other National Competitive Grant funding	
University (incl. salaries)	
Departments of Education and Industry (not including CSIRO)	
CSIRO	
State or Territory Government	
Industry	
Overseas	
Private (e.g. endowments, donations, charitable trusts)	
Other (specify below please)	

2. Please indicate the 'other' funding source(s).

*** 3. Do you believe that overall funding for research at your institution is:**

- ○ inadequate
- ○ just adequate
- ○ more than adequate

*** 4. Does your institution feel its research efforts (funding, staffing) are currently:**

- ○ expanding
- ○ steady
- ○ shrinking

*** 5. Please estimate the total expenditure contributing to astronomical teaching and research (including salaries and scholarships) at your institution over the period 2009-2013:**

6. Please estimate the approximate proportion of this budget that was expended on:

	2009	2010	2011	2012	2013
Teaching activities	▼	▼	▼	▼	▼
Research activities	▼	▼	▼	▼	▼
Other activities	▼	▼	▼	▼	▼

Please specify the 'Other' activities:

Research Quality

*** 1. Please indicate the number of major conferences that your institution has hosted in the last 5 years.**

▼

*** 2. Please indicate the number of workshops that your institution has hosted in the last 5 years.**

▼

*** 3. Please indicate the number of National Competitive Grants awarded to your institution over the past 5 years (with the funding going directly to your institute).**

	Number
ARC grants	▼
Non-ARC grants	▼

Please specify any non-ARC grants awarded:

4. Please indicate the executive positions in international organisations that members of your institution have held in the last 5 years.

List each position in a comma-separated "Position, Organisation" format, with one per line, e.g.:
Chair, IAU Commission 26
Member of Editorial Board, The Astronomical Journal

5. Please indicate the executive positions in National Interdisciplinary Organisations, Government Committees, and Industry Boards that members of your institution have held in the last 5 years.

List each position in a comma-separated "Position, Organisation" format, with one position per line.

6. Please indicate the Major Awards, Distinguished Prizes, ISI Citation Laureates, and Laureate Fellowships that your institution or members of your institution held or were awarded in the last 5 years.

List all such awards in a comma-separated "Award/Fellowship, Commencing Year of Award/Fellowship" format, with one entry per line.

Industry Commercialisation

These questions aim to identify your institutes experience with industry interactions of all types; where you may act as both a customer of, as well as a vendor for, astronomy derived technologies and products. The previous Decadal Plan set out to increase industry engagement. Here we seek to understand how has this eventuated across the astronomical community. In particular we aim to identify projects and areas deemed highly successful, as well as those which did not proceed as hoped. The answers to these questions will be shared with W3.3 (Industry) who are tasked with recommending how the community can ensure it is ready to best exploit future industry interactions and what developments and support might assist better returns for the community. This first set of questions seek to understand your institutes experience in working with integrated teams with industry.

*** 1. Has your institute implemented Integrated Project Teams (IPTs) or similar, comprised of staff as well as industry and potentially other research entities?**

- Yes
- No

2. If yes to Q1, please provide short outline of size of project (years, approximate total cost, # persons) and short outline of nature of the project (e.g. new technology development, adapting commercial products, larger-scale build of existing astronomy-derived instrumentation etc).

3. If yes to Q1, did your institute utilize structured management processes to operate the IPT?

- Yes
- No

*** 4. If your institute has implemented IPTs, please outline the process and your thoughts on the success or otherwise of these. If your institute has not implemented IPTs, please comment on the process adopted.**

*** 5. Would your group benefit from further advice or training on the successful set up and operation of IPTs?**

- Yes
- No

This next set of questions ask for information on IP related aspects of your industry engagements.

*** 6. Does your institute engage in commercial transactions where significant intellectual property (IP) is or was generated for the partner by your organisation, or is expected to be generated?**

- Yes
- No

7. If yes to Q6, please provide a very brief outline of the project details, commercial partner name, and interaction type.

8. If yes to Q6, did the contractual arrangement restrict either party's freedom to access, or otherwise further exploit, the IP?

9. If yes to Q6, what were the reasons in your view for the success or failure in generation or transfer of IP?

10. If yes to Q6, was the partner able to commercially exploit the IP that resulted from the project or interaction?

- Yes
- No

11. If yes to Q6, and if the partner was able to commercially exploit the IP, are you able to a quantitative estimate of financial benefit?

This final set of questions are to assess the community's self-view of commercial skills and how we might best develop these skills in the future.

*** 12. How developed do you consider your institute's skills to successfully exploit commercial opportunities, industry capabilities and IP management?**

- Very developed
- Somewhat developed
- Not adequately developed

*** 13. Do you believe that there is sufficient coordination and effort made within the Australian astronomy community to develop the flow of commercial products into, and IP out of, astronomy?**

- Yes
- No
- Unsure

*** 14. Would your institute be happy to be consulted further by NCA Decadal Plan WG3.3 Industry?**

- Yes
- No

Astronomy Outreach

*** 1. What type of astronomy outreach activities has your institution offered in the last 5 years and what age-groups did those activities target?**

	Primary Students	Secondary Students	Senior Secondary Students (HSC/VCE)	University Students	Special Interest Groups	General Public	Not Offered
Public lectures	☐	☐	☐	☐	☐	☐	☐
Visitor centre	☐	☐	☐	☐	☐	☐	☐
Open day(s)	☐	☐	☐	☐	☐	☐	☐
Night sky viewings	☐	☐	☐	☐	☐	☐	☐
Day/solar viewings	☐	☐	☐	☐	☐	☐	☐
Visits to schools	☐	☐	☐	☐	☐	☐	☐
School group visits	☐	☐	☐	☐	☐	☐	☐
Educational media	☐	☐	☐	☐	☐	☐	☐
None (no outreach activities)	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐

Please specify the 'other' outreach activities indicated:

*** 2. Approximately how many of each of these outreach activities has your institute hosted over the last 5 years?**

Public lectures	
Visitor centre	
Open day(s)	
Night sky viewings	
Day/solar viewings	
Visits to schools	
School group visits	
Other	

*** 3. Approximately how many people attended these outreach activities over the last 5 years?**

Public lectures	
Visitor centre	
Open day(s)	
Night sky viewings	
Day/solar viewings	
Visits to schools	
School group visits	
Other	

*** 4. Does your institution specifically provide astronomy training programs to teachers?**

- ○ Yes
- ○ No

5. If yes to Q4, approximately how many teachers attended these training sessions in the past 5 years, if they were offered?

Primary	
Secondary	

*** 6. Has your institution conducted outreach activities in conjunction with other organisations?**

- ○ Yes
- ○ No

7. If yes to Q6, how many collaborative astronomy outreach events/activities were held over the last 5 years?

8. If yes to Q6, which organisations has your institution partnered with for these collaborative astronomy outreach events?

- ☐ Other astronomy institutions
- ☐ Amateur societies
- ☐ Professional teachers associations

Other (please specify)

*** 9. How much funding does your institution make available for astronomy outreach activities?**

*** 10. Please indicate the number of popular books published by members of your institution in the last 5 years.**

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ >10

*** 11. Please indicate the number of popular articles published by members of your institution in the last 5 years.**

- ○ 0
- ○ 1-5
- ○ 6-10
- ○ 11-15
- ○ 16-20
- ○ 21-25
- ○ 26-30
- ○ >30

12. Please indicate the format of these popular articles.

- ☐ Amateur science/astronomy magazines
- ☐ Dedicated magazines/journals (e.g. University research magazines)
- ☐ Newspapers articles (but not interviews)
- ☐ Website articles

Other (please specify)

Undergraduate Teaching

*** 1. Does your institution offer courses with astronomy/astrophysics in the title and/or >50% astronomy/astrophysics component in the syllabus to students on campus?**

- ○ Yes
- ○ No

2. If you answered 'Yes' above, please provide the following course details in a comma-separated format, with one entry per line:

Course name, Year level, Average number of students in the last 5 years, Percentage of female students, Course weighting (EFTSL).

For example:
Introduction to Astronomy, 1, 80, 50, 0.125
Astronomy Research Project, 3, 50, 35, 0.25

*** 3. Does your department have formal educational links to 'engineering for astronomy' related subjects?**

- ○ Yes
- ○ No

*** 4. Does your institution offer a Summer Vacation Scholarship Program?**

- ○ Yes
- ○ No

5. If yes to Q4, what was the total number of students in your summer vacation program in the last 5 years?

6. If yes to Q4, approximately what percentage of your summer vacation students over the past 5 years were female?

7. If yes to Q4, how many of your summer vacation students continued into your PhD program?

Online and Distance Teaching

These questions relate to fully online or fully distance programs (undergraduate and postgraduate) offered by your institution over the past 5 years (excluding on campus courses that have an online component).

*** 1. Does your institution currently, or has it over the past 5 years, offered any fully online or distance degree programs?**

- ○ Yes
- ○ No

2. If yes to Q1, please provide the following details of any online or distance degree programs offered by your institution in the last 5 years (not including on-campus courses that have an online component), using a comma-separated format with one entry per line:

Name of the degrees/diplomas offered, Average number of students in the last 5 years, Percentage female students, Percentage international students, Type (D = distance or O = Online)

For example:
Graduate Diploma of Science, 200, 30, 62, O

Education Funding

*** 1. Are funding sources available at your institution for education and teaching grants?**

- Yes
- No

*** 2. Do you believe that overall funding for educational research is:**

- inadequate
- just adequate
- more than adequate

*** 3. Please indicate the number of education-related grants that were awarded in the last 5 years:**

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- >10

4. Of the education-related grants awarded in the last 5 years, please specify the ratio of internal (to your institution) to external grants:

APPENDIX B: INDIVIDUAL SURVEY TEXT

Institutional Identification

*** 1. Which Australian institution are you currently principally affiliated with?**

2. Please indicate if you are also a member of either CAASTRO or ICRAR.

- CAASTRO
- ICRAR
- Both CAASTRO+ICRAR
- Neither

Personal Information

*** 1. What is your name?**

Given name(s):

Family name(s):

*** 2. Year of birth:**

*** 3. Nationality:**

	Country
Primary citizenship	
Secondary citizenship	
Tertiary citizenship	

Other (please specify)

*** 4. Gender:**

- Female
- Male

5. If you have carer responsibilities, how many (if any) dependents do you support?

Education History

*** 1. What is the highest degree you have completed?**

- None
- Diploma
- Bachelor
- Bachelor with Honours
- Master
- Doctor of Philosophy
- Other (please specify)

*** 2. In what year did you complete your highest degree?**

*** 3. Where did you complete your highest degree?**

Country:

Institution Name:

Role and Time

*** 1. What is your primary role in Australian astronomy?**

- Research
- Teaching
- Research & teaching
- Technical support
- Administrative support
- Leadership
- Communication
- Other (please specify)

*** 2. What percentage of full-time equivalence (FTE) are you employed at by the principal Australian institution that you nominated in Q1 of Part 1?**

*** 3. How are your working hours distributed between the following categories of tasks? (Please assign a percentage of time to each category, even if it is zero)**

Research (astronomical, astrophysics and instrumentation research)	
Teaching (undergraduate and postgraduate course work)	
Graduate Supervision (MSc by research and PhD students)	
Technical/Software Support	
Administration (admin support and service roles)	
Leadership (local, national and international group leadership)	
Science Communication	
Other (please specify below)	

4. What 'other' category of task do you spend work hours completing?

*** 5. What areas of astronomy do you work on? (Please indicate the percentage of your research effort in each area, even if it is zero)**

Astrobiology	
Black holes / AGN / Quasars	
Instrumentation	
Instrumentation - space	
Cosmic rays	
Cosmology	
Mesospheric, Ionospheric and Magnetospheric Physics	
Planetary science - exoplanets	
Planetary science - Solar System	
Extragalactic astronomy	
General Relativity and gravitational waves	
Space physics	
Space physics – high energy	
Galactic astronomy	
Galactic astronomy - formation	
Pulsars	
Stellar astronomy	
Stellar astronomy - formation	
Stellar astronomy - Sun	
Other	
None of the above	

*** 6. What techniques do you use in your astronomical research? (Choose as many as apply)**

- [ ] Theory
- [ ] Computational
- [ ] Optical
- [ ] Infrared
- [ ] X-ray
- [ ] Radio
- [ ] Cosmic rays
- [ ] Other
- [ ] Do not conduct astronomical research

*** 7. Please indicate your employment type**

- ( ) Post-graduate student
- ( ) Casual work
- ( ) Fixed-term contract
- ( ) Ongoing/continuing

*** 8. Approximately how many years have you worked...**

	Number of calendar years (please round to the nearest integer)	Number of full-time equivalent years (please round to the nearest integer)
...at the principal Australian institution you nominated in Q1 of Part 1?	▼	▼
...in Australian astronomy generally?	▼	▼
...in astronomy overall?	▼	▼

Student Information

[This section was only available for those who answered 'Post-graduate student' to Q7 in 'Role and Time'.]

*** 1. What degree are you currently studying?**

- ○ Master
- ○ Doctor of Philosophy

*** 2. What was the area of your previous degree?**

- ○ Astronomy
- ○ Computer Science
- ○ Physics
- ○ Engineering
- ○ Mathematics
- ○ Other (please specify)

Fixed-term Contract Employees Information

[This section was only available for those who answered 'Fixed-term contract' to Q7 in 'Role and Time'.]

*** 1. What year did you take up your current fixed-term contract?**

*** 2. How many fixed-term contracts in astronomy have you held before this one?**

*** 3. How many continuing contracts (ongoing positions) in astronomy have you held?**

*** 4. What type of employment did you have before taking up your current contract?**

- ○ Ongoing/Continuing
- ○ Fixed-term Contract
- ○ Student
- ○ Other (please specify):

*** 5. Where were your previously based?**
(Please provide the country and institution name of your previous position)

Country:

Institution Name:

*** 6. Which continents have you worked on?**

- ☐ North America
- ☐ South America
- ☐ Europe
- ☐ Asia
- ☐ Australasia
- ☐ Africa

*** 7. For how many currently enrolled postgraduate students are you the primary supervisor?**

Bachelor with Honours	
Masters	
Doctor of Philosophy	

Ongoing/Continuing Employees Information

[This section was only available for those who answered 'Ongoing/continuing' to Q7 in 'Role and Time'.]

*** 1. What year did you take up your current continuing contract?**

*** 2. How many continuing contracts in astronomy have you held before this one?**

*** 3. How many fixed-term contracts in astronomy have you held?**

*** 4. What type of employment did you have before taking up your current contract?**

- ○ Ongoing/Continuing
- ○ Fixed-term Contract
- ○ Student
- ○ Other (please specify)

*** 5. Where were you employed before taking up your current contract?**
(Please provide the country and institution name of your previous position)

Country:

Institution Name:

*** 6. Which continents have you worked on?**

- [ ] North America
- [ ] South America
- [ ] Europe
- [ ] Asia
- [ ] Australasia
- [ ] Africa

*** 7. For how many currently enrolled postgraduate students are you the primary supervisor?**

Bachelor with Honours	
Masters	
Doctor of Philosophy	