Annex E3

Total Australian university astronomy expenditure

Total University astronomy expenditure can be calculated in several ways.

> 1. Add up all of the funding input going to each university astronomy group. This is an intractable problem because university funding comes in a variety of guises: University block grants (RTS/ITS), RIBG, Capital works funds, ARC (DP, LIEF, Linkage, Fellowships), APA awards, DEST and, increasingly, student fees. Calculating the fraction that is attributable to astronomy in each institution is fraught.

> 2. Calculate what is spent by each research team. This is also fraught, and does not capture infrastructure costs, institutional overheads etc.

> 3. Rather than look at "input" or "output", take a slice through the system at an appropriate level and apply the Equation of Continuity (aka the principle of Conservation of Money) to equate this to the total rate of funding. This is the approach taken here, the slice being made at the individual astronomy department level.

The following items are *not* included, as these should be captured in other parts of the Decadal Plan:

- Gemini, including university contributions
- Major instrument contracts, such as NIFS
- Travel costs

A number of assumptions need to be made. Any of these can be challenged, and new figures calculated. However, in most cases only a very minor change in the overall numbers results. The total figure should be accurate to better than 10%.

Assumptions:

> 1. All ARC LIEF grants are spent exclusively on equipment (or at least non-research-people). Thus, there is no double-counting by adding LIEF grants to people numbers.

> 2. All other ARC grants (DP, Fellowships, Linkage etc) are used exclusively to fund people. Thus, no funding is left uncounted by simply adding up all the people on externally funded positions at universities. This assumption is likely to be the largest source of error – if 10% of DP funding is spent on equipment etc, then we have underestimated the final figure by amount $1m.

> 3. All money received by research groups from internal university funds (eg for operating costs, scholarships etc) is spent freely by that group and is not, for example, used as matching funds for external grants. Thus there is no double counting of LIEF contributions.

> 4. Astronomers are "average" members of the experimental-science cohort of the university. Thus, the ARC's weighting factors for indirect costs apply to them.

5. Each academic and researcher spends 100% of their time on astronomy. This might be challenged – is teaching a First-year class in electronics "astronomy"? However, we can argue that our skills as teachers derive in part from our experience as astronomers. It is difficult to think of any activity that we perform that is not in some way related to either research or teaching of astronomy-related topics.

With these assumptions, the total university budget for astronomy can be calculated. At a departmental level the throughput of money is made up of the following major components:

- Salaries, which we calculate directly from the numbers of staff
- Indirect costs, which we calculate using the ARC's formula
- Equipment costs, which we equate to the LIEF grants
- Operating and consumables expenses, which are calculated from numbers the universities have provided
- APA awards, which we estimate are held by 30% of all Australian astronomy postgrads.

1. Salaries and Indirect costs.

From numbers kindly supplied by each of 15 institutions, we know how many university-funded academic staff there are (66) and how many externally-funded postdocs (75.5).

Let's assume an average salary at the top of level C (Senior Lecturer) for both categories, ie $90k/annum. To the university-funded positions we need a multiplier to account for on-costs (payroll tax, workers compensation, provision for long service leave, employer contribution for superannuation): this varies from university to university, but at UNSW is 1.28.

Using the ARC-approved formula, we can calculate the indirect costs. These include building infrastructure, libraries, workshops, technical support, administration costs. The ARC's estimate for these is 1.25 x (salary + on-costs).

So now our salary-related expenditure is:

University funded academics: $66 \times 90k \times 1.28 \times (1 + 1.25) = \$17,110k$
Externally funded researchers: $77.5 \times 90k \times (1 + 1.25) = \$15,690$
Total: $32.40m/year

2. Equipment costs

ARC LIEF awards to astronomy can be found on the web for the past four years and are as follows:

Year	Gemini ($k)	Non-Gemini ($k)
2002	1600	450
2003	1860	1172
2004	1850	0
2005	1460	782

Average non-Gemini LIEF funding per year is therefore $601k/year. This is typically 70% of the total, with cash contributions from partner institutions making up the remaining 30%. So, the total spent on equipment is around $860k/year.

3. Operating and consumable costs.
Total sum provided by the 15 universities: $3,708k. This includes RSAA, which receives a block grant.

4. APA Awards.
There are currently111 APA-eligible PhD students at Australian universities. If we assume 30% of these currently hold an APA scholarship (this fraction should be checked), there are 33 students @ $20k per annum or $660k.

Grand Total: $38.0 m per annum

Note:
1. This result is close to the figure of ~$40m/year that has previously been estimated by others.

John Storey, 1 August 2005