Advice to new astronomers: on your career

By Dr. Alan Whiting

Introduction

These notes are intended for people who are in PhD programs in astronomy (and those who are about to start) who intend to make astronomy their paying job. I expect they'll be of less use to astronomers later in their careers, and they are not particularly applicable to those who are getting their degrees in astronomy but intending to work elsewhere. (I don't mean to imply that the latter group is ignorable or not made up of good people; in fact in the UK, money for astronomy students comes from the government under the understanding that most will go into more economically useful areas of science and technology. But their situation and their concerns are different from those intending to get paid for doing astronomy.)

It is becoming more common these past few years for new astronomers to get career advice, from general statements all the way to specific and personalised workshops on CV-writing. This advice comes mostly from people who have been successful in getting jobs in astronomy and of course should be listened to and respected. But these successful people are the *exception* to the general rule for astronomy PhDs. Their experience does not reflect what most of you will see (even leaving out the variations in the job market over the space of years), and so to some degree they speak from ignorance. To balance that I present these observations and advice from someone who has not been notably successful. (Note that you often learn more from your failures than from your successes.)

Ground Rules

First: it's your career; no one will do it for you

That's obvious, of course. But its implications may be quite foreign to your experience. Consider that, as a PhD student, your life so far has centred on a very structured progression: primary and secondary school, undergraduate work, the PhD program itself. The next step to take has generally been clear, even if there have been choices (and a lot of work involved with application forms and essays). Suddenly, what you do after your degree is not so clear. Get a job, of course; but where and how won't be obvious. And if you don't succeed in getting one there's nothing in your graduate school structure that will get it for you, and no one who will take responsibility to do it. You may receive advice and even help; but those who provide the advice and help don't have to live with the results (or lack thereof). It's up to you.

Basic Stuff

The **basic fact** of astronomy as a career is that people do it because they like to do it. It's not a way to fortune or fame; people enjoy the practise of it. That means there will always be fewer jobs in the field than people willing to take them. It also means that, as an astronomer, you will be paid less (and have fewer other benefits) than someone with your intelligence, creativity and skills can get elsewhere. With a few exceptions (to be mentioned below) it's a buyer's market, and you're a commodity in good supply.

The **basic structure** of the field is hierarchical: one professor with a permanent job will have many students; one PI with a grant will have one or more postdocs, one or more students. To some degree the non-academic permanent jobs (in observatories, for instance) make the balance more even, but there are always more students and temporary employees than permanent jobs.

Together, the basic fact and the basic structure of the field generate the **basic statistic**: roughly one-third of astronomy PhDs will wind up in permanent jobs in the field. Now, you'll see various numbers quoted for the fraction of PhDs who wind up with jobs. Almost all can get a first postdoc. But most, something like two-thirds, will not be employed in the field permanently. (That includes, I believe, people in four-year liberal-arts schools who get a bit of time over the summer to do research though they spend most of their time teaching; but excludes people like the sysadmins at astronomical institutions who do no research themselves.) So your grad school, while recruiting, can quote encouraging numbers based on initial jobs; but if you manage to stay in the field, you're the exception. You will have been *better* than your peers at getting a job.

A recent study, out in eprint, concludes that about half of the astronomy PhD production will find a permanent job in academia with the other half finding support jobs (my summary). Since the study included all jobs in the AAS Job register, which means overseas jobs as well, while not counting PhDs produced overseas, I think half is an overestimate and one-third could be about right. Also, the assumption that the non-academic half gets the support jobs is unfounded from what I know about both the non-academic people and the support workers: the skill sets are just not the same.

Smith's Law

In the best tradition of astronomical nomenclature, I'm about to name an effect after someone who technically did not discover it and may in fact have had nothing to do with it.

During my time at CTIO I remember one person who had been serving on the Time Allocation Committee (TAC) talking about the various observing proposals he'd been reading. I believe it was Malcom Smith, former director of CTIO and a great man to work for. Anyway, it went something like this: ten to fifteen percent of the proposals were obviously excellent and would get all the time they needed no matter what process the TAC went through. Another ten or fifteen percent were so poorly thought out or simply impossible that they'd never get any time. The middle seventy to eighty percent were all good enough to be worth observing time, but so close in merit that there was no clear way to rank them. Unfortunately, with the telescopes oversubscribed about three to one most of them had to be cut somehow. The eventual choice depended a great deal on the TAC members, their backgrounds and views of the science, and on chances of timing and other details.

So here is **Smith's Law** restated for the astronomical job-seeker: "Ten to fifteen percent of astronomy PhDs are so clearly outstanding that they will have no trouble getting a job. Ten or fifteen percent are so unsuited to the career that no one in the science will ever hire them. The remaining seventy to eighty percent are so close in capability and merit that their eventual fate depends chance, timing and other factors."

"Other factors" can include many, many things. Writing and speaking ability appear, of course, as well as how you present yourself during the interview process. You'll get advice on many things like that. The single most important factor, and one which I've not seen addressed at all in this context, is what you choose to work on: your subfield within astronomy. I'll go into that in a bit of detail below.

What's good for the student. . .

As a PhD student your focus, almost to the exclusion of all else, is completion of the thesis. But the actions, skills and qualities that lead to a successful thesis are not identical with those giving you the best chance at a postdoc position; and these in turn are not identical with those leading to a permanent position.

A **PhD project** must satisfy rather strict criteria: it must be scientifically significant, at least enough to be worth doing; require enough skills and effort to be worth a PhD; and still be small and self-contained enough to be completed in a few years with identifiable results. Luckily for students, astronomy has quite a few nice little problems well-suited to PhDs; unfortunately, many of them lead nowhere. The subject area may be unpopular or even moribund on any higher level; the skills and background required may have no particular application to further or other work. Thus there is at least a potential source of friction between a supervisor and student over what exactly is meant by a useful project.

Most **postdocs** are rather narrowly focussed. There is a specific job to be done, sometimes amounting only to reducing a pile of data already acquired. People are hired based on a specific background or set of skills. If you don't have this background, you won't be hired. But a permanent job requires much more: the ability to initiate and organise your own research program, attract funding, publish lots of papers, attract notice. You can be the ideal candidate for some postdoc positions and have no hope at all of getting anything permanent.

So in order to raise your chances of getting a **permanent job**, you need to structure your grad school and postdoc efforts around that end. It may mean sometimes a slower, more difficult time with the thesis, and possibly more difficulty getting a postdoc, or accepting one with features you're inclined to think of as drawbacks. Remember, if it were easy, most people wouldn't fail at it.

Choose your field

The three most important choices you make come at the very beginning of your reseach career, when you know the least and are in the worst position to make them: where you do your graduate work, who is your thesis advisor, and what is the field you'll work in. It is possible to change

directions and even fields later on, but it's difficult, and hard to build up a convincing amount of momentum again.

I won't say much about choosing a school or an advisor (you'll receive plenty of advice on those matters), apart from noting that a school with a broader range of subfields allows more flexibility. You can be flexible early in your studenthood, much more so than later.

Choosing your field is more important than any student I've met realises. Of course it must be interesting to you; but if that's your only criterion you need to be financially independent, because it is by no means guaranteed that you can find anyone to pay you to do it.

The most important point is this: the field must be **FUNDED**. To increase your chance of employment you need to choose a field at which people are throwing money. I can see two different strategies for this: the conservative, in which you choose a field that is established and neither expanding nor contracting greatly; and the speculative, in which you look for the next big thing. As examples, I would put planetary nebulae and cataclysmic variables in the conservative category: there's no big explosion of interest in them at the moment, but plenty of work going on. Being conservative means you're not increasing your odds of employment greatly; on the other hand, at least there are jobs to shoot for.

I would put things like exoplanets in the speculative category. Catching the next wave is a monumentally difficult thing to do deliberately (you can, of course, fall into it by chance). You need to see it coming in advance, before most people--and that means when you've just begun your studies and are least equipped to do so. The timing of funding cycles is generally such that you'll have to start your PhD in an area that isn't getting much money, so that the funding is increasing when you're ready for employment. The worst possible thing is to be just a couple of years behind the crest: then all the jobs are full of new people, with no new openings on the horizon. *And in fact this is the situation students of newly hired permanent astronomers will find themselves in.* In this case what's good for the supervisor is very clearly not good for the student.

I've spent some time at astronomical conferences asking established, knowledgeable people about attractive fields to get into. Even phrasing the question as, "What would you do if you were starting your PhD again, but knowing what you now know about the science?" got no answers. It's such a difficult question, while being at the same time so important, none of them would commit themselves even informally!

I note that recently the importance and difficulty of a PhD student choosing a subfield has been brought out by a major figure in physics, Prof. Abraham Loeb of Harvard. In *Nature*, 484, 279 (2012) he proposes a website run by grad students (professors might have a conflict of interest) rating `the probable future returns of various research frontiers.' I don't think it would work. Students simply do not have the background to do this sort of thing, when even senior people won't make predictions. But at least he recognizes the problem.

There are two other features of your possible subfield to consider. The first of these is the ease of **PUBLISHING**. The hard fact is that, when applying for any position, employers will look at the number of your publications first. If there aren't enough you won't make the first cut, and the

quality and size will be irrelevant. So you need to choose a field in which you can get papers out in at least moderate numbers. I can't give specific figures, and anyway they change with time. Twenty years ago, a brand-new PhD could have only a handful of publications and still be respectable; now, undergraduates with several refereed papers are almost normal.

At the same time, you need to be aware that papers with many authors do not have the same weight as few-author papers, and employers do look at this point. They may not glance at the length, importance or impact of your papers, but they will look at how many there are and how many authors are on each. There is a very strong trend in astronomy for more authors on each paper, amounting even to a sociological shift in how astronomy is done. I don't know how search committees will wind up handling this.

Conversely (this is a comment made by another astronomer) if you show a strong tendency to write single-author papers, employers may suspect that you work on something no one else is interested in, or thinks important; or that you are personally hard to work with, or even antisocial.

The next point (and not entirely separate from everything else I've said) you need to be **VISIBLE**. Some fields just get more attention than others, even with similar levels of funding. Big questions are visible (which is one reason for the popularity of cosmology). And if you use the latest, biggest equipment for your work you will by definition be visible. Consider that departments everywhere tout their record of using the Keck or VLT, HST, or the most advanced computers.

Of course the biggest and best can do things impossible or impractical for smaller and older installations, and so their projects will contain more cutting-edge research. If you dream up a project that requires many square metres of mirror diameter and advanced instruments, or better yet something not yet even built, you will probably be doing a good job of advancing the science. Still it is true that, *apart from the science you do*, the tools you use to do your work impress people. Though everyone I've spoken to concedes that good work can be done, and is done, on smaller and older equipment, it has far less **visibility**.

Even when you're looking for a permanent job, in which you need to demonstrate independence and original ideas, your field is extremely important. Institutions are very reluctant to stake out a position in a field entirely new to them, preferring someone who can connect with their current faculty. And, of course, you will be expected to bring in funding, which brings us back to the need to specialise in a well-funded area.

From my own observations, it appears that theorists are in general harder to employ than observers; and that instrumentalists, of whatever sort, are always in demand. (Of course skill in making high-tech things is looked on highly outside of astronomy proper; see Alternate Plans.)

One last note in this section: you can specialize to work on a particular type of *object*, or you can develop a particular specialized *skill*. Sometimes the latter amounts to a "field" as I've been using the term, but the tendency is for skill-fields over time to become merely necessary subsidiary skills for other fields. For instance, n-body coding used to be a field of research in its own right;

now, it's more often used as an auxiliary tool for research whose point is something else. Interpreting spectra went this way rather longer ago. If you want to sell yourself on a skill as your field, be careful about where it's headed!

Job Hunting

At some point late in your graduate studenthood you'll be looking for a job. Unless you slide into one by word of mouth or being in the right place at the right time (which happens, though I can't say how often), you'll be perusing the job ads and sending out applications. One thing to remember is that, unless you're in the top Smith's Law category, you're a replacable commodity. Put aside your pride and get ready to be treated thoughtlessly.

Reading the job adverts

These will be mostly in the AAS Job Register, sometimes in the RAS email service, occasionally in other publications. They generally specify the fields of interest and the expected background of the candidates. They can be written quite strongly and in detail, or give only a few vague features plus an escape clause. The latter can be of the form "complementing and extending present research areas" or the more general "any areas will be considered."

The unfortunate truth is that there is **no way to tell just what the prospective employer does want** or will hire at the end. A general sort of desirability criteria with "any areas" escape clause can in practice mean that they will accept only a one specific type; or a very detailed and specific list can be thrown out the window and someone quite different hired. I've even been told of one ad that was placed by a school that had no job and no intention of hiring anyone, just to see what sort of people they might get applying to them. That's probably prosecutable fraud (though more recently I've seen a disclaimer in a job ad that no guarantee is being made that there is a job or that anyone will be hired); the more common practise of straying far from one's job ad, however frustrating and occasionally dishonest, probably isn't.

As a commodity, the (middle Smith's Law) job-seeker has no leverage. He or she is faced with the guessing game: do they mean what they say, or not? Should I take the time and effort to construct another hand-crafted, carefully-researched job application package, individually signed by the author, for this position that fits me perfectly, and for which they may decide to take someone quite different; or this other one, which doesn't fit me well, on the chance that I'll impress them anyway; or either, knowing there's a chance that they already have someone in mind and won't even look at me? (An ad appeared on the RAS email listing, for a UK university, with a deadline date of that same day. That's pretty obvious, and they should have been called on it. But who was in a position to do so?) Unfortunately, many times the search committee itself doesn't really decide what they want until very late in the process or changes its mind along the way. So even if you can get a definite idea (say, from a friend in the department) of what they think they want at the time of the application deadline, it may have changed before the hiring decision.

I've been advised, by people no longer in (this part of) the job market, to apply for everything. That is, I should look at not only the places I'd fit, but also those that would require the

specifications in the ad to bend significantly. At first look, that seems to be the only way out, the venerable **"carpet-bombing"** approach. But having served on a Search Committee once I can say that an application not obviously directed toward that particular institution stands **no chance** of being considered. And it takes time to customise one's work. By my estimate, applying for a wide range of positions but far fewer than all possible, I've spent between one-fourth and one-third of my productive time for years doing nothing but applying for the next job. (Multiply that by the number of graduate students and postdocs in our science and the loss of actual science time is staggering.) A true carpet-bombing would take so much time that each application would be empty: there would be no science to put in it.

One thing I've observed, small in itself but indicative, is the matter of rejection letters. One grows used to sending off one's literary efforts without any apparent effect on the world. It is only polite, however, for the employer to inform the aspirants at the end that they have been unsuccessful. Not hearing from a place a month or two after the deadline generally means that you're not on the short list, at least, but I've known places to take six months or more to make up their minds. At any rate, writing a job application requires a good deal of time and effort; a rejection letter, well, takes several milliseconds of mail-merge CPU time. Yet there are a number of places who haven't even gone to that effort: I can name **the University of Michigan, Rutgers, Yale, Oxford, Mt. Holyoke, University College London, Hertfordshire, Sheffield, Liverpool John Moore, Nottingham, Dublin, Queen's University Belfast, Durham, SISSA, Pomona, Carnegie, Leicester** and **Franklin and Marshall College**. Several of these, especially in the UK, have printed on their forms that they don't send out rejection letters in order to free administrative resources to improve the selection process (or words to that effect). That's nonsense. If the few minutes of time it would take to write and send the letters makes any impact at all on the process, it must be an exceedingly poor one.

(On the other side I must mention **Indiana University**, which sent a detailed packet describing the department and their research to each applicant for their position--and there were a lot of them. Unfortunately, I didn't get far enough in their job-selection process to learn how much more they departed from the general run of things.)

Maybe I've given the impression that astronomy employers are overtly cruel, or deliberately thoughtless. That's not really the case. As people, I find astronomers very friendly and helpful. But of all the skills and talents that will help you get employed in the science, administrative competence does not appear. You'll get a lot of interest if your research is timely and/or of high quality; you'll definitely increase your employment chances with each new grant you pick up. An example of excellent management, however, is unpersuasive and will remain unremarked on your CV. And it shows. Let me give you an example.

I applied for a job at a particular place that shall remain nameless. The deadline was January 15th; I got my application in a month ahead of time. They had not asked for letters of recommendation in the first instance, just names and contact information on referees. As of early January, two of the Search Committee members said they were looking at interviewing in early February, a non-binding estimate. Fine; well, come the end of February I contacted one of them to confirm that they weren't interested in me, since I'd heard nothing. Oh, no; they hadn't gotten

that far yet; hang on, don't go away. Well, in mid-March I got an email, one Friday, demanding letters of recommendation *by the following Wednesday*.

Let me point out that one's referees are not necessarily just down the hall, and in fact mine were on three different continents, the closest one being two thousand miles away; that they do not stay by their phones or email accounts, just waiting to dash off a letter on short notice; in fact referees do go on observing runs and travel to conferences where they cannot be contacted easily, and where they may not be able to write a letter for weeks. (My own policy, from which I deviated very rarely, was to give my letter-writers a minimum of a month notice before any deadline.) And here I was directed to contact them (why, then, did the application call for contact information to be sent to the prospective employer?) for action on essentially two days' notice, since any email I sent to an office on Friday would not be seen until the following Monday.

I never did manage to get in touch with one of my referees; luckily, another one agreed to write on short notice. And the establishment extended to deadline. To a week.

Well: I was invited for an interview after all, and was asked for my availability in April. I was finally given a date in May. And I was given another form to fill out, which included things like contact information on referees. Not terribly important, but it did rankle: they had asked for the information, hadn't used it and instead had sent me on a short-fused scavenger hunt, and now demanded it again.

Most of the Search Committee was not present for my visit; neither was the person who would actually make the hiring decision.

Of course I'm letting off steam about this (about the process, I mean; I have no particular bad feelings about not being hired; things like that happen). But I have a more important point: astronomers are poor administrators. What can appear to be treatment of job applicants with a degree of thoughtlessness amounting to contempt is simply incompetent administration. And it indicates where, in their priorities, the Search Committee lies: at the bottom. They can get away with it only because of the **basic fact** of astronomy as a career (as noted above).

Alternate Plans

Going back to the beginning: you're a PhD student, just starting out on research. You may or may not take my advice laid out above, but in any case you probably will not get a permanent job in astronomy. **Have an alternate plan.** What will you do if you can't or don't become an astronomer?

Do some planning and preparation in detail. That will be hard because your environment is all geared toward astronomical research: how to do that well, and what science is involved. Thinking of doing something else as anything other than "something else" is difficult. And your supervisor will probably consider anything not related to your astronomy work as extraneous, at best a grudgingly-conceded necessity, maybe not even that. But unless your supervisor can guarantee you a permanent job in astronomy (and none of them can), you're justified in spending time on alternatives. I mean a significant amount of time: 10% surely, I would say up to 20%;

which is quite reasonable, given that the chance you'll need it is more like 60-70%. You should know what you'd do tomorrow if all of astronomy suddenly vanished. You should have your application forms ready for the teacher certification course, if your plan is to teach in secondary school; you should have your seaman's papers ready, if you're going to run away to sea.

Most likely you'll be looking at something related to your present skill set and experience, that is, something close to astronomy in some way. Computer admin is popular and so are various kinds of mathematical modeling. If you've been building an instrument you can shift over to industry without breaking stride. I won't try to give you any specific advice. But I do highly recommend that you take time away from the astronomy research environment, enough to place sufficient mental distance between you and it so that you can think of things without applying the (implicit) standards of the field.

I'm not advocating being a defeatist. There is a reasonable chance you'll never need the alternative plan, and possibly a larger one that you'll decide to do something different if and when the time comes. But having the plan in place will drastically reduce the anxiety caused by setbacks in research and by job rejection letters. It is worthwile to have some part of yourself not bound up in a single effort, so you don't feel like a total failure if something goes wrong.

(On a speculative note: it is *technically* possible to do astronomical research without actually being employed in the field. In a way, most astronomers are doing something else to pay the bills, like teaching or support of telescopes, and do their research in the minority of their working time. But I don't think it's possible to combine an unrelated 9-to-5 job with a significant amount of research, even leaving aside things like week-long observing runs or conferences; certainly not if you want a life outside work and research. There may be suitable jobs out there, though. And I suppose there's always the [small] possibility of becoming independently wealthy and turning into a Gentleman Astronomer, or Lady as the case may be, as in the Old Days.)

Two Postscripts and One Encouragement

I have three points to make before I end up this essay: the matter of teaching, the matter of accountability and a small bit of encouragement.

Skill and experience in teaching is just not important for research astronomy job-seeking. Of course that statement will raise all sorts of cries of dissent; but it's true. Most of the academic jobs in the AAS Job Register do not even call for a teaching statement, while *all* call for a description of your research. Some call for the teaching statement (I have this on inside authority) but weight teaching not at all in the selection process. Most call for the ability to attract outside funding and all look at it carefully. Given the choice between someone who has years of classroom experience, with ideas and enthusiasm but no grant; and someone who has a grant for a postdoc and three grad students, but only a brief TA; I know of no Search Committee that would choose the first one. (There are some, I know, but they're rare in the Job Register.) Teaching experience and skill may help you in a close selection, but it's not going to be a major factor overall.

Next point: research funds come from funding bodies, mostly government nowadays but with a strong private-sector presence especially in the US. They give a certain amount of money to a PI to carry out a defined investigation; the number of postdocs and students needed is justified beforehand, and more often then not fewer are supported than asked for. Increasingly, the PI is accountable in detail for everything done with the money: who was hired as postdoc, how much progress was made this year, how many papers published. If, during a review, the overseers decide the money is not being as well-used as it might be, further funding will be directed elsewhere.

It is of course good that people are accountable for the money they've been given, especially since there are plenty of good projects that can't be funded. But it means that everyone must be focussed on demonstrable results, and results that can be produced within the time horizon of the grant: something like 3-5 years. If you need a decade to come up with your Unified Field Theory, producing nothing publishable in the meantime, you're out of luck.

I can see the trend toward detailed accountability and specialisation only getting stronger in the future, as projects get larger and more expensive. What is a good idea for the price of a postdoc and two students, a six-figure amount per year, becomes absolutely imperative in tracking the billion-dollar costs of the next big telescopes. It's the way the science is being run, and if you want to stay in it you need to adapt to it.

But keep your curiosity and idiosyncrasy alive until after you get tenure.

Finally: this is a terribly discouraging essay. One-third chance to follow your dream can sound awfully small. But it's a far better chance than most writers or actors have of making a living, far better than Humanities PhDs have of actually getting paid for their knowledge; a better chance than an Ensign or Third Mate has of ever becoming the Captain of his or her own ship. You *do* have a good shot at it. Good luck.

Return to:
ASR group home page
Dr. Whiting's home page
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