

# International physics research internships in an Australian university

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Research student internships in physics is one way that students can gain a broad range of research experience in a variety of research environments, and develop international contacts. We explore international physics research internships, focusing on the academic learning experiences, by interviewing four international research interns in a research-driven Australian university. Based on the students' internship experiences, we provide practical information regarding internships. We discuss facilitating successful learning outcomes, support of students, the choice of an Australian internship, arranging internships, and life aspects to be considered for potential internship students. This would assist students who are interested in overseas internships, and host institutions, to maximise the success of such visits.

## Introduction

Part of the trend towards increasing globalisation of higher education (Lefrere, 2007) is that students increasingly seek internships in foreign countries (international internship). In addition to benefits such as exposure to different languages and cultures, and real work experience in the field (Lacey, 2006; Rubin, 2009), it is also an opportunity to explore future career fields and build social networks for future employment (e.g. Berkeley University of California Career Centre, 2011-2012).

In the research-focused disciplines such as physics, individual physicists visiting other research groups (research visits) is a common academic activity to share knowledge and scientific methods. There is a long-standing tradition of scientific knowledge exchange between countries and within a country (Benka, 2006). Apart from the traditional mobility in physics, and other branches of science, there are now important trends towards increased international cooperation and globalisation in higher education

- for example, Universitas 21 (<http://www.universitas21.com>), and the Bologna Process and the Lisbon Strategy (Keeling, 2006) - encouraging such international or inter-continental exchanges of undergraduate and postgraduate students, and young scientists.

Accordingly, issues of student mobility motivation (Papatsiba, 2005), the correlation between study abroad and professional mobility after graduation (Teichler & Jahr, 2001), and supervision skills for international postgraduate students (Wisker, Robinson, & Shacham 2007) are receiving increased attention, along with issues such as the mutual recognition of degrees or other qualifications, and the development of joint degree programmes. However, we know little about internship in research driven disciplines such as physics. Most literature on science internship is on undergraduate exchange programmes in science, including physics (e.g. Guest, 2006), or undergraduate science teacher internship programmes (e.g. Akerson & Volrich, 2006), or non-research informational articles in the industry literature (Anonymous, 2008).

In this study, we explore international research internships in physics in Australia. In Australia, international research internship programmes, typically for postgraduates or advanced undergraduate students, can be found in physics in the forms of visiting research students, occupational trainees and interns. They typically hold an occupational trainee visa, rather than a student visa, and they are not counted as students at a government level. Records are usually kept by individual faculties or schools, rather than at a university level. As a result of this diversity of classification and recording, there appears to be no reliable statistical data on the number of international interns (Rubin, 2009).

Our study aims to provide an overview of international research internship experiences in physics. In addition, we suggest some practical advice for students considering such internship programmes and researchers, and faculties or schools, planning to supervise or host interns.

## Methodology and participants

Four international students, from France, China, Germany, and Sweden, participated in this study, sharing their personal opinions and experiences. All four were interns in the same host institute. Thus, this is a case study with a sample limited in both number and scope, and results should not be over-generalised.

Their ages were from 24 to 28 when the interviews were conducted. One of them was in a PhD programme in his home country university, two were studying at an honours/masters equivalent level, and the last was an undergraduate student. These students were active participants as co-researchers (Boylorn, 2008, pp. 599–601) and co-authors in this pilot study, providing a genuine and creative voice (e.g. positive and negative experiences, and advice and suggestions) rather than being passive interview subjects. This was important since the interns' stays in the host university were very short (2.5 months for the majority of them), providing co-ownership that facilitated effective data collection including follow-up interviews a year after the original interviews, analysis, and writing. Thus, the questionnaires and interviews were a starting point for their participation as active agents, rather than the entirety of the data collection. None of them was in a supervision relationship with either of the other two researchers (a social scientist and a physicist).

Financial support for their overseas internship varied (e.g. scholarships from the home country or home supervisor, support by parents, and research assistant work). None of them were required to pay a tuition fee to the host university in Australia. Half of them (two students)

had previous internship experiences, one having spent nine months in the current host university in the previous year. For the other two, this was the first internship.

- Intern 1: In 2nd year of degree, 21 years old, French, internship duration of 2.5 months, funded by a small scholarship paid by the laboratory, and further supported by parents, and had 1 month previous internship experience at a research centre in France.
- Intern 2: In PhD, 25 years old, Chinese, internship duration of 6 months, funded by a PhD scholarship from government and PhD supervisor, with no previous internship experience.
- Intern 3: In 3rd year of degree, 24 years old, German, internship duration of 5 months, funded by scholarship from government for study outside Europe (BAFoG), with no previous internship experience.
- Intern 4: In 4th year of degree, 28 years old, Swedish, internship duration of 3 months, self-supported, with some limited paid work as a research assistant, and with 9 months previous internship experience at the same host university.

## Procedure

A three-stage procedure was used for data collection. In stage one, the four international visiting students were asked to fill out a questionnaire. Focusing on individual motivations for overseas internship and learning experiences in the Australian university, the questionnaire consisted of four areas: (1) reasons to choose the host university in Australia, (2) academic learning experiences, (3) related life-experiences in Australia, and (4) self-assessment of their own internship experience. The questions were open-ended.

In stage two, each student was interviewed for approximately two hours. As co-researchers and co-authors, the students were also asked to add any other related questions to discuss and share together. If needed, the students provided further explanations on a second, augmented, version of the questionnaire. Discussion was also continued by email.

In the third stage, approximately one year after their internship in the host university, short individual follow-up interviews were conducted with three of the students (the last one was not contactable) through email. The follow-up interviews focused on perceived benefits or advantages resulting from the physics research internships in Australia that may have affected their academic learning and life, and any useful resources for other potential interns who might consider overseas internships.

The questionnaires and interviews were analysed using thematic analysis (Julien, 2008, pp. 120-121). We focused on five main themes: (1) internships being either required, recommended, or supported by home institutes, (2) factors affecting the choice of internship hosts in Australia, (3) arranging the internship, (4) positive academic learning experiences, and (5) life aspects to be considered for internships in Australia. On the basis of these themes, practical advice for students considering such internship programmes, as well as for researchers and faculties planning to supervise interns, were drawn out.

## Results and discussions

### *Internships being either required, recommended, or supported by home institutes*

For some of the interns, an internship was a compulsory part of their degree studies, while for others it was optional. In either case, undertaking an *international* internship was entirely optional

For intern 2, a PhD student, the goal was to bring back expertise in accomplishing a specific task, learned from an eminent theorist in the field at the host university. Thus, there was an overall mission on behalf of intern 2's research group, which provided financial support. In cases like this, selection for international internship can be very competitive (e.g. 4 selected for such internships from 70 PhD students in the home institute), with academic excellence often being the major criterion.

The selection procedure for interns in either research or industry can vary greatly. In industry internships, the employers usually choose the interns by assessing applicants' CVs, motivation letters, and phone interviews. Some industrial internships are well-paid (e.g. similar level to a beginning employee per month, with accommodation provided), and can lead to future employment with the host company on completion of the degree, and can be very competitive.

### *Three factors for choice of internship hosts in Australia*

The combination of three main factors – the presence of groups working in a particular research field, the Australian natural environment, and Australia being an English-speaking country – influenced the choice of internship hosts in Australia. The first of these was a major factor affecting the choice of host institution within Australia, while the latter two were reasons to choose Australia rather than other countries.

Despite Australian universities and degrees being largely unknown or unrecognised in most of the world

(the only exception in our study here was China), some particular physics research centres or groups were well known to the internship students. The research performance of these groups or centres was even regarded as excellent at the world-level, as evidenced by high-profile research publications. Since three Federation Fellows (the most prestigious Australian research fellowship scheme), one State Fellow (highly selective state-level research fellowship scheme), and many other research fellows have been working in physics at the host institute, the high recognition of some groups or centres and their research productivity might be a reasonable result.

It is thought excellence in my country. There are many famous professors here and their group are excellence in their research field...I got the information for the internet and their papers...published many famous papers...I wanted to come to [the host university] because it is a famous university and excellent in [my research field]. (intern 2)

Apart from the reputation of the particular physics research groups, Australia is viewed as an attractive tourist destination; this was a major factor affecting the choice of host country for the European interns. Moreover, with the de facto dominance of English as the current international language of science, internships in English-speaking countries were attractive to the interns who are non-native English speakers.

It [Australia] is in an English speaking country. Moreover it is a very attractive country, tourism, kangaroos, surf, Sydney, the Great Barrier Reef, the weather... English and find solutions by myself, I spent three month speaking only English and that's what made me improve my level. (intern 1)

As English-speaking countries with world-famous universities and a strong reputation in research, many students consider the USA and UK as host countries. However, from a European perspective, the UK hardly offers an exotic foreign experience, or has already been visited. Individual students can have many reasons to rule out various potential host countries, from having already studied there, or planning to visit or study there in the future, the typical weather, and others.

### *Improved English and some strategies for obtaining it*

Improving English skills is one of the main aims, like learning research, for these interns, especially those who are non-native English speakers. Although they must have mastered a certain academic level of English skill to be accepted by the host university, it is still not a simple

matter to apply English in a research context and real life. In particular, at the beginning of internship, it typically requires a great deal of attention and concentration to follow and participate in the flow of the conversation with others.

The interns commented on two elements of their English improvement during their internship. First, the interns have felt that their English skills, especially related to speaking and listening, improved. In their home country, they often had experience with reading English (e.g. English textbooks and journal articles) and writing, but less experience in conversation. Second, they felt their confidence increased in the use of English as well as decreased fear of making mistakes – this did not mean that they did not make mistakes, but they did feel more comfortable and willing to risk mistakes.

Since the interns had only short-term internships, some strategies to enhance rapid improvement of English skills were used. One of the interns commented that he chose not to go together with friends for this internship, choosing to be located in a different city. He believed that being apart from them maximised the opportunity to use English (and this was a successfully strategy). Another intern strongly recommended for international students to seek accommodation with Australians or others from countries other than their own. Similarly, making friends, with English as the common language, and spending time with them forces one to speak English and understand it. At work, frequent discussions with supervisors and colleagues are highly desirable.

Interns can also take opportunities for formal presentations. Apart from regular discussions within the research group, the opportunity to give a formal presentation of research results, such as at a regular meeting of the research group or department, or perhaps even at a conference, can be a valuable learning experience.

### **Arranging the internship**

Internships are sometimes arranged through various agencies or organisations (Rubin, 2009), but none of the interns here had used an agency. For Intern 2 (as a delegate of the home institution research group), the home group leader arranged the international internship. The other three interns used Internet search of university websites, investigating research publications, and asking academic staff in their home institutes as initial methods to find internship places. After choosing a potential host, the internship students emailed the leading researcher of the research group they were interested in. In reply, sometimes, an academic record or reference letter from

the home institute was requested. This process was very quick, with, for example, three email communications leading to an invitation from the host research group. Also, previous links or contacts between researchers in the countries involved, and previous positive experience with interns from the home country or university, appeared to contribute to such speed.

After a little inquest in the Internet I figured B out as one of the leading heads in this school. I wrote him an email with my [study] intentions and asked if there is a chance to realise them. He forwarded me to C with whom I managed some further stuff. C just said that B forwarded my email to him and he offered me so fields where I could do some projects...a very interesting event for me. (intern 3)

### **Research learning experiences by supports from supervisors and colleagues**

As Vygotsky indicated, more and better academic learning would occur in supportive social contexts (Jarvis, 2004). This is shown in Walsh's study (2010), where international research students experienced positive learning in socially cohesive and inclusive research groups with supportive supervisors compared to socially isolated or less supportive groups in science and engineering disciplines. Similar opinions were expressed by the interns in our study. The benefits of support from supervisors, postdocs and colleagues were evident – all the interns reported that they felt that discussion with them was an important contribution to their learning about research. The interns' research learning occurred not only through formal meetings (e.g. supervision meeting) but also through informal sessions (e.g. discussions in lunch together). Supervisors' open door policies allowed the interns frequent impromptu meetings to ask questions, seek advice, etc.

Overall, the interns pointed out that positive social and collaborative relationships with supervisors and colleagues helped their research learning. Three out of the four internship students felt well integrated within their research groups and comfortable from the beginning of their internship. They were surrounded by other PhD students and other researchers such as postdocs in their laboratory or office. They felt hands-on help was almost always available. Their official meetings with supervisors ranged from daily, to once or twice a week, or once per fortnight, depending on issues needing discussion and work circumstances. They lasted from ten minutes to one hour per meeting. The doors of supervisors were open for possible extra meetings if the interns had research problems to solve.

Compared to the other three interns, the last student reported that he felt more or less integrated socially over-

all, but less so at the beginning of his internship. This was due to no other PhD students, technicians, or postdocs in physics working in the same laboratory, and much of his interaction was with the engineers involved in the cross-disciplinary project. Due to the shortage of hands-on help available for him, he had to spend more time to become familiar with the new laboratory environment at the host university. In his home academic culture, supervisor's did not usually have open door policies – it was usual for appointments to be required – and before establishing rapport with his supervisor and becoming familiar with the system of the host university, the intern hesitated to use the supervisor's open door policy.

In relation to experimental work in the laboratory, all the interns pointed out the importance of hands-on help or immediate availability of help. If the supervisor was busy and no other people such as postdocs, technicians, and PhD students were readily available, especially at the beginning of the internship, the students could be frustrated and their progress delayed. As Doing (2004) indicated, physics laboratory work is an epistemic orchestration of technical skills to deal with tools and equipment ('lab hands', a primary skill for technicians) and knowledge of the field to make decisions (often possessed by scientists). This requires a supervisor, technician, or other sufficiently skilled or experienced person to be available and able to communicate skills with interns (Grey, 2002). However, the interns also mentioned that the supervisors or colleagues should spend an appropriate (not excessive) amount of time and avoid unnecessary help to promote the interns' independent learning over time.

I'm to a high degree responsible for my own project but still have great support from my supervisors and colleagues...my lack of experimental experience... since I worked mainly autonomously in the lab...For me, hands-on help in the lab would probably have saved me some time. (intern 4)

With guidance by the supervisor, the research experience itself is also a vital part of learning about research. The interns' learning widens through solving more problems in a range of fields of physics. The possibility of a research publication based or partly based on their work was regarded as the best tangible outcome of the research internship and it was often encouraged by their supervisors.

### ***Some life aspects***

Often, in the research groups in the host university, social activities (e.g. welcome BBQ parties) to welcome an international intern were organised by the leader of the individual research group to which the intern belonged.

On the other hand, personal assistance (e.g. helping to find accommodation and local tours) by group members was voluntary. The interns appreciated social activities and personal courtesy. In the host university, the Student Union provides services and information for study-related skills, student welfare, transport information, and legal advice. However, these services and information need to be found and accessed by individual students. The short-term interns were not systematically told about such services. No separate official or formal processes were available to help the interns settle down or socialise at the host university.

For the short-term internship, an information package containing accommodation, transport, study skills, etc. would be useful. In general, these are available for international students at the beginning of the year or semester at the host university. For international interns, this could be made available by the host faculty or department as a booklet or ebook, before they leave their home country, or a dedicated website with frequent updates. Intern 3 found that the orientation session for international students run by the host university at the beginning of the year was very useful. University services for providing international students with information on accommodation can be useful because they can provide information about rights and duties of tenants and whom to contact if any problem occurs.

### ***Positive internship impacts on the future study or career: one year follow-up***

In the follow-up interviews, the three interns answered that their research internships in Australia had significant positive impacts for their further studies or work – they did not think that the internship was merely a nice trip overseas. For intern 1, physics internship in Australia was an opportunity to see the work conditions for his PhD study. One year after the internship, he chose to return and began his PhD study in the same research group in the host university in Australia. Intern 4 commenced his PhD study in his home country. As Shaw, Holbrook, and Bourke (2011) found, this indicates that undergraduate research experience obtaining insights about research environment and self-motivation towards research can be an excellent opportunity to prepare for further research study. Intern 2 considered it an invaluable learning experience helping to achieve the tasks given by his research group in his home institute, and beneficial for his future research career. According to intern 3, with a substantial trend of internship programme in higher education curricular at home (Klein & Weiss, 2011), the one-year study abroad experience including the research internship in an English speaking country was very posi-

tively perceived by a company interviewer in a European country. After the study abroad, including the physics internship in Australia, he has also maintained fluency in English by watching English language news, television, and movies and reading English books. Overall, the interns perceived a positive impact of their physics research internships in an English speaking country as a tool to widen their learning and their career choices, similar to the findings by Norris and Gillespie (2009).

### Advice and consideration for students, advisors and supervisors

Given that there are diverse reasons for undertaking international internships, students would do well to consciously consider exactly what their aims are. It is important to note that a student having diverse aims will not necessarily find them all compatible. However, students can successfully combine positive and educational research experience and learning, improvement in English, and tourism.

Of these goals, tourism is perhaps the most straightforward – if a country of interest, perhaps one that the student has not visited before, and would be unlikely to visit in the near future otherwise, is English-speaking and has suitable research facilities for the internship, all that is required is to plan sufficient time for the desired tourist activities. We do not intend to overemphasise tourism as a motivation – for many interns, the primary motivation is to work with a particular research group in physics – but it is important for some interns.

To maximise the improvement of English, the prospective intern can avoid working with or living with, and perhaps travelling with fellow speakers of their native language, especially if the internship is short. Depending on the initial level of English-language ability, this may well make adjustment to the host country more difficult.

The requirements of, and consequent achievement of a positive and educational research experience are much more complex. The working environment is clearly important, and the availability of ready assistance in the laboratory can facilitate progress, and help avoid frustration. Thus, it might be best to avoid potentially empty laboratories. On the other hand, working with a large group can lead to work with a very narrow focus, essentially acting as a tech-

nician for somebody else's project. In practice, the role of research interns in physics can be considered as a combination of both learner and research labourer, in terms of a research apprenticeship. As learners, they practice hands-on skills and receive 'higher' knowledge from seniors (e.g. PhD students and postdocs). As research labourers, interns provide their time and effort to contribute to the research of their research groups. While we cannot generalise from such a small exploratory sample with certainty, it may well be that a medium sized group is best, with perhaps two or three postgraduate students or postdocs readily available for assistance or advice in the laboratory. Otherwise, the supervisor must be prepared to, and able to, spend enough time in the laboratory to provide such assistance. Apart from assistance – such as where to find a particular piece of equipment, how to obtain needed materials, and so on – interaction with other members of the group is important

to learn about the aspects of research that transcend technical skills (Campbell, 2003; Walsh, 2010).

Apart from skills learned, another possible outcome that can benefit students, especially if they are interested in a career in research or academia, is authorship on research publications or

conference presentations. Research publication, especially in peer-reviewed journals in the physics discipline, during an undergraduate or masters degree can increase the chances of obtaining competitive scholarships or being accepted into a PhD programme. As authorship can be a difficult issue (Louis, Holdsworth, Anderson, & Campbell, 2008), it might be useful to discuss the group's policies on authorship early during the internship, or even before.

These are also important considerations for the host. As Tremblay (2005) noted, from a host perspective, international research internship, especially in science and technology, can be regarded as a highly skilled temporary migration (i.e. involved in research productivities) that may lead to either subsequent recruitment for further degrees (for example, intern 1 in our study) or further migration for employment at host country. Therefore, it might be useful for the host to discuss these issues with potential interns, asking about the degree of autonomy expected in a project, and the skills that the potential intern wishes to acquire. To facilitate learning, the host institute and supervisors need to provide effective intern-

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ship programmes, with achievable short-term projects and tasks, in advance. When interns were left without tasks, it cannot maximise their research learning.

I only followed my supervisor doing his experiments. So when he did not do experiments (because of meetings or writing...) I had nothing special to do and I only spent my time reading papers and books about [a field] which is good if it's not during a too long time (intern 1).

Since the Internet is a standard tool used by prospective interns to find information about potential hosts, institutions or research groups wishing to attract interns should ensure that suitable information is provided, and can be found readily by those searching. Web pages of individual academics and their groups can include lists of projects – perhaps clearly labelled as suitable for interns or short-term research visitors – and links to information about internships and who to contact and how.

As for contacting potential hosts, email appears to be a good option. Based on the interns' experiences, we suggest that if you have decided that you would like to be hosted by a particular group for an internship, emailing the group leader is usually a successful strategy. While it is nice to receive a prompt response, keep in mind that group leaders are often senior academic staff, and may well have heavy administrative or teaching demands on their time. Therefore, if you do not receive a quick response, follow up your original email, or perhaps contact another member of the group. It would be useful to note in the email that you would like to undertake an internship specifically with that group, and perhaps briefly explain why, and what kind of project you are interested in. You could also mention how you came to know about the group.

Finally, we recommend that prospective interns do not hesitate to ask about practical matters of living in the host country, such as accommodation and travel. Your host group might be able to assist with short-term accommodation on your arrival while you make longer-term arrangements.

### Limitations and future study

As a pilot study to explore international research internship, caution is needed not to overgeneralise in interpreting the data. The scope of this study was only four international interns in physics (and only in physics) in one host institute. We remind the reader of the hazards of extrapolating from such a small sample and suggest further research to determine the generality of these findings. Most international interns' visiting periods are very short

(in this study, mostly 2.5 months), and they try to take as much as they can during the visit. They are extremely busy during the period for their research work during the week, and, often, tourist activities during weekends.

Considering that individual disciplines have different academic culture and tradition (Smerek, 2010) towards internationalisation (Stohl, 2007), it would be interesting to compare international internships in different disciplines in a future study, and would be beneficial for our understanding of research internships in the future.

### Conclusion

In summary, the status (compulsory or optional), durations (2.5–6 months), and usages (combined with international degree, carrying out group tasks during PhD research training, or individual learning opportunity about research work) of research internship in physics vary, partly depending on the course of study in the home countries. A specific advantage of international research internships in physics in Australia is learning by interaction in their research groups or collaborating with foreigners in an English-speaking research culture. This involves and enhances not only proficiency in social and technical English but also forming social networks with possible future research colleagues.

In general, Australian science is not well known. However, some research fields in physics are viewed as competitive with the rest of the developed world, and international interns can have productive and positive research internships. Along with learning research, they can obtain benefits such as improved English-language skills and easy access to tourist attractions. These strengths in Australian internship training should be known in relation to the development of internationalisation of Australian higher education.

Based on our finding, we claimed that learning in an international research internship in physics is not much different from learning in other research degree study. Although its duration is shorter than other research degrees, it should be understood in the research context of the discipline – research is research. Like other research education, successful learning outcomes of research internship abroad also depend on the students' preparation, including their learning readiness and motivation as well as guidance from both home and host universities (Stronkhorst, 2005). This was seen in this study. The physics research internship students of this study effectively and independently prepared their own internships with self-search using various sources. Their positive

academic learning was achieved, in general, in supportive social contexts with supervisors and colleagues in the host university.

As mentioned earlier, scientists travelling to learn, exchange and share knowledge in the same country or in different countries is a historical tradition in science (Benka, 2006). Academic publications by international co-authorship are greatly increased, especially in natural science, as an impact and products of international collaboration in modern internationalisation (Patricio, 2010). International internships are grounded in both this old tradition in science, and the modern trend towards globalisation and the consequent increased opportunities for international education. Preparation by academic staff and researchers in the host institution can help maximise the benefit of such international internships. Via research interns, the research group can benefit from additional research labour, and has an opportunity for recruiting future PhD candidates. Furthermore, student international research internships are not only an academic issue, but also affect the world recognition and reputation of the host university, which is, in turn, vital to business and management issues in international higher education in the host nation.

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