THE PURSUIT OF EXCELLENCE

A HISTORY OF THE PROFESSOR HARRY MESSEL INTERNATIONAL SCIENCE SCHOOL

TREVOR DANOS

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UWAP CUSTOM

First published in Australia in 2012 by
UWA Publishing
Crawley, Western Australia 6009
www.uwap.uwa.edu.au

UWAP is an imprint of UWA Publishing
a division of The University of Western Australia

National Library of Australia Cataloguing-in-Publication entry

Author: Danos, Trevor.

Title: The pursuit of excellence : a history of the Professor Harry Messel International Science School / Trevor Danos.

ISBN: 9781742584874 (hbk.)

Subjects: Professor Harry Messel International Science School--History.
Science--Study and teaching--New South Wales--History.

Dewey Number: 500

Typeset in 12 pt Bembo by Lasertype
Printed by Griffin Press

I dedicate this history to Harry Messel,
because without him there would never have been the
first or indeed any International Science School.

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Prologue

I knew the name Harry Messel when I was in high school because of the 'blue books' – the ubiquitous, integrated *Science for High School Students* text[1] in two volumes[2] that guided every New South Wales student through science, in its branches of physics, chemistry, biology and geology, in the first four years of high school (for me, those years were 1970 to 1973). I remember it was comprehensive – I never needed to look at encyclopaedias or other textbooks – and also dense, but in the positive meaning of the word. It had colour plates at the front, including spectral lines, a drawing of the blood transport system and, most memorably, a photograph of the dissection of a rat. When I progressed into senior high school, non-Messel books were used at my school for physics and chemistry, but the Messel *Senior Science* volumes, yellow for physics and orange for chemistry, were used in class and for homework as parallel texts. My senior science elective was biology, and it was taught exclusively from the Messel green volume.

In my fifth year of high school, I was lucky enough to be selected to attend the 17th International Science School for High

School Students, run by the Science Foundation for Physics from 26 August to 6 September 1974. The theme was 'Solar Energy'. Here I was, having just turned seventeen, attending lectures by leading Australian and international scientists on world energy needs, the design of nuclear reactors, and the valence and conduction bands for a semiconductor. I am sure I pinched myself daily to remind myself how fortunate and privileged I was. I am certain I was not alone. My recollection, still clear to this day, is of the quality and excitement of the fortnight, and Harry Messel's energy, drive, humour, straight talking, vision and commitment to excellence. For the entire fortnight, we were treated as adults, as fully fledged members of the scientific community.

My memories of the high points of the fortnight have not faded: receiving the book of lectures on the first morning; being presented with the medal and certificate at a dinner at Cranbrook School in Bellevue Hill; being taken on tours of the Physics Building at the University of Sydney; and walking to the University Union Buttery at lunchtimes to buy a well-priced lunch. I remember using my $25 stipend ('pocket money' doled out on the first day by Oscar Guth in crisp $5 notes) to buy a three-volume physics textbook that was years beyond my abilities from the University Co-op Bookshop across the hockey field from the School of Physics. Things were a little different from the current format of the International Science Schools: it was not residential for metropolitan students and I attended each day in my school uniform, despite it being school holidays, arriving around 8.30 am and finishing soon after 3.30 pm.

I still recall the names of many of my cohort, and when I hear of their successes in a broad range of professions and academic fields, locally and from distant parts of the world, I feel a strong sense of belonging to a remarkable alumni group – as well as satisfaction and pride. I have become a little blasé about my fellow alumni's achievements. When good fortune allows me to meet an alumnus, our conversation usually starts and finishes with a discussion of the book of lectures, suitably

autographed, and the silver commemorative attendance medals, individually engraved, that were given to each of us and that remain prized and cherished possessions.

Some twenty-five years later I returned to the School of Physics to commence a mature-age, undergraduate science degree majoring in physics. Despite the passage of time, my sense of belonging was as strong as ever. Harry Messel – who had left the School of Physics in 1987 and gone on to become Chancellor and CEO of Bond University – had returned and was once more a formidable presence in the corridors. I quite quickly reconnected with the Science Foundation for Physics and went on to be president for three years. Indeed, the wheel had turned full circle: I was now organising and speaking at the (renamed) Professor Harry Messel International Science School, handing out awards and scholarships. I was even on a first-name basis with Harry, who would call me on my mobile with his booming and immediately recognisable voice.

This year, 2012, marks the fiftieth anniversary of the first International Science School for high school students.[3] For those in the School of Physics and the close to 4,000 alumni for whom the fortnight of science was a transformative experience, a fascinating history of the International Science School deserves to be written. This is that history. The topics and speakers listed in Appendix 1 foreshadow a rich and exciting story.

Each International Science School was based on an earlier, well-tested format but had its own circumstances, including financial, and evolved and was improved to meet the realities and the challenges of those circumstances. My intention in writing this history is to give an account of general themes, including achievements and challenges. As such, it does not give a daily chronology or the minutiae of each International Science School, nor a listing of each and every person who was in some way involved. There were both intended and unintended differences between International Science Schools, but not all of them warrant identification or commentary.

In researching this history, I have had full access to the records of the Science Foundation for Physics. I have conducted interviews with past International Science School speakers and scholars, as well as members of the School of Physics, including Emeritus Professor Richard (Dick) Collins, Professor Lawrence Cram, Emeritus Professor Harry Messel, AC, CBE, and Dr Jennifer (Jenny) Nicholls. Drafts of this history were kindly reviewed and commented upon by Professor Anne Green, Emeritus Associate Professor Bob Hewitt, Lord Robert (Bob) May, OM, AC, FRS, Hong C. Nguyen and David Varvel. I also had the pleasure of interviewing Mrs Miriam Butler, the widow of the late Professor Stuart Butler. I want to thank Bob Hewitt in particular for the painstaking job he has done in preserving and organising the records of the Science Foundation for Physics, including correspondence, annual reports and the early journal of the Science Foundation for Physics, *The Nucleus*.

The records of the Science Foundation for Physics are voluminous, most especially in the period before electronic communications (sadly, recent records are far more impersonal and lack much of the fascinating detail and vibrancy of earlier years). The records are sorted into years but are not catalogued. Most are typed, but some are handwritten. Many of the early pages are badly yellowed and are at the point of requiring conservation. There are lots of carbon copies. The paper size is irregular and, up to the early 1990s, almost anything but standard A4. The petering-out of detailed correspondence in the age of emails and the challenges of storing and gaining access to electronic communications have been a disappointment in researching this history. From the period before electronic communications, there is daily and weekly correspondence from the secretary of the Science Foundation for Physics or from Harry Messel or his personal secretary, sometimes by express airmail or telegram: inviting and securing lecturers; cajoling lecturers for overdue manuscripts and proof copies; revising schedules; arranging accommodation and travel for lecturers and for interstate and

overseas students; thanking and occasionally chasing sponsors and donors; liaising with science teachers' associations and departments of education; requesting the payment of moneys by or responding to queries from the University of Sydney's internal accountants; dealing with anxious parents; arranging for distribution of the book of lectures; and responding to requests for copies of the book of lectures and the taped lectures.

One can only imagine the patience required from the secretary of the Science Foundation for Physics and at times from Harry Messel (a charming man, but a man always in a hurry) to deal with the mundane and the unusual: to write a letter to the University of Sydney administration seeking permission for a visiting lecturer to be allowed to drive through the University of Sydney gates; to thank a member of the public, inspired by the telecast lectures, for a donation of $2; to respond to disappointed parents whose children had not been offered a scholarship and every so often to respond to an allegation from a dissatisfied parent or disgruntled teacher of elitism or private-school bias in the selection of scholars; to politely decline a request from a parent in Poland who wanted his son to attend as a foreign scholar; to request an audience with the Shah of Iran for the Chancellor of the University of Sydney, who was travelling to London to present the United Kingdom scholarships; to organise and locate transport concession cards; and to advise an attendee (unclear, possibly a chaperone or escort) on Australian evening-wear fashion and what opportunities existed to hire such clothing in Sydney.

Despite the volume of the correspondence and its occasionally difficult or sensitive subject matter, the style of writing by the Science Foundation for Physics is fresh, can-do and positive. In Harry Messel's frequent inbound and outbound correspondence with intimates, there is tremendous *bonhomie* and boundless energy, friendship, brashness and generosity.

The records of the Science Foundation for Physics, while voluminous, are not complete, and in places there is conflicting

material. Appendix 1, which lists the dates each speaker appeared and what they spoke about, is primarily based on the books of lectures. Very occasionally, some lecturers failed to meet the publication deadline and I have had to reconstruct the relevant lecture topic from the records of the Science Foundation for Physics. Reconstructed details are shown at the bottom of each relevant year in Appendix 1. Demonstration lectures, such as those given by Professor Julius Sumner Miller and later by Professor Dick Collins, by their very nature do not feature in the books of lectures, and a small number of my references to them in Appendix 1 may be problematic. Overall, I have erred in favour of inclusion in Appendix 1 even when the evidence is not entirely clear. The creation of Appendix 2, which gives details of the International Science School scholars, has been a challenge, especially for the early years. The figures are a careful re-creation of attendee numbers broken down by gender and geography using available information. Some of what appears in Appendix 2 is at odds with later consolidated reports published by the Science Foundation for Physics. Based on my research, it seems that some of the statistics in the later consolidated reports are incorrect. I am satisfied that Appendix 2 is as accurate and correct as it can be, based on available archival materials.

I derived great insight from the book *The Messel Era: The Story of the School of Physics and its Science Foundation within the University of Sydney 1952–1987* edited by D. D. Millar (1987, Pergamon Press). Oscar Guth's paper on the formation and history of the Science Foundation for Physics and the International Science Schools, which appeared in the 1966 book of lectures, also provided extremely useful background information.

For a number of years, the United Kingdom International Science School scholars and their escorts prepared a detailed written report, *Five from Sydney*, at the end of their time at the school. These were very informative and gave a personal insight into the achievements and impact of the International Science Schools on the overseas scholars.

The books of lectures of the International Science School make fascinating and impressive reading, and give a good sense of the occasion and quality of the relevant times. I benefited from viewing the oral history, *Harry Messel and the School of Physics*, that the Science Foundation for Physics commissioned in 2009. In particular, the interview of Harry Messel by Dame Leonie Kramer, AC, DBE, former Chancellor of the University of Sydney and long-time friend and supporter of Harry Messel and the Science Foundation for Physics, provided useful information. The oral history makes powerful and immensely enjoyable viewing.

I wish to thank the International Science School alumni and current and former School of Physics staff who allowed me to interview them and who responded enthusiastically to my questions and surveys submitted by email.

For any errors or omissions in this history, I accept full responsibility and apologise to those affected or concerned.

From this point on, I will use the following abbreviations:

- **Butler** – the late Professor Stuart Butler (d. 1982). During the relevant period of this history (until 1977), Stuart Butler was Professor of Theoretical Physics, University of Sydney, and for some of the period dean of the Faculty of Science.
- **Collins** – Emeritus Professor Dick Collins. During the relevant period of this history (1980–2000), Dick Collins was Professor of Applied Physics, University of Sydney, and for some of the period Head of the School of Physics and director of the Science Foundation for Physics. Collins, an honorary governor of the Science Foundation for Physics, retired from the University of Sydney on 31 December 2000.
- **Cram** – Professor Lawrence Cram. He was Professor of Physics (Astrophysics), University of Sydney, from 1987 to 2004 and Head of the School of Physics and director of the Science Foundation for Physics between 1991 and 1996. Cram, an honorary governor of the Science Foundation for

Physics, resigned from the University of Sydney in 2004 to become Deputy Vice-Chancellor at the Australian National University. Cram retired from this position in 2011 and is now the master of University House at the Australian National University.

- **Foundation** – the Science Foundation for Physics within the University of Sydney. It was established in 1954 as the Nuclear Research Foundation (its name was changed in 1966 because the Foundation's original name was no longer considered an apt description of its activities and scope) and in 2012, became the University of Sydney Physics Foundation.
- **Guth** – the late Oscar Guth, AM (d. 1988). During the relevant period of this history (1960–1981), Guth was executive assistant in the School of Physics and secretary of the Science Foundation for Physics.
- **Guth Paper** – 'The University of Sydney School of Physics and its Nuclear Research Foundation', the paper written by Oscar Guth that appeared in the book of lectures for the 'Atoms to Andromeda' International Science School in 1966.
- **ISS** – the International Science School for High School Students), known as the Summer Science School until 1967 and in 1998 renamed the Professor Harry Messel International Science School.
- **Messel** – Emeritus Professor Harry Messel, AC, CBE. During the relevant period of this history (1954–87), Messel was Professor of Physics and Head of the School of Physics, University of Sydney, and director of the Science Foundation for Physics. Messel, the founder and an honorary governor of the Science Foundation for Physics, retired from the University of Sydney on 31 December 1987.
- **Millar Book** – *The Messel Era: The Story of the School of Physics and Its Science Foundation within the University of Sydney 1952–1987* edited by D. D. (Don) Millar (1987, Pergamon Press).

- **Miller** – the late Professor Julius Sumner Miller (d. 1987). An American physicist and a prolific lecturer and science demonstrator of basic physics phenomena at the International Science Schools, he was well known to and much loved by the Australian public for his *Why Is It So?* television appearances on the ABC, his admonitory 'Watch!' and his appearances in Cadbury chocolate advertisements.
- ***Nucleus*** – *The Nucleus*, the periodic publication of the Science Foundation for Physics that at various times served as a newsletter, a report and a review of the activities of the Science Foundation for Physics and the School of Physics. It was published at least annually from 1954 to 1976 (due to a change in reporting periods, it was not published in 1968). It was not published from 1977 to 1983. From 1984 onwards, it was replaced by an *Annual Report of the Science Foundation for Physics* (somewhat of a misnomer, as the 'annual' report sometimes covered two years during the late 1980s and early 1990s).
- **School** – the School of Physics at the University of Sydney.
- **University** – the University of Sydney.

Where a quotation appears without a citation, I have taken the material from the records of the Foundation. Wherever possible, I have kept to the actual wording or style of the primary source materials, including, as an example, only using initials for the first names of speakers. Over time, wording and styles changed and I have adopted the changes where relevant. References to dollar and pound amounts are to the amounts at the relevant time; no attempt has been made to determine present-day values.

In recognising and honouring Messel as the father of the ISS, I wish to give due acknowledgment to the quiet, efficient and behind-the-scenes professionalism of Butler, Messel's partner in the creation of a flourishing and enduring School and Foundation. Butler, a man of great intellectual gravitas and formidable

academic contacts but without Messel's entrepreneurship, bravado and panache, complemented Messel and gave important leadership to the creation, planning and implementation of the ISS. I also wish to recognise David Varvel, Don Millar, Max Brennan, Lawrence Cram, Dick Collins, Bob Hewitt, Jenny Nicholls and Anne Green, for their strong stewardship of the ISS in subsequent years and for having the vision and stamina to refine and expand the concept of the ISS while remaining true to the 'In the Pursuit of Excellence' motto, and never being defeated by the challenges, financial and otherwise, involved in delivering a successful ISS.

Chapter 1

Genesis: the early days, including the historical context and the reasons for the ISS

To understand the genesis of the ISS, it is necessary to go back a handful of years to 1958, before the first ISS for science students. This was the first year in which the Foundation ran a fortnight-long series of lectures (as a summer school) in modern physics for high school science teachers. The expression 'modern physics' remains in use in the present day[1] and is generally understood to include relativity, atomic structure, quantum mechanics, condensed matter, nuclear physics and cosmology. The purpose of the lecture series was to:

> give science teachers the contact with modern science which they so badly need, and [to] help them to give their pupils that true appreciation of the power and the meaning of modern science that has become such an urgent necessity to all those who want to understand the cultural and economic life of the world we live in.[2]

Consistent with this purpose, the preface to the 1958 book of lectures identified a growing shortage of scientists and

technologists and a small percentage of undergraduates enrolled in science and engineering. The post-war wunderkinds – Messel deserves to be included in this group – with all their energy and brilliance, hoped to bring science teachers up to date and to inspire them and in turn their students.

In the first summer school, open to all high school teachers in New South Wales, lectures were given by nineteen scientists, including Messel, Butler, John Blatt, Sir Mark Oliphant and M. R. (Robbie) Schafroth, as well as astronomy lectures by Bart J. Bok. The first summer school was described as '[exceeding] all expectations' and 'inspiring, pleasant and eminently satisfying'.[3] The lecture notes ran to 168 pages and were subsequently reprinted by Macmillan.

The science teacher summer schools were repeated in 1959 ('Nuclear Power and Radio Isotopes'), 1960 ('From Nucleus to Universe', with lectures on atomic and nuclear physics, thermonuclear research, cosmology, the Solar System, interferometry, the Earth, artificial satellites, the possibility of space travel, cosmic radiation and Antarctic research from lecturers who included George Gamow and Thomas [Tommy] Gold) and 1961 ('Space and the Atom', with lectures on atomic physics, aeronautics, radio astronomy, electromagnetic radiation, relativity, quantum mechanics, high-energy nuclear physics and solid-state physics).

From the very outset, it was decided, on Messel's advice, that as a matter of policy no effort or expense should be spared in inviting only top-ranking scientists in the different fields, 'even if this meant flying them to Australia [from] half-way around the world', not only to ensure that science teachers obtained the latest and best information about present developments but also to underline the importance the Foundation attached to the purpose and subject matter of the science schools. Lecturers were recruited from the University, other universities in Australia, CSIRO and from abroad. As Guth observed in 1966,[4] with some understatement, events have since proved this policy to be right.

The science teacher summer schools were jointly funded by the Foundation and through specific and substantial donations and special contributions secured by the Foundation from major public and private companies (some of which were already members of the Foundation), industrialists and philanthropists. Reasons for this generosity included raising the level of scientific education and bridging the cultural gap between scientists and non-scientists. Messel was a highly effective fundraiser.

By 1961, in a way that set the scene for the first ISS in 1962 and all future ISSs: the duration of the science teacher summer schools was two weeks; the number of attendees was between 100 and 120; science teachers attended both lectures and practical sessions in laboratories (as well as other activities such as the screening of educational science films produced by the American Academy of Sciences and inspection tours of the School and the Australian Atomic Energy Commission's Research Establishment at Lucas Heights in southern Sydney); science teachers had to apply to attend; the attendees were chosen through a rigorous, independent and transparent process; expenses of the attendees were partially reimbursed or met by the Foundation (including the full cost of interstate travel); although science teachers from New South Wales dominated, a small number of science teachers from each of the other states (as well as from New Zealand) also attended; attendees received a book of the lectures; copies of the book of lectures were distributed free of charge to all science teachers in New South Wales as well as high schools throughout Australia (and the book was subsequently published for sale to the general public); lecturers were well-known world leaders in their fields; topics and lecturers were selected to stimulate scientific enthusiasm; a formal closing dinner – with grace and a toast to the queen – was held at Cranbrook School for the attendees, the lecturers and accompanying spouses, members of the School and distinguished visitors, including education and science ministers, high commissioners, consuls general and senior bureaucrats; there was a high level of media interest and

coverage; and there was a significant presence and a high level of financial and/or in-kind support from the New South Wales Department of Education and the New South Wales Science Teachers' Association. One interesting but minor difference was that the lectures were held in the now non-existent Lecture Theatre 3, the mirror image of Lecture Theatre 8 (also known as the Slade Lecture Theatre) at the western end of the Physics Building that was demolished in the early 1960s to make way for an addition housing computing equipment.

How did the transformation from science teacher school to student school come about so successfully in just four years? The answer lies in Messel and the era.

Messel was a human dynamo who could galvanise people into action. His doctoral adviser and referee for his appointment to the University, Nobel laureate Erwin Schrödinger, described Messel's eagerness and planful endeavour as 'unparalleled by any thing I have met with before'.[5] Messel was said to have an irresistibly stimulating influence. He came across as a visionary. The University gave Messel carte blanche to re-establish the standing of the School – this included recruiting new staff, setting up new departments and creating multiple professorial chairs. Messel's arrival coincided with an era when the business community wanted to partner with science (especially in the area of nuclear research, in part motivated by Cold War–related demands for rapid scientific advances and breakthroughs); when business was exercising a new level of power and leadership to benefit the nation; when investment in science at all levels was seen as a long-term business proposition and not philanthropy; when government and business wanted to encourage more school students to enter into a scientific or technological career; and when the Western public (and perhaps Messel even more so, given his Ukrainian–Canadian background), awed by the technological achievement of Sputnik but deeply alarmed by its implications in the context of the start of the space race, showed a thirst for scientific knowledge, a case of 'educate or perish'.

The Nucleus, as a strong advocate for the building of nuclear reactors and the training of reactor scientists and engineers in Australia, won the support and respect of senior businessmen and federal and state politicians.

Science in this era was far less compartmentalised than it is now: not only were there many new areas (such as cosmic radiation, nuclear and plasma physics) but it was quite common for senior scientists regularly to shift their area of focus, including by establishing entirely new departments. Messel was fabulously connected and networked tirelessly: he was close to Schrödinger and through him the Institute for Advanced Study at Princeton University,[6] and he knew well and worked with the leading figures in the United States in the areas of cosmic rays, radio astronomy and cosmology and, through them, the top echelons of the National Science Foundation, the American Atomic Energy Commission and the Office of Science and Technology within the White House.

Messel's new recruits were no less well connected. It is truly extraordinary that he was able to identify this youthful and talented cohort and persuade it to come to Sydney and the School. Blatt, a graduate of Cornell University recruited by Messel to the University from the University of Illinois, was a graduate student of Victor Weisskopf[7] and had co-authored with him the leading text worldwide for nuclear physics in the late 1950s and in the 1960s. Butler, who went on to become one of the most important nuclear physicists of his generation, had spent time abroad early in his career (including at the Institute for Advanced Study at Princeton University) and had become a lifelong friend and confidant of Sir Rudolf Peierls.[8] Butler's strong ties included Cornell University. Schafroth, regarded by his PhD student Robert May as the brightest of Messel's recruits, had been a student of Nobel laureate Wolfgang Pauli and worked as his assistant for a number of years before coming to the School. Schafroth was the first person to recognise that a charged Bose gas would be a superconductor, which redefined

the hottest topic in physics at that time. Schafroth and his wife died tragically in an aircraft accident in 1959. Many of his contemporaries believe that his early death denied him a Nobel prize.

It was the era of international, open and non-competitive scientific collaboration between individuals and between universities. Messel and his colleagues were not stepping outside professional protocols in exploiting the eminence of their scientific contacts. Combined with his own charm, Messel's pulling power was second to none. Within a couple of years, the popularity and ubiquity of the Messel 'blue books' would reinforce his standing in the worlds of science, education and politics, and encourage him to aim higher and aspire for more. Messel had also become incredibly well connected with the captains of Australian industry, including media baron Sir Frank Packer. He understood the importance of communication: apart from speaking on science at Rotary functions and black-tie dinners hosted by the Foundation, he established *The Nucleus* in 1954 as the bimonthly publication[9] of the Foundation with the purpose of informing its readers of the latest overseas developments in the fields of fundamental and applied physics.

Messel was a showman and understood how to publicise the science teacher summer schools. As noted above, the lectures were printed in book form and made available without cost to each science teacher in New South Wales and every high school throughout Australia. The press and the general public showed an increasing interest in the schools, and the press published more and more reports of the lectures. In 1960, Channel 9 (owned by Sir Frank Packer) started to televise the lectures live in all capital cities (with replays at breakfast time the next day). In the early 1960s, these broadcasts were unique: they stimulated the audience and had a sense of occasion and goodwill about them. Bringing a superb and mesmerising science showman and inspiring communicator such as Miller to Australia and putting him on television was a stroke of genius on Messel's part. The

1961 television audience was said to be 100,000 in New South Wales alone. In those early days, the most watched broadcast was a debate on the origin of the Universe between Gamow (evolutionary/big bang) and Gold (steady state, the concept he co-authored with Hermann Bondi and Fred Hoyle), chaired by Butler.

To quote from Guth:

> It was this 1960 summer school which really put the Foundation summer school effort 'on the map' in Australia, and interest in these summer schools not only by educationists but also by ever-wider sections of the general public has since been steadily increasing.
>
> By 1962 this general enthusiasm had become so strong that the Foundation, after consultation with governmental and education authorities, decided to interrupt the summer schools for science teachers and instead hold a series of similar summer schools for high-school students who had just completed their pre-leaving year and were embarking on their final year of secondary education.[10]

A stated reason for the 'interruption' was that it would give students a first glimpse of university life. But there were other, less publicised reasons. Messel did not regard the teachers as sufficiently engaged or appreciative of the course. Some of the teachers did not respond well to (nor perform well in) a surprise end-of-course examination set for them by Messel. It was time to remould a good idea into a better idea.

Reasons for this change in focus from science teacher cohort to student cohort can be clearly distilled from the preface of each year's book of lectures and from *The Nucleus*. Messel primarily saw the ISS as a means of honouring excellence. He repeatedly dismissed criticisms of the smallness of the ISS: 'We don't want those who are very good, we want only the best'. ISS scholars have always been selected on the basis of academic performance and

otherwise without discrimination. The ISS was seen as having a number of secondary purposes: to encourage and stimulate the scholars to continue their studies at university and follow careers in science, by bringing them together to hear lectures on some of the most exciting contemporary developments in science, given by lecturers who were themselves contributing to those developments; to participate in important discussions relating to the sociological impact of science; and to see the pervasive impact that science has on culture and society. To the extent that the chosen themes or topics were cross-disciplinary, ISS scholars were to be given the opportunity to see science as a process, not only of deep investigation of specialist topics, but also of developing a pattern and structure in human knowledge. The history of science was included in the syllabus, so that ISS scholars could see how science unfolds as a process of deliberate action on the part of dedicated researchers, and also as the result of 'accidents' whose significance is only appreciated by the well-prepared mind. And finally, ISS scholars would be given a chance to meet inspiring teachers, to encounter university life for a short period and to establish lifelong friendships with other young people with kindred abilities, ideas and aspirations.

In later years, these secondary purposes were clarified and expanded: contributing to the scientific understanding and application of ISS scholars and their overall scientific development; allowing ISS scholars to have contact with acknowledged experts and to observe scientists in a working environment, thus gaining an understanding of the generic attributes of a scientist, including expressing ideas and solving problems; giving ISS scholars role models; via laboratory work, allowing ISS scholars to see modern scientific equipment and instrumentation and to gain familiarity with how science is done, through formal and informal projects; and to permit ISS scholars to appreciate the design, trade-offs and costs of scientific experimentation. The Foundation would have failed in its mission if ISS scholars, at the end of the fortnight, were

not more culturally aware, capable of interpersonal relations, open to new ideas and able to validate their own value systems as fledgling members of the broader scientific community.

In 2010 and 2011, in the context of discussing the future format of the ISS, some from within the University suggested that the ISS should be used as a recruiting tool for the School. This was quickly and firmly rejected by Messel:

> Young and old Australian heroes were mostly to be found in the sporting world not in the academic one – and this is still so today, after many decades. Yet I realised that the movers and shakers of our society were not usually to be found here. We had to look elsewhere – among the young most brilliant of our youth. We needed to project the message that the top students in our society in all fields were our important national asset and that because they were blessed with great ability, they had a moral obligation to do well and be the leaders in our society. We needed to honour them and let them know that we too believed in their importance. I have stood before the scholars of every science school since 1962 and stressed this point over and over again – we know how important they are – we applaud them – they must be leaders and do well. The Science Schools **WERE NEVER** [emphasis in original] founded as a recruiting tool for Physics (although it has often acted as such). They were founded to honour excellence among the most brilliant of our scholars from Australia and eventually from overseas.[11]

Chapter 2

The 1960s: the launch of the ISS and its glory days

The first student ISS in January 1962 was a course of twenty one-hour lectures on astronomy, space rocketry and physics. The program also included nine half-hour science films, an inspection tour of the School, an inspection tour of the Atomic Energy Commission's research establishment at Lucas Heights and a Lord Mayor's reception at the Sydney Town Hall. More than 1,000 students applied for scholarships and 150 students in their penultimate year of secondary education were selected from New South Wales and Australian Capital Territory schools. There were two students from Auckland Grammar School in New Zealand and one other student from Sydney, in the year below all the other students, who was selected for a special scholarship because of his exceptional abilities and circumstances (for more on this, see Chapter 10). The cost of the ISS was about £17,500 ($35,000), and sponsorship was obtained from, in addition to the Foundation, Ampol Petroleum, Australian Factors, Ducon Condenser, Mr H. G. Palmer, Philips Electrical Industries and Sydney City Council.

Application forms required details of the applicant's subjects being studied, position in class, position in science subjects and vocational interests, and had to be supported by written comments from the applicant's science teacher and school principal. The application form stated that:

> The scholarships are intended to be a reward and inspiration to successful students…The Foundation means to applaud their ability and diligence by giving them an opportunity to meet and be instructed by a group of world-ranking scientists…The boys and girls chosen to attend the Summer School will be the most able and successful of those who apply. It will be possible for a student not studying physics at school to win a scholarship, but preference – all things being equal – will be given to students interested in science as a career. The Foundation hopes that girl students will be well represented.

Completed applications from public school students were sent direct to the New South Wales Department of Education, which was to choose 100 students, and from private school students to the Science Teachers' Association of New South Wales, which was to choose fifty students, in each case for independent assessment and selection.

Messel began sending out media releases some three months before the commencement of the ISS. The external lecturers were of the highest calibre: Professor Bondi from King's College London, Professor Ronald Bracewell from Stanford and Dr Wernher von Braun from NASA. Bondi at this time was at the forefront of the debate on the nature of the Universe, with him, Gold and Hoyle propounding the controversial 'steady-state' model in opposition to the 'big-bang' model. Bondi's five lectures were on the structure of the Universe and the Solar System. Bracewell, an alumnus of the University and a former researcher at CSIRO, was doing seminal work on radio astronomy. Bracewell's lecture topic was the possibility

of intelligent life beyond Earth. Dr von Braun's arrival in 1962 generated enormous media interest, especially coming only nine months after Russian Yuri Gagarin's triumph as the first man in space. Von Braun was an international celebrity as the West's foremost space rocket expert and the leader of NASA's rocket program. (He was, of course, a different type of celebrity for his earlier work on the Nazi V2 rockets. These were the cause of written demands for his deportation and threats being made against him while in Australia, so much so that the New South Wales Police had to provide him with security escorts for the duration of his visit, including when water skiing with the Messel family on the Hawkesbury River.[1]) Von Braun had already been awarded NASA's highest award, the NASA Distinguished Service Medal. Public awareness of von Braun was heightened by the release, in the year before the ISS, of a film on his life. There was genuine and widespread public excitement about his first visit to Australia. Von Braun's visit was peppered with media conferences and television appearances arranged by Messel. A selling point for the media was that von Braun would bring with him a large number of slides and diagrams to illustrate his five lectures on the subject of space rocketry. Messel and Butler gave nine afternoon lectures on elementary atomic physics and the applications of atomic energy.

The first student ISS in 1962 was a resounding success. The morning lectures from the 1962 series (all the lectures by von Braun, Bracewell and Bondi) were telecast live in Sydney by Channel 9 and were later rescreened in all Australian capitals, followed by repeat screenings in all Australian capitals (including Sydney). Some lectures were delivered on Saturday morning, and this increased the opportunity for public viewing. At the conclusion of the 1962 ISS, the 153 scholars were each presented with an engraved silver medal and £20 ($40) in cash. The presentation of medals was made at the Lord Mayor's reception. There are no reports of any misbehaviour – perhaps this is because the students were mindful of the presence of

Miss V. Medway, Principal of Queenwood School, Mosman, who acted as honorary supervisor of the female students. ISS scholars from outside Sydney were refunded their travel expenses (up to £20 [$40]) and avoided accommodation expenses by being billeted in the homes of ISS scholars from Sydney (host parents were paid an amount of ten guineas [$22] towards the costs incurred). Each of the ISS scholars also received a free copy of the richly illustrated 500-page book published by Shakespeare Head Press containing all lecture materials (as mentioned earlier, 3,000 copies of the book were also distributed free to all New South Wales schools and other schools throughout Australia).

The Sydney *Daily Telegraph* wrote in 1962 of the first student ISS in an editorial:

> In this age, scientific knowledge is the greatest single instrument for progress and survival and peace – not just scientists but ordinary citizens are becoming more acutely conscious of that every day. It is this consciousness that has made the annual summer schools sponsored by the Nuclear Research Foundation a popular success, beyond expectation.

It was a winning formula: an enthusiastic cohort of students; a celebration of excellence with the outstanding student contribution being rewarded with a donated prize of a full set of *Encyclopaedia Britannica*; a clamorous public; a supportive education department (the New South Wales Minister for Education and the Director-General for Education attended several lectures); appreciative science teachers; and lecturers who praised the keen interest of the ISS scholars. After 1962, the ISS for students rather than teachers became the norm.[2] The numbering of the ISS does not ignore the antecedent science teacher summer schools, however, so the 1962 ISS is regarded by the Foundation as, and is now somewhat curiously counted as, the 5th ISS.

The successful format of 1962 was repeated in 1963, 1964, 1965 and 1966. Miller and his demonstration lectures made their first appearance in 1963. Television Corporation (the owner of Channel 9), Plessy Pacific, Dr S. Goldberg, Mr L. J. F. Brimble and College of Civil Aviation became additional sponsors. Interstate scholars (two each from Victoria, Western Australia, South Australia, Queensland and Tasmania) first attended in 1963. Students from outside New South Wales were independently selected by the Science Teachers' Association in the relevant state. Students from Victoria and Queensland travelled by rail, students from the other states by air. The success of these inclusions motivated the Foundation to take the ISS to the next level for 1967, by inviting students from the United States.

If we accept that space was the key scientific focus and theme of the 1960s, then it is important to note that by 1970 the ISS scholars had been lectured to by NASA's director; NASA's associate administrator for manned space flights; NASA's director of the Apollo Special Task Team; three astronauts; NASA's mission controller for *Apollo XI*; NASA's director of lunar operations; and NASA's director of the Apollo Program. Many of those lectures had been publicly broadcast. Add to that, lectures by Nobel laureates Glenn Seaborg and James D. Watson, and the showmanship of Miller. These were clearly glory days for the Foundation and for the ISS.

Chapter 3

Funding the ISS

From a financial perspective, the 1960s were the Foundation's best years. The Foundation was a highly visible player in scientific education and scientific research: the ISS belonged not only to the students but also, by reason of the television broadcasts, to the nation; the Messel 'blue books' were being used by almost every high school student in New South Wales; new astronomical apparatus such as the Mills Cross Radio Telescope were being built and commissioned; partnerships with leading overseas universities were being established; and planning for the 'nuclear age' was well under way. The Foundation was spoken of in the company of the National Science Foundation of America and the Nuffield Foundation of Great Britain. In the pre-jet age, Messel was making up to five round-the-world trips each year (not to mention numerous appearances at onshore promotional events). Business, government and, unusually, the public regarded the Foundation as a progressive and moral cause, and it is not an exaggeration to say that each stakeholder was strongly and proudly committed to the Foundation and the ISS. Messel was

a dynamic, unashamedly aggressive and in-your-face networker and fundraiser – described by himself as a 'professional beggar' and by the University's Vice-Chancellor Emeritus Professor Stephen Roberts in 1965 as 'strikingly successful'[1] – but he always took time and great care to acknowledge generously the supporters of the Foundation and the ISS and to reward them and set up connections between them.

At this time the Foundation was still spending some £17,000 ($34,000) a year on the science teacher summer schools. The Foundation was already meeting substantial funding commitments in establishing new departments within the School, building a new computer for the School, and constructing the Mills Cross Radio Telescope and the Narrabri Interferometer. By 1963, the cost of the ISS was around £21,000 ($42,000). Messel acted quickly to identify and secure special 'full' Foundation sponsors, both individual and corporate, who would contribute £3,500 ($7,000) on an annual basis to defray the costs of the ISS. Names that regularly appear in the early years as ISS sponsors include Mr H. G. Palmer, Ampol Petroleum, Philips Electrical Industries, Ducon Condenser, Sydney City Council, Australian Factors and Channel 9. Over time, a 'part' (as opposed to full) sponsorship category was created. By 1969, the cost of the ISS was between $80,000 and $90,000, and a full sponsorship was $10,000.[2]

Despite the substantial sums involved, the Foundation met all of the travel costs of the United States scholars in 1967, and in later years all international students (with a few exceptions). Until about 1978, these international scholars all received round-the-world tickets. Other substantial costs of each ISS included: the printing of 3,000 copies of the book of lecture materials; air travel and accommodation costs for interstate attendees (overseas scholars were billeted); first-class air travel and accommodation at the Sebel Townhouse in Elizabeth Bay for overseas and interstate lecturers, as well as for student escorts; overseas air travel for Messel and others from the University

who attended the presentation ceremonies in London, Tokyo and Washington DC; medals and certificates; and dinners and receptions in Sydney, both for the ISS scholars and separately for the lecturers (dinners for lecturers were usually held in the early years at the Hunter's Lodge in Double Bay or the Grotta Capri in Kensington). Other lesser, out-of-pocket expenses included morning teas and an honorarium for the lecturers of $50[3] for each lecture delivered. It was generally money well spent, but it was adding up quickly and there were some minor abuses, prompting Messel to write tersely to Guth in October 1973 that:

> It is obvious that the time has come when it will be necessary to spell out what costs the Foundation is prepared to cover in relation to invited speakers…and escorts. We cannot be expected, for instance, to pay for overseas telephone calls and hairdressers' bills which are charged to hotel bills and left for us to settle!

In those early years, the only costs not met by the Foundation were United States domestic travel for the United States ISS scholars and hotels for them in cities other than Sydney. These were met by the United States National Science Foundation, along with passport, immunisation and travel insurance costs and all travel costs associated with the escort.

Money was always going to be the challenge. As the then president of the Foundation commented in *The Nucleus*:

> Whether or not we shall accede to such requests [to bring students from other nations], indeed whether or not we shall be able to continue our Science Schools – successful as they may be – must in the end depend on the special funding by sponsors of these Schools. Unfortunately, this is not a happy subject because the Foundation has been finding it more and more difficult to pay a major part of the Schools' cost, while surprisingly special sponsors pay only a minor part. In fact, particularly last year and this year this has been so, and this in the long run is obviously an

> untenable situation. The Foundation cannot continue to finance the Science Schools itself and if more special sponsors cannot be found there is great danger that the project may have to be curtained. This would be a great pity and must not be allowed to occur.[4]

The funding of the ISS was an annual challenge, made harder by the ever-increasing costs. By 1974, the annual cost was close to $100,000. There was neither capital nor investment earnings from capital to defray the costs. The full cost of the ISS had to be covered by an annual appeal and fundraising was becoming harder. As an example, in one year an expected grant from Sydney County Council was cut, without notice, from $10,000 to $2,000. Even a newly received grant-in-aid from the Commonwealth Department of Education of $20,000 a year for three years commencing in 1975 (but subsequently reduced to two years because there was no ISS in 1976) could not overcome the cuts and vanishing support. Indeed, but for the last-minute first instalment of the grant-in-aid from the Commonwealth, the 1975 ISS would have been cancelled.

By the 1970s, as hard and as aggressively as Messel revisited the list of past supporters and sought to identify new ones, the shortfall remained significant. The plea to support excellence was falling on deaf ears, as Messel noted in his speech in the Great Hall at the University in October 1977:

> Excellence in every field is not something to be sneered at, but must be applauded. And today it is not – even in many of the highest offices and departments of this nation. Increasingly during the past decade, when I have discussed the need for encouraging and honouring excellence I have been stared at in disbelief, as if I were the village idiot, given a polite hearing and that has been the end of it. But support – 'oh, no Professor, it's a fine idea, but we have to look at our priorities and we find that we can't help you'. Priorities, what priorities? Heavens, if the

support of excellence hasn't top priority in every department and organisation throughout the nation it should close its doors. Our society simply cannot continue to support mediocrity at the expense of excellence and this is precisely what it has been and is doing to-day. How much longer are we going to continue supporting the worst at the expense of the best? Would you like a good example? Some of you may be aware of the Science Schools which the Science Foundation for Physics (whose motto, by the way, is 'Honouring Excellence') has been running for 20 years now. The last one just finished some 5 weeks ago. These Science Schools were started 20 years ago with a view to honouring, encouraging and inspiring the best of our youth, in many fields; to try to demonstrate to them that the nation – the people of Australia – were interested in them, cared for them and that they have a special responsibility to society and themselves to develop and utilise to the maximum the gift which was given to them through the accident of birth. In the late 1950s and early 1960s the Science Schools went tremendously well, then as the radicalism and appeal to the 'higher consciousness' of the late 1960s took hold, interest in excellence declined. By the early 1970s no one any longer cared a hoot about excellence – mediocrity, and the support of all sorts of 'hocus pocus' ideas, were in the vogue. By 1977 even the mention of the word 'excellence' immediately brought strange stares, laughs, giggles and responses usually reserved for the club buffoon Yes, sir – this is the wonderful Australia of 1977. We sure have our priorities straight – support mediocrity and the hell with the rest – 'if pushed into a corner half-heartedly agree that excellence is a good thing, but be absolutely sure to do nothing about it and certain that it gets no financial support'. 'But', you may say, 'Professor, the Science Schools are still going on, what are you complaining about?' I've got plenty to complain about. They're not going on because the necessary funds are being provided. The Science Foundation has been slowly going bankrupt keeping going something we feel is of tremendous importance to Australia, but for which only

a minuscule fraction of the funds required are provided from outside sources.

Despite Messel's passion and frankness, the captains of industry he had known well and who had been his great supporters had moved on. A number of life governors and inaugural members of the Foundation had also ceased making regular contributions, even though they continued to enjoy recognition in Foundation publications. Second generations of sponsors (most notably Kerry Packer, son of Sir Frank Packer) had lost interest, with the important exceptions of the Slade and Kirby families whose support of the ISS has continued to the present time and has never wavered. The support of the Boden family has also been enduring and deserves mention. Letters and follow-up letters from Messel and Guth to past and prospective supporters, in strong and at times fervent and surprisingly blunt terms and identifying the need for help as 'imperative', were politely but firmly rebuffed. Companies and individuals applied much greater scrutiny to philanthropy. For some, Messel had received more than his fair share of benefaction over the years. Physics and education were less elevated in stature and seen as less of a noble and worthwhile cause. The ABC had ceased to broadcast the lectures in 1974 (and thus to make the tapes available to Channel 9 in 1974 for rebroadcasting), citing 'insufficient interest' and the need to compete with commercial ratings. Channel 9 pulled out in 1975 at the last moment, citing technical reasons.

These factors heralded a serious crisis, which came in 1975 following the 1973–74 oil shock and stock market crash. The 1974 economic downturn had already contributed to the postponement of the preliminary planning for an International Science Symposium, tentatively titled 'The Frontiers of Scientific Knowledge', that would have reconvened all past ISS lecturers, scholars and escorts in Sydney to mark the Foundation's twentieth anniversary. Guth identified ongoing 'insurmountable

financial difficulties' as the reason for this postponement. The key problems were twofold: a decline in contributions to the Foundation, which were, worse still, unwisely pegged at 1954 levels; and the impact of high inflation on the nominal value of contributions. The Foundation was forced to make 'economies' to preserve funding for the survival of priority scientific projects within the School and so was reluctantly compelled to postpone, but in reality to skip, the 1976 ISS with the hope that it might resume in 1977. An immediate consequence was that the number of United States scholars was reduced from ten to five in 1975 and the number of overseas lecturers was drastically reduced.

The records of the Foundation provide clear evidence of the brutality of the economic slowdown in the decade from the mid-1970s. Local and overseas governments were slashing funding of science and education. Even amounts that might otherwise have been seen as trivial were not immune. Thankfully, the Commonwealth and New South Wales governments were often, but not always, able to provide a last-minute lifeline. Having lived through these tough times, it is understandable that Messel has unshakeable loyalty to those who endured and those who stuck by him. It also explains the prominence given to the names of sponsors of the ISS on banners that hang in the Slade Lecture Theatre during the fortnight of the ISS.

When the ISS did resume in 1977, after a so-called 'one-year pause', it was without any scholars from the United States, the United Kingdom or Japan. Messel was aware from private correspondence that a Republican Nixon–Ford White House had not been nearly as interested in the ISS as the earlier Democrat White House. Messel knew there were those in Washington DC, at senior political and bureaucratic levels, who would have been quite happy to use the suspension of the 1976 ISS as a basis for severing the relationship. He was also aware that the Foundation would need to apply discretion to this fragile situation and sell the cost–benefit ratio of ongoing United States participation, including the United States continuing to absorb

the costs of running the selection process, United States air travel and sending the escort.

Messel sought financial contributions from the overseas countries to cover travel expenses for their scholars but it was not forthcoming. Without those financial contributions, the Foundation had no choice but to implement the necessary savings and exclude the overseas students in 1977, thus reducing the cost of the ISS to $60,000. Messel unsuccessfully attempted to conflate a commitment from the New South Wales Government to fund solar energy research with funding requests for the ISS. Pleas to the Commonwealth and New South Wales governments sometimes went unanswered, with each seeking to put the responsibility for additional funding back on the University. The New South Wales Government also cited the newly assumed responsibilities of the Commonwealth for the funding of tertiary education, which was strange, given the scholars were high school students. This allocation of responsibility has continued to trouble the Foundation to the present time, with the ISS often being disadvantaged because it is a program for secondary students (a New South Wales Government responsibility) run and conducted by a tertiary education institution (a Commonwealth Government responsibility).

In 1978 there was a second 'one-year pause'. Because 1979 marked the twenty-fifth anniversary of the Foundation and the 20th ISS, all effort was made to resume the ISS on a full scale in that year, to the standard that had to be abandoned after 1975 because of the prevailing economic conditions. The quality of the overseas lecturers, four of the five being old hands at the ISS, was as good as it had ever been in past years. The ISS was officially opened by the New South Wales Premier, Neville Wran. Messel was pulling out all stops to put the ISS back on the map. The Commonwealth Government renewed its grant-in-aid, and the New South Wales Government became a sponsor, along with the Slade family, the Kirby Foundation, Ampol Petroleum, Shell Australia and Mr Alexander Boden.

With a timely and topical theme of 'Energy for Survival', the involvement of the oil companies was understandable and strategic on their part. Interestingly, Messel never approached any other state governments for financial support, reasoning that the scholars from the other states had always been looked upon as guests of the Foundation. By this time, the cost of the ISS was more than $125,000. This included the international air travel costs of all overseas scholars. There was some initial discussion about direct flights rather than round-the-world tickets but those discussions appear not to have resulted in any change of policy.

The decade from 1975 represents the lean years of the Foundation, in spite of Messel's efforts to ensure that the standards of the ISS should as far as possible be maintained. Attendance at overseas presentation ceremonies was cut back even for the Chancellor of the University. In later years, when overseas travel was undertaken by a representative of the University to attend an ISS presentation ceremony, the travel was structured to coincide with other opportunities or was even self-funded. It did mean that there was neither an informal reception nor a dinner in 1975 and no dinner in 1977. Lectures started later in the morning and morning tea was no longer provided. Not only were costs rising and funds falling, but some lecturers were now asking for more than an honorarium, including, in the case of Miller, board and lodging for a period longer than the ISS itself. The scrambling and pleading for financial support was never as intense as during this period. As noted above, the ISSs were costing $125,000 (this excluded the international travel of Foundation members to attend ceremonies in London and Tokyo, and the annual reports do not mention cutting back these activities), even if they were worth many multiples of that amount. The Foundation wisely noted that 'honouring excellence is expensive but it does have its rewards'.[5]

The report from the chairman of the Foundation and Messel in the 1984/85 annual report – a typewriter-generated 'economy edition' report of only eighteen pages without

colour or photographs except for the cover, and a poor cousin to earlier editions of *The Nucleus* – which were professionally published, ran to more than ninety pages, contained a several-page summary of the ISS and were richly illustrated with photographs – illustrates how the Foundation's money base was being steadily eroded through inflation, devaluation and effective cutbacks in University funding. The 1984/85 annual report succinctly summarises the challenge:

> The Science Schools must rank as one of the most important educational enterprises undertaken by the Foundation over the past 30 years. Their impact both in Australia and overseas has been beyond measure – though difficult to quantify – and has focused international attention on education and excellence in Australia to a high degree – specially in those seven overseas nations involved in the Science Schools. For instance, every British Prime Minister in office, since the International Schools started, has awarded the Foundation's certificates in London – on our behalf. Despite this high international profile, the Foundation has been unable to convince the present Australian Government to continue support of the Science Schools and were it not for the support of a few Foundation members and the N.S.W. Government, the School could simply not be held. The Foundation has decided that, with or without the Australian Government, the 1987 Science School will be held. This important educational project is simply too important to drop.[6]

This strong commitment to an impressive and memorable ISS in 1987 would have been motivated, in part, by the fact that it would be the last ISS to be held under the direction of Messel.

Since 1979, the New South Wales Government has been a permanent supporter of each ISS. This is one reason why students from New South Wales continue to form the largest scholar cohort. For the past decade each biennial ISS has received a contribution of approximately $90,000. Although the money

has always been received, it is a discretionary amount and has to be applied for and secured for each ISS.

The Commonwealth Government has been a frequent, but not permanent, funder of the ISS (this is separate from its funding of the Foundation that dates back to 1954 and is described in lively detail in the Millar Book[7]). The Commonwealth Government has provided ad hoc funding for the ISS since 1983. From 2005 to 2011, each biennial ISS received a contribution of approximately $90,000 from the Commonwealth Government. This funding is over and above the $1,000,000 contribution the Commonwealth Government made to the Messel Endowment in 2003. This biennial funding has now ceased and will not be replaced.

The Foundation established the Messel Endowment in 1999 as a strategic decision to overcome the chronic difficulty of raising enough money for each ISS, and to ensure their continuation in perpetuity. The Slade family was a significant initial donor. In 2001, the Messel Endowment was relaunched under the chairmanship of Foundation life governor John Hooke, CBE. The mission of the Messel Endowment remains to ensure the existence in perpetuity of the ISS. The aim is for the Messel Endowment to have sufficient capital for the cost of the ISS to be met from investment earnings. It is an important feature of the Messel Endowment that it is to be managed so that the real value of the capital is preserved. Funds raised by the Messel Endowment include both donations and bequests. The two most significant donors to the Messel Endowment to date have been the Commonwealth Government (with its grant of $1,000,000 in 2003 at the direction and with the support of Dr Brendan Nelson MP, the then Minister for Education, Science and Technology) and Mulpha Australia. Pleasingly, a growing number of ISS alumni are appearing on the list of donors or are making the Messel Endowment a major beneficiary in their will. Based on 2012 costings of approximately $430,000 per ISS and assuming no future financial or investment shocks,

the Messel Endowment is believed to be close to sufficiently funded to permit the continuation of the ISS in perpetuity on a biennial basis.

On several occasions, the Commonwealth and New South Wales governments wrote to express disappointment about the level of private or industry funding of the ISS. Neither Messel nor the Foundation ever responded. It certainly was not on account of lack of effort on Messel's part: Messel was aggressive; he would try everything he could; he was not backwards in selling the ISS or expressing his frustration. In the past two decades, a number of organisations, such as Qantas, Pacific Power, Commonwealth Bank, Westpac, Australia Post, Cochlear and IBM, have made cash contributions for one ISS or perhaps several ISSs but then did not renew their support. Cadbury ceased sponsoring the ISS through travel and in-kind donations shortly after Miller's death. The simplest explanation for the falling-away of interest by these and other short-term (or even medium-term) sponsors is that many of the halcyon-day factors described in chapters 1 and 2 no longer applied. But there may be other, deeper explanations. Even though the ISS once provided great occasion, ceremony and international goodwill in the delivery of knowledge to the public on scientific matters, other avenues are now available to acquire information about cutting-edge science. Company boards are exercising their independence and demand to be consulted; they no longer kowtow to the direction of a strong chair. Many private or industry donors look for quick or immediate returns. That is not compatible with a long-term commitment to excellence or to a program, however brightly it might burn for a fortnight, that delivers results in periods measured by decades. Some, deaf to Messel's exhortations about excellence, regard the ISS as elitist. Government and business support had become increasingly unsympathetic to student unrest and agitation, and wanted to distance themselves from causes or circumstances associated in any way with student agitators; unfortunately, this included

universities. Another explanation is that philanthropists – and this includes governments – are now much more widely focused and it is only natural for them to change causes over time, no matter how much they might enjoy a particular project. Messel, the Foundation and the School had been a unique science proposition earlier in their lives but by the mid-1970s, the ISS had to compete with other science-education programs. A further explanation is that the costs of the ISS were coming under increasing scrutiny and unfortunately Messel's explanations, mostly premised on 'quality costs money', did not win over the sceptical or the so-called bean counters. And finally, on many occasions, Messel has spoken about the dumbing-down of education and its impact on society. If Messel was right, then his forceful leadership, directness and candour, admired by some and once so effective, would have been a turn-off for some of the new captains of industry. One cannot imagine Kerry Packer being too impressed in 1987 by Messel's sign-off letter:

> As you know, Channel 9 televised the Science Schools from 1960 to 1977 inclusive and what a marvellous job they did! Even though all your television gurus say that the Australian public only wishes to have pap and pineapple on the screens, there is still a component of the population who keep asking me why they never see the Science School being televised these days?!… You televised the first Science School, what about televising my last? You may lose money, but what the hell!!

Many of the thank-you letters from ISS alumni refer to Messel's sense of personal responsibility and anxiety over sponsorships, and to hearing repeatedly during the fortnight of the ISS about the sponsors and their generosity and importance. The ISS scholars have been the most appreciative and captive audience on these topics but, sadly, the least financially able, at the relevant time, to make any meaningful financial contributions.

Chapter 4

ISS scholars: selection process, accommodation and demographics

The ISS cohort has always been around 140. There is no better explanation for this than this is the seating capacity of the Slade Lecture Theatre. As it turns out, the number works well as it ensures a cohesion and intimacy among the cohort and allows the lecturers and members of the School to become well acquainted with the ISS scholars over the fortnight.

For the first ISS in 1962, the Foundation decided to award 150 scholarships to pre-leaving-year students, boys and girls alike, without discrimination.[1] From more than 1,000 applicants from more than 330 New South Wales and Australian Capital Territory schools, 100 ISS scholars were selected by the New South Wales Education Department from public schools and fifty by the New South Wales Science Teachers' Association from private schools.

Selection was strictly based on merit. Foolscap application forms, signed by the applicant, a parent, and the school's science master and principal, required the following information to be supplied:

- Full Intermediate Certificate (later School Certificate) results, including composite science and maths scores
- Full current-year results to date, including subjects and levels, percentages and position in class
- Statement of vocational interests
- Science master's (or mistress's) comments
- Principal's comments, including applicant's interests, potential, character, diligence and school service, and position in order of merit if more than one applicant is submitted by the school.

By 1977, to give an idea of the size of the ISS enterprise, 2,500 copies of the application form were being printed by the New South Wales Government Printer.

Preference was given to students interested in a career in science although, as *The Nucleus* notes,[2] a number of students interested in the humanities were also chosen. This approach has continued to apply to the present time, except that within a couple of years of the first ISS, the distinction between public and private schools was dropped, and all assessment and ranking was (and is) done by the New South Wales Department of Education (and for students outside New South Wales, other similar, independent bodies) and there was (and is) no longer any suggestion of preference.

On no more than perhaps two occasions, the Foundation awarded a supernumerary scholarship to an individual who had not undergone the usual selection process but was considered deserving of a scholarship. This certainly happened in 1962 and 1981.[3]

In the process of assessing and ranking the applications, a shortlist of 'reserves' is prepared, followed by a list of 'commended candidates' (this latter list is apparently for information purposes only). The lists over the years contain some distinguished and readily identifiable names. The 'reserves' who were not called up to attend the ISS received, in financially sound years, a copy of the book and a certificate of commendation and, in

some instances, a tour of the School and, in other years, a letter informing them of their identification as deserving special commendation and encouraging them to further study and dedication. The commended candidates also received such a letter.

In 1963, the ISS was extended to become Australia-wide (other than the Northern Territory) and scholarships were awarded to students from each of the other five Australian states. Students in those states were selected by the local Science Teachers' Association.

The planning for the 1962 ISS envisaged that all students from outside the Sydney metropolitan area (i.e. country and interstate scholars), would be put up in colleges at the University and would be supervised during the ISS by experienced teachers. This was not how the accommodation eventuated, however, and the ISS scholars were billeted. In 1963, the male ISS scholars were accommodated at Cranbrook School and the female ISS scholars at Abbotsleigh at Wahroonga, other than those who elected to stay with family or friends in Sydney. This continued for several years until the accommodation at Abbotsleigh became unavailable. The female ISS scholars were then also accommodated at Cranbrook School, but in a separate building. Parents and ISS scholars were advised by the Foundation that 'it is confidently anticipated that you will comply with all [Cranbrook School] regulations'. No further details of those regulations are known, perhaps consistent with the 'confidence' expressed by Guth's written notification and welcome to scholars. As is stated in one of the flyers, 'A breach of common sense is a breach of Science School rules'.

One such breach did occur at Cranbrook in 1991. An overseas ISS scholar, whose grandparent was gravely ill, left the dormitory very late one night to spend some quiet, reflective time on the oval. Some ten or so fellow ISS scholars followed, to give comfort. A door was left ajar; somehow it closed. The ISS scholars were caught. Each had to write a letter of explanation

and apology to his or her principal back home, his or her parents and Don Millar. Despite the innocence of it all and the lack of harm done, each was 'grounded' for the weekend.

The international scholars from the United States, the United Kingdom and Japan were assessed and ranked by the United States National Science Foundation (in conjunction with the National Merit Scholarship Corporation), the Royal Institution (in conjunction with the Association for Science Education) and the Japanese Agency for Cultural Affairs/Ministry of Education respectively. In some instances, the selection process was more rigorous than that in Australia. For example, the United Kingdom scholars were selected based on a written application, a short essay, a presentation and an interview. Similar, and at times even more rigorous, approaches were also taken in Japan and Singapore. The ISS scholars from the Philippines came from a selective school. In India, more than 5,000 students have applied each year for the selective entrance exam conducted by the Raman Research Institute.

The international scholars were billeted at other scholars' homes to make it a more personal experience. The application forms asked the parents of Sydney applicants whether they would be prepared to accommodate an overseas ISS scholar as a house guest for the duration of the ISS. For those parents who agreed, a nominal allowance of $20 was paid (increased to $30 in 1979).

In 1995, the decision was taken, at the suggestion of David Varvel and under the leadership of Cram, for the ISS to be fully residential for all ISS scholars. Reasons for this decision included maximising the opportunities for ISS scholar interaction, which was seen as a prime purpose of the ISS; maximising group cohesion (previously there had been two distinct groups, the residential students and the metropolitan students); allowing ISS scholars the time to discuss the ideas presented during the day; avoiding the ongoing challenge of locating billets; eliminating travel time and late-night travel for metropolitan ISS scholars; and delivering better supervision and pastoral care.

This proved to be an excellent evolution of the ISS format and generated all the desired outcomes. The ISS scholars from 1995 to 2003 were accommodated in St John's College at the University, with boys and girls on separate floors. In subsequent years, the accommodation has been in Women's College at the University. The only complaint heard, mainly from ISS scholars and escorts from warmer climates, has been about the cool or cold temperatures, along with suggestions for additional heating. In later years, when the ISS scholars have been issued with jumpers or football jerseys (as had been the case at some of the ISSs in the 1990s) with the ISS year displayed on the front and back, and University 'hoodies', those complaints have become fewer in number.

Appendix 2 contains a breakdown of ISS scholars by geography and gender. In later years, striking a gender balance was identified as a priority issue and, presumably in a way that did not prejudice the commitment to excellence and the principle of merit-based selection, was given due attention.

In 2005, a decision was taken by the Foundation to include places at the ISS for Indigenous students across Australia. This fulfilled a condition of the $1,000,000 grant made by the Commonwealth Government in 2003. Two Indigenous students attended in that year, four in 2007, five in 2009 and eight in 2011. Their attendance was also supported by the Commonwealth Department of Education, Science and Training and the University's Koori Centre.

Chapter 5

International perspectives: overseas ISS scholars and their home countries

Up until 1967, a handful of Auckland-based New Zealand students had attended each ISS. In 1967, the ISS went truly international. Messel had exceptionally strong contacts and connections with the leadership of the United States science community through friends and mutual friends as well as through the work he was doing for the Office of Naval Research. It was a time when the physics and science communities were much smaller and closer. Messel wrote to President Lyndon Johnson on 10 October 1966 ahead of the 10th ISS:

> As a tribute to your interest in both education and science the Foundation would like to award special scholarships to ten United States high school science students and to name them in your honour…We believe that to honour excellence in science and to make science education as widely available as possible is wholly in keeping with the deep concerns of your administration…We believe that the Lyndon B Johnson Australian Science Scholars will demonstrate that the life of the mind knows no national boundaries.[1]

Messel was able to note that Nobel laureate Glenn Seaborg would be at the upcoming ISS and to describe the impressive ISS achievements to date, including the televising of the lectures and the publication and free distribution of the books of lectures.

President Johnson, himself a former schoolteacher, wrote back to Messel on 17 October 1966 accepting the offer.[2] President Johnson asked the National Science Foundation (in conjunction with the National Merit Scholarship Corporation) to select 'ten of our best students – boys and girls from all over the country – and to invite them to the White House before their departure for Australia'.

Messel met the selected ISS scholars and President Johnson at the White House on 5 January 1967, presenting the President with a copy of the book of lectures, *Apollo and the Universe*. Six boys and four girls were selected from a cross-section of more than 200,000 American students. The competition was described as being one of the most regional ever held. Dr Keith R. Kelson, National Science Foundation Deputy Associate Director (Education) and his wife accompanied the students as their official escorts. After some debate, it was determined that 'escort' was a more appropriate word than 'chaperone'.

President Johnson's remarks at the award ceremony in the Cabinet Room reflect the achievement of Messel in securing this connection:

> This is a highly unusual meeting. Because today a great Australian university, the National Science Foundation and distinguished officials of this Government join me to honor you 10 American high school students – because you have done your homework well. That says a great deal about the high value the world puts on academic excellence today. Just before I visited Australia last fall, Professor Harry Messel wrote me a letter. The great University of Sydney, he said, wanted to include 10 American high school students in its summer science program. These students would receive not only an opportunity to visit Australia – and we

> know that is a great privilege – but they would hear some of the world's great scholars. They would meet some of the most talented and interesting young people living today. They would receive scholarships that would literally take them around the world in 20 days. It gave me pleasure to accept the generous offer and I did it quickly…I want to say to each of you that you give all of us great cause for pride, because of your application, your dedication, and your achievement. You represent a great idea: the idea of international educational opportunity…And the journey that you will begin tomorrow will strengthen, I think, the friendship between our countries.[3]

The United States scholars were a resounding success. In an evaluation prepared by the National Science Foundation for the White House Office of Science and Technology after completion of the 1967 ISS, the following observations were made:

> Were the project to be repeated, I can think of no administrative arrangements that I would want to change. The project followed the plans precisely and without difficulty…The lecturers at the school, the Australian students with whom they associated, and the Australian families with whom they lived, quite literally came to love [the United States scholars]…They were constantly acclaimed by both the press and TV for their brilliance and gracious behaviour, nor did they lose their perspectives because they were treated as celebrities…From the standpoint of international relations the project was an absolute unqualified success, far beyond anything I could have foreseen. Every Australian – quite literally – knew about it, was immensely pleased and it was the topic of conversation everywhere…As one distinguished Australian Government official remarked to me, 'We are moved that your President has sent us ten of his best. He will not regret it nor shall we forget.'…From purely academic grounds – if this be a reasonable yardstick with which to measure success – I judge the venture to have

> been worthwhile. All of the lectures were good and some truly remarkable…Incidentally, enabling the Scholars to visit briefly in three quite different cities (Hong Kong, Rome and London) on the way home was an excellent idea. The Scholars were visibly and audibly thoughtful about what they saw there and grew into much better citizens and humans as a result of it. Their perception and appreciation of freedom, government, history, international relations and political science increased many fold. One said he would never be the same or think the same as a result of it…I would recommend most strongly that favorable consideration be given to continuing U.S. participation for at least the next few years. The costs are trivial as compared to the results.

By the end of the 1967 ISS, conversation was already turning to how the international flavour of the ISS might be expanded through embracing a number of countries. It was at this point that discussion began about changing the dates from January to the first week of September, to coincide roughly with the second-term high school holiday as well as vacation time in the northern hemisphere (it was later, from 1987 onwards, changed to July to accommodate the four-term year in the New South Wales school system).

Messel's aim had been to expand to one other international jurisdiction for 1968. He bested himself and got two: the United Kingdom and Japan, each of which provided five ISS scholars.

The British ISS scholars were named 'Royal Institution Australian Science Scholars' and came under the aegis of the Royal Institution. The scholars were presented with their awards by Prince Philip at Buckingham Palace on 9 July 1968. This became the pattern in later years with the following exceptions: in 1969 the presentation was by the president of the Royal Institution, in 1970 by the Prince of Wales, in 1972 by Earl Mountbatten, in 1973 and 1975 by the then British Prime Minister and in 1974 by the Duke of Kent (in 1989, the presenter

was Princess Anne and the last royal occasion, in 1991, involved Prince Michael of Kent).

The Japanese ISS scholars were named 'Sato Eisaku Australian Science Scholars' and came under the aegis of the Japanese Prime Minister. In 1975, they were renamed 'The Japanese Prime Minister's Australian Science Scholars'. The Japanese scholars were selected by Japan's Agency for Cultural Affairs (and later the Ministry of Education, Science and Culture [known as Monbusho]) and were received by the Japanese Prime Minister at his official residence on 9 August 1968. Their escort was Dr Arita from the Japanese Ministry of Education.

The Japanese ISS scholars flew to London after their award presentation ceremony. The combined United Kingdom and Japanese contingents then flew from London to Washington DC, where they and the ten Lyndon B. Johnson Australian Science Scholars were all received by the President at the White House. Other attendees included the scholars' escorts, the Vice-Chancellor of the University and senior representatives of the National Science Foundation. During their time in Washington DC, the combined contingent attended a reception at the Australian Embassy, a dinner hosted by the National Science Foundation, a sightseeing tour, lunch at the White House and a theatre performance. The trip to Sydney included a day's relaxation in Honolulu. The return trip for the United States ISS scholars was via Hong Kong, New Delhi and Rome, finishing in New York. This became the pattern in later years, with the exception that from 1969 onwards the presentation was by the Science Advisor to the President and occurred at either the White House or the National Science Foundation. In later years, the return trip was sometimes via Bangkok or Singapore.

The importance and grandeur of these events in the early years eventually led the Chancellor of the University, as representative of the Foundation and the University, and his wife to attend the overseas ceremonies of presentation in 1972,

1973, 1974 and 1975. The Chancellor's trip reports are splendidly detailed, and make note of tours of the White House and the Japanese Prime Minister's official residence; attending theatre in Washington DC, the Queen's Garden Party at Buckingham Palace, and other prominent buildings in London; fine dining in Soho in London; handing out maps of Sydney; meeting up with former ISS alumni and former escorts; the screening of films (on dung beetles and the like) at the Australian Embassy; receptions with 'champagne and viands' or 'coke[4] and conviviality' and less formal events with 'sturdy Australian afternoon teas' and 'refreshments, Australian style', and promises by him of 'lethal' hospitality to the ISS scholars.

Later but more fiscally conservative times would see only two other Foundation representatives, Cram and Max Brennan (1991), travel abroad at the Foundation's expense to meet the international scholars before they came to Australia or otherwise to accompany them on their journey to Australia. After that travel, it was only on rare occasions – such as 2003 when Bob Hewitt went to Washington DC and London, and 2009, when Head of School Professor Anne Green went to Bangalore, India, and Dean of Science David Day went to London – that the Foundation was represented at award presentation ceremonies, but on each such occasion the travel was generally incidental to some faculty-funded requirement to be abroad at the relevant time. There were also at least two occasions on which Foundation representatives funded their own travel or coordinated their own overseas holidays to ensure that the Foundation was represented at the relevant time in Washington DC, London and Tokyo. Messel always spoke forcefully at Foundation Council meetings on the importance of maintaining the international connections of the ISS as 'money well spent'.

From 1969 onwards, the Lyndon B. Johnson Australian Science Scholars became known as 'The President's Australian Science Scholars'. Present at the White House ceremony in 1969 was Dr Harrison Schmitt, who went on to become the last

Apollo astronaut to walk on the Moon (*Apollo XVII*) and, later, a United States senator.

Representatives from the United States were absent for several ISSs from 1981 onwards because of a severe reduction in science funding in that country. The United States scholars returned in 1991 with financial support from the United States Department of Energy (this financial support did not extend to a round-the-world air ticket). At that time, they became known as the 'United States Department of Energy's Australian Science School Scholars'. Eventually, those chosen as the United States ISS scholars would be the members of the team that won first place in the senior high school National Science Bowl final in Washington DC, with the team's coach as the escort. On several occasions, representatives of the Foundation travelled to Washington DC to be present for the finals, including Cram in 1991 when First Lady Barbara Bush presented the scholarships, and me in 2009 when Nobel laureate and Energy Secretary Steven Chu was the guest presenter.

The overseas contingents were progressively joined by Malaysia, Singapore, Thailand, and the Philippines (1985), China[5] (1999), India (2007) and Canada (2009). The Canadian ISS scholars came from Messel's home town of Rivers in Manitoba, some 150 miles west of Winnipeg. Over the years other countries, including Indonesia and Saudi Arabia, have unsuccessfully sought to join the international program.

Up until 1997, the New Zealand ISS scholars were exclusively selected from Auckland Grammar School. From 1997 onwards, the selection has been conducted across New Zealand by the Royal Society of New Zealand and applicants have had to submit a short essay as part of the selection process.

The presence of gifted scholars from overseas gives the ISS a truly international ambience. It unconsciously emphasises the universal character of science and the nature of academic excellence in many cultures. By experiencing the values of those cultures, ISS scholars learn new ways of doing things.

Chapter 6

The ISS lectures: themes and lecturers, and other ISS scholar academic activities

In moving in 1962 from a summer school for science teachers to a summer school for science students, it was clear that there would be no change in the breadth of the talks or the quality and calibre of the lecturers. Messel and the Foundation would never have permitted any dumbing-down. Lecturers had to be internationally acknowledged authorities in their particular field and all the better if they were themselves contributing to the developments in science. As the preface to the 1962 book of lectures states:

> Because these lectures have been specifically prepared, written and edited for [penultimate year] High School students, we feel that they will be of interest to the widest section of the public. We feel that the material as presented will be appreciated not only by the increasingly science-conscious layman in this scientific age but also, in fields other than his own, by the specialist scientist. The [ISS] and, indeed, this book are intended to stimulate and develop science-consciousness in Australia

> generally, and in particular in the 150 outstanding New South Wales [students].

One thing was immediately clear. Apart from an appropriate focus on 'modern physics', the fortnight was going to be topical and not restricted to physics. Where themes were biological (such as 1964, 'Light and Life in the Universe'), basic physics and chemistry were introduced as 'necessary for appreciation of the later biology lectures', with topics in physics and chemistry seen as going hand in hand with the main lectures on the subject of life.

Themes and topics appear to have been chosen to reflect the cutting edge of science. They were certainly not confined to one branch of science; more often than not, they were cross-disciplinary and intentionally so. In the 1960s, the cutting edge of science included particle and nuclear physics (with the contemporaneous development of the standard model), the United States space program and the peaceful uses of nuclear energy. Topics on ecology in the 1960s and 1970s seem prescient.[1] Each of 'Solar Energy' in 1974 and 'Energy for Survival' in 1979 was chosen because of the world energy crisis and humankind's struggle to develop alternate sources of energy (and no doubt Australia's nascent leadership position at the time in the development of solar cells). The detailed energy topics for 1979 were particularly comprehensive and contemporary. Some topics, such as 'Living with the Environment' (1991), were intended to evoke a 'What can I do, how can I act?' reaction from the ISS scholars in response to an issue of special urgency. The 1999 topic 'Millennium Science' requires no explanation. Later topics were chosen to celebrate United Nations–designated international years (2005 – International Year of Physics and also the Einstein centenary, 2007 – International Polar Year and International Year of Planet Earth, 2009 – International Year of Astronomy and also the fortieth anniversary of the *Apollo XI* Moon walk, and 2011 – International Year of Chemistry and the

fiftieth anniversary of the laser). The choices in 2005 and 2007 were in part influenced by a survey of the 2003 ISS scholars and the 2005 ISS scholars respectively. Choices were sometimes made with regard to potential practical applications (for 1981, 'The Biological Manipulation of Life', those implications were seen as extending to industry, medicine and agriculture). The fall-back choice was otherwise the simple selection of topics 'within a wide range of fields that will be of interest'. A lesson learnt from 1981 was to avoid a single-themed ISS.[2] Clearly, judging from the ISS scholar responses and from the calibre of the speakers, none of the topics was dull or passé.

The lectures on the United States space program were among the most remarkable. It is really quite astonishing that people (administrators, technocrats and astronauts) of the seniority and responsibility of those who came to the ISS were prepared to give up their time and reduce the details of the program into such detailed and elegant notes, all the more so in 1968 when the Apollo Program was so close to the scheduled launch of *Apollo XI* and the deaths from the cabin fire in *Apollo I* in 1967 were so recent. The sixty-three diagrams included in von Braun's 1962 lectures are likely to have been the most up-to-date material available to the general public at that time. Another example is the lecture entitled 'Achievements in Unmanned Spacecraft' by Eberhard Rees (1968), which traverses topics including satellite meteorology, communications, navigation and air traffic control, Earth resources and geodesy, technology utilisation, bioscience, stellar astronomy, planetary environments and lunar technology. It is almost certain that this information would not have been available to the general public and, in our own times, might be the subject of security-classification restrictions. By 1970, the lectures were looking forward to people living, eating and sleeping in space, with drawings of state suites and early drawings of the space shuttle.

Quite early on (starting in 1969), the ISS scholars were formally introduced to the importance of the history of science

and the wider implications of science in the context of society. David Z. Robinson, in his paper 'Science and Society' (1969) gave an insider's account of the relationship between government and science in the United States (Robinson had worked in the office of the President's Science Advisor), including detailed case studies of the development and negotiation of the Nuclear Test Ban Treaty and the machinations of government in the development of a policy on, and investment in, high-energy physics. Disappointingly, but perhaps not surprisingly, Robinson describes the Oppenheimer trial as being, in retrospect, related to 'personal animosities' without reflecting on the tumultuous struggle that was taking place for civilian or military control of nuclear energy.

In 1970, the ISS scholars were privileged to hear from Sir Mark Oliphant on 'Science and Mankind', including how science and technology now determine the course and nature of civilisation and the responsibilities of the scientist. In a most impressive and perceptive address, written with great clarity and simplicity, Oliphant first identified the three momentous discoveries, all around 1895, that shattered the certainty of many men of science that they knew all the answers, revolutionised the physical sciences and launched all modern technology: J. J. Thomson and the electron, Roentgen and X-rays, and Becquerel and radioactivity. He observed that our lives are dominated by technology and it determines the course of development of countries and hence the policies of governments. He reminded the ISS scholars that while technology improves our lives, it also has a dark side: it revolutionises armed conflict and presents insidious dangers, such as biological weapons, pollution, the population explosion and the misuse or careless use of scientific knowledge. He left the ISS scholars with a clear message that these problems arise as a result of advances in natural knowledge, and that the scientist has a special responsibility to endeavour to contribute to their solution, including through creating awareness and encouraging rational and informed debate. His final words remain relevant to the present time:

> Finally, there can be little doubt that you who are young, whose future as men and women of science, and as citizens of the world, lies before you, are more likely to bring about the necessary reformation than are those already immersed in the system. It is the young who make the important discoveries in mathematics and science. It is they who have the uncommitted minds and the courage to look at all the problems without preconceptions or embarrassment. I hope that you will prove as successful in these important directions as you undoubtedly will in your learning and research.[3]

In 1971, Chapman Pincher, the science editor from the *Daily Express,* delivered three talks on the interaction of science and society with special reference to the media. Acknowledging that his purpose was to promote discussion, he held no qualms about being controversial or outrageous. Starting with the observation that there is a growing disenchantment with science by society, he explored themes that included whether science was in crisis, the boundaries of bioscience, the social responsibility of scientists, the gullibility of society and the role of reason.

In 1981, in the context of the theme 'Biological Manipulation of Life', the ISS scholars were very directly introduced to the challenging social and ethical issues and the philosophical arguments surrounding cloning, genetic engineering and eugenics (with a historic review of Sparta and Nazi Germany, and digressions ranging from Plato to Darwin, Marx and Mendel). Miller (most notably in 1985) was at pains to point out that humanism is required of scientists. In all these cases, the notion of ivory-tower science was portrayed as an anachronism. Under the leadership of Cram, the history of science made a return in 1995 with lectures on the development of the telescope and the contribution of Sir Michael Faraday.

In 1997, under the theme 'Light', the ISS scholars were addressed by Marrette Corby, who had recently been an undergraduate representative on the University's Senate. Her

talk was much deeper than her own visual impairment; it covered important themes about disability, the rights and duties of citizens, and access to information and public facilities.

In 2001, Honorary Associate Professor Ian Johnston gave two insightful lectures that reflected on the future of science, most appropriate in the context of theme 'Impact Science'. He introduced the topic in an unusual way, through a review of science-fiction writing (*Frankenstein* by Mary Shelley, *The Time Machine* by H. G. Wells, and *Jurassic Park* by Michael Crichton), before asking and answering the question of whether science fiction can predict the future. In the second lecture, he took on the difficult topic of the relationship between the public and science, discussing contemporary periods of approbation, mistrust and dispensability through examples from literature and cinema.

The ISS trialled in 2009, and repeated in 2011, workshops on 'Ethics and Leadership in Science'. The course material included pre-reading, overnight reading and handouts of notes, quotations and questions. The course material was developed by the Foundation and the University's Department of Philosophy with financial support from the Smithsonian Institution in Washington DC.

In most cases, the papers in the lecture books are written in the first person. As you read the papers to yourself, you can almost hear the lectures being spoken. The writing is elegant, concise, clear and effective. The words cannot help but inspire the audience and the reader. Difficult concepts are extremely well explained. There is erudition without being remote or inaccessible. Knowledge is presented as a sufficient end product. These features no doubt reflect the quality of the speakers and their preparation, but there must also be an element of reward for clear direction and encouragement given by the editors from within the Foundation. Speakers come across as brilliant, with both depth and breadth of knowledge. Many speakers contextualise their lectures through history, literature

and ancient civilisations. Quotations, obscure and popular, biblical and scientific, historic and contemporary, abound. The knowledge of the lecturers does not appear limited to their specialisations. In that vein, it comes as no surprise that Robert May has made the transition from gifted physicist to world leader in the disciplines of biology and theoretical ecology.

Names of lecturers that immediately impress include Nobel laureates James D. Watson (1964), Glenn T. Seaborg (1967), Lord George Porter (1971) and Jerome Friedman (2003); present and future fellows of the Royal Society Sir Eric Ash, Sir Walter Bodmer, Sir Hermann Bondi, Professor Margaret Burbidge, Professor David Cockayne, Professor Thomas Gold, Professor Robert Hanbury Brown, Sir Richard Harrison, Professor Malcolm Longair, Professor Raymond Lyttleton, Sir John Maddox, Lord Robert May, Professor Bernard Mills, Sir Mark Oliphant, Sir John Pendry, Lord David Phillips, Professor Roger Short, Sir John Thomas and Dr Paul Wild; and other prominent scientists who include Dr Wernher von Braun, Professor Adrienne Clarke, AC, FAA (former chair of CSIRO), Professor Paul Ehrlich (author of *The Population Bomb*), Dr Michael M. Gore, AM (foundation director of Questacon), Dr Thomas Lovejoy (who introduced the term 'biological diversity' to the scientific community in 1980, although there are some suggestions that the term had earlier usages), Dr Graeme Pearman, AM (internationally recognised climate scientist), Professor Carl Sagan (astronomer, cosmologist and visionary space-documentary producer and narrator), Professor John Shine, AO, FAA (until recently the executive director of the Garvan Institute and a winner of the Prime Minister's Science Prize), Professor Grant Sutherland, AC, FAA (a past president of the Human Genome Organisation and a winner of the Prime Minister's Science Prize), Professor Jill Tarter (astronomer and former director of the Center for SETI Research) and Professor Lord Robert Winston (acclaimed television presenter on biology and fertility), as well as NASA astronauts Donald (Deke) Slayton, Alan Shepherd and Gordon Cooper.

The faculty of lecturers has also included some of Australia's most promising young scientists and a number of recognised and respected Australian scientists, including Associate Professor Stephen Bartlett, Professor Jennifer (Jennie) Brand-Miller, AM, Professor Christine Charles, Dr Deanna D'Alessandro, Professor Ben Eggleton, Professor Martin Green, AM, Professor Charles Lineweaver, Professor Thomas Maschmeyer, Professor Tanya Monro, Professor Dietmar Müller, Professor Huw Price, Professor Elaine Sadler, Professor Michelle Simmons, Professor Stephen Simpson and Professor Fred Watson, AM.

Over the years, the ISS has also been fortunate to have as lecturers leading academics from the University, other Australian universities and from scientific bodies such as CSIRO and ANSTO who have generously given their time and who have been no less popular with the ISS scholars than their fellow scientists named in the preceding paragraphs.

Many of the lecturers must have enjoyed themselves, judging by multiple attendances at the ISS over a number of years: these include Miller (nine), Sir Hermann Bondi (seven), Thomas Gold (seven), Lord Robert May (six), Robert Hanbury Brown (five), Ronald Bracewell (four), Sir Walter Bodmer (three) and Sir Gustav Nossal (two). The regular appearances of Bondi and Gold are all the more remarkable given the very public rivalry of their (along with Fred Hoyle's) steady-state cosmology against the big-bang model during the relevant period.[4]

One disappointment is how few women lecturers have presented to the ISS. The first woman was Professor Margaret Burbidge in 1973 at the 16th ISS. The next was Jane Menken at the 23rd ISS (1985). The advance in numbers of female lecturers has been slow: Barbara Grosz (1989); Adrienne Clarke (1989); Marilyn Ball (1991 and 1993); Carol Cogswell, Helen Garnett and Holly Given (1995); Judith Dawes and Helen Gleeson (1997); Jennifer Nicholls, Miriam Baltuck and Elaine Sadler (1999); Anne Green, Michelle Simmons and Tanya Monro (2001); Rachel Codd, Victoria Meadows, Anya Salih and Virginia Trimble

(2003); Halina Rubinsztein-Dunlop, Lidia Morawska, Judy Kay and Raffaella Morganti (2005); Mahanandra Dasgupta, Victoria Metcalf and Rhian Salmon (2007); Alaina Ammit, Jennie Brand-Miller, Helen Johnston, Naomi McClure-Griffiths and Jill Tarter (2009); and Christine Charles, Deanna D'Alessandro and Joanne Whittaker (2011).

In his valedictory preface (1987), Messel speaks of straining the bonds of friendship in recruiting lecturers and persuading them to accept the invitation. This is unlikely to have been the case, given the obvious pleasure derived by the lecturers. Of course, Messel's dynamism and penchant for air travel would have been a formidable factor in successful recruitment. The breadth of Messel and Butler's friendships, already identified in Chapter 1, is also relevant.

Other reasons for recruitment are found in the history of the School and the physics conducted in the School. For example, in the early 1960s, the University and Cornell University established the Cornell-Sydney University Astronomy Centre. That very likely explains or partially explains the attendances of Thomas Gold, Carl Sagan, Robert Hanbury Brown and others. The substantial funding from the United States Government (through the US Air Force) for the construction of the stellar interferometer at Narrabri would have done no harm in securing ongoing support from the White House in encouraging visits to Australia by United States scientists.

Humour (sometime more cutting than laugh-out-loud), humility, teaching by analogy and flamboyance are constant features of the lecturers. Robert May (1966) is a good example of all these traits. In describing factorial notation and giving the example of 52!, May noted in passing that it makes Bridge an interesting game.[5] He made regular references to Roman history and often quoted from Lewis Carroll's *The Hunting of the Snark*. Apart from describing the state (in 1966) of elementary particles as an 'appalling mess', he opened his talk on elementary particle physics with a series of questions:

> When it is said that high energy nuclear physics is important, you may ask in what sense is it important? Will it provide cheaper electricity? Faster cars? Breakfast cereals with more snap, crackle and pop?[6]

In 1968, in his talk on cosmology and having touched on the topic of astrology, May observed:

> Indeed, even today we find astrology columns in most magazines and newspapers. The belief that the planets move for so frivolous a purpose as to warn people to avoid dealings with blondes on Tuesdays is a great deal more silly than the beliefs of the ancient Mesopotamians who constructed the zodiac.[7]

Even the stern-looking Sir Hermann Bondi gave the humorous anecdote (1962, in his lecture on 'The Propagation of Sound') of two elderly ladies on their first flight. As soon as they sit down in the cabin of the luxurious airliner they call for the steward and ask him to tell the pilot not to fly faster than sound, please, as they have a lot to talk about.[8]

One lecturer who won enduring affection was Miller. He is perhaps best known for his flamboyant and excitable style and his ingenious demonstrations of physical phenomena of the 'simplest sort' (done with sticks and strings and sealing wax) but performed with flair, drama and wonderment, and with a maestro's touch. He aimed to and did arouse curiosity. As Collins observed, his technique was to provoke, embarrass and stimulate, rather than encourage and explain.[9] His lectures were described as 'demonstration lectures'.[10] Unless you were there at the time or have read his papers, you could not fully appreciate his beguiling charm, the breadth of his knowledge and philosophy, his wisdom, his vignettes of past scientists, and his talent at entertaining and arousing curiosity. With the broadcasting of his lectures, he successfully introduced the public to basic physics (in 1963, his first appearance, he reached

an estimated audience of 3.5 million). More often than not over the years, Miller was one of the opening lecturers for the televised ISS – he was known to draw in the viewers and Messel knew the benefits of starting the fortnight with a demonstration lecture. In 1965, Miller presented a series of lectures on 'Men of Science'. The scientists about whom he spoke are identified in Appendix 3, and include one woman. For each, there is a two- to three-page life story (except for Einstein, where it runs to eight pages), with the context of the scientist's work and struggle clearly identified. Quotations appear abundantly. In the book, each scientist's image is depicted by international stamps (these stamps are the very first colour plates in the ISS books). It is an interesting list, a very personal list, with many names omitted but appearing as part of the subtext (for example, through Pasteur we learn about Lister; through Helmholtz, Joule; through Carnot, Boltzmann; through Hertz, Maxwell; and through Marie Curie, Rutherford). The list is not confined to physicists and chemists, and includes biologists, mathematicians and medical researchers.

Miller was inspiring and sheer good fun. The extracts below are taken from the introduction to his 1965 talks and give a flavour of the man and his gift for teaching and inspiring:

> Men of Science: Being especially some of their own utterances in which they speak of their labours, their fears, their travail physical and mental – how they were inflamed with the desire to know and their constant zealousness after Truth – how the Drama and Beauty of nature stirred them, fired their imagination, aroused their curiosity, kindled their intellect – how their Wonder on the Great Scheme of Things was awakened – how they appraised themselves and their work and how some later giants of the intellect measured what they had done. The great body of knowledge which the human race has gathered up has not come to be by the mystic gyrations of a magical wand. It has not appeared full-grown and in bloom. It has not come up with a

> suddenness out of the dark as the sun follows the night. It is first of all *the work of men* and more often than not their lives and their labours were clouded and burdened with fear and with travail. The advance of a new idea has ever been fraught with danger and this boldness has cost some their very lives. Now these men of whom we shall tell were all different in their private ways and in their personal histories, as men are and as they must be, but they were all singularly alike and in this way: they were inflamed by the desire to *know.* The Order and Beauty of Nature stirred them in their deepest souls; their intellect was kindled by the Great Drama and Wonder which envelops us all – *why* is the sky blue? *why* is the sunset red? And they were forever possessed by a steadfast zealousness after Truth and a fanatical devotion to their hopes. So the study of Science and the meaning of Science and the hope of Science take on a new complexion and a new depth *when we know the men who made it*…And so my case is clear. What we need in the schooling at all levels and in every subject is more history, more biography, more humanism, more anecdote. For science especially, my case is very strong, for in the study of science these ingredients are shamefully wanting. Whatever science is, it is first of all *human adventure* on the highest intellectual grounds revealing constantly the great spirit of questioning and wonder which prevail in the human mind. In science proper lie the noblest aspects of man, the highest goals, the deepest hopes for things eternal. For this intellectual process has one singular intention, one noble ambition, and it is this: *to uncover the orderly Beauty of Nature.* With this comes the great satisfaction of **understanding** which must indeed rank as the highest ambition of man [all emphases in original].[11]

This approach is reminiscent of the title, contents and elegance of Gerald Holton's classic physics textbook, *Physics, the Human Adventure*.[12]

Miller very much enjoyed pointing out the nobility of achievement of these great scientists and how it was incremental,

building on earlier discoveries, and that many of these great scientists were parvenus. Miller concludes with this epilogue:

> It is our singular hope that your brief adventures in these pages have given some pleasant hours and the ambition to know more about these men who changed the world. It may indeed come to pass that one of you, filled with the fire of curiosity and the will to know, possessed as by a demon with a spirit of untiring labour, will one day be honoured as we honour those whose names are on these pages.[13]

Miller returned in 1967 with a series of essays, this time focusing on fewer men of science, but in much greater depth. He chose as his subjects for his essays the illustrious Bernoulli, Archimedes and Faraday.

One other memorable feature of Miller was to pose questions to his audience – a prelude to his famous line: 'Why is it so?' In 1963, Miller did this informally and there is no record of the questions. When he returned in 1965, he came armed with a list of 110: 'Some Enchanting Questions for Enquiring Minds'. Some of the more interesting of those questions include the following:

> In breaking a stout string it is found that a *sudden* pull on it succeeds where a steady pull does not. What do you make of this?

> Someone says to me: 'How much does the Earth weigh?' To which I reply: 'As much as *you* do.' What do you think of this?

> When sand or gravel or the like is dumped from the truck the pile assumes a conical shape. What lies in the steeper cone – coarse gravel or fine sand?

> Suppose that you, a physicist, shoot a polar bear on the Arctic ice. You are equipped with a rope but no scale or devices to weigh him. How could you approximate his weight?

> You pour water from a jug. It goes glub-glub-glub. Molasses does better. Account for this sound and for change in pitch as the liquid empties.
>
> Think out how a simple pendulum would behave in an elevator.
>
> Explain precisely how it is that the air in an automobile tyre supports the weight of a car.
>
> Is the ice of an iceberg at sea salty to the taste?
>
> Here's a good one: Why not make the walls of your living room excellent reflectors and thus keep yourself warm by the heat energy that you yourself radiate?
>
> Would you expect living organisms to be affected by magnetic fields? Maybe this ought to be explored.
>
> Can a mirage be photographed?
>
> What is the likelihood of the human mind ever having a 'true' picture of the physical world?

As is clear from this sample, the questions achieve their goal of stirring interest, awakening enthusiasm, arousing curiosity, kindling a feeling and firing up the imagination. In 1967, Miller outdid himself and produced a list of 239 questions in a 'Quick Quiz on Men and Ideas', this time supplying answers.

In 1985, Miller closed the ISS with a talk on 'So You Want to be a Scientist'. This was to be his final ISS (he died in April 1987). Here are some memorable extracts that capture the man and his contribution to the ISS:

> The world is run by science, they say, and lots of young people are heading for such a career. But with nearly seventy years in this business I have some points of view on this matter and my purpose in this writing is to tell you some very important things. Your ambition is a noble one indeed and praiseworthy, but I

> would still acclaim it if you wanted to be a poet or a linguist or a lawyer or to spend your life writing history. So you see, all noble ambitions must be equally esteemed. Science is no sacred cow! Now the first thing you must know is this: It is said that science is *one thing* and the humanities *another.* They who say this mean of course that men of science have a very different view of the world than the humanists. *This is not true*. Of all the divisions of human knowledge and of all the activities of men, science is really the most humanistic [all emphases in original].[14]

After identifying the practical consequences of science – what he calls technology – Miller reminds us that they (for example things that assuage pain, conquer disease and feed the hungry) are not science. Science has a vastly different purpose from technology: 'to uncover the orderly beauty of Nature'. His final words distil special characteristics that the ISS scholars should cultivate and include the following: learn to reason and to rely less on memory; learn to see when you look and hear when you listen; plague yourself with the question why; learn to ask questions beyond the pale of the book and the classroom; if it interests you, go ahead with it without asking about use or utility; and do not waste your time.

Aspects of the buoyant, easygoing, avuncular and absent-minded professor public persona of Miller are not always reflected in his correspondence with Messel, Guth and the Foundation. All letters from Miller, mostly written on aerogram or airmail paper, have very strict paragraph and subparagraph numbering (including subparagraphs headed alpha, beta and so on). They evidence a strong-willed and stubborn correspondent, very much used to getting his own way and not at all unwilling to make personal demands or complain. Collins accurately observes that Miller was a pedant who seldom laughed and took himself very seriously.[15] Others have commented on Miller's sensitivity if his scientific credentials were questioned. There are many instances in Miller's letters of CAPITAL LETTER

rage. Messel responded to one such letter in 1980: 'I would have hoped for greater understanding from an old friend and congratulations. Please don't let me have complaints!'

Despite some of this testier correspondence, Miller was a wonderful ambassador for the ISS and very generous towards it with his time and occasionally his money. He did play an important part in putting the ISS in the public's mind and more generally in raising an awareness of science. The Foundation chose to commemorate the contribution of Miller by creating the Julius Sumner Miller Fellowship. The first and so far only Fellow (appointed in 1995) is the very popular Dr Karl Kruszelnicki, AM. Dr Karl, as he is commonly known, made his first appearance at an ISS in 1995, covering breakthrough topics as diverse as spider webs, mineral flotation and the bionic ear. Dr Karl has appeared at every ISS since then, giving formal lecturers, answering puzzling questions and acting as quiz master. He is always a favourite among the ISS scholars.

Chapter 7

The ISS scholar experience

The ISS scholar experience is the hallmark of the ISS.

There are a number of common themes to the ISS scholar experience, along with innumerable unique impressions. Some of these themes are period-related – for example, from the time before the ISS became fully residential.

The common themes, drawn from the records of the Foundation and from interviews, are not surprising: a totally new learning experience; a feeling of honour, pride and satisfaction for having attended the ISS; deep and sincere gratitude for a seriously enriching, mind-opening, mind-extending and life-changing experience that gave rise to a new world perspective; an epiphany moment, involving a sudden clarity of thinking and, for some, a crystallisation of thinking about a career in science; an acknowledgment of the tremendous success of the ISS but at the same time an awareness that science is a human subject; boundless affection for Messel and his genuine and enthusiastic interest in the ISS scholars, and a personal connection and indebtedness to him; amazement at Messel's vibrancy, charisma, spruiking

skills and ability to make the seemingly impossible possible; an understanding of the international aspects of learning and of science generally, and a commitment to finding and implementing international solutions; high praise for the topical lectures, the outstanding lecturers and the intellectual stimulation; astute observations on the egalitarianism of the scientific community and the openness of scientific conversations; the development, at times surprising, of a positive attitude to learning generally and thinking in a precise manner; an initiation into the philosophy of science and important related areas of sociology, economics and politics; the discovery of the existence of and an affinity with other likeminded youth, including sharing the same doubts and frustrations about pursuing a career in science; the start of lifelong friendships, often international; the benefits of the ISS in the transition to tertiary studies; and above all – and this is repeated again and again – a commitment to the importance of excellence and statements about 'one of the highpoints of my life' and 'the best two weeks of my life'. Even the youthful cynics and sceptics who had approached the fortnight questioning its worth were won over. Expressions most commonly used by ISS scholars in any evaluation of the ISS or in letters of thanks include: 'inspiring', 'marvellous', 'delightful', 'transforming', 'amazing', 'brilliant', 'extraordinary', 'awesome', 'stimulating', 'wonderful', 'rewarding', 'utopian', 'unique', 'unforgettable', 'pivotal event', 'once-in-a-lifetime', 'exhilarating', 'the best two weeks of my life'. One ISS scholar, reflecting on his time at the ISS at a distance of more than three decades, said that attending the ISS was like 'Harry Potter going to Hogwarts'.

Again and again, there are references to being 'in the company of people who have the ability to create the future'. There are also repeated references to 'questioning everything' and 'honesty'. Many express the sentiment that 'thank you is an understatement'.

For a number of ISS scholars, the impact of meeting inspiring scientists led to a career in science and a determination

to make discoveries 'of my own'. Some ISS scholars benefited from having experienced a new social setting and from speaking publicly for the first time. Some described themselves becoming more outgoing and confident, less inhibited. For some, the impact of the ISS was pivotal, setting off a career-determining chain of events. There are several instances where decades-long professional collaborations can be traced back to conversations with ISS lecturers, the friendships developed among an ISS cohort and/or subsequent time in or visits to the School.

All ISS scholars prize their medals (for those who received them, before 1987) and the book of lectures. Invariably, the book of lectures is displayed prominently on a shelf, and the medal is stored safely, at the home of parents or just 'somewhere', with words that suggest that it could be easily found and retrieved at short notice.

Messel's careful attention to the ISS sponsors features prominently in recollections. So too the name or office or both of the prominent person who opened the ISS on the first morning, whether it was (among others) the Governor-General of Australia, the Governor of New South Wales, the Chancellor of the University, a state or federal minister, the Chief Scientist of Australia, the Chief Justice of Australia (Hon. Robert French AC, himself a proud ISS alumnus, who opened the 2009 ISS with a speech that reflected on the progress of science since he had attended in 1964) or other prominent Australians such as Sir Gustav Nossal.

At a less profound level, ISS scholars have shared memories of touring the School, the University's museums (Macleay and Nicholson) and other University science and research facilities (including laboratories and the Electron Microscope Unit); from 1999 onwards, participating in experiments – in physics, chemistry (including one on adhesives run by the Key Centre for Polymer Colloids in 2001), biochemistry and solar energy – engineering challenges facilitated by the University of Newcastle[1] and astronomy role-plays conducted by Dr Paul

Francis of the Australian National University; an occasional Planet Ark Eco Challenge; meeting School staff, including in the context of 'speed dating' careers discussions and advice; visits to the ANSTO nuclear facilities at Lucas Heights; playing football or with frisbees on the hockey field in front of the School; as well as evening and weekend excursions to the Rocks and Sydney Cove, Darling Harbour and the IMAX Cinema, the Sydney Observatory, Bondi Beach, Taronga Park Zoo, the Australian Museum, the Powerhouse Museum, bushwalking in the Royal National Park, cycling in Centennial Park, sailing on Sydney Harbour, taking a ferry to Manly, and other activities that have included a bush dance, rock climbing and going to the movies or the theatre. From very early on in the history of the ISS, there was at least one 'Aussie barbecue'. From 1993 onwards, a harbour cruise has been held on the 'middle' Saturday night. The ISS scholars regard it as one of the best parts of the fortnight; for some of the organisers in the Foundation, it is an inexpensive 'Saturday-night lock-up' of highly spirited ISS scholars. Some ISS scholars in the early years were taken water skiing by Messel. ISS scholars have always commented favourably on the level of independence, freedom and self-responsibility afforded them – the structured program of the ISS does not impede their ability to explore and enjoy Sydney responsibly.

From at least 1987 onwards, a tradition developed of holding a concert-cum-revue for the ISS scholars who were living at Cranbrook. Once the ISS became fully residential, this became a major activity in the second week, and gave the teams of overseas ISS scholars full opportunity to demonstrate their talents, whether musical, variety or comedic. Another well-received tradition in later years was a disco night, often after the end-of-fortnight guest talk and presentation by Messel.

In 1993, a trivia night was held in the first week (at St John's College at the University) to allow the ISS scholars to get to know each other. Compered by Dr Karl Kruszelnicki, it proved very popular and has been repeated at many subsequent ISSs,

although in some instances it has been modified to a trivia 'relay race' event. Over the years, quiz topics have included 'Famous People', 'Astronomy', 'The Earth', 'Plants and Animals', 'Potions and Lotions', 'Bits and Pieces', 'Medicine' and 'Obscure Facts'.

In 2007, receptions were held by their consuls general for the visiting ISS scholars from the United States and the United Kingdom. ISS scholars from the relevant country were permitted to take an Australian ISS scholar with them. In 2007, the reception for the United States ISS scholars was held aboard the USS *Kitty Hawk*. These events proved very successful and have been repeated at each subsequent ISS, now extending to the consuls general of Japan and India.

The year 2005 also saw the introduction of a gala reception in the Great Hall of the University in the middle of the second week. This event allowed supporters and past ISS alumni to meet the current ISS cohort and catch up with Messel and other members of the School. The occasion is now used for the presentation of the Basser and Mulpha leadership awards. Apart from the warmth of the occasion and the grand speeches, including Messel's exhortations to his ISS alumni, the evening has become famous for the chocolate fountain installed for the current ISS cohort.

The Basser Prize (a medal) was named after Len Basser, a distinguished and much-respected science teacher from Sydney Boys High School whose students included Robert May. The Basser Prize is awarded to an ISS scholar who demonstrates leadership in science through a contribution of originality of thought and a willingness to assist others in participating in the ISS. This prize is generously sponsored by the Commonwealth Government.

The Mulpha Prize (also a medal) recognises the international kinship fostered through an ISS scholar who displays diplomacy, friendship, encouragement and understanding of students from all cultures. The winner is an ISS scholar who brings together students of different cultures and countries in a spirit of

friendship and stronger international ties. This prize is generously sponsored by Mulpha Australia.

The winners of these two prizes are chosen by the ISS cohort and the 'staffies' (see later in this chapter for an explanation of staffies and their role).

In 1993 the practice of a formal farewell dinner on the Friday night began. Certificates were presented at this event, along with Young Scientists of Australia awards. From 2009 onwards, the formality of the dinner has been abandoned to allow the ISS scholars more time to relax and spend time together on their last night, with the certificates and awards now being presented earlier in the second week, in the Slade Lecture Theatre.

In 1993 casual clothing was allowed during the fortnight for the first time, with school uniforms (for those who had them) only required on the first and last days and at the formal dinner.

From 1991 onwards, several of the ISS lecturers have participated in public talks or public debates. Examples include Robert May's public talk in 1991 on 'Predicting Chaos'; the 1993 debate between Richard Haworth and Thomas Gold on 'The Origin of Carbon Mineral: Biological or Non-biological?'; the 1995 National Selby Lecture by Professor Malcolm Longair on 'Measuring the Fundamentals';[2] a talk on 'Pseudoscience' by Associate Professor Ian Johnston in 1999; talks in 2001 by Professor Suzanne Hogg on 'Making Movie Stunts Safer' and by Dr Lea Williams on 'How the Brain Produces Emotions'; talks in 2007 by Dr Caleb Owens on 'Mysteries of the Mind' and by Professor Lord Robert Winston on 'Manipulating Genetics – Threat or Promise?'; a debate in 2009 by the 'Sleek Geeks', Adam Spencer and Dr Karl, on whether the Moon landing occurred or had been faked; and in 2011, Professor Allan Clark spoke on the Large Hadron Collider. Bryan Gaensler, the 1999 Young Australian of the Year, gave an occasional address in that year. In 2003, additional talks were given by Australian Business, an affiliate of NSW Business Chamber, on careers and leadership. If the lectures were held away from the University (such as

those at the Art Gallery of New South Wales), the ISS scholars were transported to these talks and enjoyed the privilege of front-row seats.

ISS scholars, it seems, had few expectations for the fortnight beyond attending inspiring lectures and gaining some insight into the theme of the ISS. For overseas ISS scholars, there was the excitement and anticipation of overseas travel, often a first overseas experience, and a desire to get to know the Australian lifestyle.

For the ISS scholars who came from outside Sydney in the period before the ISS became fully residential, there was the additional experience of bonding with a host family or with fellow ISS scholars who had travelled from outside Sydney, including over games of pool and billiards or during trivia nights. For those ISS scholars lucky enough to be on a round-the-world ticket, there are rich memories of building a human pyramid at the Taj Mahal and playing 'hotel balcony frisbee' in Hawaii.

Overseas ISS scholars have memories of arriving a day or two before the start of the ISS and being met at the airport, usually around 6.00 am, by representatives of the University or (in the early days) by host families wearing University identification cards and blue and gold ribbons. Despite the early hour, a press conference at the airport with Messel usually awaited the ISS scholars and their escorts.

Before the ISS became fully residential, ISS scholars would arrive on the first day and register. They would receive the book of lecture materials (and an encouragement to read it) and a blue plastic satchel (an in-kind contribution from Ampol Petroleum) containing a name badge, a full lecture program, details of the tours of inspection with the ISS scholars broken into groups, details of the reception/dinner, details about lunch, an admonition against noisy behaviour especially during televised lectures, and a list of lecturers and scholars. There were two lectures each day, one around 8.45 am and the other straight after lunch. The day would end around 3.30 pm. In most years, a

free morning tea would be provided. Lunch was available at the University Union Buttery and, in later years, at Manning House and the Women's Sports Union. The menu for lunch included meat pies, sandwiches, fish by the piece, cakes, fruit, tea, coffee and flavoured milk. In later years, yoghurt and pasta were added to the menu. There were daily tours of the various departments in the Physics Building. Scientific films from the United States Atomic Energy Commission, the United States Information Service, the Australian Atomic Energy Commission and CSIRO would be screened between lectures. There might be an informal reception one evening at Manning House (or later, the Wentworth Building) or a formal dinner at Cranbrook School. Seldom was there both, especially if economising was warranted. At one of those events, medals and certificates (printed by the New South Wales Government Printing Office, before the University had facilities to print the certificates itself) would be presented. At the more formal events, dignitaries were in attendance, including the New South Wales Minister for Education, consuls general, the lecturing faculty and escorts. There were no weekend activities. Five sets of *Encyclopaedia Britannica* were presented, two sets to local ISS scholars, one male and one female, and one set each to an ISS scholar from the United States, the United Kingdom and Japan. These were given to the ISS scholars who, through asking the most searching questions, distinguished themselves as the most outstanding. Over time, and mainly for financial reasons, the international sets of *Encyclopaedia Britannica* (or 'EB', as they were known) were dropped, and eventually in 1975 the local sets were too. For those of you who were not around or living at this time, these were enormously generous and valuable prizes. In time, the outstanding ISS scholar awards were replaced by occasional book prizes and, in more recent times, by the Basser and Mulpha leadership awards.

For those staying at Cranbrook, there were all the features of boarding school: rising bells, lights out, a school library, a school laundry (as long as items of clothing were marked), a

school health sister and recreation facilities. Breakfast and dinner were provided. Permission to visit family and friends could be granted. A chartered bus provided transport to and from the University. While the girls got the dormitories, the boys slept on stretchers on covered outside balconies – eventually they recognised this as a treat, given the prime water views.

Scholars who attended once the ISS became fully residential have enduring and affectionate memories of the 'house parents',[3] of talent and music nights and variety concerts, and of award ceremonies. Lots of tears were shed upon departure. For everyone, the fortnight concluded too quickly and too soon.

ISS scholars from the United States and the United Kingdom have memories of being called the USPASS and the RIAAS respectively, and would in later years sign correspondence using these acronyms.

One of the most enduring memories for ISS alumni are Messel's aphorisms, neatly written on the blackboards (in turn green,[4] now whiteboards) behind the speakers. Some of the most memorable and oft-repeated of Messel's 'blackboard hints' include:

- 'The harder you work, the luckier you get'
- 'Take the hard options and you'll be rewarded for the rest of your life'
- 'All matter consists of atoms, all knowledge – of hard work'
- 'Major factor for failure – laziness!!!'
- '(Four rules): (1) Think, (2) Hard work, (3) Hard work, (4) Hard work'
- 'Sleep fast!'
- 'The smart are smarter than ever before, the dumb are dumber than ever before'
- 'The greatest pleasure in life is accomplishment'
- 'The quality of one's life is directly proportional to one's commitment to excellence – whatever the field'.

Beyond these common themes, each ISS scholar left with unique impressions. These usually reflect the background of the ISS scholar, especially if they had travelled from abroad, from interstate or from regional or rural areas, and given some were less worldly or mature than others. Until the ISS became fully residential, not all ISS scholars experienced a residential aspect of the fortnight, with different accommodation arrangements applying within cohort groups. For ISS scholars who were billeted, activities with the host families added to the memories, and many have kept in touch, including through visits in Australia and abroad by second generations. Over the years, a number of ISS scholars returned to the School for undergraduate and postgraduate studies.

One particularly memorable and commented-upon incident during the ISS fortnights was Collins' 'simulated nuclear decay of a radioactive substance' during one of his lectures. Before the lecture, all the ISS scholars had been given a dozen or so sheets of paper that had been scrunched up into little balls to represent neutrons and given necessary instructions on the delivery of the neutrons. Collins started the demonstration by randomly throwing a neutron into the crowd. Depending on where it landed and how close to an ISS scholar it landed, the ISS scholars obeyed Collins' earlier instructions and launched their own neutrons. Collins varied the launch parameters, in turn demonstrating an unsustainable reaction, a controlled reaction and a nuclear explosion. Collins also involved other ISS scholars in various front-of-the-class experiments, with pendulums suspended from the roof of the Slade Lecture Theatre and almost touching the ground, and with balloons and smaller rubber balls dipped in liquid nitrogen and then thrown against a wall so as to shatter. The reward for assisting was a 'lamington', a quintessentially Australian cake previously unknown to the overseas ISS scholars.

In 1995 the Sydney chapter of the Young Scientists of Australia (YSA) became involved for the first time in organising

and staffing the evening and weekend activities (this coincided with the ISS becoming fully residential in that year). More serious activities organised by the YSA included a YSA Science Show and a YSA Communications Seminar, as well as organised science experiments. The YSA was paid a small fee by the Foundation for providing this support. At this time, they were just known as 'staff' or 'Science School leaders'. In later years, past ISS scholars have been able to apply to return to the next ISS as 'staffies' to take on these roles. There have been two levels of 'staffies': first-time 'staffies' and the 'senior staffies', who had been 'staffies' at the previous ISS. Competition for the staffie positions is intense. On three occasions, staffies have been previous overseas ISS scholars who have paid their own fares to return. Usually there have been between around eight staffies but in some years as many as thirteen.

The criteria used for recruiting staffies include an ability to establish rapport with Year 11 and 12 students; an ability to interact with a wide range of people; a willingness and ability to explain science concepts clearly; a willingness and ability to follow directions; maturity, initiative and an ability to assume responsibility; and a 'clean' driver's licence.

The staffies have played an important part in the success of the ISS, especially in ensuring that all ISS scholars are quickly assimilated into the spirit of the ISS and feel comfortable in participating in the full range of ISS activities.

The records of the Foundation are full of handwritten and typed letters of thanks and vivid memories from ISS scholars, escorts and parents. Many sent immediate letters of thanks, others remained in contact by sending annual Christmas cards. Several wrote asking for subsequent years' books of lectures. Messel kept in touch with a large number of ISS scholars for many years by sending copies of *The Nucleus*. He never failed to respond to a letter or card containing news and he always did so with generosity, courtesy and genuine interest (so, too, in later years, did Don Millar and David Varvel). Messel would read out

a good letter or card to members of the School and current ISS scholars. For several years, some of the escorts (especially the Whitmers in the United States) sent out an annual newsletter on cohort news. Nothing delighted Messel more than a visit from a former ISS scholar or catching up with former overseas ISS scholars or escorts on his frequent travels abroad. He happily gave career and course-selection advice as well as letters of support for university scholarship applications. He even took time to respond to an ISS scholar's question on the psychology behind satisfaction with scientific research. On a number of occasions, Messel arranged research studentships within the School (as long as the ISS scholar had a first-class honours degree in physics from an Australian university or had achieved excellence abroad) and site visits to observatories or other scientific facilities in New South Wales.

Some ISS correspondents have proffered constructive criticisms of the ISS, mainly around increasing post-lecture discussion, even if that means turning off the cameras. The only substantive criticism that has been voiced over the years has related to 'college food' – the criticism is not constructive, but some note that it adds to the memories of the ISS!

Chapter 8

Dissemination of the ISS and media: books, television and the internet

The success of the books of lectures has paralleled the success of the lectures themselves. A book containing the entire lecture materials for each ISS has been prepared and edited within the School. The editors of each book are identified in Appendix 1. The book is published each year before the start of the ISS, so that ISS scholars can read the lectures before listening to them. Apart from the free copies that were made available to schools and science teachers, there was a time when the books were republished worldwide each year (by Pergamon Press, Oxford, as part of the Pergamon International Library of Science, Technology, Engineering and Social Studies), so that members of the general public could enjoy them and read them while the lectures were being televised.

Many generous letters of thanks from school principals and schools are kept within the Foundation's archives. Some seem to suggest that the schoolteachers viewed them as a useful resource.

The Nucleus notes that the books from 1962, 1963 and 1964, which were released as a group, had the 'top review' in the

Times Educational Supplement, *Physics Today*, the *American Journal of Sciences* and the *Contemporary Journal of Physics*.[1]

The high point of publicity was the 1967 ISS, when the American ISS scholars were met at the airport by a large number of press, radio and television representatives. *The Nucleus* notes that for every man, woman and child living in the greater Sydney area, more than 100 column inches of space were devoted by Sydney publications to the 1967 ISS.[2] The *Sydney Morning Herald* on 9 January 1967 commented in this way in its editorial:

> Professor Harry Messel is often criticised, both in public and private, but only a very prejudiced person would find fault with one of his more lively creations. This is the annual Science school which opens today…By introducing High School students to some of the world's finest scientific minds this school has already proved its value beyond any doubt…This year Professor Messel has brought off another stroke by including American high school students.

The opening ceremony in 1967 had as its guests William McMahon, then Federal Treasurer (and later Prime Minister) and Ambassador Clark from the United States – Messel had a film of this ceremony sent to the White House. In 1968, Messel secured for the opening ceremony Malcolm Fraser, then Federal Minister for Education and Science (also a future Prime Minister), the New South Wales Minister for Education, the Director-General of Education, the Ambassador of Japan, the Ambassador of the United States and the Deputy High Commissioner for the United Kingdom.

In most cases, the papers in the books are written in the first person. The writing is elegant, concise, clear and effective. In the early years, especially when the topic was intended as an overview of an entire field of physics, the books were often more up-to-date than university textbooks (even though they avoided any calculus).

From 1969 to 1979, Guth was responsible for the design and production of the lecture books. As no one is named before or after those dates, we can assume this fell within the broad responsibility of the editors themselves.

Up until 1975, each book of lectures was hard-bound. The books can be best described as 'nuggetty' – in their original dimensions, 8½ by 5½ inches (21.5 by 14 centimetres) – often running to 500 pages and richly illustrated with black-and-white drawings, photographs and hand-drawn diagrams (including Hertzsprung-Russell diagrams), and in some instances more than sixty drawings, photographs and diagrams per lecture. The only exceptions were the colour plates of stamps depicting Miller's 'Men of Science' (1965) and of a hand-drawn table of the elementary particles (1966). In those early years, the format of the book was very simple: the book's title; a preface; a contents list with the names of the contributors and the title of the lectures, often abridged, so that the scope of the lectures was not apparent until they were turned to ('chapters' in each lecture are identified in the notes for Appendix 1), and the names of the sponsors. The format changed in 1989, becoming a softback with new and larger dimensions, 25 by 17.5 centimetres. They were first desktop-published in 1995. Under Cram's editorial leadership, the words 'In the Pursuit of Excellence' first appeared on the cover or on the frontispiece of the book in 1995. Cram was also responsible for the first appearance of brief biographical notes on the lecturers. The first all-colour ISS book appeared in 1997 (*Light*). This is in strong contrast to earlier frugality when, in 1989, colour images of fractal boundaries submitted by Robert May had to be omitted.

The 1962 lectures were televised by Channel 9 in Sydney and all other state capitals. The eleven lectures by Professors Bondi and Bracewell and Dr von Braun were chosen as particularly suitable for television. Due to their popular reception, the lectures were rescreened within a month of the end of the ISS. It was estimated that one in ten Australians viewed at least some of the

lectures. The more serious and technical lectures by Messel and Butler were not televised, even though similar lectures had been televised during the last science teacher science school in 1961.

In 1963, the lectures were televised each weekday at 7.00 am 'to afford people of all walks of life an opportunity to view the programme before going to work'.[3] By now, one in three Australians had seen some of the lectures. Miller's extraordinary showmanship made a major contribution to the unprecedented success of the lectures on television. In 1969, the Channel 9 network and the ABC jointly broadcast them to an even larger audience. This joint telecasting continued until 1973. Channel 9 alone telecast the 1974 ISS and the 1975 ISS. Telecasting in 1977 and 1979 was in colour, by Channel 7 under the production leadership of well-known journalist and film-maker Robert (Bob) Raymond. Lecturers were under special instructions on the use of slides and film, as these would be projected from the studio and not the lecture theatre. The series of lectures was successfully rebroadcast several months after the ISS.

In 1981, the ABC declined to broadcast the lectures, this time citing a busy transmission schedule already locked in from the previous year and stating a preference for 20-minute programs that better fitted the needs of teachers and scheduled lessons in the classroom. Messel made one last plea to Channel 9, only to receive a terse response from the then chairman, Kerry Packer:

> Any program which the ABC refuses to carry gives you some indication of its popularity. I have mentioned the Science School to my people and you would think the subject was The Bounty and my name was Bligh.

With Channel 7 also unwilling or unable to broadcast in 1981, the days of public television broadcasting of the ISS lectures were officially at an end.

In 1983, 1985 and 1993 the lectures were videotaped by the University Television Services. Apart from a few requests

for copies of the videos, there appears to have been no public dissemination. In 1999, a prototype was developed for webcasting the lectures, but there was insufficient sponsorship for this to occur. In 2003, seven lectures, including one by Dr Karl Kruszelnicki, were webcast, and the ISS scholars also received a DVD of the lectures. The lectures in 2005 were all webcast. In 2007, with an enlarged cohort of staffies that included a production crew, all lectures were webcast and podcast. This was also the first year in which the book of lectures was available as a downloadable pdf file. These practices have now been followed in 2009 and 2011 (and additionally, the lecture slides have been made available online, along with podcasts).

Chapter 9

The impact of the ISS, including spin-offs and copies, locally and abroad

One great shame is that the records of the Foundation do not indicate the careers later pursued by ISS alumni. One can guess that almost all would have gone on to tertiary studies. Googling alumni names has not always been instructive, especially for the female alumni, many of whom would have changed their names since attending the ISS. The 24 July 1975 edition of *New Scientist* contained some analysis of the first thirty-five British participants. It reported:

> Of the first 35 scholars, 23 went to Cambridge and nine to Oxford; it was not until 1973 that one of the recipients opted for a different university…medicine and natural sciences have been easily the most popular subjects of study…Of those who have kept in touch with the Royal Institution, only one appears to have stopped studying after a first degree.[1]

There have been several spin-offs of the ISS. In 1994, the Association of International Education, Japan, in conjunction

with the National Laboratory for High Energy Physics, Okazaki National Research Institute, ASF Japan Association, YFU Japan Foundation and the Ministry of Science and Culture, Japan (Monbusho), held the first Japanese International Science School. Two Australian students attended. The Japanese International Science School was modelled on the ISS and was held annually until 1999, when difficult financial conditions in Japan brought them to an end. The students, including scholarship-winners from Australia, Canada, Indonesia, Korea, Malaysia, New Zealand, Philippine, Singapore, Thailand and the United States, spent twelve days in Japan in different research institutes, learning research techniques, developing linkages with other high school students and establishing mutual understanding and stronger bonds with students from other Asia-Pacific countries. The Australian scholars were selected after a public call for applicants by a judging panel comprised of the Head and other senior members of the School.

The Australian National University in Canberra established the National Youth Science Forum (NYSF) in 1984, a twelve-day program for students moving into their final year of high school who are thinking about a career in science, engineering or technology. Courses are held in Canberra and Perth. Unlike the ISS, students pay to attend, with some industry and university subsidy from NYSF partners. One ISS scholar who had also attended the NYSF expressed a strong preference for the ISS because it 'gave the ISS scholars far greater freedom, it was less regimented and less predictable and it did not overly emphasise personal development'. A contrary view, perhaps not inconsistent with the earlier comments, is that a key focus of the NYSF is developing 'character', hence it has no qualms in seeking to provide a richer set of experiences and developing communication and similar skills.

In the period from 1992 to 1997 the Foundation was the point of contact for and ultimately selected Australian high school students wanting to attend the United States Department

of Energy High School Science Students Honors Program. While not strictly a spin-off, this was a prestigious program in which students spent time at one of the Department of Energy's research facilities, including the Lawrence Berkeley National Laboratory, the Fermi National Accelerator Laboratory and the Oak Ridge National Laboratory.

Chapter 10

Some ISS trivia

- A handful of ISS scholars have paid for their own airfares or been sponsored by their school. They are the two ISS scholars from Auckland Grammar School in 1962, the Malaysian ISS scholars in 1993 and the two ISS scholars from Canada in 2009.
- The youngest ISS scholar is believed to be George Prahov from Merrylands in 1962, who had just finished his third year of high school. He had only come to Australia from China four years earlier and was awarded a special scholarship to attend the ISS.
- In 1994, *The Scholar* was launched as a newsletter for the benefit of ISS scholars, escorts, sponsors and lecturers. The archives of the Foundation suggest there was only ever one edition, however, no. 1 of February 1994.
- Brian James, an ISS alumnus from 1962, became Head of the School of Physics in 2003.
- In 2001, Dick Collins enjoyed the residential experience of an ISS by living in at St John's College for the fortnight.

- The Governor of New South Wales became patron of the ISS in 2003 and opened the ISS in that year.
- There are at least three known occasions on which a parent and their offspring have both been ISS scholars: Lawrence, Edward and Andrew Cram; James and Felicity Allen; and Trevor and Andrew Danos.
- There is at least one known occasion when ISS alumni have married: James Traill and Hiromi Inoue (ISS 1975). There are also several reported occasions when an ISS alumnus has married the sibling of another ISS alumnus.

Epilogue

Messel's arrival at the School in 1952 reinvigorated physics at the University. Existing departments were strengthened and new departments were established, and in 1954 he founded the Foundation. Messel's most visionary and enduring creation has been the ISS. To this day, Messel still receives spontaneous letters and calls from ISS alumni. Scholars and alumni years have been moved to compose paeans to the ISS, including 'Holiday Lost' from 1981 by Carolyn Field of North Ryde High School, when the theme of the ISS had been 'The Biological Manipulation of Life':

The Science School is rather cool,
It's not a waste of time.
The lectures are so thrilling
That the walls we try to climb.

As head, Professor Messel tells,
In filling out his role,

That if we don't do Physics
We'll all end up on the dole.

We are quite multicultural;
From private schools and state.
From Aussieland and overseas,
Our intellects equate.

While at the lectures, we are all
Referred to as: 'The SCHOLARS',
So does this mean when we grow up
We'll make a pile of dollars?

When our pet balloons in lectures burst,
Prof. Millar does not smile.
It seems for all the world, as if
He thinks we're juvenile.

We have tops fun at lunchtimes,
The football games are neat,
The uni students beat us
'Cause they know more ways to cheat.

They're trying to confuse us all
With talk of DNA,
We know that ABC comes first,
We weren't born yesterday!

So be careful when you fool with genes,
Or handle chromosomes,
For the life that you manipulate
Could be your very own!

Messel rightly regards the ISS as having had the greatest impact of all the things he has done, and this is certainly true

from a long-term point of view. Messel's concept of honouring excellence, of identifying and nurturing the 'movers and shakers', of supporting 'the best of the best of the best' and lifting them to their maximum potential, and of inviting and securing some of the world's finest and most inspiring achievers in science as lecturers, has proved to be a winner. Messel has never deviated from these original aims. The execution of his concept by the Foundation and the School is nothing short of brilliant. Its impact, if only measured by reference to the ISS scholars, has been tremendous. Even if ISS scholars might have forgotten what was said to them in lectures, they usually remember the names and qualities of some of the lecturers, and no matter what, they always remember, like and admire Messel and his principles.

From the perspective of the ISS scholars, the legacy of the ISS is manifold: it honoured talented students, interested them in science, pushed them to become high or higher achievers and broadened their academic interests and horizons; it created international perspectives and understanding for the ISS scholars;[1] it cut down any vanity or arrogance by showing the ISS scholars that there were others just as smart; and it established lifelong friendships. It completely fulfilled all of its desired goals and desired outputs described in Chapter 1. Add to that broader benefits for the School and the University, including fostering international contacts and securing a large number of former ISS scholars as future researchers, and the ISS can only be seen as an unqualified success.

The ISS could never have been achieved without Messel's energy, stamina, determination, tenacity, focus, brilliance, resourcefulness, and outstanding networking and fundraising skills. Messel is a generous human being and a warm friend. He does not shirk a fight and the word 'no' is simply not in his vocabulary. He alone took the ISS from concept to reality, and he did this in an unbelievably short time. He had the immense good fortune to have been supported by:

Butler, a brilliant and talented physicist who gave the School the necessary administrative and intellectual leadership and direction when Messel was focused on other matters or away from the University; Guth, his inexhaustible, trusted and meticulous colleague who managed the Foundation's almost endless and at times delicate correspondence with efficiency and aplomb; and Rita Knight, his highly talented, refined, gracious, unfailingly courteous, resourceful and devoted personal assistant, who served as assistant secretary to the Foundation from 1968 and who succeeded Guth as secretary of the Foundation. The calibre and leadership of the Foundation directors and ISS organisers who came after Messel, most especially Don Millar and Cram, and the very clear template that Messel left for them, with the overriding requirement for the 'Pursuit of Excellence', ensured the ongoing success of the ISS. Success usually requires some element of luck – just being in the right place at the right time – but as Messel has stated so many times, 'The harder you work, the luckier you get'. There is probably no better word than 'remarkable' to describe the existence, endurance, achievement and international reputation of the ISS. The ISS and Messel have been inspirational. As Messel himself acknowledges, the ISS has changed lives and had an impact beyond comprehension.

There is a charming but telling story recounted in *The Nucleus* in which Messel reflects on the retirement of the then Vice-Chancellor, Sir Stephen Roberts:

> Unknown to many of you, every time I come back from overseas, every time I do have something to report, I make an appointment with Sir Stephen and go and see him. He makes the odd little jibe or two but always pats me on the back when I leave the room and says, 'Messel – carry on'.[2]

In 1965, Messel observed that that the ISSs are one of the most successful things the Foundation has ever done and must

never be allowed to die.[3] In 1967 he aspired to make the ISS almost like Nobel prizes for high school students.[4] Certainly, attending an ISS was an experience, one about contributing, definitely not being a passive receiver of knowledge.

From the time of President Johnson's involvement, the Foundation took pleasure in quoting Ralph Waldo Emerson's words: 'The true test of civilisation is not the census, nor the size of the cities, nor the crops – no, but the kind of man that the country turns out'.

President Johnson, in his 1968 address to the United Stated, United Kingdom and Japanese scholars gathered at the White House, captured well the essence of the student experience and why the close to 4,000 alumni cherish and are inspired by their time at the ISS:

> There is one more thing that matters more [than trained intelligence], and there is one thing that is more important than all of man's knowledge and all of man's skill – that one thing we need to concentrate on and try to develop every day – that one thing is better human understanding. At a time when nations are quarrelling, when differences of race and class and religion trouble people everywhere, when there is general restlessness among the youth of all lands, when there is an insecure feeling among many, many peoples, when mighty armies can cross borders and people are not sure of what tomorrow holds for them – then your journey is an important one because the trip that you are beginning, in my judgment, offers great promise to increase and to enrich and to promote better understanding between men and between nations.

Not a bad speech from the President on a day when his mind must have been elsewhere – Russia had just invaded Czechoslovakia.

Despite the financial vicissitudes experienced by the Foundation, the ISS was always true to its motto 'In the Pursuit of Excellence'. If nothing else has been achieved, nearly 4,000

ISS scholars have had an enriching and rewarding experience and, in whatever field they might have chosen, understand the universality of science and its importance to the world and to humanity, and the importance to themselves of striving for excellence.

For many alumni, the history I have presented here might be missing some elements: in some years there were no medals and no $25 student allowances; in some years, lunch was available at the Women's Sports Union rather than elsewhere on campus. I would hope that these differences are minor and inconsequential. Each alumnus was uniquely privileged to meet Messel and to grow as a person. For some, attendance at the ISS was a key factor in their decision to pursue a lifelong interest in science or turn away from some earlier career goal, having found a new or a renewed interest in science. For every alumnus, Messel was, is and always will be a hero, a once-in-a-lifetime encounter and a constant reminder that excellence deserves to be pursued no matter the financial circumstances, the politics or – in the words of Messel – 'any other bloody thing!'

Serious and focused fundraising is currently being planned by the Foundation to increase the corpus of the Messel Endowment and enable the ISS to be restored to an annual event.

Meanwhile, the concept of the ISS continues to evolve. This is quite natural – excellence is not a static concept. Social media will have an important role to play. Even the book of lectures might need to be replaced by more modern modes of data capture and storage. What is critical, however, is that the style, feel, size and nature of the ISS are preserved. To me, the critical features that should never change include the following:

- The name of the ISS must remain 'The Professor Harry Messel International Science School'. The ISS must focus on science generally and should not be confined to physics. The ISS must honour excellence and must

suitably recognise and memorialise the seminal role and contribution of Messel. To the fullest extent possible, the ISS must include and showcase science at the University.

- The format must ensure that the ISS is an 'outstanding' and 'life-changing' experience for the students, and that the international reputation of the ISS is maintained and enhanced. At least one internationally recognised and eminent scientist must be a member of the ISS teaching faculty. The ISS must endeavour to remain at the leading edge of science and must include elements of interactive learning. Students must continue to receive a memento such as the book of lectures or a medal.
- The ISS must be held at least biennially and must be residential for all students. The students must attend on full scholarships (but, generally speaking, without the Foundation being responsible for international travel costs of the students). There must be gender balance. The student cohort must be 130 to 150 senior high school students from across Australia and overseas.
- Students must be independently and competitively selected on the basis of merit (including academic ability and future leadership qualities). Specific focus must be given to attracting a small number of Indigenous and low-socioeconomic-status students who otherwise might not qualify.
- The excitement of science and the achievements of the ISS must continue to be shared with the public through webcasts, podcasts and whatever technologies succeed them.
- A book of or other permanent means of recording and accessing lecture notes and papers for the ISS must be available before the commencement of the ISS. This is all the more important for those ISS scholars for whom English is not their first language.

It is hoped that in the future the School will maintain a more comprehensive and extensive ISS database so that the next chapter in the history of the ISS can access and analyse a rich holding of information that includes data on the subsequent careers of ISS alumni.

Appendix 1
ISS DATES, TITLES, TOPICS AND SPEAKERS[1]

1962 (8–19 January), 5th ISS

A Journey through Space and the Atom

(Selected Lectures in Astronomy, Space Rocketry and Physics, Edited by S. T. Butler and H. Messel)

- Hermann Bondi, Professor of Applied Mathematics, King's College, University of London – 'The Structure of the Universe'[2]
- Ronald N. Bracewell, Professor of Electrical Engineering, Stanford University – 'Life in the Galaxy (Are We Alone?)'
- Wernher von Braun, Director, National Aeronautics and Space Administration [NASA] – 'Space Rocketry'[3]
- Stuart T. Butler, Professor of Physics (Theoretical), School of Physics, and Harry Messel, Professor of Physics and Head of the School of Physics – 'Elementary Atomic Physics and Applications of Atomic Energy'[4]

1963 (7–18 January), 6th ISS

The Universe of Time and Space

(Twenty Selected Lectures in Astronomy, Cosmology and Physics, Edited by S. T. Butler and H. Messel)

- R. A. Lyttleton, Fellow and Lecturer of St John's College, Cambridge, and Reader in Theoretical Astronomy, University of Cambridge – 'The Moon, Planets and Comets in the Expanding Universe'
- Hermann Bondi, Professor of Applied Mathematics, King's College, University of London – 'Gravitation and Modern Physics'[5]
- Robert Hanbury Brown, Professor of Radio Astronomy, University of Manchester – 'The Narrabri Stellar Interferometer'
- Stuart T. Butler, Professor of Theoretical Physics, School of Physics, and Harry Messel, Professor of Physics and Head of the School of Physics – 'The Atom, Electromagnetism and Relativity'[6]

- Thomas Gold, Professor of Astronomy, Cornell University, and Director of the Cornell University Center for Radiophysics and Space Research – 'The First Five Years of Space Research'
- Demonstration lectures were given by Professor Julius Sumner Miller from El Camino College in California

1964 (6–17 January), 7th ISS

Light and Life in the Universe

(Selected Lectures in Physics, Biology and the Origin of Life, Edited by S. T. Butler and H. Messel)

- Stuart T. Butler, Professor of Theoretical Physics, School of Physics, and Harry Messel, Professor of Physics and Head of the School of Physics – 'Atoms and the Universe – the Building Blocks and Environment for Life'[7]
- Ronald N. Bracewell, Professor of Electrical Engineering, Stanford University – 'Life in the Galaxy'
- M. Yčas, Associate Professor of Microbiology, State University of New York – 'Life and its Origins'[8]
- James D. Watson, Professor of Biology, Harvard University – 'The Replication of Living Molecules'[9]

1965 (4–15 January), 8th ISS

Time

(Selected Lectures on Time and Relativity, the Arrow of Time, the Relationship of Geological and Biological Time and on Men of Science, Edited by S. T. Butler and H. Messel)

- Stuart T. Butler, Professor of Theoretical Physics, School of Physics, and Harry Messel, Professor of Physics and Head of the School of Physics – 'Time and the Universe'[10]
- Hermann Bondi, Professor of Applied Mathematics, King's College, University of London – 'Relativity and Time'[11]
- Thomas Gold, Professor of Astronomy, Cornell University, and Director of the Cornell University Center for Radiophysics and Space Research – 'The Arrow of Time'

- Julius Sumner Miller, Professor of Physics, El Camino College, University of California – 'Men of Science'
- Julius Sumner Miller (as above) – 'Some Enchanting Questions for Enquiring Minds'
- Six demonstration lectures were given by Professor C. B. A. McCusker of the School of Physics, who on very short notice replaced Professor Julius Sumner Miller who had suffered a sudden and serious heart attack

1966 (4–14 January), 9th ISS

Atoms to Andromeda

(Selected Lectures on Theoretical Physics, High-Energy Nuclear and Cosmic Ray Research, Plasma and Thermonuclear Physics, Astronomy, Astrophysics and Electronic Computing, Edited by S. T. Butler and H. Messel)

- L. S. Peak, Lecturer in Nuclear Physics, School of Physics, and M. W. Winn, Senior Lecturer in Nuclear Physics, School of Physics – 'Cosmic Rays'[12]
- Robert Hanbury Brown, Professor of Astronomy, School of Physics – 'Light from the Stars'[13]
- M. I. Large, Senior Lecturer in Astrophysics, School of Physics – 'Observing the Radio Waves'[14]
- D. D. Millar, Associate Professor of Plasma Physics, School of Physics – 'Plasma Physics'[15]
- C. S. Wallace, Senior Lecturer in Electronic Computing, School of Physics – 'Digital Computers'
- Robert M. May, Reader in Theoretical Physics, School of Physics – 'Theoretical Physics'[16]
- Stuart T. Butler, Professor of Theoretical Physics, School of Physics – 'Physics in the New Senior Science High School Course'

1967 (9–20 January), 10th ISS

Apollo and the Universe

(Selected Lectures on the US Manned Space Flight Program and Selected Fields of Modern Physics and Cosmology, Edited by S. T. Butler and H. Messel)

- G. Mueller, Associate Administrator for Manned Space Flights, National Aeronautics and Space Administration [NASA] – 'Space Rocketry and a Man on the Moon'
- E. E. Salpeter, Professor of Theoretical Physics, Cornell University – 'The Evolution of the Stars and the Origin of the Elements'
- G. T. Seaborg, Chairman, US Atomic Energy Commission – 'The Transuranium Elements'
- Hermann Bondi, Professor of Applied Mathematics, King's College, University of London – 'Gravitation and the Universe'
- Thomas Gold, Professor of Astronomy, Cornell University, and Director of the Cornell University Center for Radiophysics and Space Research – 'Radio-astronomy'
- J. Sumner Miller, Professor of Physics, El Camino College, University of California – 'Biographical Essays'
- J. Sumner Miller (as above) – 'Quiz Questions'

1968 (26 August – 6 September), 11th ISS

Man in Inner and Outer Space

(Selected Lectures on the US Manned Moon Landing Programme, the Sun and Our Planet, Edited by S. T. Butler and H. Messel)

- Ronald N. Bracewell, Professor of Electrical Engineering, Stanford University – 'The Sun'[17]
- G. J. F. MacDonald, Executive Vice-President, Institute for Defence Analyses, Washington DC – 'Science and Technology of the Environment'[18]
- R. M. May, Reader in Physics, School of Physics – 'The Time Scale of Creation'[19]
- E. F. M. Rees, Deputy-Director, Technical, NASA, and Director, Apollo Special Task Team, NASA – 'Introduction to Space Flight'[20]
- D. K. Slayton, A. B. Shepherd and L. G. Cooper, NASA astronauts – 'Introduction to Space Flight'[21]

- A demonstration lecture was given by Professor Julius Sumner Miller from El Camino College in California

1969 (25 August – 5 September), 12th ISS

Nuclear Energy Today and Tomorrow

(A Course of Lectures on Selected Topics in the Fields of Nuclear and Atomic Energy, Edited by S. T. Butler and H. Messel)

- D. Z. Robinson, Vice-President of Academic Affairs, New York University – 'Science and Society'
- P. W. McDaniel, Director of Research, US Atomic Energy Commission – 'The Peaceful Uses of the Atom'[22]
- C. B. A. McCusker, Professor of High Energy Nuclear Physics, School of Physics – 'Cosmic Radiation'[23]
- W. K. H. Panofsky, Director, Stanford Linear Accelerator Center, and R. H. Dalitz, Professor of Theoretical Physics, Oxford University – 'Particle Physics'[24]
- A demonstration lecture was given by Professor F. C. Brown, University of London Institute of Education

1970 (24 August – 4 September), 13th ISS

Pioneering in Outer Space

(A Course of Lectures on Selected Topics in Modern Physics and Space Flight, Edited by S. T. Butler and H. Messel)

- Hermann Bondi, Professor of Applied Mathematics, King's College, University of London, and Director-General of the European Space Research Organisation – 'Europe's Space Effort'[25]
- Hermann Bondi (as above) – 'Gravitation'[26]
- G. Hage,[27] Vice-President for Development, Boeing Company, Lee B. James, Director of Lunar Operations, NASA, and G. E. Mueller,[28] Vice-President, General Dynamics Corporation – 'US Space Flight'[29]
- Sir Mark Oliphant, FRS, Emeritus Professor, Fellow of the Australian National University, Canberra – 'Science and Mankind'[30]

1971 (23 August – 3 September), 14th ISS

Molecules to Man

(Edited by S. T. Butler and H. Messel)

- Chapman Pincher, Science Editor, *Daily Express*, London – 'The Interaction of Science with Society with Special Reference to the Media'[31]
- Paul R. Ehrlich, Professor of Biology, Stanford University – 'Population, Resources and Environment'
- G. J. V. Nossal, Director, Walter and Eliza Hall Institute of Medical Research, Royal Melbourne Hospital – 'Immunity in a Modern Setting'[32]
- Richard J. Harris, Professor of Astronomy, University of Cambridge – 'Dolphins and Man (A Study in Mammalian Adaptation)'
- G. Porter, FRS, Director, The Royal Institution, London – 'Molecules to Man'[33]
- D. C. Phillips, FRS, Professor of Molecular Biophysics, Oxford University – 'Nucleic Acids'[34]

1972 (28 August – 8 September), 15th ISS

Brain Mechanisms and the Control of Behaviour

(Edited by S. T. Butler and H. Messel)

- L. C. Birch, Professor of Biology – 'Biology and the Image of Man'[35]
- R. M. May, Professor of Physics, School of Physics – 'Terrestrial Ecology Systems'[36]
- John Maddox, Editor, *Nature*, London – 'Problems of Predicting Population'[37]
- W. M. O'Neill, Emeritus Professor – 'Brain and Mind'
- W. Ross Adey, Professor of Anatomy and Physiology, University of California, D. B. Lindsay, Professor of Psychology, University of California, and James Olds, Professor of Biology, California Institute of Technology – 'Brain Mechanisms and the Control of Behaviours'[38]
- Demonstration lectures were given by Professor Julius Sumner Miller from El Camino College in California

1973 (27 August – 7 September), 16th ISS

Focus on the Stars

(Edited by S. T. Butler and H. Messel)

- B. J. Bok, Professor of Astronomy, University of Arizona – 'Probing Our Galaxy'[39]
- J. P. Wild, FRS, Chief of the Division of Radiophysics, CSIRO – 'The Sun'[40]
- Carl Sagan, Laboratory for Planetary Studies and Professor of Astronomy and Space Sciences, Center for Radiophysics and Space Research, Cornell University – 'Mars – the View from *Mariner 9*'
- R. Hanbury Brown, FRS, Professor and Head of the Chatterton Astronomy Department, School of Physics – 'A New Look at the Stars'
- R. D. Brown, Chairman, Department of Chemistry, Monash University – 'Molecules in Space – Galactochemistry'
- P. Goldreich, Professor of Planetary Studies and Astronomy, California Institute of Technology – 'The Evolution of the Universe'
- Frank D. Drake, Professor of Astronomy and Associate Director of the Center for Radiophysics and Space Research, Cornell University – 'The Radio Search for Intelligent Extraterrestrial Life'
- Demonstration lectures were given by Professor Julius Sumner Miller from El Camino College in California
- Professor Margaret Burbidge, FRS, Department of Physics, University of California, and Director of the Royal Greenwich Observatory, also gave two lectures (not included in the book of lectures) on 'Galaxies, Quasars and the Active Universe' and 'The Structure of the Universe: Galaxies and Quasars as Tools for Cosmology'

1974 (26 August – 6 September), 17th ISS

Solar Energy

(Edited by S. T. Butler and H. Messel)

- J. L. Tuck, Walker-Ames Distinguished Professor, Los Alamos Scientific Laboratory, Los Alamos – 'World Energy Resources and Consumption'[41]

- G. J. Pearman, Division of Atmospheric Physics, CSIRO – 'Energy Conversion, the Atmospheric Environment and Climate Change'
- R. G. Giovanelli, Chief of the Division of Physics, CSIRO – 'The Nature of Solar Energy Optical Magnification of Solar Radiation'[42]
- N. K. Boardman, Chief Research Scientist, Division of Plant Industry, CSIRO, and A. W. D. Larkum, Senior Lecturer, School of Biological Sciences – 'Biological Conversion of Solar Energy'[43]
- J. O'M. Bockris, School of Physical Sciences, Flinders University – 'Batteries'[44]
- R. N. Morse, Director of Solar Energy Studies, CSIRO – 'Thermal Conversion and Solar Devices Today'[45]
- L. W. Davies, Chief Scientist, Amalgamated Wireless (Australia) Limited – 'Direct Solar Production of Electricity'
- C. N. Watson-Munro, Professor of Physics and Head of the Wills Plasma Physics Department, School of Physics, and C. M. Horwitz – 'Selective Surfaces'
- D. W. George, Professor of Mechanical Engineering – 'Heat Transfer and Storage'

1975 (25 August – 5 September), 18th ISS

Our Earth

(Edited by S. T. Butler and H. Messel)

- G. M. Philip, Professor of Geology and Head of the Department of Geology and Geophysics – 'Time and Its Measure'
- G. M. Philip (as above) – 'The Atmosphere and Evolution'
- G. M. Philip (as above) –'The Origin of Life'
- A. Day, Senior Lecturer, Department of Geology and Geophysics – 'The Interior of the Earth'
- E. C. Leitch, Lecturer, Department of Geology and Geophysics – 'Chemical Composition of the Solid Earth'
- D. A. Falvey, Lecturer, Department of Geology and Geophysics – 'Geomagnetism'
- S. W. Carey, Professor of Geology, University of Tasmania – 'The Face of the Earth'

- S. W. Carey (as above) – 'The Necessity of Expansion'
- S. W. Carey (as above) – 'The Subduction Myth'
- J. T. Wilson, Professor of Geophysics and Director-General of the Ontario Science Centre – 'The Development of Continental Drift and Plate Tectonics'
- J. T. Wilson (as above) – 'The Life Cycle of Ocean Basins: Stages of Growth'
- J. T. Wilson (as above) – 'The Life Cycle of Ocean Basins: Stages of Decline'
- J. T. Wilson (as above) – 'Pre-Mesozoic Drift'
- J. T. Wilson (as above) – 'Possible Mechanisms, and the Nature of Plate Motion'
- T. Gold, Professor of Astronomy, Cornell University, and Director of the Cornell University Center for Radiophysics and Space Research – 'The Origin of the Terrestrial Planets'
- T. Gold (as above) – 'The Earth and the Moon'
- T. Gold (as above) – 'The Planets Inside the Earth's Orbit'
- T. Gold (as above) – 'The Most Tantalising of Planets: Mars'
- N. W. G. Macintosh, Emeritus Professor, Anatomy Department – 'The Evolution of Man and Ape'

1977 (29 August – 9 September), 19th ISS

Australian Animals and Their Environment

(Edited by S. T. Butler and H. Messel)

- T. J. Dawson, Professor of Zoology, School of Zoology, University of New South Wales – 'Evolutionary History of the Australian Fauna'
- E. Newsome, Division of Wildlife Research, CSIRO – 'The Red Kangaroo – An Example of Biological Indicators of Environmental Change'
- Green, Senior Research Scientist, Division of Wildlife Research, CSIRO, and P. Catling, Experimental Officer, Division of Wildlife Research, CSIRO – 'The Biology of the Dingo'

- H. Tyndale-Biscoe, Division of Wildlife Research, CSIRO – 'Environment and Control of Breeding in Kangaroos and Wallabies'
- H. Tyndale-Biscoe (as above) – 'Marsupial Reproduction – An Alternate Strategy'
- T. J. Dawson (as above) – 'Energy and Temperature Relationships of Marsupials with Some Comments on Monotremes'
- T. J. Dawson (as above) – 'Kangaroos: Advanced Mammals'
- G. B. Sharman, Professor of Biology, School of Biological Sciences, Macquarie University – 'Sex Determination and X Chromosome Inactivation in Marsupials'
- S. D. Bradshaw, Professor of Zoology and Head of the Department of Zoology, University of Western Australia – 'Reptiles and their Adaptation to Arid Environments'
- S. D. Bradshaw (as above) – 'The Regulation of Water and Electrolyte Balance in Desert Lizards'
- H. Heatwole, Associate Professor, Department of Zoology, University of New England – 'The Consequences of Leglessness'
- H. Heatwole (as above) – 'Adaptations of Sea Snakes'
- H. Messel, School of Physics – 'The Crocodile Programme in Northern Australia'
- G. J. W. Webb, Professional Officer, Environmental Physics Department, School of Physics – 'The Natural History of *Crocodylus porosus*: Habitat and Nesting'
- G. J. W. Webb (as above) – 'The Natural History of *Crocodylus porosus*: Growth, Movement, River Distributions and General Comments'
- M. J. Yerbury, Lecturer and Head of the Telemetry Group, Environmental Physics Department, School of Physics – 'Telemetry and Crocodiles'
- G. C. Grigg, Senior Lecturer in Biology, School of Biological Sciences – 'Ionic and Osmotic Regulation in the Estuary Crocodile, *Crocodylus porosus*'
- G. C. Grigg (as above) – 'The Body Temperature of Crocodiles and Dinosaurs'

- Demonstration lectures were given by Professor Julius Sumner Miller from El Camino College in California

1979 (27 August – 7 September), 20th ISS

Energy for Survival

(Edited by H. Messel)

- R. N. Bracewell, Professor, Radio Astronomy Institute of the Radioscience Laboratory, Stanford University – 'Energy Resources and Use: How It All Began'
- R. N. Bracewell (as above) – 'Energy Resources and Use: Man the Lazy Animal'
- Sir Hermann Bondi, Chief Scientist, Department of Energy, London – 'Energy Resources and Use: World Energy Demand'
- Sir Hermann Bondi (as above) – 'Energy Resources and Use: World Energy Supply'
- T. Gold, Director, Center for Radiophysics and Space Research, Cornell University – 'Energy Resources and Use: The Earthquake Evidence for Earth Gas'
- T. Gold (as above) – 'Energy Resources and Use: The Supply of Natural Fuels'
- L. C. Birch, Professor, School of Biological Sciences – 'Energy Resources and Use: Zero Energy Growth'
- J. B. Kirkwood, Commissioner, Western Australian State Energy Commission, and Professor, School of Biological Sciences – 'Energy Resources and Use: The Risk of Not Developing Energy'
- J. B. Kirkwood (as above) – 'Today's Energy Kings: Coal (Black and Brown): The Risk of Not Developing Energy'
- W. Leonard, Chairman, Ampol Petroleum Limited, Sydney – 'Today's Energy Kings: Coal (Black and Brown): Oil and Gas (Parts I and II)'
- R. A. Gross, Professor, Department of Mechanical and Nuclear Engineering, Columbia University – 'Today's Energy Kings: Coal (Black and Brown): The Potential of Nuclear Energy'
- R. A. Gross (as above) – 'Today's Energy Kings: Coal (Black and Brown): The Nuclear Fuel Cycle'

- R. A. Gross (as above) – 'The New Energy Sources: Fusion'
- R. N. Bracewell (as above) – 'The New Energy Sources: Electricity from Sunlight'
- B. Window, Solar Energy Group, School of Physics – 'The New Energy Sources: Solar Power: The Thermal Energy Source of the Future'
- Sir Hermann Bondi (as above) – 'The New Energy Sources: Hydro, Wind, Wave, Tidal and Geothermal Power'
- Sir Hermann Bondi (as above) – 'The New Energy Sources: Energy Storage'
- D. J. Nicklin, Head of the Department of Chemical Engineering, University of Queensland – 'The New Energy Sources: Liquid and Gaseous Fuels from Coal'
- M. G. Pitman, Head of the School of Biological Sciences – 'The New Energy Sources: Bioconversion'
- C. B. A. McCusker, Head of the Falkiner High Energy Nuclear Physics Department, School of Physics – 'Physics and Mankind: The Past Fifty Years'
- Demonstration lectures were given by Professor Julius Sumner Miller from El Camino College in California, who also gave one lecture on Albert Einstein (not included in the book of lectures)

1981 (31 August – 11 September), 21st ISS

The Biological Manipulation of Life

(Edited by H. Messel)

- W. J. Peacock, Chief of the CSIRO Division of Plant Industry – 'The Rise of Molecular Biology and Gene Manipulation'
- R. H. Symons, Department of Biochemistry, University of Adelaide – 'Structure and Replication of DNA'
- R. H. Symons (as above) – 'The Genetic Code and Protein Synthesis'
- J. Shine, Research School of Biological Sciences, Australian National University – 'Recombinant DNA Technology'
- J. Langridge, CSIRO Division of Plant Industry – 'Genetic Transformation in Higher Organisms'

- J. Pittard, Professor of Microbiology, Department of Microbiology, University of Melbourne – 'Nature's Manipulation of DNA: Jumping Genes'
- K. D. Brown, School of Biological Sciences – 'Anatomy of the Bacterial Chromosome'
- W. J. Peacock (as above) – 'Anatomy of the *Drosophila* Chromosome'
- J. Langridge (as above) – 'Recombinant DNA in Evolution'
- J. Shine (as above) – 'Cloning of Hormone Genes'
- J. W. Goding, Walter and Eliza Hall Institute of Medical Research, Royal Melbourne Hospital – 'The Impact of Recombinant DNA on Understanding the Immune Response'
- D. M. Danks, Professor of Paediatrics, Department of Paediatrics, Royal Children's Hospital, Melbourne – 'Diagnosis and Therapy of Genetic Disease'
- J. Pittard (as above) – 'The Recombinant DNA Debate: Social and Ethical Issues'
- W. R. Sowcroft, CSIRO Division of Plant Industry – 'Cellular and Molecular Plant Breeding'
- O. H. Frankel, CSIRO Division of Plant Industry – 'Conservation of Genes, Gene Banks and Patents'
- W. F. Bodmer, Director of Research, Imperial Cancer Research Laboratories, London – 'HLA – The Major Human Tissue Typing System'
- W. F. Bodmer (as above) – 'The Genetic and Cellular Basis for Cancer'
- B. Kerr, Professor of Preventative and Social Medicine, Commonwealth Institute of Health – 'Negative and Positive Eugenics I: A Chequered History; Utopian Ideas with Dangerous Consequences'
- B. Kerr (as above) – 'Negative and Positive Eugenics II: New Concepts of Human Quality Control'
- W. F. Bodmer (as above) – 'Implications of Advances in Genetics for the Future'

1983 (29 August – 9 September), 22nd ISS

Science Update

(Edited by H. Messel)

- Sir Hermann Bondi, Chairman, Natural Environment Research Council, England – 'Gravitation: Is It a Force?'
- Sir Hermann Bondi (as above) – 'How Dark Is the Universe?'
- Sir Hermann Bondi (as above) – 'Who Needs the World's Energy?'
- Sir Hermann Bondi (as above) – 'New Views of the Ocean'
- R. Hanbury Brown, President of the International Astronomical Union – 'Astronomy in Space'
- Professor B. Y. Mills, Head of the Astrophysics Department, School of Physics – 'Our Galaxy'
- M. I. Large, Reader, School of Physics – 'Pulsars: Beacons in the Milky Way'
- R. W. Hunstead, Senior Lecturer, School of Physics – 'Beyond the Milky Way – Radio Galaxies and Quasars'
- M. H. Brennan, Professor and Head of the Wills Plasma Physics Department, School of Physics – 'Nuclear Fusion – Energy Source of the Future'
- M. H. Brennan (as above) – 'The Tokamak Reactor'
- M. H. Brennan (as above) – 'Some Alternative Fusion Reactor Concepts'
- R. E. Collins, Professor of Applied Physics, School of Physics – 'Solar Energy – Fact'
- R. E. Collins (as above) – 'Solar Energy – Future or Fantasy?'
- C. B. A. McCusker, Professor and Head of the Falkiner High Energy Nuclear Physics Department, School of Physics – 'The Search for Particles'
- C. B. A. McCusker (as above) – 'The Fundamental Nature of Matter'
- W. F. Bodmer, Director of Research, Imperial Cancer Research Fund Laboratories, London – 'Molecular Genetics'
- W. F. Bodmer (as above) – 'Genetic Engineering'
- W. F. Bodmer (as above) – 'Tissue Typing and Immune Response: The HLA System'
- W. F. Bodmer (as above) – 'Genes, Viruses and Cancer'

1985 (26 August – 6 September), 23rd ISS

The Study of Populations

(Edited by H. Messel)

- R. M. May, Class of 1877 Professor of Zoology, Princeton University – 'Population Dynamics: Introduction'
- R. M. May (as above) – 'Population Dynamics: Single Populations'
- R. M. May (as above) – 'Population Dynamics: Interactions between Species'
- R. M. May (as above) – 'Population Dynamics: Communities'
- J. A. Menken, Professor of Sociology and Public Affairs, Assistant Director, Office of Population Research, Princeton University – 'Human Population Growth in Historical Perspective'
- J. A. Menken (as above) – 'Fertility Patterns and Population Change'
- J. A. Menken (as above) – 'Mortality and Migration and Their Effects on Population Size and Distribution'
- J. A. Menken (as above) – 'Population Problems of Developing Countries and Efforts to Alleviate Their Impact'
- R. V. Short, Professor of Physiology, Department of Physiology, Monash University – 'Reproductive Patterns in Man and the Great Apes'
- R. V. Short (as above) – 'Contraceptive Research and Development'
- J. Bannister, Director, Western Australian Museum, Chair, Scientific Committee of the International Whaling Commission (1979–82) – 'Sustainable Harvesting of Whale Populations: 1. Theory and Background'
- J. Bannister (as above) – 'Sustainable Harvesting of Whale Populations: 2. Putting It into Practice'
- G. Caughley, Senior Principal Research Scientist, Division of Wildlife and Rangelands Research, CSIRO – 'Problems in Wildlife Management'
- T. E. Lovejoy, Executive Vice-President, World Wildlife Fund, Washington DC – 'Biosphere Dynamics or Biological Diversity in Peril'
- T. E. Lovejoy (as above) – 'The Value of Biological Diversity'

- H. Messel, Professor of Physics and Head of the School of Physics – 'The Scholastic Crocodile'
- T. E. Lovejoy (as above) – 'Protecting Biological Diversity'
- T. E. Lovejoy (as above) – 'Forest Fragmentation in the Amazon: A Case Study'
- J. Sumner Miller, Emeritus Professor of Physics, El Camino College, California – 'So You Want to Be a Scientist?'
- A demonstration lecture was given by Professor Julius Sumner Miller (as above)

1987 (6–17 July), 24th ISS

Highlights in Science

(Edited by H. Messel)

- H. Messel, Head of the School of Physics – 'Science – What Is It?'
- Sir Walter Bodmer, Director of Research, Imperial Cancer Research Fund Laboratories, London – 'Genes, DNA and Genetic Engineering'
- Sir Walter Bodmer (as above) – 'Tissue Types, Transplantation and Disease'
- Sir Walter Bodmer (as above) – 'Genetics and Cancer'
- Sir Walter Bodmer (as above) – 'When Will Pigs Have Wings?'
- R. May, Professor of Biology, Department of Biology, Princeton University – 'Biological Populations and Deterministic Models with Apparently Random Dynamics'
- R. May (as above) – 'The Role of History in Biology: Stochastic Models with Apparently Deterministic Models'
- R. May (as above) – 'Voting Paradoxes, Prisoner's Dilemmas, and Other Games Animals Play'
- R. May (as above) – 'How Many Species?'
- Sir Gustav Nossal, Director, Walter and Eliza Hall Institute of Medical Research, Royal Melbourne Hospital – 'Strategies of Natural Defence Against Infections'
- Sir Gustav Nossal (as above) – 'Vaccines as History's Most Cost-effective Public Health Tools'

- T. Gold, Honorary Fellow of Trinity College, Cambridge – 'The Theory of Hearing'
- T. Gold (as above) – 'Pulsars'
- T. Gold (as above) – 'Moon'
- T. Gold (as above) – 'The Origin of Natural Gas and Petroleum'
- D. Phillips, Deputy Director, The Royal Institution, London – 'Lasers'
- D. Phillips (as above) – 'Lasers and Spectroscopy'
- D. Phillips (as above) – 'Nanoseconds to Femtoseconds'
- D. Phillips (as above) – 'A Little Light Relief (Lights and Lasers in Medicine)'
- R. Hanbury Brown, Emeritus Professor, School of Physics – 'Photons, Stars and Uncommon Sense'
- R. Hanbury Brown (as above) also delivered a talk in tribute to Professor Harry Messel (not included in the book of lectures, but included in the Millar Book)

1989 (26 June – 7 July), 25th ISS

Today's Science, Tomorrow's Technology

(Edited by M. H. Brennan AO, Professor of Physics [Plasma Physics], Head of the School of Physics, and Director of the Science Foundation for Physics, and Dr D. D. Millar, Secretary of the Science Foundation for Physics)

- R. A. Gross, Dean, Applied Physics and Engineering, Columbia University – 'High Temperature Physics and Fusion'
- J. M. Thomas, Director, The Royal Institution, London – 'The Chemist as the Architect of New Technologies'
- J. M. Thomas (as above) – 'Probing the Internal and Surface Structure of Solids'
- J. M. Thomas (as above) – 'Crystals Replete with Channels, Cages and Cavities'
- J. M. Thomas (as above) – 'Catalysts for Today and Tomorrow'
- L. E. Cram, Professor of Physics (Astrophysics), School of Physics – 'Images of the Radio Sky'

- D. Malin, Anglo-Australian Observatory – 'Astronomical Photography under the Microscope'
- B. J. Grosz, Gordon McKay Professor of Computing Science, Aiken Computation Laboratory, Harvard University – 'Machine Intelligence'
- E. A. Ash, Rector, Imperial College, Science, Technology and Medicine, London – 'The Philosopher's Stone – Semiconductors'
- E. A. Ash (as above) – 'Nuclear Energy and the Perception of Risk'
- E. Clarke, Professor, Plant Cell Biology Research Centre, School of Botany, University of Melbourne – 'Engineering Plants Using Recombinant DNA Technology'

1991 (1–12 July), 26th ISS

Living with the Environment

(Edited by L. E. Cram, Professor of Physics [Astrophysics], Head of the School of Physics, and Director of the Science Foundation for Physics, and Dr D. D. Millar, Secretary of the Science Foundation for Physics)

- R. V. Short, Professor, Department of Anatomy and Physiology, Monash University – 'Human Population Growth'
- R. M. May, Professor, Department of Zoology, University of Oxford – 'How Many Species are there on Earth Today?'
- R. M. May (as above) – 'And How Many Species Tomorrow?'
- R. M. May (as above) – 'Managing the Ark'
- M. Westoby, School of Biological Sciences, Macquarie University – 'Road Maps for Predator-prey Interactions'
- M. Westoby (as above) – 'Making Biotechnology Effective under Field Conditions'
- M. Westoby (as above) – 'Embryos with Packed Lunches'
- M. C. Ball, Fellow, Research School of Biological Sciences, Australian National University – 'Strategies of Carbon Gain and Water Use in Higher Plants'
- M. C. Ball (as above) – 'Coping with Extreme Light Environments'
- B. G. Thom, Professor of Geography, Pro-Vice-Chancellor – 'Sea Level Changes'

- G. P. Harris, Director, CSIRO Office of Space Science and Applications – 'Monitoring the Earth from Space'
- G. P. Harris (as above) – 'Climate Change and Marine Ecosystems: Some Australian Case Studies'
- B. McBratney, School of Crop Sciences – 'Environmental Changes and the Soil'
- G. I. Pearman, CSIRO Division of Atmospheric Research – 'The Changing Chemical Composition of the Atmosphere'
- G. I. Pearman (as above) – 'Understanding and Predicting the Behaviour of Global Climate'
- R. E. Collins, Professor of Applied Physics, School of Physics – 'Energy'

1993 (28 June – 9 July), 27th ISS

Carbon: Element of Energy and Life

(Edited by L. E. Cram, Professor of Physics [Astrophysics], Head of the School of Physics and Director of the Science Foundation for Physics, and D. A. Varvel, General Manager, Science Foundation for Physics)

- Professor Malcolm S. Longair, Jacksonian Professor of Natural Philosophy, University of Cambridge – 'The Origin of the Chemical Elements: The Case for the Hot Big Bang and Cosmological Nucleosynthesis'
- Professor Malcolm S. Longair (as above) – 'The Origin of the Chemical Elements: Element Formation and the Origin of the Galaxies'
- Dr David Allen, Research Astronomer, Anglo-Australian Observatory – 'Carbon in Space'
- Professor Emeritus Thomas Gold, Cornell University – 'The Outgassing Processes of the Earth: The Origin of Natural Gas and Oil'
- Dr Richard T. Haworth, Director-General, Geophysics Marine and Sedimentary Geoscience Branch, Geological Survey of Canada – 'Oil and Gas'
- Dr Richard T. Haworth (as above) – 'Coal'
- Dr Richard T. Haworth (as above) – 'Methane'

- Professor Richard Collins, Head of the Department of Applied Physics, School of Physics – 'Energy'
- Professor David Cockayne, Director, Electron Microscope Unit – 'Structure of Carbon Materials I: Exploring the Structure of Matter'
- Professor David Cockayne (as above) – 'Structure of Carbon Materials II: The Carbon Siblings'
- Damon Ridley, Associate Professor of Organic Chemistry and Pro-Dean of the Faculty of Science – 'Carbon Comes to Life I: Carbon: The Key Element'
- Damon Ridley (as above) – 'Carbon Comes to Life II: The Molecules of Life'
- Damon Ridley (as above) – 'Carbon Comes to Life III: Different Substances for Different Tasks'
- Dr Marilyn C. Ball, Fellow, Research School of Biological Sciences, Australian National University – 'The Carbon Cycle: Responses of Plants to Carbon Dioxide'
- Dr Marilyn C. Ball (as above) – 'Life: Coping with Light'
- Dr Marilyn C. Ball (as above) – 'Life: Coping with Cold'
- Dr Mike Barbetti, Director, the N. W. G. Macintosh Centre for Quaternary Dating – 'Radiocarbon Dating'
- Epilogue: 'Out of the Stars We Came' (a poem of 110 lines written by Lorna Hobbs, Science Teacher, Benalla High School)

1995 (2–14 July), 28th ISS

Breakthrough! Creativity and Progress in Science

(Edited by L. E. Cram, Professor of Physics [Astrophysics], Head of the School of Physics and Director of the Science Foundation for Physics, and [as Associate Editor] D. A. Varvel, General Manager, Science Foundation for Physics)

- Dr Michael M. Gore, AM, Director, Questacon – 'The Invention of the Telescope'
- Dr Michael M. Gore, AM (as above) – 'Discoveries with the Telescope from 1610 to 1900'
- Professor Malcolm S. Longair, Jacksonian Professor of Natural Philosophy, University of Cambridge – 'Technological Advances and

Astronomical Discovery: Optical Astronomy – From Tycho Brahe to the Hubble Space Telescope'

- Professor Malcolm S. Longair (as above) – 'Technological Advances and Astronomical Discovery: Optical Astronomy – The Opening Up of the Electromagnetic Spectrum – The New Astronomies'
- Associate Professor Lawrence Peak, Head of the Falkiner Department of High Energy Physics, School of Physics – 'Probing the Heart of Matter Part 1 – An Introduction to Accelerators'
- Associate Professor Lawrence Peak (as above) – 'Probing the Heart of Matter Part 2 – The World of Subatomic Particles'
- Dr Peter Robinson, Senior Lecturer, School of Physics – 'Laser Tests of Quantum Physics'
- Professor Helen M. Garnett, Executive Director, ANSTO – 'Hunting Invisible Organisms: The Role of Microscopy in the Development of Microbiology'
- Associate Professor Damon Ridley, Associate Professor of Organic Chemistry – 'Nuclear Magnetic Resonance: The Discovery – Some Nuclei Spin!'
- Associate Professor Damon Ridley (as above) – 'Nuclear Magnetic Resonance: From Spectrum to Molecular Structure'
- Associate Professor Damon Ridley (as above) – 'Nuclear Magnetic Resonance: It Is all a Matter of Timing!'
- Professor Lawrence Cram, Director of the Science Foundation for Physics and Head of the School of Physics – 'Michael Faraday 1791–1867: A Genius of His Time'
- Dr Holly K. Given, Executive Director, Project IDA, Institute of Geophysics and Planetary Physics, Scripps Institution of Oceanography, University of California, San Diego – 'Topics in Global Seismology 1995'
- Dr Karl Kruszelnicki, Julius Sumner Miller Fellow, School of Physics – 'Absolutely Fabulous Breakthroughs!'
- Carol J. Cogswell, Senior Lecturer, School of Physics – 'Optical Microscopy: Revealing the Design of the Microscopic World'

1997 (7–18 July), 29th ISS

Light

(Edited by J. A. Nicholls, Senior Research Fellow, Special Research Centre for Theoretical Astrophysics, School of Physics, and Executive Officer, Science Foundation for Physics, and R. E. Collins, Professor of Physics [Applied Physics], Head of the School of Physics and Director of the Science Foundation for Physics)

- Professor Richard Collins, Director, Science Foundation for Physics and Head of the School of Physics – 'The Nature of Light'
- Professor Richard Collins (as above) – 'Light – Particles or Waves?'
- Professor Lawrence Cram, Professor of Physics (Astrophysics) – 'The History of Light'
- Dr Peter Robinson, Reader, School of Physics – 'Light and Relativity'
- Professor Tony Larkum, Professor of Plant Sciences, School of Biological Sciences – 'Photosynthesis Reaction Centres – The Engine of Life'
- Professor Tony Larkum (as above) – 'Nature's Light Harvesting Kaleidoscope'
- Dr David Malin, Photographic Scientist at the Anglo-Australian Observatory and Adjunct Professor of Scientific Photography at Royal Melbourne Institute of Technology – 'Colour and Light in Astronomy'
- Dr David Malin (as above) – 'Photography and the Birth of Astrophysics'
- Professor Lawrence Cram (as above) – 'Doppler Effects in Astronomy'
- Dr Helen Gleeson, Senior Lecturer, University of Manchester – 'newIMAGES I. Liquid Crystal Displays: How to Manipulate Light with Molecules'
- Dr Helen Gleeson (as above) – 'newIMAGES II. Interference in Nature: The Twist in the Tail'
- Dr Judith Dawes, Senior Lecturer, Macquarie University, and Professor Jim Piper, Professor of Physics and Director of the Commonwealth Special Research Centre for Lasers and Applications at Macquarie University – 'Lasers: Their Development and Characteristics'

- Dr Peter Krug, Senior Research Scientist at the Optical Fibre Technology Centre of the University of Sydney, part of the Australian Photonics Cooperative Research Centre – 'Optical Communications: Meeting the Challenges'
- Ms Marrette Corby – 'What It Means to Be Blind'

1999 (5–16 July), 30th ISS

Millennium Science

(Edited by J. A. Nicholls, Executive Officer, Science Foundation for Physics, and Senior Research Fellow, Special Research Centre for Theoretical Astrophysics, School of Physics, and R. E. Collins, Professor of Applied Physics, Head of the School of Physics and Director of the Science Foundation for Physics)

- Professor Grant Sutherland, AC, Department of Cytogenetics and Molecular Genetics, Women's and Children's Hospital, Adelaide, and Dr Jennifer Nicholls, Executive Officer, Science Foundation for Physics, and Senior Research Fellow, Special Research Centre for Theoretical Astrophysics – 'Human Molecular Genetics'
- Professor Grant Sutherland, AC (as above) – 'The Human Genome Project'
- Associate Professor Warwick Britton, Head of the Immunology Unit, Department of Medicine – 'Living in a Dangerous World: How Our Immune System Copes with Infections'
- Associate Professor Warwick Britton (as above) – 'Harnessing the Immune System: The Power of Immunisation'
- Professor Richard Collins, Director of the Science Foundation for Physics and Head of the School of Physics – 'The Nature of Energy'
- Professor Richard Collins (as above) – 'The Importance of Energy'
- Dr Leon Poladian, Australian Research Council Senior Research Fellow, Optical Fibre Technology Centre – 'New Waves in Communication'
- Dr Leon Poladian (as above) – 'Terabits, Solitons and Quantum Secrets: The Future of Communications'
- Dr Graeme Pearman, Chief, CSIRO Division of Atmospheric Research – 'The Changing Composition of the Atmosphere'
- Dr Graeme Pearman (as above) – 'The Greenhouse Effect'

- Dr Miriam Baltuck, NASA Senior Representative in Australia – 'Space Exploration'
- Dr Elaine Sadler, Australian Research Council Senior Research Fellow, School of Physics – 'Life in the Galaxy – Is Anyone Out There?'
- Dr Elaine Sadler (as above) – 'The Far Horizon – Astronomy in the New Millennium'

2001 (1–14 July), 31st ISS

Impact Science

(Edited by J. A. Nicholls, Executive Officer, Science Foundation for Physics, and Senior Research Fellow, Special Research Centre for Theoretical Astrophysics, School of Physics, and R. E. Collins, Emeritus Professor of Physics and Director of the Science Foundation for Physics)

- Dr Anne J. Green, Senior Lecturer, School of Physics – 'Astronomy – Instruments from the Past'
- Dr Anne J. Green (as above) – 'Astronomy – What Instruments for the Future?'
- Dr Murray Stewart, Head, Structural Cell Biology Group, Structural Studies Division, Medical Research Council Laboratory of Molecular Biology, UK – 'The Physics of Life'
- Dr Murray Stewart (as above) – 'The Impact of Genomics on Biology and Medicine'
- Dr Michelle Y. Simmons, ARC Queen Elizabeth II Research Fellow, School of Physics, University of New South Wales – 'Quantum Computing'
- Dr Michelle Y. Simmons (as above) – 'Nanotechnology: Physics, Chemistry and Biology Unite at the Ultra-Small Scale'
- Dr Tanya Monro, Research Fellow, Optoelectronics Research Centre, University of Southampton – 'The Communications Revolution'
- Dr Tanya Monro (as above) – 'New Technology for Communications'
- Professor Robert G. Gilbert, Director, Key Centre for Polymer Colloids, School of Chemistry – 'Polymer Science and Everyday Life'

- Emeritus Professor Richard Collins, Director of the Science Foundation for Physics – 'Vacuum Glazing: A Case Study in Innovation Part 1: Science and Technology'
- Emeritus Professor Richard Collins (as above) – 'Vacuum Glazing: A Case Study in Innovation Part 2: Other Important Things'
- Honorary Associate Professor Ian Johnston, School of Physics – 'Reflections on the Future of Science: The Future's Not What It Used to Be'
- Honorary Associate Professor Ian Johnston (as above) – 'Reflections on the Future of Science: Mirror Mirror on the Wall'

2003 (6–19 July), 32nd ISS

From Zero to Infinity

(Edited by J. A. Nicholls, Executive Officer, Science Foundation for Physics, and B. A. Pailthorpe, Immediate Past Director of the Science Foundation for Physics)

- Professor Jerome I. Friedman, William A. Coolidge Professor of Physics, Department of Physics, Massachusetts Institute of Technology, and Dr Juris Ulrichs, School of Physics – 'The Road to Quarks and Beyond'
- Professor David N. Jamieson, Director, Microanalytical Research Centre, School of Physics, University of Melbourne – 'Ions from Space: Cosmic Rays, Aviation and You'
- Dr Rachel Codd, BVR Lecturer in Bioinorganic Chemistry, School of Chemistry – 'Biomolecules from Extremophilic Life'
- D. Anya Salih, Research Fellow, Electron Microscope Unit and the Australian Key Centre for Microscopy and Microanalysis – 'An Exploration of Light Regulating Pigments of Reef-building Corals from Macro- to Micro- to Nano-scales'
- Dr Christopher R. Dickman, School of Biological Sciences – 'Australian Native Animals: Marsupials'
- Professor Lance M. Leslie, Director, Centre for Environmental Modelling and Prediction, University of New South Wales, and Robert E. Lowry Chair, University of Oklahoma – 'High Resolution Computer Weather Forecasting Part I: Background'
- Professor Lance M. Leslie (as above) – 'High Resolution Computer Weather Forecasting Part II: Applications'

- Dr R. Dietmar Müller, Director, University of Sydney Institute of Marine Science – 'Understanding How the Earth Works: A Geodynamic Revolution Based on Linux Computing'
- Dr R. Dietmar Müller (as above) – 'Marine Geo-informatics'
- Dr Victoria Meadows, Principal Investigator, NASA Astrobiology Institute, Pasadena, California – 'The Search for Planets around Other Stars: Dancing in the Dark'
- Dr Victoria Meadows (as above) – 'The Search for Habitable Worlds: How Would We Know One if We Saw One?'
- Professor Virginia Trimble, Professor of Physics, University of California, Irvine, and Visiting Professor of Astronomy, University of Maryland – 'Warmed by the Sun'
- Professor Virginia Trimble (as above) – 'Fed by the Stars'
- Dr Geraint F. Lewis, School of Physics – 'Galactic Cannibalism'
- Professor John Peacock, Royal Observatory Edinburgh, also gave a lecture (not included in the book of lectures) on 'The Early Universe'

2005 (3–16 July), 33rd ISS

Waves of the Future

(Edited by Dr Chris Stewart, Executive Officer, Science Foundation for Physics, and Associate Professor Robert Hewitt, Director of the Science Foundation for Physics)

- Dr Frank Seebacher, School of Biological Sciences – 'Radio Telemetry in the Study of Wildlife'
- Professor Halina Rubinsztein-Dunlop, Head of Physics and Director of the Centre for Biophotonics and Laser Science, University of Queensland – 'Catch, Move and Twist with Optical Tweezers: Biophotonics at Work'
- Dr Clive Baldock, Director of the Institute of Medical Physics, School of Physics – 'The Treatment of Cancer Using Ionising Radiation'
- Associate Professor Simon Carlile, Lecturer in Neuroscience, Department of Physiology – 'The Psychophysics of Real and Virtual Auditory Spaces'

- Professor Martijn de Sterke, Reader, Centre for Ultrahigh-bandwidth Devices for Optical Systems (CUDOS) – 'Telecommunications: The Here and Now'
- Professor Martijn de Sterke (as above) – 'Telecommunications: Looking to the Future'
- Professor Lidia Morawska, School of Physical and Chemical Sciences, Queensland University of Technology – 'The Science of the Aerosols We Breathe'
- Associate Professor Judy Kay, School of Information Technologies – 'Creating and Overcoming Invisibility: Scrutably Personalised Ubiquitous Computing'
- Professor David Cockayne, FRS, Department of Material, University of Oxford – 'Seeing in the Nanoworld'
- Professor David Cockayne, FRS (as above) – 'Building in the Nanoworld'
- Professor Peter Robinson, School of Physics – 'Understanding Brain Dynamics'
- Professor Andrew D. Short, School of Geosciences – 'Wind, Waves and Beaches'
- Dr Raffaella Morganti, Netherlands Foundation for Research in Astronomy (ASTRON) – 'The Ever Changing Life of Galaxies' (delivered by Dr Elaine Sadler, School of Physics)
- Dr Raffaella Morganti (as above) – 'Monsters Lurking in the Centre of Galaxies' (delivered by Dr Elaine Sadler [as above])
- Dr Joseph Hope, ARC Centre of Excellence for Quantum-Atom Optics, Australian National University – 'Quantum Mechanics: The Wild Heart of the Universe'
- Professor Huw Price, Challis Professor of Philosophy – 'Einstein and the Quantum Spooks'
- Dr Karl Kruszelnicki, Julius Sumner Miller Fellow, School of Physics – 'Einstein Failed School', 'Use Your Brain', 'Albert Einstein: Scientist or Superstar?', 'Y-Chromosome: Waste- or Wonder-Land', 'Einstein's Miraculous Year (Parts 1, 2, 3 and 4)', 'Mexican Wave', 'Radioactive Boy Scout', 'Right Way to Kiss', 'Rock, Paper, Scissors', 'Tibet Cooled the World'

2007 (1–14 July), 34th ISS

ecoscience

(Edited by Dr Chris Stewart, Director of Outreach Programs at the School of Physics and Executive Officer, Science Foundation for Physics, and Associate Professor Anne Green, Head of the School of Physics and Director of the Science Foundation for Physics)

- Professor Barry Brook, Foundation Chair of Climate Change, University of Adelaide – 'Extinction – Past and Present'
- Professor Barry Brook (as above) – 'The Future of Biodiversity in a Changing World'
- Dr Karl Kruszelnicki, Julius Sumner Miller Fellow, School of Physics – 'Mouse with Human Ear'
- Dr Mark Curran, Ice Core Researcher, Australian Antarctic Division – 'Secrets from Antarctic Ice'
- Dr Mahanandra Dasgupta, Department of Nuclear Physics, Australian National University – 'Stardust All around Us: Fusion and Element Formation'
- Dr Karl Kruszelnicki (as above) – 'Toxic Chocolate'
- Dr Mahanandra Dasgupta (as above) (with Dr Stephen Tims) – 'Unstable Atoms as Detectives'
- Professor Hugh Durrant-Whyte, Australian Centre for Field Robotics – 'The Robots Are Coming!'
- Dr Karl Kruszelnicki (as above) – 'Uluru to You'
- Professor Ian Lowe, President, Australian Conservation Foundation – 'Renewable Energy Technologies: Key to Sustainable Futures'
- Professor Ian Lowe (as above) – 'Shaping a Sustainable Future – An Outline of the Transition'
- Dr Karl Kruszelnicki (as above) – 'Vitamins Not Always Safe'
- Dr Victoria Metcalf, School of Biological Sciences, University of Canterbury, New Zealand – 'Fishy Tales from Antarctica'
- Dr Victoria Metcalf (as above) – 'Extreme Living in Antarctica'
- Dr Karl Kruszelnicki (as above) – 'Folding Paper'
- Professor Michael Oppenheimer, Albert G. Milbank Professor of Geosciences and International Affairs, Princeton University – 'How Warm Is too Warm? Avoiding Dangerous Climate Change'

- Dr Graeme Pearman, Consultant and Interim Director, Monash Sustainability Institute – 'The Warming Planet'
- Dr Karl Kruszelnicki (as above) – 'Exploding in a Vacuum'
- Dr Graeme Pearman (as above) – 'Climate Change: Impacts and Adaptation'
- Dr Rhian Salmon, Education and Outreach Coordinator, International Polar Year – 'The Poles and the Planet: International Polar Year'
- Dr Karl Kruszelnicki (as above) – 'Water Recycling'
- Professor Fred Watson, Astronomer in Charge, Anglo-Australian Observatory – 'Dark Secrets: Dark Matter, Dark Energy and Dark Skies'
- Professor Lord Robert Winston also delivered a talk (not included in the book of lectures) on 'Manipulating Genetics – Threat or Promise?'

2009 (12–25 July), 35th ISS

Genes to Galaxies

(Edited by Dr Adam Selinger, Executive Officer, Science Foundation for Physics, and Professor Anne Green, Director, Science Foundation for Physics)

- Malcolm Walter, Professor of Astrobiology, University of New South Wales, and Director of the Australian Centre for Astrobiology – 'The Search for the Earliest Life on Earth'
- Malcolm Walter (as above) – 'The Search for Life on Mars'
- Jennie Brand-Miller, Professor of Human Nutrition, Human Nutrition Unit, School of Molecular and Microbial Biosciences (with Neil Mann and Loren Cordain) – 'Paleolithic Nutrition: What Did Our Ancestors Eat?'
- Naomi M. McClure-Griffiths, Senior Post-doctoral Fellow, CSIRO Australian Telescope National Facility – 'A Walk around the Neighbourhood: Understanding the Nature and Structure of the Milky Way'
- Peter Waterhouse, Professor and ARC Fellow in the School of Molecular and Microbial Biosciences – 'Gene Silencing I: A Virus Defence Pathway and a Technology'

- Dr Karl Kruszelnicki, Julius Sumner Miller Fellow, School of Physics – 'The X-Chromosome eXplained'
- Michel Morange, Professor in Biology, Ecole Normale Supérieure, France – 'The Frontiers of Current Biological Research'
- Michel Morange (as above) – 'Why Is It Important to Read *On the Origin of Species* in 2009?'
- Geraint F. Lewis, Professor in Astronomy and Astrophysics, School of Physics – 'Cosmic Evolution: The Birth, Life and Death of Galaxies'
- Peter Waterhouse (as above) – 'Gene Silencing II: Gene Regulation'
- Jill Tarter, Director of the SETI Institute, USA – 'SETI – Planning for Success: Who Will Speak to Earth? What Will They Say?'
- Wayne Lee, Altair Vehicle System, Manager, NASA – 'Six Minutes of Terror'
- Dr Karl Kruszelnicki (as above) – 'Man on the Moon Conspiracy'
- Jill Tarter (as above) – 'Extremophiles and Exoplanets'
- Wayne Lee (as above) (with Erisa K. Hines) – 'New Stars in NASA's Constellation'
- Alaina J. Ammit, Associate Dean, Research and Innovation, Faculty of Pharmacy (with Melanie Manetsch and Emma E. Ramsay) – 'Asthma and Airway Remodelling: Targeting Mitogen-activated Protein Kinases as Future Therapeutics'
- Charles H. Lineweaver, Senior Fellow, Research School of Earth Sciences and Coordinator of the Planetary Science Institute, Australian National University – 'Cosmobiology: Our Place in the Universe'
- Helen Johnston, Research Fellow, School of Physics – 'The Private Life of a Proton'
- A chapter on 'Research and the School of Physics' by Professor Anne Green was also included in the book of lectures

2011 (3–16 July), 36th ISS

Light & Matter

(Edited by Dr Chris Stewart, Manager, International Science School, School of Physics)

- Associate Professor Stephen Bartlett, School of Physics – 'Smaller, Faster, Better, Unimaginable-er? The Quantum Revolution Is Coming'
- Professor Christine Charles, Space Plasma, Power and Production Laboratory, Australian National University – 'Children of the Stars, Plasma is the Fourth State of Matter'
- Professor Allan G. Clark, Director, Department of Nuclear and Particle Physics, University of Geneva – 'A Very Large Microscope to Probe Very Small Distances – Part I'
- Professor Allan G. Clark (as above) – 'A Very Large Microscope to Probe Very Small Distances – Part II'
- Dr Karl Kruszelnicki, Julius Sumner Miller Fellow, School of Physics – 'Bending Spoons for Fun and Profit'
- Dr Deanna D'Alessandro, School of Chemistry – 'Capturing CO2'
- Professor Martin Green, ARC Federation Fellow and Scientia Professor, University of New South Wales – 'Photovoltaics: Solar Electricity by Coupling Light and Matter'
- Dr Karl Kruszelnicki (as above) – 'Spontaneous Human Combustion'
- Professor Sir John Pendry, Imperial College, London – 'Metamaterials and the Science of Invisibility'
- Professor Sir John Pendry (as above) – 'Negative Refraction and a Perfect Lens'
- Professor Stephen Simpson, ARC Laureate Fellow, School of Biological Science – 'Paintbrushes, Cannibal Crickets and Human Obesity'
- Professor Fred Watson, Astronomer-in-Charge, Australian Astronomical Observatory – 'Dark Secrets: Dark Matter, Dark Energy and Dark Skies'
- Dr Joanne Whittaker, School of Geoscience – 'Exploring the Earth's Varied and Dynamic Seafloor'
- Dr Karl Kruszelnicki (as above) – 'Twinkling Stars'

Papers were also presented (but not included in the book of lectures) by:

- Professor Ben Eggleton, ARC Federation Fellow, School of Physics and Research Director, CUDOS [Centre for Ultrahigh-bandwidth Devices for Optical Systems] – 'Photonics and the Future of Communications Technology'
- Professor Thomas Maschmeyer, ARC Future Fellow, School of Chemistry – 'Green Chemistry'
- Robyn Williams, AM, Science Broadcaster – 'Stories from a Lifetime of Reporting Science'

Appendix 2
DEMOGRAPHICS OF ISS SCHOLARS

All ISS scholars: breakdown by gender

Year	Boys	Girls	Total
1962	108	45	153
1963	91–104	49–51	140–155
1964	88–106	52–53	140–159
1965	110	44	154
1966	100	42	142
1967	105	57	162
1968	96	28	124
1969	99	25	124
1970	90	36	126
1971	89	35	124
1972	96	28	124
1973	93	30	123
1974	90	33	123
1975	76	43	119
1977	54	50	104
1979	65	54	119
1981	50	65	115
1983	64	55	119
1985	73	58	131
1987	71	55	126
1989	69	58	127
1991	61	70	131
1993	60	72	132
1995	81	58	139
1997	72	65	137
1999	73	66	139
2001	72	69	141
2003	58	89	147
2005	73	66	139
2007	68	65	133
2009	67	71	138
2011	81	62	143

International ISS scholars: breakdown by country

Year	NZ	US	UK	Japan	Singapore
1962	2	—	—	—	—
1963	?	—	—	—	—
1964	?	—	—	—	—
1965	3	—	—	—	—
1966	2	—	—	—	—
1967	2	10	—	—	—
1968	2	10	5	5	—
1969	2	10	5	5	—
1970	2	10	5	5	—
1971	2	10	5	5	—
1972	2	10	5	5	—
1973	2	10	5	5	—
1974	2	10	5	5	—
1975	2	5	5	5	—
1977	2	—	—	—	—
1979	2	5	5	5	—
1981	2	—	5	5	—
1983	2	—	5	5	—
1985	2	—	5	5	5
1987	2	—	5	5	5
1989	2	—	5	5	5
1991	2	5	5	5	5
1993	2	5	5	5	5
1995	2	5	5	7	5
1997	2	4	5	10	5
1999	5	4	5	10	5
2001	6	7	5	10	3
2003	6	4	5	10	5
2005	6	4	5	10	5
2007	6	5	5	8	5
2009	5	4	5	8	—
2011	5	4	5	10	5

Malaysia	Thailand	Philippines	China	India	Canada
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
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—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
5	5	4	—	—	—
—	5	—	—	—	—
—	5	—	—	—	—
—	5	—	—	—	—
5	5	—	—	—	—
4	—	—	—	—	—
5	5	—	—	—	—
5	—	—	5	—	—
5	7	—	5	—	—
6	7	—	0[2]	—	—
5	7	—	5	—	—
—	5	—	5	4	—
—	7	—	5	5	2
2	7	—	5	5	—

Australian ISS scholars: breakdown by state

Year	NSW[1]	Vic.	Qld	SA	WA	Tas.	NT	ACT
1962	151	—	—	—	—	—	—	—
1963	140	?	?	?	?	?	—	—
1964	140	?	?	?	?	?	—	—
1965	141	2	2	2	2	2	—	—
1966	130	2	2	2	2	2	—	—
1967	140	2	2	2	2	2	—	—
1968	75	10	5	5	5	2	—	—
1969	75	10	5	5	5	2	—	—
1970	77	10	5	5	5	2	—	—
1971	75	10	5	5	5	2	—	—
1972	75	10	5	5	5	2	—	—
1973	76	10	5	3	5	2	—	—
1974	74	10	5	5	5	2	—	—
1975	75	10	5	5	5	2	—	—
1977	75	10	5	5	5	2	—	—
1979	75	10	5	5	5	2	—	—
1981	75	10	5	5	5	2	—	—
1983	76	10	5	5	5	2	2	2
1985	75	10	3	5	5	0	0	2
1987	75	10	5	5	5	2	0	2
1989	75	10	5	5	5	2	2	2
1991	73	10	5	7	5	2		2
1993	69	10	5	5	5	2	2	2
1995	75	10	5	5	5	2	2	2
1997	71	10	5	5	5	2	1	2
1999	69	9	6	4	5	2	2	3
2001	62	10	5	4	5	3	2	2
2003	71	12	5	4	6	2	2	2
2005	60	10	5	5	5	2	3	2
2007	67	11	5	4	5	2	2	2
2009	63	10	5	5	7	2	2	2
2011	59	10	5	6	6	2	4	3

Appendix 3
JULIUS SUMNER MILLER'S 'MEN OF SCIENCE'

Pythagoras
Democritus
Hippocrates
Avicenna
Leonardo da Vinci
Nicolaus Copernicus
Andreas Vesalius
Ambroise Paré
Tycho Brahe
Simon Stevin
Galileo Galilei
Johannes Kepler
William Harvey
René du Perron Descartes
Otto von Guericke
Evangelista Torricelli
Blaise Pascal
Christiaan Huygens
Anton van Leeuwenhoek
Isaac Newton
Claus Roemer
Gottfried Wilhelm Leibniz
Leonhard Euler
Benjamin Franklin
Carl Linnaeus
Jean le Rond d'Alembert
Joseph Louis Lagrange
Charles-Augustin Coulomb
Luigi Galvani
Carl Wilhelm Scheele
Antoine Laurent Lavoisier
Alessandro Volta
Pierre Simon, Marquis de Laplace
André-Marie Ampère
Amedeo Avogadro
Hans Christian Oersted
Carl Friedrich Gauss
René Laënnec
Nicolas Léonard Sadi Carnot
Niels Henrik Abel
Johann Bolyai
William Rowan Hamilton
Charles Robert Darwin
Urbain Jean Joseph Leverrier
Hermann von Helmholtz
Gregor Johann Mendel
Louis Pasteur
Dmitri Ivanovitsch Mendeleeff
William Conrad Roentgen
Ivan Petrovitch Pavlov
Antoine Henri Becquerel
Jules Henri Poincaré
Heinrich Rudolf Hertz
Max Planck
Marie Sklodowska Curie
Albert Einstein

NOTES

Prologue

1 Science for High School Students was published by the Nuclear Research Foundation, with Harry Messel as editor-in-chief, and printed by the New South Wales Government Printer.

2 For a time, it was also available as a massive single blue volume of 1,040 pages.

3 As will be seen in Chapter 1, there were four earlier International Science Schools (1958–61) for science teachers. They were significant events in their own right but we do not celebrate their anniversary: they predate the period that ends with the fiftieth anniversary in 2012 and therefore are not the subject of this history. The only 'glitch' in this approach is that the first International Science School for high school students, held in 1962, has always been counted as the '5th ISS'. D. D. Millar's book The Messel Era: The Story of the School of Physics and its Science Foundation within the University of Sydney 1952–1987 (Pergamon Press, Oxford, 1987, pp. 38 and 39), gives a good account of the teachers' science schools.

Chapter 1: Genesis: the early days, including the historical context and the reasons for the ISS

1 The undergraduate text used in the School of Physics in 2000–01 for first-year students was Sears and Zemansky's University Physics with Modern Physics (tenth edition) while the second-year text was Modern Physics by Serway, Moses and Moyer.

2 The Nucleus, vol. 3, no. 3, September 1957, p. 6.

3 The Nucleus, vol. 4, no. 1, April 1958, p. 5.

4 Oscar Guth, 'The University of Sydney School of Physics and its Nuclear Research Foundation', 1966 ISS book of lectures, Atoms to Andromeda, p. 16.

5 D. D. Millar (ed.), The Messel Era, p. 9.

6 Messel did his graduate studies at the Dublin Institute for Advanced Studies, but had given a seminar at the Princeton counterpart.

7 Weisskopf's doctoral advisers were Max Born and Eugene Wigner. Weisskopf was the first director of CERN.

8 Peierls' doctoral adviser was Nobel laureate Werner Heisenberg. Peierls' doctoral students included fellow Australian E. E. Salpeter, who spoke at the 1967 ISS. After World War II, Peierls assembled an extraordinary group of people around him in the Physics Department at the University of Birmingham, which was generally regarded as the best graduate school of its era (Freeman Dyson was one among many noted graduates of that group).

9 By 1957 The Nucleus had become biannual and in 1962 it became annual.
10 Oscar Guth, 'The University of Sydney School of Physics and its Nuclear Research Foundation', p. 17.
11 Harry Messel, 'The School of Physics, the Foundation and the ISS: Short Reflections, after 59 years at the University of Sydney', December 2011.

Chapter 2: The 1960s: the launch of the ISS and its glory days

1 Messel's keenness to have von Braun at the ISS was not matched by all involved. Bondi initially cancelled his plans to be part of the same ISS, although finally he was persuaded to come. Many people, including a number from within the School, regarded von Braun as a war criminal. Bondi arranged his affairs so that he finished at the ISS and left Australia before von Braun arrived.
2 As noted in Chapter 1, in a number of early references the student ISSs are described as an 'interruption' in the practice of science teacher science schools.

Chapter 3: Funding the ISS

1 The Nucleus, 1969, p. 7.
2 The Nucleus, 1969, p. 26.
3 The lecturers' honorarium was increased over the years to $100, and then $200.
4 The Nucleus, 1970, p. 14.
5 Annual Report of the Science Foundation for Physics, 1986/87, p. 2.
6 Annual Report of the Science Foundation for Physics, 1984/85, p. 1.
7 D. D. Millar (ed.), The Messel Era, pp. 19–20.

Chapter 4: ISS scholars: selection process, accommodation and demographics

1 The sexist attitudes of the 1960s are not concealed in any way: 'Girl students are not only brilliant – they're also a pleasure to watch', Australian Women's Weekly, 19 January 1966, p. 17, http://trove.nla.gov.au/aww/read/222303?q=messel&s=0&resultId=num6#page/17/mode/1up.
2 The Nucleus, 1962, p. 15.
3 In 1981, the award was described as the Philips Prize and was made in connection with the 13th European Philips Contest for Young Scientists and Inventors – the young scholar from the Federal Republic of Germany withdrew at the last minute because of timetable clashes with written exams he was required to take at home.

Chapter 5: International perspectives: overseas ISS scholars and their home countries

1 The Nucleus, 1967, p. 2.
2 The Nucleus, 1967, p. 3.
3 The Nucleus, 1967, p. 7.
4 One hopes this is an innocent reference to Coca-Cola. It reminds me of unintended cultural and language differences that arise with overseas ISS scholars. In 2009, when I travelled to Rivers in Manitoba, Canada (a town of 600, where Messel had grown up), to present the scholarship awards, I remarked to a formal assembly at their school comprised of all students, parents and teachers that I would ensure that the scholars would 'have a hoot' – Australian vernacular for an exciting time. The students giggled, the parents looked concerned. The ISS scholars did have a good time, but no marijuana cigarettes, as a 'hoot' is known in Canada.
5 In 2003, the SARS epidemic caused the ISS scholars from China to pull out at the last minute.

Chapter 6: The ISS lectures: themes and lecturers, and other ISS scholar academic activities

1 Charles Birch, who was Professor of Biology at the University of Sydney and twice lectured at the ISS, was a close collegial friend of Messel and Butler, having helped write and edit the biology volumes of the Messel high school and senior high school texts. From the early 1950s, Birch had an increasing media presence, sounding many warnings of ecological problems, including overpopulation and pollution. In 1974 he coined the phrase 'the ecological sustainable society' and it is arguable that it was actually due to him that the word 'sustainability' in a short time became an everyday term. This was partly through his very widely read book Confronting the Future published by Penguin in 1975. Birch was Paul Ehrlich's post-doctoral supervisor and they were very close friends for nearly fifty years. It is therefore no surprise that Ehrlich was one of the later ISS lecturers. Birch was also one of the pivotal figures in Robert May's life, having played an important role in turning him from physics to population ecology.
2 As explained by Collins, in correspondence with the author, each lecture in 1981 built on the material of the previous one, with the assumption that the ISS scholars would become completely familiar with each concept as fast as it was presented. Learning was never like that!
3 ISS book of lectures, 1970, Pioneering in Outer Space, p. 505.
4 It is of course possible that Bondi and Gold were getting a hearing in Australia that they were no longer getting elsewhere, in just the same way as Miller was far more famous in Australia than he was at home in the United States.
5 ISS book of lectures, 1966, Atoms to Andromeda, p. 253.
6 Ibid., p. 267.

7 ISS book of lectures, 1968, Man in Inner and Outer Space, p. 142.
8 ISS book of lectures, 1962, A Journey through Space and the Atom, p. 11.
9 Richard Collins, Lots of Scars: The Life of a Scientist, Lexington Avenue Press, Copacabana, NSW, 2004, p. 110.
10 Miller's assistant for many years, fondly remembered by television viewers, was Ray Anderson. Anderson, ever obliging, was tasked with getting all of Miller's demonstration apparatus prepared and in working order.
11 Book of lectures, 1965, Time, pp. 167–71.
12 Gerard Holton and Stephen G. Brush, Physics, the Human Adventure: from Copernicus to Einstein and Beyond, 4th paperback edition, Rutgers University Press, New Brunswick, New Jersey, 2001.
13 Book of lectures, 1965, Time, p. 305.
14 Book of lectures, 1985, The Study of Populations, p. 253.
15 Richard Collins, Lots of Scars, p. 119.

Chapter 7: The ISS scholar experience

1 Over the years, these engineering challenges involved designing, building and packaging a chair; building bridges, boats, air cannons and lighter-than-air aircraft (and then piloting them through a maze); and designing wings for humans.
2 This is a reference to the fundamental constants: G (the Cavendish experiment), c (Foucault and the Stefan-Boltzman law), e/m (Thomson's experiment), e/h (the photoelectric effect), k (Brownian motion) and e (Millikan's experiment).
3 The house parents in question are the Stones; the Andrews; the Grootenboers; and Karen Palmer and John Bright.
4 The black chalkboards were painted green around 1967 to enhance the quality of the television broadcast. This conversion was well ahead of its time.

Chapter 8: Dissemination of the ISS and media: books, television and the internet

1 The Nucleus, 1966, p. 17.
2 The Nucleus, 1979, p. 18.
3 The Nucleus, 1963, p. 50.

Chapter 9: The impact of the ISS, including spin-offs and copies, locally and abroad

1 New Scientist, 24 July 1975, p. 221.

Epilogue

1 One ISS scholar reflected on the outcome of his ISS, which ran during the heady and troubled world events of the 1960s, noting that it gave him and his cohort international perspectives, peace and rational solutions, a dream and an ability to bring about world peace: 'A global society can retain the flavour of each individual culture, but it would also contain a grandeur that is not possible in our fragmented world'.

2 The Nucleus, 1967, p. 37.

3 The Nucleus, 1965, p. 16.

4 The Nucleus, 1967, p. 61.

Appendix 1: ISS dates, titles, topics and speakers

1 Speakers are from the University of Sydney, unless otherwise stated. Lecturers and their topics are listed in the order in which they and their papers appear in the relevant ISS book. This is not necessarily the order in which they were delivered during the ISS fortnight. The lecturers' names, academic positions and titles are also as given in each ISS book.

2 Lectures covered 'The Propagation of Sound', 'Motion and Relativity', 'Space and Time', 'The Astronomer's Universe' and 'The Universe of Galaxies'.

3 Lectures covered 'Liquid Rocket Propulsion', 'Solid Rocket Propulsion', 'Electric Propulsion;', 'US Space Vehicles', 'Spacecraft: Guidance and Control' and 'The Saturn Programme'.

4 Lectures covered 'Atoms and Nuclei', 'Atomic History', 'Electron and Proton', 'The Rutherford Atom', 'Electromagnetic Radiation', 'Velocity of Light and the Theory of Relativity', 'Nuclear Reaction and the Neutron' and 'Nuclear Power and Radio Isotopes'

5 Lectures covered 'Newtonian Gravitation', 'Relativity' and 'Einstein's Theory of Gravitation'.

6 Lectures covered 'Atoms and Nuclei', 'Electron and Proton', 'The Rutherford Atom', 'Electromagnetic Radiation – Bohr's Theory of the Atom', 'Velocity of Light and the Theory of Relativity' and 'Mass and Energy'.

7 Lectures covered 'Atoms, Molecules and Nuclei', 'Electromagnetic Radiation – Bohr's Theory of the Atom',' 'The Influence of Gravitational Fields', 'The Origin of the Solar System', 'Evolution of the Earth' and 'The Primordial Atmosphere and the Origin of Life'.

8 Lectures covered 'Introducing Proteins', 'The Functions of Proteins', 'The Problem of the Origin of Life', 'Alone in the Universe', 'Reason and Purpose in Biology' and 'The Practical Effects of Biology on Our Lives'.

9 Lectures covered 'Introduction', 'A Chemist's Look at the Living Cell' and 'The Concept of Template Surfaces'.

10 Lectures covered 'Time on Earth', 'The Universe', 'Hubble's Time Constant', 'Space and Time', 'Velocity of Light and the Theory of Relativity' and 'Mass and Energy'.

11 Lectures covered 'Relativity', 'The k-calculus', 'Time Stretching' and 'Time and Gravitation'.
12 Lectures covered 'Introducing Cosmic Rays', 'Measuring and Investigating Air Showers' and 'Cosmic Ray Astronomy'.
13 Lectures covered 'Stars', 'The Nature of Light' and 'The Stellar Interferometer at Narrabri Observatory'.
14 Lectures covered 'The Nature of Radio Waves', 'The Molonglo Radio Observatory' and 'The Milky Way and Far Beyond'.
15 Lectures covered 'Mankind's Energy Resources', 'Plasma – the Fourth State of Matter' and 'Plasma Heating and Measurement'.
16 Lectures covered 'The Nature and Scope of Theoretical Physics', 'Elementary Particle Physics' and 'Theoretical Physics at Sydney University'.
17 Lectures covered 'Introduction to the Sun', 'Character of Sunlight', 'Sunspots', 'Active Regions of the Sun' and 'Radio Phenomena caused by the Sun'.
18 Lectures covered 'Weather Modification', 'How Can We Effectively Use the Oceans?', 'Earthquakes and the Interior of the Earth' and 'The Origin of Earth'.
19 Lectures covered 'Cosmologies, Past and Present', 'Evolution of Stars' and 'Looking Backward in Time'.
20 Lectures covered 'Introduction to Space Flight', 'Achievements in Unmanned Spacecraft', 'Apollo Hardware', 'Apollo Mission', 'Selected Technical Aspects of the Apollo Programme' and 'The Future'.
21 Lectures covered 'Manned Flight Operations' and 'Astronaut Training'.
22 Lectures covered 'The Development and Use of Isotopes and Radiation', 'Nuclear Electric Power Development', 'Nuclear Energy in Space and Remote Terrestrial Environments', 'Large Scale Industrial and Social Uses for Cheap Nuclear Power' and 'Feasibility of Controlling Thermonuclear Reactions for the Generation of Electric Power'.
23 Lectures covered 'Discovery', 'The Great Particle Hunt (Parts I and II)' and 'Nature and Origin'.
24 Lectures covered 'The Purpose and History of Elementary Particle Physics', 'The Family of Particles', 'The Interaction and Identification of Particles', 'The Basic Tools – Sources of High Energy Particles', 'The Basic Tools – the Stanford Linear Accelerator', 'The Basic Tools – Particle Detection and Analysis', 'Symmetries and Selection Rules', 'Hadron Physics and the Uniting Symmetry', 'The New Spectroscopy', 'The Weak Decay Interactions', 'Hunts for the Quark', 'Survey of the Basic Forces in Nature' and 'The Future'.
25 Lectures covered 'Is Space Only for the Big Ones?' and 'Europe in Space'.
26 Lectures covered 'Newtonian Gravitational Theory', 'General Relativity' and 'Gravitational Waves'.
27 Formerly mission controller for Apollo XI.
28 Formerly director of the Apollo Program.
29 Lectures covered 'Origins and Building Blocks of Manned Space Flight', 'Development of the Saturn Launch Vehicle', 'Development of the Apollo

Spacecraft', 'Astronaut Selection and Training', 'Apollo Missions 1 through 10', 'The Lunar Landing', 'Scientific Results of Apollo 11 and 12 Missions', 'Impact of Space on Planet Earth', 'Future Apollo Missions Apollo 14 through 19', 'The Skylab Programme', 'The Highroad to Space' and 'Planning for the 1970s and 1980s'.

30 Lectures covered 'Science and Technology Now Determine the Course and Nature of Civilisation' and 'The Responsibilities of the Scientist'.

31 Lectures covered 'Science and Violence', 'Science and Sex' and 'Science and Conscience'.

32 Lectures covered 'Antibodies and Lymphocytes', 'The Immune System and Cancer' and 'Truth and Fiction about Organ Transplants'.

33 Lectures covered 'In the Beginning, the Molecules', 'Molecules in Disorder', 'Patterns of Change', 'Molecules in Microtime' and 'Molecules in Evolution'.

34 Lectures covered 'Nucleic Acids and Heredity', 'The Structure of Proteins: Fibrous Proteins', 'The Structure of Proteins: Globular Proteins and Enzymes', 'The Activity of Enzymes' and 'Self Assembly and the Genesis of Higher Levels of Organisation'.

35 Lectures covered 'Evolution and the Image of Man', 'Genetics and the Image of Man' and 'Ethology and the Image of Man'.

36 Lectures covered 'First Three Billion Years' and 'Next 50 Years'.

37 Lectures covered 'Problems of Predicting Population', 'Raw Materials and the Price Mechanism' and 'Pollution and World-wide Catastrophe'.

38 Lectures covered 'History of Thought about Man, His Brain and Behaviour', 'Brain Organisation and Behaviour', 'Contemporary Brain Research' and 'Brain, Behaviour and Society'.

39 Lectures covered 'Outline of the Galaxy', 'Interstellar Gas and Cosmic Dust', 'The Spiral Structure of the Galaxy' and 'Life Cycles of Stars'.

40 Lectures covered 'Close-up of a Star' and 'Explosions on the Sun'.

41 Lectures covered 'Introduction' and 'Nuclear Fission, Nuclear Fusion and Geothermal Energy'.

42 Due to Dr Giovanelli's unavailability, the lectures were presented, at a moment's notice, by Dr John Davis of the Chatterton Astronomy Department of the School of Physics.

43 Lectures covered 'Energy Exchange in the Living World', 'Solar Energy Conversion in Photosynthesis' and 'Conversion of Plant Materials to Liquid and Gaseous Fuels'.

44 Lectures covered 'Batteries' and 'Fuel Cells'.

45 Lectures covered 'Water Heating and Steam Generation', 'Building Heating and Cooling' and 'Desalination and Drying'.

Appendix 2: Demographics of ISS scholars

1 From 1962 until 1981, this also included the Australian Capital Territory. From 1983 onwards, scholars were separately selected from the Australian Capital Territory.

2 Late withdrawal due to SARS epidemic.