SUBMISSION No. 60

INQUIRY INTO
AUSTRALIA'S INTERNATIONAL RESEARCH COLLABORATION

SUBMISSION BY:

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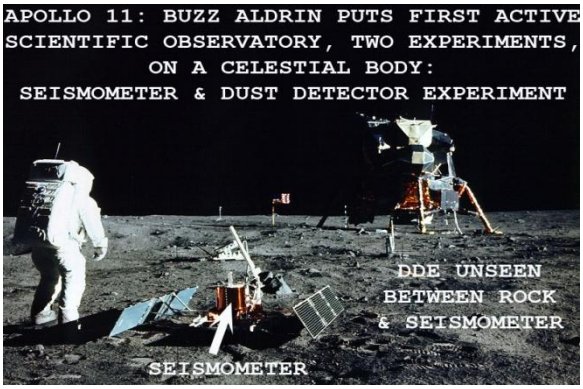

SUBJECT: This personal submission is focussed on Australia's potential international research collaboration in the field of space science, with particular reference to research into Apollo measurements, analyses and thence research developments relating to dust on the Moon. Some case studies lead to strategies applicable to many fields of research.

FIG.1: O'Brien GRL 6 May 09

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INTRODUCTION

This personal submission enthusiastically advocates strengthening and extension of Australian international research collaboration (IRC), despite frustrations.

I was able to become a scientist completing in 1957 the first PhD in Physics from the University of Sydney under Professor Harry Messel only because of support from his innovative Science Foundation for Physics. In August 1959 I joined Prof. James Van Allen's team in Iowa one year after they had built the first four American satellites. In 1963 as Professor of Space Science at Rice University in Houston I worked with, and lectured to, new classes of astronauts. My experiments were selected for the self-powered scientific observatories each Apollo team put on the surface of the Moon, to transmit back environmental measurements long after all astronauts departed. In July 1969 Buzz Aldrin put the first Dust Detector experiment on the moon. (see 40-year anniversary ABC Catalyst 16 July 2009 http://www.abc.net.au/catalyst/Moon)

In May 2009 my peer-reviewed discoveries from personal archives of Dust Detector measurements - long lost in official USA – were highlighted and made the subject of a globally-distributed relatively rare Media Release by the American Geophysical Union. In the past 9 months and after two invited talks at specialist conferences in the USA, IRC links are firmly established by phone and E-mail with increasing numbers of lunar-dust scientists, engineers and administrators, some as formal electronic groups advising NASA.

Lessons from this Apollo example with wider relevance to this Inquiry include the importance of establishing and maintaining IRC over generational periods, and the need to preserve science archives and routinely upgrade their technological accessibility. Each has costs, whose justification may not be fully appreciated until it is too late, perhaps irretrievably so.

In my opinion, just as geology was the principal science motivation assisting the magnificent Apollo expeditions to the Moon, increasingly the new science of dusty plasmas is helping energise lunar expeditions, robotic or human, by the USA, China, Russia, India, Japan and the European Union. Dust is the Number 1 environmental problem facing robotic and human exploration of the Moon. The only direct active measurements of dust movements on the Moon are 30 million in Perth, whose analyses are giving clues to management and mitigation of dust problems. There will be no lunar mission to repeat or improve such measurements for about 3 years for a robot or 10 years for a human. They cannot be simulated in any laboratory.

A vital issue is whether our demonstrably-successful first stage of self-funded Perth-based research will be funded externally, as it must. NASA presently has policies of no transfer of funds outside USA. Now under consideration by the new Australian Space Research Program (ASRP) is a 4 December proposal from the University of Western Australia involving extensive IRC with several leading US groups. If so funded, leadership and coordination of future IRC on the unique Apollo lunar dust measurements, analyses and applications can remain within UWA. A collateral benefit already is an Apollo stimulus of associated technology under a joint proposal between UWA and local industry SpectrumData.

So a vital strategic issue for this Inquiry is the age-old one of Local *vis a vis* Global priorities. The challenge exists not only in fundamental social issues of education and health but pure and applied frontier science such as lunar dust, with boundless future possibilities that the exotic lunar surface is a unique laboratory of nano-dust in dusty plasmas. If Australia is to be other than a bit-player in scientific research it must in the national interest continually expand and build on its respected contributions to international scientific collaboration. Choices and priorities will require far-ranging as well as immediate strategies.

I will be delighted to meet for personal discussions.

ToR 1: the nature and extent of existing international research collaborations.

My submission deals only with international research collaborations begun in earnest about 9 months ago. Currently they are individual to individual, particularly research into dust on the moon. Collaboration is mainly between O'Brien as Adjunct Professor and colleagues at the University of Western Australia and other individuals within the USA, at Universities and NASA Research Centers.

Thus they are presently of limited interest to most participants in Australian research. Nevertheless, several aspects may be of interest to this Inquiry.

First, over the past 9 months I have been invited to join several internet-based groups, set up by request from NASA on a particular task as a source of advice on lunar exploration, or coming together to prepare individual white papers for 'community" review and endorsement, to lead towards a US Decadal Plan for Planetary Science Exploration. Many Australian scientists in many fields similarly play international roles electronically.

Second, the NASA Lunar Science Institute (NLSI) in Ames, "the heart of Silicon Valley", is interested in having an Australian institution becoming an international partner. Discussions are underway. Institutional collaboration internationally is essential for survival.

Third, because of my time in the USA in the late '50s and the '60s, those who were my PhD students are now world-famous researchers, some indeed Emeritus Professors, with many of ***their*** former PhD students now respected senior researchers themselves, including several currently leaders in lunar science. One is a Researcher in the UWA proposal to ASRP.

As can be the case with stock market successes, it is not only the timing ***of*** international research collaboration that is important, but also time ***in*** the collaboration.

The benefits are far beyond issues such as familiarity with logistics. There is no substitute for the bonding that can result when the Chairman of a distinguished Research Institute introduces herself as "Professor O'Brien is my space grandfather." Her introduction of her young South American PhD student as "O'Brien IV" follows as a natural, easy consequence.

Lessons for long-range strategic planning of Australia's international research collaboration therefore include:

- **Establish international research collaborative networks as early as possible at each node of the collaboration, and nurture those networks beyond the working lives of individuals or projects;**
- **In these days, short-term advance visits e.g. by well-briefed students or colleagues, can implant a sympathetic ambience for later more intense IRC;**
- **Maintain Australian archives and progressively update their accessibility using contemporary best-practice technology. Include such costs in early funding.**

The third dot-point arises because NASA "misplaced" the original computer tapes on which Dust Detector measurements were recorded. Fortunately, as inventor and Principal Investigator of the experiment, I got a copy of each primary tape at the University of Sydney, sent Air Express every few days from 1969. They are now stored at SpectrumData in Perth.

But the 7-track tapes cannot be read with modern technology. So SpectrumData, a Perth-based specialist in data storage and data asset management, offered to help in 2007. A joint proposal with UWA has been made to develop a world-leading low-energy tape transport and ultra-sensitive reader, with application to the very noisy Apollo 11 tapes as a priority but with far greater flexibility and applications.

ToR 2: the benefits to Australia from engaging in international research collaborations.

In 1959 the only promising opportunities for wide-ranging space research were international, off-shore from Australia. The dream I had in 1958 on an icebreaker in the Antarctic of putting a new-fangled satellite above the magnificent auroral displays to understand both causes and effects could only be realized in America. I was fortunate to build the first such satellite, little Injun 1, with a small team in Iowa and have it operational in 1961.

By the mid-1960s, opportunities arose to have Apollo astronauts put experiments on the moon as remote scientific observatories. Again I was fortunate to have my proposal accepted to extend my auroral rocket and satellite research on to the stable platform of the surface of the moon. Again that opportunity arose only within the United States.

Now such individual systemic opportunities seem rare, even internally in the USA. Frequent time-consuming program reviews and management oversight in the USA seem very intrusive under current management practices, compared with the 1960s. Individual achievements may now be much more difficult to achieve.

Whether such management practices would be accepted by modern-day Australian researchers is for them to say.

One inevitable consequence is that in some space research projects the individual is giving way to collaborative efforts. Teams and teams of teams, with very frequent endorsements and reviews by "communities" of research seem to be a necessary and perhaps even sufficient endorsement for approval.

Challenges for a future space research program within Australia include not least the challenge of whether the home base for that research should be within Australia or within a larger country with an established research base in space science subject to such governance.

If requested, I will be pleased to discuss a relevant suite of rather sad Australian case studies in which I have had personal experience since 1964 (see also ToR4).

The pending choices of successful proposals for Round 1 of grants under the new Australian Space Research Program (ASRP) will set not only the domestic scenario but also the future international research collaborations on space science generally. I await those decisions with considerable interest, and declare an interest in the outcome.

ToR3: the key drivers of international research collaboration at the government, institutional and researcher levels.

No comment here at this time.

ToR4: the impediments faced by Australian researchers when initiating and participating in international research collaborations and practical measures for addressing these.

In 1964 and around 1982 I was closely involved in two opportunities for building and launching a joint US-Australian research satellite, one for auroral research and another for a remote-sensing focus on water resources. Each was advanced but collapsed because of lack of support at Australian government levels. Neither called for significant Australian funds.

Details can be discussed if the matters are now still of interest.

On current issues, specifically revisiting Apollo dust analyses, difficulties included:

- Technical - The prime data were on 7-track computer tapes which cannot be read with modern machinery safely and with highest integrity i.e. no false bits;
- Personal/professional - There was initially a climate of two types of aggressive disbelief among NASA and other US experts in lunar issues and lunar dust.

The practical measures for overcoming the technical problems were straightforward and can be documented if desired.

The two types of aggressive disbelief had different origins.

The first was centered in NASA. The official NASA Preliminary Science Reports in 1969 to 1971 on the Dust Detector experiments were demonstrably either incorrect – Apollo 11 and Apollo 15 – or incomplete – Apollo 12 and Apollo 14 - omitting any mention. The collateral consequences were very wide-ranging. Histories of Apollo usually omit any reference to the Dust Detectors. Although most NASA personnel of the Apollo era are no longer with NASA, the problems with inaccurate or omitted reporting of Apollo dust measurements were major.

Dust has been recognised as the Number 1 environmental problem for robotic and human exploration of the Moon. With Apollo, costly experiments and equipment were damaged by overheating caused by dust, and damaged directly by dust. Hazards to astronaut safety and health arose. Due to rejection of dust data, no second-generation dust research occurred before Apollo missions ended. The aerospace industry remained unnecessarily ignorant.

Consequently, funding for the past 5 years of laboratory and space projects to address such dust issues has been without recognition of the Apollo facts, mistakes and omissions.

These issues can be discussed with the Committee or staff if desired.

The second personal/professional difficult was very significant and can occur in any field of research. Many groups had been working on lunar dust since the President Bush initiatives revived interest in 2004. None was aware of the peer-reviewed publication by me and NASA officials in Journal of Applied Physics in 1970 correcting the error in the official NASA Report SP-214 a year earlier. None was aware of my Apollo 12 Preliminary Science Report of 22 December 1969 scheduled to be Chapter 8 in the official NASA report but omitted.

Thus various research groups are deeply committed to theoretical models of dust behaviour and to both laboratory and space ventures. These were begun in ignorance of the 40-year-old facts. More particularly, the new discoveries reported in the peer-reviewed paper in May 2009 were largely unexpected, not fitting with existing concepts and, more severely, raising basic issues such as adhesion to horizontal *vis a vis* vertical surfaces that study groups had not contemplated. The discovery that the "stickiness" of dust increases with illumination by the Sun was totally unpredicted. Apollo astronauts were on the Moon only in the weak light of very early morning. Researchers thus met one-two blows of new realities.

Various discoveries are now being absorbed into at least one group of theoretical modellers but with more difficulty into on-going laboratory and spacecraft aspects.

Addressing the problems was a practical measure of simple traditional scientific methods:

First, preprints of the proposed first paper were circulated in late 2008 - early 2009. **Second**, the paper was subjected to peer-review. **Third**, in July 2009 at the 2nd Lunar Science Forum and at NASA I gave seminars on the paper, and on another unpublished discovery.

Fourth, and most recently, I was invited to a specialised Workshop on "*Lunar Dust, Atmosphere and Plasmas: the Next Steps*", in Boulder, Colorado, 27-29 January 2010. With the professional group of 80, I was free to show and discuss personal archives of letters and reports where NASA errors, particularly with reports and papers on Apollo 11, are evident.

Various exchanges on issues created unusual but expected tensions and encountered some mind blocks which are now largely faded, gradually overwhelmed by genuine desire and scientific curiosity for improved rigorous research and realistic modelling and simulation.

US leaders of research into lunar dust endorsed a White Paper I developed on lunar dust issues developed with a NASA research engineer. It is now part of the basic material for the US Decadal Plan on Space Science. They are also supporters of the UWA proposal to ASRP, and are included as researchers for the proposal.

ToR5: Principles and strategies for supporting international research engagement.

As a practical fact, the dominant reality at present for the writer is waiting for a decision as to whether ASRP will fund the UWA proposal of 4 December 2009 for future research on lunar dust. I will be interested in whatever principles and strategies guided it.

I and USA colleagues involved in this project will be better placed to comment on Principles and Strategies for Australia once a decision is known.

CONCLUDING COMMENTS

The merits of Australia having a strong international research engagement are modulated by international and domestic economic and political factors.

So I respectfully refer this Inquiry to an eternal theme extolled by President John F. Kennedy at Rice University in Houston on 12 September, 1962, a much more troubled time, a month before the Cuban missile crisis brought this planet closest to a global nuclear war. He said "***We set sail on this new sea because there is new knowledge to be gained, and new rights to be won, and they must be won and used for the progress of all people. For space science, like nuclear science and all technologies, has no conscience of its own.***" http://er.jsc.nasa.gov/seh/ricetalk.htm

I had just published discovery of the globe-circling artificial radiation belt of fission electrons from 1.4 Megatonne nuclear explosion "*Starfish*", 70 times more powerful than the Nagasaki and Hiroshima bombs that ended World War 2 (O'Brien, Laughlin and Van Allen, *Nature*, **195**, 935, 1962). I was very conscious that technology has no conscience of its own.

Australia must, through international research collaboration, be an active part of this voyage and explore this new sea. More, we must actively gain the new knowledge and win and use the new rights. Surely such a resolution must win bipartisan acclaim.