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Antarctic Astronomy

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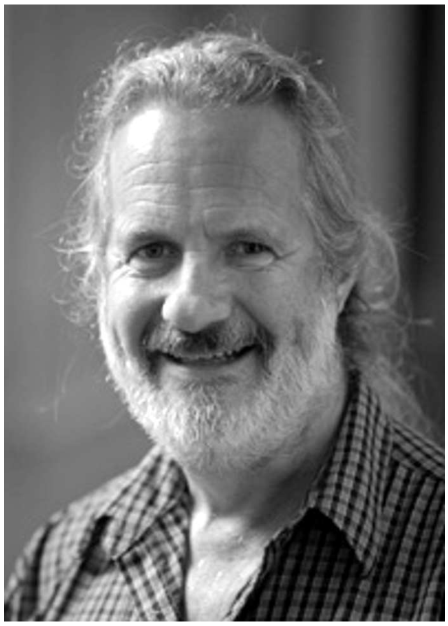
Abstract: John Storey is a Professor of Physics at the University of New South Wales. He was awarded the Pawsey Medal by the Australian Academy of Science and the Antarctic Service Medal of the US Congress. His research interests include Antarctic astronomy, infrared astronomy and millimetre wave astronomy and energy-efficient vehicles. He is Chairman of the Antarctic Astronomy and Astrophysics Expert Group of SCAR which helps to coordinate international astronomical research in Antarctica.

Keywords: Bio-astronomy, Infrared astronomy, Large telescopes

INTRODUCTION

John Storey's parents were both school teachers and as a result of that profession they moved around various towns during his early childhood. 'So we never spent more than a few years in any one place.' He had a varied and interesting childhood and perhaps because his parents moved from one place to another he did not have a large number of friends. So he spent a lot of his childhood in building things and playing with mechanical and electrical things. At about the age of ten he was given an OC71 germanium transistor which he built into his first crystal set. He remembers he said, 'listening to my one-transistor radio and hearing the announcement that President Kennedy had been shot. I went and told my parents who were shocked by the news.' That hobby evolved into amateur radio and at the age of fifteen he obtained an amateur radio license but was not able to legally operate a transmitter until he turned sixteen. These early experiments with things scientific and technical sparked in him a desire to be a scientist and later in life it showed up in his interest in building scientific equipment. It is rather surprising that his interest in astronomy came much later.

He was always near the top of his class and won a scholarship to study at Melbourne Grammar School. 'I was very lucky to have outstanding teachers in physics and chemistry. I also fondly remember the history and language teachers and I always enjoyed languages and history as much as I enjoyed science.' His father was 'probably the main person who motivated him into a physics-type discipline.'



LA TROBE AND THE UNIVERSITY OF CALIFORNIA

For his undergraduate studies he went to La Trobe University which happened to be close to his home. It was the time of the Vietnam War and like many socially conscious students he got 'into student politics and anti-war demonstrations.' At La Trobe he came under the influence of Keith Cole a well known ionospheric physicist and a great advocate of space science in Australia. From Cole he learnt 'that we should never worry about getting a job. That what we should do is what we were interested in.' 'I think it was very good advice', he told me.

After completing his Honours degree he joined the Chemistry Department at Monash University rather than the Physics Department to do his PhD under the supervision of Ronald Brown, an internationally recognized astrochemist. 'I saw this as an opportunity to do laboratory spectroscopy at microwave frequencies of molecules that had just been detected, or additional molecules that might be detected in interstellar space.' His PhD topic was on microwave spectroscopy and radio astronomy of biologically interesting molecules. 'For many years people believed that molecules could not exist in interstellar space because of the ultra-violet radiation field. I think the OH radical had been known since World War II from optical observations but it was not until 1968 that Charles Townes and Al Cheung discovered ammonia that it was realized that quite complicated molecules could exist. In the years immediately after 1968 I guess a dozen or more molecules were detected at radio telescopes including Parkes.' In searching for biological molecules he succeeded in 'getting a microwave spectrum of urea.' According to him, 'our ability to measure the microwave spectrum of urea was something of a breakthrough because that was the first biological molecule for which a microwave spectrum had been achieved.'

He went to Kitt Peak with Brown and Peter Godfrey to search for glycine with the 36 foot diameter radio telescope. While there 'we were able to look for the carbon 13 line of HNC and the fact that we were able to detect this meant that the identification of HNC was then assured (Brown, et al., 1976)'. The search for glycine was not successful (Brown, et al., 1979). In fact, over the years several astronomers have been trying to search for glycine in space but to date have not been able to detect it. Storey believes that 'there are tantalizing indications that glycine is there. I think it will eventually be detected. It is a surprisingly difficult molecule to find and in fact if you calculate how abundant you think it should be, just on the basis of how many atoms it has, at that abundance level it is extremely hard to find. The problem with it is that it is a completely asymmetric molecule.' There is much interest in the search for biomolecules in space because some astronomers and astrobiologists believe that life on Earth may have been seeded by biomolecules from outer space rather than having to start from scratch in Darwin's small warm pond on Earth.

For his post-doctoral fellowship he went to the University of California at Berkeley in the late 1970s and joined Charles Townes' group. Townes was a Nobel prize winner and the inventor of the laser. According to Storey, 'Townes was an absolute delight to work with. He was very much a renaissance man, interested in not just physics but also philosophy, religion, history and languages. He was extraordinarily kind and generous and very much engaged with his students. Townes was a great inspiration to me.' Storey spent four and a half years at Berkeley.

He said his time at Berkeley was one of his most creative periods. He was involved in 'developments there of infrared interferometry, and airborne astronomy on the Kuiper Airborne Observatory (KAO).' The interferometer had been built by Townes and his students Michael Johnson, Al Betz and Ed Sutton. With the 'two-telescope interferometer they were able to look at objects with much greater spatial resolution than had been possible before. But the main result at that time was looking at dust shells around stars. We were able to measure the diameter of those dust shells and measure the inner radius of that dust shell (Sutton, et al., 1977)'. He developed his own spectrometer (Storey, et al., 1981), a Fabry-Perot scanning spectrometer with a helium cooled detector and this 'flew on about eighty flights with the KAO.' They were able to detect molecules and characterize the warm gas component of interstellar gas clouds. They were also able to detect fine structure lines of various ionic species like [OI], [OIII] and [NIII]. When he returned to Australia he tried to arrange regular flights for the KAO in Australia. He succeeded in getting it once to Sydney at the Richmond Air Force Base. Due to some administrative and financial problems with the Richmond Air Force Base the KAO subsequently went instead to New Zealand and 'flew out of Christchurch.' KAO ceased flying in the late nineteen-eighties to make way for SOFIA and an Australian woman astronomer Jackie Davidson is one of its leading lights. SOFIA will be a tremendously powerful probe of the far infrared universe.

He wrote a review on infrared astronomical spectrometers which was a summary of the major developments in the field (Storey, 1985). ‘It was a very exciting in around 1985 because we were opening up this new spectral region. And part of the debate at the time and in fact is still ongoing is that at radio wavelengths it’s very clear what techniques to use. You use heterodyne techniques where you mix the incoming signal with a local oscillator and as soon as possible convert the signal into an electrical signal you can then process digitally. At optical wavelengths again it is clear you use a grating spectrometer or a Fabry-Perot spectrometer and do all the processing optically. And at the very last part of the instrument is the detector where you turn it into an electrical signal.’ ‘So it’s two completely different approaches,’ he said. ‘Now clearly these two techniques meet in the middle and they meet in the far infrared. And it’s in the far infrared that you really have to understand what the benefits are of using one technique or the other.’ The technology has changed very rapidly and according to Storey, ‘we are getting very close to the quantum limits of detection across the entire electromagnetic spectrum from low frequencies to X-rays. And so there is no longer really any debate. You simply look at what it is that you are trying to measure and it becomes very clear whether you use an optical technique or a radio type technique.’ In the far infrared both techniques have their place and he believes that the Herschel satellite will carry some radio-type heterodyne instruments and also some optical-type direct detectors.

UNIVERSITY OF NEW SOUTH WALES

He returned to Australia in 1981 and joined the Anglo-Australian Observatory which at that time ‘had been going for five or six years and was riding the crest of a wave as one of the most productive of the new generation of four-metre telescopes’ under the directorship of Donald Morton. He came back to a five-year position at the Anglo-Australian Observatory but a year later he joined the Physics Department at the University of New South Wales as a lecturer because they ‘offered him a permanent job.’ Five years later he was appointed to a new position as Professor of Physics. He was thirty-six and probably one of a very few academics in Australia to get a professorship at that age. Most Australian academics get a professorship in their late forties or fifties.

At the time he joined the School of Physics he said, ‘it was a lumbering kind of school. I think there were forty-two academics, most of them approaching retirement age so there were a lot of resources available.’ With Louise Turtle and colleagues he built the Astronomy Department which he said, ‘became the second highest cited Astronomy Department in the country.’ Turtle was also responsible for nominating him for the Pawsey Medal.

He was involved in the acquisition of a satellite-tracking optical telescope from NASA when NASA closed down their satellite tracking station at Orroral Valley. With Jack Cochrane, Louise Turtle and Peter Mitchell he heavily modified it for use as an astronomical facility and relocated it to Siding Spring to become the Automated Patrol Telescope. ‘It is now being operated by Michael Ashley and used for searching for extra-solar planets, gamma ray burst sources and for all kinds of transient sources. It is now a very successful and very productive facility and they are churning out several papers a year’, he said. With Michael Burton he was instrumental in fitting out the Mopra radio telescope with millimetre-quality panels over the entire surface. ‘So we basically turned Mopra into a millimetre telescope and then using ARC LIEF funding we are providing a very wide bandwidth receiver for the back end.’ Millimetre wave astronomy is a rapidly growing field. At the moment Mopra is the only big millimetre wave telescope in the southern hemisphere but that window of opportunity will be lost when ALMA (Atacama Large Millimetre Array) comes on line in South America.

ANTARCTIC ASTRONOMY

His major interest now is in Antarctic astronomy (Aitken, et al., 1994; Burton, et al., 2004). According to him, 'Antarctica offers several advantages. One is of course it's very cold and it's very high on the Antarctic plateau. Because the atmosphere is very dry you have got much better atmospheric transparency. In addition of course the infrared background is very much lower because it's colder and the skies are effectively twenty to fifty times darker across the infrared and so at infrared wavelengths you get a sensitivity gain of up to seven or ten. In addition to that the atmosphere's also extremely stable and so the image quality is much better than you get at any other site.' He believes that the high plateau sites are by far and away the best Earth-based sites for a lot of infrared and optical astronomy as well as submillimetre and millimetre wave astronomy. The other advantages, he said, 'of constructing there are the very low wind speeds and lack of earthquakes. So potentially you can build extremely large telescopes there, probably cheaper than they could be built at other sites.'

His ultimate ambition would be to build a 25 metre extremely large telescope. He has written a paper with Roger Angel from Arizona. But to get to that stage they are planning to firstly build a 2.4 metre optical infrared telescope. Called PILOT, he said, 'we would like to get on with that straight away (Burton, et al., 2005)'. The cost is about ten million dollars. The reason for building this first is to demonstrate that there are no insurmountable problems. The next stage after that is to build an eight metre telescope. He has in mind a proposal called 'LAPCAT' for that. The final step is to build the 25 metre telescope which would effectively be derived from the Giant Magellan Telescope.

They have done enough site testing at the moment to show that 'one can sensibly talk about building a big telescope. Furthermore the site conditions are so favourable that it is worth building a big telescope.' They have also done a great deal of technology development so that they know how to make things work in Antarctic conditions. They have, he said, 'built a robotic observatory that's worked for months with nobody around in Antarctica under the harshest conditions (Ashley, et al., 2004). We know how to do it and it is just a question of putting the pieces together.'

ACHIEVEMENTS

He has supervised about a dozen postgraduate students who have gone in different directions. Some of these are Kate Brooks who is now at the CSIRO Australia Telescope National Facility, Tony Travouillon is at Caltech while Paolo Calisse is at Cardiff University.

He has a very active research profile. He attributes this to Townes' influence which is 'not to do what is necessarily the obvious thing to do. That if it's clear what the next step is going to be in some field then why not let someone else do that because if it really is obvious then other people are going to come along and do it. So what's the point of you going in there and competing with them. It's much better to do something which otherwise wouldn't happen and to try and be creative and actually make a difference to the way science develops. So I guess throughout my career I've tried to do things that will actually make a difference rather than doing things that are perhaps easy.'

As to his achievements to date he said, 'I think putting UNSW physics and astronomy on the map. I think the other achievement of effectively launching the field of bio-astronomy has been something I can take some pride in although clearly I was only a PhD student at the time and so most of the credit should go to my supervisors. Opening up the far infrared spectroscopy through the work I did at Berkeley. But I would say that Antarctica would have to be the most important thing I've done. I thank the group here and it's been very much of a team effort with Michael Ashley and Michael Burton. Peter Gillingham at the Anglo-Australian Observatory I think should take a lot of the credit for stimulating the work that we've done and contributing to it. What we have shown is that Antarctica does offer enormous advantages for optical/IR astronomy and for other fields as well. And I think we've shown that this is an opportunity for Australia and I think if Australia does take the opportunity up then that will be the thing that saves optical/IR astronomy in Australia.'

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