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James Douglas Morrison 1924–2013

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Jim Morrison was born in Scotland in 1924 and completed his PhD studies in X-ray crystallography at the University of Glasgow before taking up a position with CSIRO in Melbourne in 1949. There he became expert in the construction and operation of mass spectrometers, mainly for the study of ion physics. In 1967, he became the Foundation Professor Physical Chemistry at the new La Trobe University in Melbourne where he continued his work in mass spectrometry but was also involved in university leadership that included a period as head of a residential college. Together with his students, he developed the use of compact, rapid-scanning quadrupole mass spectrometers, linking them in series to allow secondary studies (including photochemistry) of particular ions, but also taking advantage of the speed of the quadrupoles to link them to gas chromatographs for the study of mixtures of organic compounds. In all of this he was a pioneer in the use of computers with spectroscopic instruments. Internationally he was a recognized expert, speaking at conferences, establishing collaborations, and spending periods of leave at the University of Utah. After his retirement in 1990 he spent a long period as Emeritus Professor before his death in 2013.

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Early Years and Education in Scotland

James Douglas (Jim) Morrison[1] was born in Glasgow in 1924 to James Kinloch Morrison, a soldier returned from World War 1 service with the Kings own Scottish Borders and his wife, Yorkshire born Rose Annie née Wheeler, who had married in 1923. Soon after his birth the family moved to Broughty Ferry, a town on the Firth of Tay a few miles east of Dundee. Morrison senior began work as an office boy for the Vacuum Oil Co. (later Mobil) and ended his career as head of Mobil in Scotland.

As a small boy, Jim was free to roam the sands near Broughty Ferry, but he soon showed an interest in matters technical and mechanical, gleaning information from the pages of the *Boys Own Paper*[2] and collecting bits of machinery from a friendly scrap merchant. From the magazine he learned how to make a crystal radio set and also his own fireworks and gunpowder that he compounded from materials available from the local ‘chemist shop’. Among the scrap he collected were the magnetos[3] from cars, and from them he was able to generate large sparks. His interest in physical science was piqued by the science fiction of H. G. Wells. It was further developed in visits, from time to time, to an uncle, an engineer who lived in a small town where he was in charge of an electric generating plant, a water supply and a cinema. In his uncle’s excellent workshop, Jim learned to use a lathe and other tools and to appreciate how a workman looked after his tools.

Jim went to grammar schools in Broughty Ferry (Grove Academy) and Dundee (Morgan Academy) until the family moved further west in Scotland to Kirkintilloch, about six miles north-east of Glasgow, where he attended the Lenzie Academy. There he learned that English, the language spoken at home, was unacceptable and had to be replaced with Scots.[4] Discipline in the schoolyard was replaced with discipline in class, with the result that, among other things from the English master, Jim could recite many years later most of the Prologue of Chaucer’s *Canterbury Tales.* World War 2 started when he was in third form, with the immediate effect that sport was cancelled for the duration and all pupils had to spend two nights a week fire watching, armed with shovels and buckets of sand with which to extinguish incendiaries. Jim’s private life of technology continued to flourish, however, and he was able to use reject lenses (provided by an employee of Barr and Stroud, father of a friend) to construct a telescope, a camera and an enlarger.

In 1942, Morrison fulfilled a long-held dream by enrolling in chemistry at the University of Glasgow, where he was supported by one of the grants of £50 that were made available by the Carnegie Trust to Scottish students proceeding to university. The four-year honours course was condensed into two years and nine months—the extent of deferment from military service—by eliminating vacations. Only courses in science, engineering and medicine were offered—all other courses being suspended while staff were conscripted for military service—and students worked hard at regular studies along with military drill and instruction. ‘I think they had some idea of turning us all into guerrilla fighters’, Morrison said, 'because they showed us how to use plastic explosives and shaped bombs. I never found any use for it later, but it was useful information at the time'.[5] An event that stood out in memories of those years was a lecture in which Professor J. Monteath Robertson[6] showed the structure of a large molecule[7] that had been determined by X-ray crystallography, a field that Morrison was consequently keen to enter. Another was meeting, in his chemistry class, a fellow-student, Krysia who was to become his wife in 1947. She was Christine Barbara Maria Mayer, daughter of Stefan Antoni Mayer and his wife Marya née Golenska. Colonel Stefan Mayer (1895–1981) was the head of Polish intelligence from 1930 until 1939, supervising cryptologists who worked on a captured German 'Enigma' encrypting machine. After sharing the Polish result with Britain and France, and providing them with Polish-made replicas of the Enigma, Mayer left his home country and he and his wife settled in Britain where she enjoyed a career as a professional artist.[8] During the war Mayer was head of the Polish Government-in-Exile military officers school, first in London and then in Glasgow.[9]

Christine studied at Glasgow University and then was employed in an Imperial Chemicals Industries (ICI) research group at Billingham, near Stockton-on-Tees. After her marriage, ICI was able to transfer her to the Nobel Division at Ardeer, where she worked on the infrared spectroscopy of explosives manufactured there, and later to a fibre research group.

In 1945, Morrison began research towards his PhD, undertaking research in X-ray crystallography with Robertson, who provided a £50/year scholarship. Enduring the tedious calculations that were the lot of a long-range crystallographer—no electronic computers in those days—the crystal structures of sebacic acid ($C_{10}H_{18}O_4$) and hexamethylene diamine ($C_6H_{16}N_2$) were determined. The scattering power of the hydrogen atoms in the crystals was enhanced by their greater preponderance in the molecules, leading to the identification of their positions in the crystal structure. Morrison was lead author on the publication.[10] Since X-rays are diffracted by electrons, and the hydrogen atom has but a single electron, it was a widely held view at the time that hydrogen positions would not be determined by the technique, but Robertson had alluded to the possibility of doing so when he reviewed the field in the 1945 Tilden Lecture. He commented on the determination of the coronene structure that 'we see that there are distinct bulges around every outer carbon atom to which we expect to find a hydrogen atom attached'.[11] Morrison's PhD work included several other determinations of structure of dicarboxylic acids. (A complete publication list is included in the Supplementary Material). Morrison's last crystallographic work at Glasgow, published after he had settled in Australia, was on the structure of colchiceine and its copper salt.[12] A definitive structure was never elucidated but was provided many years later by Morrison's colleague at La Trobe University, Dr Maureen Mackay.[13] Over a decade later the Glasgow group returned to study in more detail the structure of the β modification of succinic acid.[14]

Robertson was obviously impressed with Morrison's abilities and he appointed him to an assistantship, a junior post, but the first step on the academic ladder. Although he was interested in a career in academe, Morrison formed the view that the good jobs in Britain went to Oxbridge graduates and that he would be wise to look elsewhere. Several factors combined to put into his mind the idea that 'elsewhere' might be Australia. The Morrisons were friendly with the Australian organic chemist, Geoffrey Badger,[15] who was then studying at Glasgow, and his wife Edith. The Badgers, who later returned to live out their lives in Australia, beguiled them with pictures of sunlit beaches, at a time when 'from 1944 to 1948, the weather in Scotland had been dreadful. It was mist and rain all the time and the sun never shone in Glasgow'.[16]

At this point there was a significant visitor to the Department, Dr Ian Wark,[17] who had been appointed as the inaugural Chief in 1940 of the Division of Industrial Chemistry in Australia's Council for Scientific and Industrial Research (CSIR, later the Commonwealth Scientific and Industrial Research Organisation, CSIRO).[18] Wark was at the time recruiting scientists for his new Section of Chemical Physics, that he later claimed 'soon became celebrated throughout the world for its innovative improvements in the equipment and techniques of its subject'.[19] Another of Robertson's students, A. McL. (Sandy) Mathieson,[20] who had become a close friend of the Morrisons (he was best man at the wedding), who was just completing his PhD at that time, applied for a position with Wark and was appointed to that Section. Completing his PhD the following year, Morrison did the same.

Moving to Australia

Mooroolbark

The Morrisons arrived in Melbourne on 26 January 1949 aboard *Orontes*.[21] At first they rented in Sandringham but then bought land—two blocks—on Sherlock Hill in Mooroolbark, an outer eastern suburb of Melbourne. Several other scientists from the Industrial Chemistry Division also settled in the area. The Morrisons bought a small prefabricated hut and erected it on their land, and they lived in it while they and their friends began construction of the house. Once the frame was up, the task was taken over by professional builders. At St Francis in the Fields Anglican church built in late 1953 in Hull Road, Jim was in the first Vestry. There was a strong community spirit in the area, with an annual Christmas party in the old Mooroolbark Hall that was attended by many of the farmers who still lived in the area as it gradually changed from rural to suburban. Edna Walling helped Christine design their garden.[22] Three sons were born to the Morrisons—Richard (1955), Gordon (1958) and Alan (1960).[23]

Christine found it difficult to gain suitable employment due to restrictions on the employment of married women that were in place in the 1950s, but was able to work as a Demonstrator in undergraduate chemistry classes at the University of Melbourne.

CSIRO Chemical Physics

Wark had invested in the latest physical instrumentation with a view to using it to study chemical problems, and he recruited young scientists to work with the new equipment and exploit its possibilities. It was a very fruitful recruiting visit that Wark had made to Glasgow and what followed showed his acumen in selecting scientists who could move beyond their initial training and develop new fields of study. X-Ray crystallography in the new research Section was in the hands of Sandy Mathieson (1920–2011),[24] and so although Morrison was an expert in this field, he had been recruited to work in mass spectrometry. There was an embargo on the export of mass spectrometers of any kind from the USA because of their use in atomic weapons research, notably the separation of uranium isotopes, but

Figure 1. Morrison with the Model 21.102 mass spectrometer at CSIRO in 1949 (Source: Morrison family).

high-level connections enabled Wark to purchase an instrument. Morrison spoke about this transaction as follows:[25] 'It so happened that Ian Wark managed to get John Curtin, our Prime Minister at the time to write to Harry Truman.[26] I believe there was some correspondence back and forth, after which Curtin got back a letter from Truman saying, "in recognition of your successful collaboration in the Battle of the Coral Sea, we're going to give you one", so that's how we acquired the machine that I was given'. The instrument was a Consolidated Engineering Corporation 180°-type mass spectrometer model 21.102,[27] an instrument that had been identified by Lloyd Rees,[28] head of the Chemical Physics Section. Rees had visited companies and laboratories in the USA in 1944 as he returned to Australia following PhD studies and wartime work in Britain, and reported to Wark on what he had seen. A member of his staff, Graham Hercus, was sent to the company to be trained in the use of the instrument and to 'see it safely to Australia' (Fig. 1).[29]

Morrison was interested in ion fragmentation, not for determination of structure but for the measurement of bond energies. Despite the acquisition of the state-of-the-art mass spectrometer, the equipment available to the CSIRO researchers was primitive by modern standard. Pumps struggled to maintain the high vacuum needed for the ionization experiments, the electronics for controlling the spectrometer and recording were barely adequate, being based on thermionic valves and other simple components. Producing electron beams in narrow energy ranges with this equipment was challenging, and failure to narrow the spread of energies limited the precision with which bond energies could be obtained. However, access to a well-equipped workshop—always an adjunct to research in physics—and assistance from highly trained technicians enabled good work to be produced. In his reminiscences, Morrison wrote warmly about the staff of mechanical workshops at CSIRO, Chicago and La Trobe.[30]

In 1956, Morrison was awarded a Commonwealth Fund (later Harkness) Fellowship that enabled him to work for a year at the University of Chicago with Professor Mark Inghram (1919–2003), a physicist with a reputation as a machine builder. As a graduate student Inghram had worked on the Manhattan Project, in which mass spectrometers were used to separate uranium isotopes ^{235}U and ^{238}U. Relics of those grand days were still in evidence at Chicago, such as the primitive mass spectrometer that had to be removed from the room assigned to Morrison. It was destined not for the rubbish tip, as he surmised, but instead went into the Smithsonian Institute collection of scientific instruments. It was a productive year at Chicago, during which Morrison constructed apparatus for photoionization of various species, the ions being detected and identified by mass spectrometry.[31] In Chicago, he had access to mass spectrometers of vastly superior performance (resolution 1 : 4000, and extremely high vacuum) than the CSIRO instrument. On his return he was able to construct an instrument having resolution 1 : 5000 and thus, for example, capable of separating three ions of nominal mass 28: carbon monoxide 27.995, nitrogen 28.0062, and ethylene 28.0540 atomic mass units.

In a postgraduate lecture organized by the Victorian Branch of the Royal Australian Chemical Institute, Morrison pointed to the existence of two groups of users—researchers, who often build their own instruments and can become so involved in instrumentation as to lose sight of its applications—and those who see the instrument as a tool for other studies. It is important that those purchasing a mass spectrometer should have a clear idea of what they need, he said, since '£30,000 worth of white elephant is a good advertisement for no one'. However, he concluded his account by reflecting 'that once an instrument has been acquired, it very often happens that the primary reason for its acquisition may soon be superseded by some other much more important application, which becomes evident only as familiarity is gained with the technique'.[32] The first instance that showed that Morrison was able to walk on both sides of the researcher/user dichotomy occurred in the late 1950s when Edmund Gill,[33] a palaeontologist from the National Museum of Victoria, sought his help in examining fossil oyster shells that were up to 40 million years old. Under Morrison's guidance, the old mass spectrometer was modified and his colleague F. H. Dorman was able to measure the ^{18}O: ^{16}O isotope ratios for carbon dioxide that was produced from the shells by acid treatment. The results showed that 20 million years ago the temperatures in which the oysters lived were up to 5° higher than those of the last million years.[34] Dorman continued the work with fossil material from Australia and Antarctica.[35]

Morrison's ion physics work was attracting international attention and he was invited to speak at the 12th Conseil Solvay de Chimie held in Brussels in November 1962.[36] While in Belgium, Morrison was one of the Solvay participants who also participated in a conference on the chemical physics of the ionization phenomena in the gaseous state, held at the Université de Liège in October.[37] In both presentations, and in a publication that followed,[38] Morrison spoke about the spread of energies in the electron beam (at its narrowest, 0.03 eV) that caused broadening of the ion peaks in the mass spectrum. While attention had been paid to narrowing the spread of electron energies, a limit, at least with present-day technologies, seemed to have been reached. Further improvement in resolution in the spectrum could be achieved, however, with deconvolution techniques using Fourier transform methods as had been done with radar images. 'The greater the gain in resolving power', Morrison wrote, 'the greater the sacrifice which has to be paid in signal-to-noise ratio', but this was acceptable. These calculations were achieved with the help of retired University of Melbourne physicist (and father of Morrison's colleague Graham Hercus) Eric Hercus,[39] who was the consulting programmer for the CSIRAC computer that had been transferred from CSIRO to the University. Morrison was able to program the computer to perform the necessary calculations to deconvolute the peaks and so reveal their components.

At the Fourth Australian Spectroscopy Conference, held in Canberra in 1963,[40] Morrison addressed the needs of the 'users' of mass spectrometers, discussing the possibility of programming a computer to compare the spectrum of an unknown with a library of known spectra, and demonstrated a tape recording of a mass spectrum that was used to transfer the information to the computer. He also spoke about the use of electron impact measurements, conducted in a mass spectrometer, to determine the energy levels of positive ions. J. S. Shannon,[41] of CSIRO's Division of Coal Research, spoke about fragmentation patterns and their use in determination of the structures of organic molecular ions, as did J. L. Occolowitz (Defence Standards Laboratory). Because of his concentration on the physical chemistry of ionic processes, Morrison's colleagues in the neighbouring CSIRO Division of Organic Chemistry often turned to Shannon for their structure work, but Morrison did, from time to time, also become involved in projects such as the identification of the volatile substances of apples, fatty acids in milk, and constituents of Australian plant species.[42]

In 1964, Morrison accepted an invitation to be a visiting professor at Princeton University and he spent a year working there. The university, much to Morrison's surprise, did not possess a mass spectrometer but he had ready access to an advanced computer. Its 32k memory, tiny by modern standards, was sufficient for him to write programs to identify the species giving rise to mass spectra and another to track ions through the electric and magnetic fields in the mass spectrometer. Details of the identification programs were published later, after Morrison had left CSIRO for academe.[43]

La Trobe University

Morrison had been promoted steadily at CSIRO (Supplementary Material), reaching the rank of Chief Research officer in 1964.[44] Morrison considered job offers in the USA but he and his wife decided that Australia was a better place to bring up children, and their decision to return was sealed when he accepted the offer of the foundation chair of Physical Chemistry at La Trobe University, and took it up in 1967. He had been happy at CSIRO and somewhat reluctant to leave, writing that 'it wasn't that I disliked life at CSIRO, quite the reverse—I was too happy and comfortable there. If you are born and bred in Scotland, Presbyterianism is in your bones. If life is too easy, there is something wrong somewhere'.[45] The idea of teaching attracted Morrison but at the organizational level he did not find the transition easy. It 'was an eye-opener for me', he told an interviewer,[46] 'because learning was not the sole purpose of a university; I also got an education in university politics. In CSIRO, we had been a collection of gentlemen' but at La Trobe 'it was boots and all'. It was not only the competition for resources in the academic sphere that troubled Morrison, because within a few years he also had responsibility for a student residence, Chisholm College. Morrison was in Utah (see below) when Vice-Chancellor David Myers telephoned him and asked him to design the college. As Morrison designed it, the college had clusters of 10–12 private bedrooms in units with shared bathrooms, kitchens and common areas, and was home to 360 undergraduates. Morrison was the first Master, and he and his family lived on-site for six years through the turbulent period of student unrest in the late 1960s and early 1970s.[47]

When Morrison moved to La Trobe University the old Consolidated mass spectrometer went with him and it bore a plaque commemorating President Truman's generosity.[48] Morrison was intent on construction of new instruments, and so within a year of taking up his appointment at La Trobe he had established mechanical, electronic and glass workshops[49] that were accessible to staff and students as well as trained technicians. John Smith, a colleague from CSIRO, joined the department as Research Associate and a new mass spectrometer was constructed. John Traeger, Morrison's first PhD student, was involved, with Smith, in the interfacing of a gas chromatograph to the mass spectrometer. Interfacing the room-pressure samples emerging from the gas chromatograph with the high-vacuum environment inside the mass spectrometer was a challenge, and another was construction of suitable magnets (laminated rather than solid iron) that could be cycled quickly so that the mass spectrometer could keep up with the samples emerging from the gas chromatograph.[50] Laminated iron magnets have become the 'industry standard' for construction of sector-type mass spectrometers. A third challenge was the great quantity of data produced as mass spectra were recorded for the eluted components. These data were managed by interfacing the mass spectrometer to a small computer (a Digital Equipment Corporation PDP8) that could control the operations of the spectrometer and assist with data analysis. For example, the library of 20,000 mass spectra stored on disc could be interrogated to indicate a match—if there was one—within 10 s. This was the beginning of GC-MS that is so widely used in analytical laboratories today. The group also wrote artificial intelligence programs that could analyse the spectra of unknown compounds (at least, those not in the library) and indicate likely structures. Of course the Morrison group were not alone in developing programs to interpret mass spectra. With graduate student R. J. (Bob) Mathews, Morrison surveyed the available methods and concluded that those basing their methodology on the six or eight largest peaks in the spectrum were most successful when applied to a family of terpenes that was felt to comprise a reasonable challenge of any system.[51] Although Morrison's main lines of research were continuations of his interests in ion physics and especially photo-ionization, he and his students were from time to time involved in GC-MS analysis of organic materials including industrial pollutants.[52] In related work, the detection of aromatic hydrocarbons in water was found to be limited to ~1 ppm because of the leaching of volatile material from the resin used to sequester the hydrocarbons.[53]

Most of Morrison's graduate students worked on ion physics, however, and one of the most successful was Don McGilvery, who developed the ion-tracking program SIMION[54] that underwent progressive development and achieved wide use by designers of mass spectrometers.[55] The significance of this software was acknowledged by the American Society for Mass Spectrometry by a joint award for Distinguished Contribution to McGilvery and David Dahl of the Idaho National Engineering and Environmental Laboratory. In 1985, Dahl had adapted SIMION for use on personal computers, and a Macintosh version was later developed by McGilvery and Richard Morrison. McGilvery's main work, however, was the development of apparatus that enabled photo-excitation of single ions generated in a quadrupole mass spectrometer, and study of the ionization and photo-fragmentation processes.[56]

Using two mass spectrometers in tandem—that is, with ions generated and separated in the first mass spectrometer being further processed in a second mass spectrometer—was not a new idea,[57] but the advent of rapid-scanning quadrupole instruments provided new opportunities that were taken up more or less simultaneously by Morrison and by researchers at Michigan State University.[58] Christian Enke had been at Princeton and interacted with Morrison during the latter's 1964 sabbatical leave there, and when they met again at the 1977 meeting of the American Society for Mass Spectrometry they discovered that each had constructed triple quadrupole mass spectrometers. Enke and his graduate student Richard Yost, with Austin Wahrhaftig (University of Utah, see below) met with Morrison over dinner to discuss their mutual interests, and it was agreed that Yost would come to Morrison's laboratory in Melbourne to conduct experiments that had not been possible with the Michigan instrument.[59] A series of publications followed, with acknowledgements by the Michigan group, a joint article and a review.[60] Enke and Yost appear in a YouTube video, discussing the chance meeting

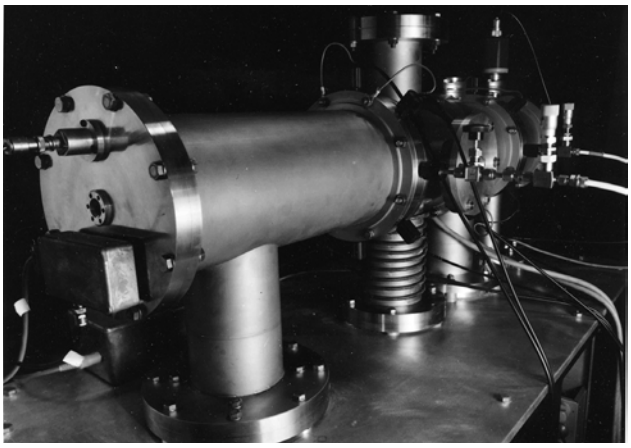

Figure 2. Triple Quadrupole Mass Spectrometer (jacketed because its operation requires low pressures) (Source: Morrison family).

with Morrison and the subsequent development of the 'triple quad' (Fig. 2).[61]

Morrison encouraged the construction of chemical instrumentation and development of expertise by La Trobe physical chemists in such fields as photoelectron spectroscopy, thermal analysis, and field-desorption mass spectrometry that enabled large molecules to be introduced to the gas phase. Most instruments were controlled by small computers—PDP8 or (later) PDP11 or Apple II. Morrison himself constructed the department's first quadrupole mass spectrometer, after seeing one in use elsewhere. In such an instrument the ions move in spiral paths in an electric field generated by four electrodes and the spectrum can be scanned as often as 50 times a second. Resolution is much lower than in magnetic machines but quite adequate for most GC-MS work (Fig. 3).

Over time, the La Trobe workshop built 30–40 of these machines and the design of a tandem pair if these instruments used in ion physics studies was patented.[62] Using three quadrupoles in series—one to generate a molecular ion, one in which to irradiate it with a tunable laser, and the third to examine the products—Morrison was able to measure bond lengths and bond angles. Morrison spoke about this development at a workshop in Utah in 1983[63] and at the International Workshop on the Structure of Small Molecules and Ions held in Israel in December 1987.[64]

University of Utah

Morrison had a collegial relationship with a leading mass spectrometrist, Austin Wahrhaftig (1917–97)[65] at the University of Utah, and he spent a period of sabbatical leave there in 1971. Wahrhaftig was a visiting professor at La Trobe University in 1977 and the two published together from time to time.[66] As an adjunct professor, Morrison visited Utah frequently in the period 1973–2001 to undertake research and also to teach. For a quarter in every second year he taught a Special Topics Course on Mass Spectrometry, usually selecting a topic such as ion energetic or electrospray techniques. The visits served to ease the tensions of life at La Trobe and also to facilitate contact with a wider group of ion physicists than were to be found in Australia. In 1983, he participated in an annual workshop conducted by the Department of Chemistry at the University

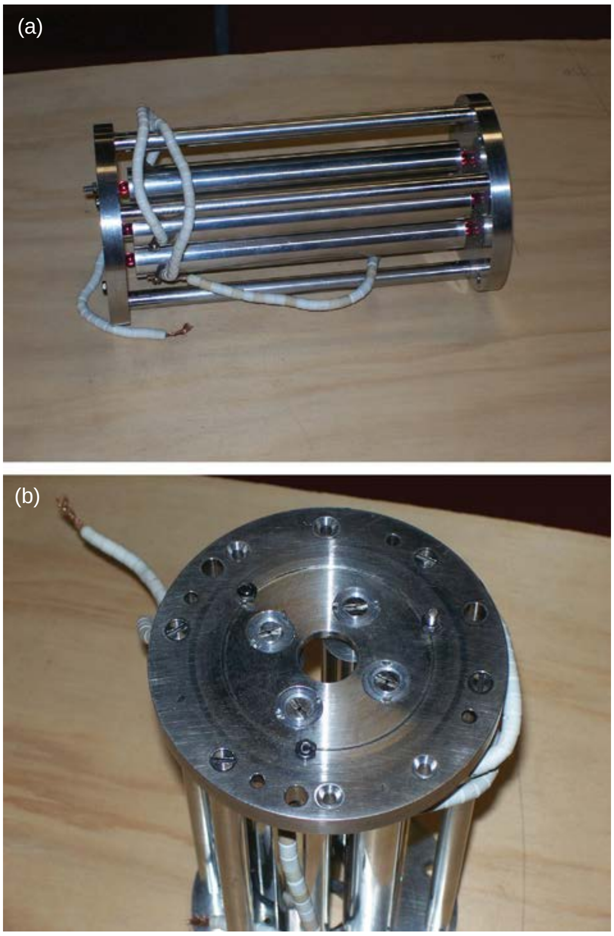

Figure 3. The working core of a quadrupole mass spectrometer constructed in the La Trobe University workshop. Note ruby mountings of electrodes (Source: author's photograph).

of Utah, which for that year took the theme 'gaseous ion chemistry and mass spectrometry'. His three presentations were included in the volume arising from that conference.[67]

Both Jim and Christine Morrison were amateur geologists who described themselves as 'rockhounds' and they found much to interest them in the state of Utah. A local geologist introduced them to the rocks of the coincidentally named Morrison Formation[68] in which dinosaur fossils could be found, and the Australians built up a modest collection of fossil bones. In one case, Morrison found a reddish deposit in the centre of a dinosaur tail bone, and examined it by mass spectroscopy, searching for haemoglobin. 'I didn't find haemoglobin', he told an interviewer,[69] 'but I did find porphyrins which are another molecule of life'.

Collaborations

Other researchers brought their problems to Morrison, especially those requiring GC-MS. He was proud of the versatility and sensitivity of his instrumentation, pointing to an example in which a 'cardboard' taste in milk was shown not to be due to the milk's contacting cardboard but instead the action of sunlight transmitted through the glass bottle and causing chemical reactions among the milk constituents.[70] Other examples involved the volatile constituents of Australian honeys;[71] a defensive substance that smelled like cucumbers but was secreted by fish;[72] various foods; the smell of wet rocks;[73] and volatiles from the inks used in counterfeit banknotes.

Sometimes larger samples were available, as with the plant oils contained in 'bush medicines', a bicentennial project that involved the La Trobe researchers with the committee compiling the Aboriginal pharmacopoeia. This began with Morrison's membership of a delegation supported by the Australia-China Council to visit China in 1984 to investigate the use of traditional medicines. Other members of the delegation were Dr Geoffrey Vaughan, Director of the Victorian College of Pharmacy, and Dr Ella Stack, a medical practitioner from Darwin with a special interest in Aboriginal traditional medicine.[74] Morrison was surprised to learn that Chinese researchers were using mass spectrometry to investigate the composition of traditional medicines. Following the visit, the Northern Territory and Federal Government supported a project to investigate Aboriginal medicines and to prepare an Aboriginal Pharmacopoeia.[75] The project involved researchers at La Trobe University with Dr Naseem Peerzuda from the Darwin Institute of Technology and Professor Wu Cheng-Shun from the Institute of Botany in Beijing, who spent five months as a visiting scientist at La Trobe. The results of the survey were published in an illustrated book, *Traditional Bush Medicine, an Aboriginal Pharmacopoeia* that included an appendix on the investigations of plant oils conducted by Professor Morrison, Senior Lecturer John Smith and technical officer Graham Bratspies at La Trobe.[76]

Towards the end of his time at La Trobe, Morrison was once again involved with the use of oxygen isotope ratios as dating tools when his last graduate student, Michael Godfrey, investigated modern molluscs and fossil samples of the same species taken from middens in south-western Victoria. Isotope ratios for the growing edge of the fossil shell revealed temperatures that corresponded to Spring conditions, suggesting cultural or ritual harvesting at that time of the year.[77]

Honours and Awards

Morrison joined the Royal Australian Chemical Institute in 1950 and was elected to Fellowship in 1958. He was awarded two of its memorial medals (Rennie, 1953) and H. G. Smith (1961). The H. G. Smith Memorial lecture was published in the Institute's review journal.[78] He was a member of several scientific organizations and served on several advisory bodies (Supplementary Material). Elected to Fellowship of the Australian Academy of Science in 1964, he was Vice-President, 1986–7, and served for many years on the sectional committee for chemistry. In 1985, he was elected to Fellowship of the Royal Society of Edinburgh, and in 1977 he was awarded the Queen Elizabeth II Silver Jubilee Medal. In June 1990, he was made an Officer of the Order of Australia (AO), the citation reading 'for service to science, particularly in the field of chemistry, and to education'. In January 2001, he was awarded the Centenary Medal 'for service to Australian society and science in mass spectrometry'.

In less formal settings, he was a member from 1964 of the Melbourne-based walking club, the Wallaby Club, where he shared with other members, mostly drawn from the professions, the enjoyment of 'good fellowship, talking and an appreciation of both the natural and built environments'.[79] He was President of the club, 1985–6.

Shortly after Jim's retirement from La Trobe University, the Australian and New Zealand Society for Mass Spectrometry established the ANZSMS Morrison Lectureship in his honour. The recipient delivers the lecture at an ANZSMS conference and receives the Morrison medal.[80]

Concluding Remarks

Morrison was a pioneer in the use of computers in association with mass spectrometers, at first for calculations related to ion physics and then for instrument control and data analysis. He was aware of the potential for much more sophisticated applications of computing and he spoke about these in the Meredith Memorial Lecture delivered at La Trobe and at the Gordon Institute of Technology (Geelong) in July 1975, under the title 'The Information Revolution—Mans' Second Mind'.[81] Morrison claimed that the information tools—writing, printing, photography, electronics (vacuum and transistor), microcircuits and computers have done more than all the rest—meaning weapons and energy tools—'to differentiate man from animal'. Nonetheless, he cautioned, they were good servants, but poor masters.

During the 1970s, small computers (microprocessors) became available for use in a range of applications that were discussed at a meeting that Morrison led for the Science and Industry Forum of the Australian Academy of Science[82] at the end of the decade.[83] From the distance of nearly forty years, the most interesting part of the meeting was the contribution by Parliamentarian Barry Jones, MHR, who cautioned about too great a reliance on science and technology 'that could lead to rule by men in white coats, wearing steel rimmed spectacles, who suggest that matters should be left in their hands'.[84] Morrison, who had made a similar point in his 1975 Meredith Lecture, albeit less dramatically, agreed with Jones but nonetheless stressed the need 'to increase computer literacy in the general population'.[85]

Morrison was adept at using computers to control the operations of mass spectrometers as well as to analyse the data they produced. In the best tradition of the chemical physicist, he liked to build his own instruments. 'Our commercial builders of mass spectrometers are first rate', he wrote, 'but they can only meet needs that have already been defined'. As a consequence, he implied, only those who develop their own instruments can hope to go on 'finding and establishing new principles and discovering hitherto unimagined new problems'.[86] 'It helps, of course, if you're good with your hands, if you know how to use a soldering iron and if you are a good scrounger.' When it comes down to it, 'you don't need millions of dollars; you just need a good workshop'.[87]

Christine Morrison passed away in 2001, and after suffering for several years with lung problems, Morrison died of a pulmonary embolism in February 2013. His sons and Robin Gray, husband of Jim's younger sister Pamela who had also relocated to Australia, spoke at the funeral service, and in keeping with his musical interests, Harry Belafonte's 'Banana Boat' song was played. There was a whimsical side to Morrison's interest in electronics and instrumentation: an obituarist recalled that Morison had once connected the output of a scanning mass spectrometer to an audio amplifier and claimed that familiar compounds could be identified by the sound of their mass spectra![88] It had been, as his colleague John Traeger wrote, 'an amazing career'.[89]

Conflicts of Interest

The author declares no conflicts of interest.

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I express my thanks to the following people who provided information and guidance in the development of this biographical memoir: Drs Richard Morrison, John Willis, Don McGilvery, Barrie Peel and Bob Brownlee.

Endnotes

1. There are several sources of information about Morrison's life and work that complement each other. He was interviewed by Professor Tony Klein in 2010, https://www.science.org.au/learning/general-audience/ history/ interviews-Australian- scientists/ professor- james-morrison-physical-chemist, accessed April 2017. The special issue of the *International Journal of Mass Spectrometry* 194, (2–3) (2000) published on the occasion of Morrison's 75th birthday included the following: J. C. Traeger, 'Introduction', vi–vii and 'James D. Morrison: Curriculum Vitae', ix–xiii. The 36th meeting of the American Society for Mass Spectrometry in 1988 heard a testimonial to Morrison: F. W. McLafferty, *Organic Mass Spectrometry*, 26 (1991), 181–182 and also his account of his career (J. D. Morrison, 'Forty Years of Mass Spectrometry', *Organic Mass Spectrometry*, 26 (1991), 183–194, which was received by a standing ovation (this volume, 26(4), was a Morrison *festschrift*). J. C. Traeger, 'James Douglas Morrison', in *Encyclopedia of Mass Spectrometry, Vol 9, Historical Perspectives, Part B: Notable People in Mass Spectrometry*, eds K. A. Nier, A. L. Yergey and P. J. Gale (Amsterdam, 2015), 161–162. S. Cory, 'James (Jim) Douglas Morrison, Leader in Mass Spectroscopy', *Chemistry in Australia*, 80 (5) (2013), 30. The Mooroolbark Christian fellowship published an account of the Morrisons' early life in Melbourne: R. Bourchier, 'Morrison of Mooroolbark', *Living Today*, Issue 32 (June 2010), 12–13.
2. Published from 1879 to 1967, the *Boys Own Paper* was a magazine for young boys. Each issue carried some technical information, for example, about photography, as well as stories of adventure, puzzles and essay competitions. [https://en.wikipedia.or/wiki/The_Boy%27s_Own-Paper, accessed May 2017.
3. The magneto is an electrical generator in which a rotating magnet induces a current in surrounding windings. It can produce high voltages, often 20,000 volts at low currents.
4. Scots was spoken particularly in northeastern and lowland Scotland. It is, like English, a Germanic language and quite different to the Celtic language, Gaelic. G. Price, *The Languages of Britain* (London, 1983).
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9. 'Stefan Mayer', https://en.wikipedia.org/wiki/Stefan_Mayer, accessed October 2017.

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16. Klein interview, already cited (n. 1).
17. A. L. G. Rees, 'Ian William Wark 1899–1985', *Historical Records of Australian Science*, 6(4) (1987), 533–548.
18. I. W. Wark, 'The CSIRO Division of Industrial Chemistry 1940–1952', *Historical Records of Australian Science*, 7(2) (1987), 153–177.
19. As above, p. 28. See also J. B. Willis, 'The CSIRO Division of Chemical Physics 1944–1986', *Historical Records of Australian Science*, 6(4) (1987), 533–548.
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21. Bourchier, already cited (n. 1).
22. Garden designer Edna Walling was an enthusiast for the use of Australian native plants in domestic gardens. P. Watts, 'Walling, Edna Margaret (1895–1973)', *Australian Dictionary of Biography*, 16 (2002), 474–476. http://adb.anu.edu/biography/walling-edna-margaret-11946, accessed October 2017.
23. Richard (PhD Cornell University 1982) pursued a career in chemical physics at Monash University (1984–2010) and Agilent Technologies. Gordon graduated BA(Hons) at the University of Melbourne, following which he worked in exhibitions and collection management and since 2004 has been Director of the Art Gallery of Ballarat. Alan studied Mechanical Engineering, formed his own company and now works as Metrology Products manager for Renishaw.
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29. Personal communication from Dr John Willis, who joined the Division of Industrial Chemistry in 1948.
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36. J. D. Morrison, 'Electron-molecule and Photon-molecule Collisions', in *Energy Transfer in Gases (Report of the 12th Conseil de Chimie)* (New York, 1963), pp. 397–452. Among the leading scientists attending the Solvay meeting were Ubbelohde, Norrish, Semenov, Kondrtaiev, Prigogine, Wigner, Polanyi, Porter and Pauling, a number of whom contributed to the discussion following Morrison's paper, reported on pp. 453–480.
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38. J. D. Morrison, 'On the Optimum use of Ionization Efficiency Data', *Journal of Chemical Physics*, 39 (1963), 200–207. This work was 'in press' and alluded to during discussion at the Solvay meeting.
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86. Morrison, ‘Forty Years’, already cited (n. 1), p. 194.
87. It is a testimony to the quality of Morrison’s designs and the skill of the La Trobe workshop that several pieces of equipment that were built for him are still in use at the University of Melbourne in the research group of Professor Evan Bieske.
88. Enke and Yost, already cited (n. 59).
89. Traeger, already cited (n. 45).