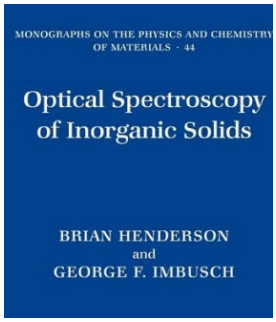


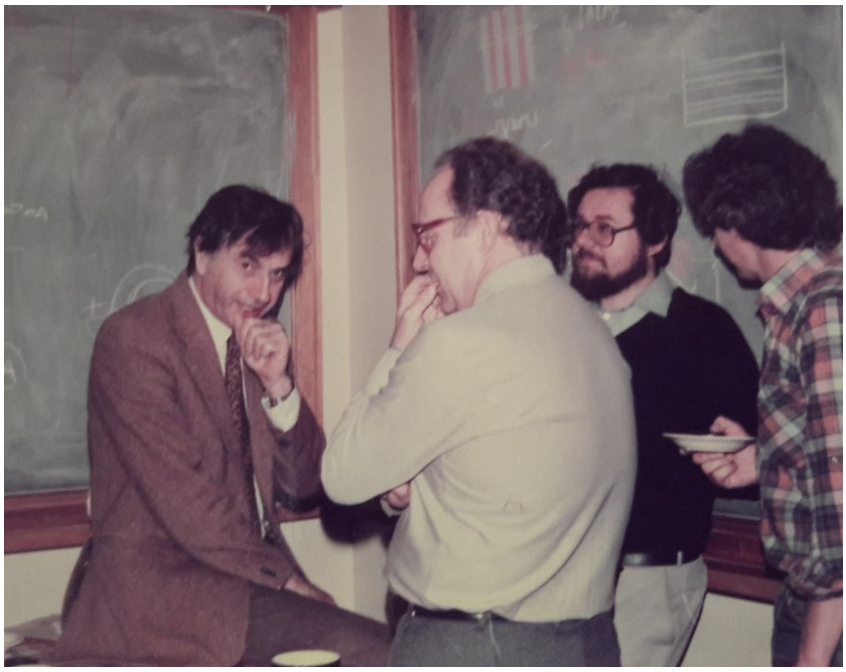
Lights of Change

Professors
Brian Henderson (1936–2017)
and
Daniel Bradley (1928-2010)

Werner J Blau, School of Physics

Provost, Fellows, and Scholars; Herr Botschafter, ladies and gentlemen; colleagues and friends. I would like to extend a special welcome to Martin Bradley with Daniel (named for his grandfather) and Benjamin, who are the only ones of Dan's 15 grandchildren to study at Trnity.

I am most grateful to be allowed to join the distinguished line of previous Trinity Monday speakers, dating back to 1895. Many thanks to the Provost and the School of Physics for their kind invitation, and to the many friends and colleagues who have provided me with insights, information, and advice in the preparation of this lecture.



Departmental Coffee in October 1983

Departmental coffee in the Physics seminar room on the first floor of the Dixon Hall, (probably) on Friday 14th October 1983, shortly after 11 a.m. From left to right: Dan Bradley - Brian Henderson - Yours truly, aged 29, just arrived 2 weeks earlier at TCD and Dan O'Connell, a junior lecturer in spectroscopy, then aged 38. This is the only photo that I could find which shows both Brian and Dan together. It was taken two days after the Board had accepted Brian's resignation and exactly a week before Dan's devastating stroke.

The topic of discussion can be inferred from the drawings on the blackboard: MQWs - multiple quantum well semiconductors. How far-reaching this debate then was can be seen from the fact that quantum confinement of electrons in nanometre thick semiconductor layers is still an interesting research subject in both nanoscience and quantum science, four decades later. And the structures that we discussed have since become essential building blocks of technology that we use regularly in our daily lives. An interesting observation on the side is that none of the four people depicted here come from an 'traditional' academic family background, as you will see and hear later in this discourse.

How it all began

The word 'Physics' comes from Greek, meaning nature. By 1724, the study of nature came to be called "natural philosophy" as can be seen from the title of the Erasmus Smith's professorship, the tricentenary of which we celebrate this year. As such, it is constantly developing as we as a human race keep on discovering new facts and understanding new processes. How wrong was Albert Abraham Michelson, 1907 Physics Nobel Laureate, when he said:*' The more important fundamental laws and facts of physical science have all been discovered, and these are so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is exceedingly remote.'* The interferometer that carries his name was essential to confirm the quantum nature of light, postulated in 1905 by A Einstein but only verified experimentally by Kimble (in the early 1980s a BP Venture Research Fellow) , Dagenais and Mandel in 1977. And it was, and still is, essential for the observation of gravitational waves, proposed by O Heaviside in 1893 and experimentally verified by the LIGO consortium only in 2015. Early in the 20th century, the understanding of the atomic structure of nature had developed into the study of the atomic nucleus, that subsequently evolved into nuclear physics and on to elementary particle physics. And the study of the electron shell had developed into atomic and molecular physics, quantum physics and on to solid state physics. When ETS Walton, still Ireland's only Physics Nobel laureate, was appointed as 18th Erasmus Smith's professor in 1946, he came with a particle physics background from a highly respected and well-equipped Cambridge laboratory into a Trinity College, and back into a home country, that was struggling financially to survive the economic hardships that the 'emergency' and previous internal struggles imposed. Despite excellent new appointments and immense efforts it seemed practically impossible to establish a world-class research activity in particle physics at Trinity then. For comparison, it should be noted that the first 600 MeV Synchrocyclotron at CERN cost 104 million CHF (481 million CHF in today's money) annually in 1957. This is in stark contrast to the *ad misericordiam* funding of £35,000 provided by Taoiseach de Valera in 1947 for the entire College (€1.7 million in today's money).

However, TCD under Walton demonstrated great foresight when they widened the research scope from nuclear physics to a more modern and fundable area, and appointed Vincent McBrierty, a polymer physicist, in 1967. Coming via Belfast and Bristol, Vincent went on to establish a world-class polymer physics laboratory and established several highly productive research collaborations with local and international industries.

Professor Brian Henderson (1936–2017)

In accordance with normal practice at the time, ETS Walton formally retired on the 30th September 1974, the last day of the academic year following his 70th birthday. (I remember him coming into the department regularly for many years afterwards and giving several most memorable demonstration lectures.) An extended, almost one-year long period of search for his successor, the 19th Erasmus Smith's professor, followed, that was guided by the eminent Cavendish Professor of Physics at Cambridge University, Brian Pippard, FRS. *'One candidate, from England, did not hesitate on an initial visit to express considerable surprise at the condition of the department, with its relative lack of finance and quantities of old apparatus…Indeed, probably unknown to the candidates, it was around or a little before this time that the idea was said to have been floated within College that the activities of the Department of Physics should be scaled down, or even that it should be closed altogether.'* (EC Finch, p.191) Undeterred by the situation, this '*whirlwind from England'*, Brian Henderson, accepted the offer from Trinity in 1974 and moved over to Ireland with his family into a modern house on Saval Park Road in Dalkey. As he told the author, he felt greatly honoured to be the successor to a Nobel Laureate. Brian promptly used a large £30,00 grant from college to supplement the research equipment he had brought over from Keele University for his highly productive solid-state spectroscopic research – "games spectroscopists play with inside-out atoms", as he light-heartedly described his work to students.

Born on 26th March 1936 into a coal-mining family living near Doncaster, Henderson was educated at Maltby Grammar School in South Yorkshire. At the University of Birmingham he proved to be a bright, hard-working student, graduating with a BSc in physical metallurgy in 1958 and a PhD just two years later. His thesis was entitled "The lattice spacings of alloys with reference to electronic constitution". Subsequently the university elected him to a research fellowship.

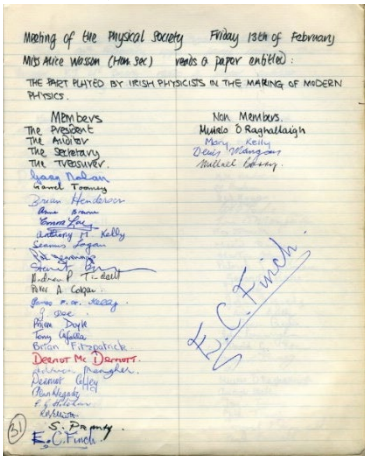
In 1962 Henderson joined the Basic Ceramics Group at Harwell Atomic Energy Research Establishment as a senior scientific officer. Here he studied the structure of point defects produced by neutron radiation damage. One of his co-workers there, Tony Hughes, writes that *"it is a testament to Brian's achievements that just a few years later he wrote a definitive review article on defects in the alkaline earth oxides with John Wertz [a pioneer in the field] from the University of Minnesota".*

Taking samples, large electromagnets, and shelves of valve electronics with him, Henderson went in 1968 to Keele University, becoming a reader in physics four years later. He quickly established a strong research group with the help of a major research grant from the Science Research Council. One of his first research students there, Peter McGeehin, emphasises that *"Brian was driven almost exclusively by his interest in the physics; he was a prodigious worker, expected the same of us, was fair-minded and wore his ambition lightly. He had a real nose for the 'cookery' involved in crystal growth"*. Another, Peter Weightman, describes how Henderson *"provided his PhD students with excellent research problems and the resources they needed to solve them but allowed them the freedom to manage the research in their own way, intervening only when necessary"*.

Immediately after his arrival in Dublin in 1974, Henderson started to dispose of a significant amount of older equipment. In due course, a nitrogen liquefier was purchased which was still operational when this author arrived. To get down to the very low temperatures, 4.2 K = -269 C, that were needed for much of the spectroscopic work, a liquid Helium liquefier was also acquired. It proved very difficult to maintain this complex machine and liquify significant useful amounts. I still remember various unsuccessful attempts to revive this machine located on the ground floor of the Fitzgerald building during the 1980s and 1990s. While liquid Helium in nowadays commonly used and available for medical MRI machines, it had to be purchased and imported from British Oxygen by ship at great expense. On one occasion, an empty 500 Liter container was delivered to us together with a bill for £2500, as all the liquid had evaporated during a dockers' strike in Liverpool.

The department that Brian envisaged was a modern solid-state Physics institute. He also strengthened interdisciplinary collaboration by taking an active role in the appointment to Chairs in Chemistry of John (Seán) Corish and Bob Lloyd, both of whom had strong interests in Materials Science. As such, he created the precursor to the joint Advanced Materials degree and to the Advanced Materials and Nanotechnology institutes of later years. Henderson also emphasised that Physics not only included experimental work, but also theoretical and applied research, and therefore changed the name to 'Department of Pure and Applied Physics' in 1976. In that way, he also established Physics as an integral part of technological development in Ireland and ensured that Trinity became one of the major players in the subsequent industrial and economic well-being of the country.

During his 10-year tenure at Trinity, Henderson made many highly successful appointments. The first one was a Trinity graduate with a PhD from Cambridge, Robert Barklie, who returned to College from Cambridge in 1974 to help Henderson establish his spectroscopy group. In 1975, Dan O'Connell, another spectroscopist from Stirling joined. (He died suddenly in 1990 aged only 45). In 1977, a surface chemist, John McGilp was appointed. In 1978, JMD Coey was appointed, and he went on to become a world leading expert in magnetism and an FRS. In 1979, Iggy Mc Govern, another surface physicist, joined from Pennsylvania and Wisconsin, and in 1980 James Lunney, a plasma spectroscopist from Belfast. In the same year, a world-famous laser physicist was offered a personal chair in optical electronics, coming from Imperial College, Dan Bradley, FRS. With such excellent and dynamic staff and quite a few short-term lecturer appointments along the way, Brian created a flourishing modern Physics Department and a lasting collegiality and esprit de corps among its whole staff, that can still be felt today, for instance at the 11 o'clock Physics coffee meetings that started under him. Remarkably, within a decade, Henderson had increased the academic staff to 12, i.e. doubled it from 6 in 1969. In that way, Trinity Physics reached a critical mass with which it could compete internationally in solid state physics research and establish the international reputation that it has enjoyed since.


Meeting of the Physical Society Friday 13th of February
Miss Alice Wasson (Hon. Sec) reads a paper entitled:
THE PART PLAYED BY IRISH PHYSICISTS IN THE MAKING OF MODERN PHYSICS.

Members
The President
The Auditor
The Secretary
The Treasurer.
Gavel Toomey
Brian Henderson
Anthony M. Kelly
Andrew P Tindall
Peter A. Colgan
Brian Doyle
Tony Cafolla
Brian Fitzpatrick
Dermot Mc Dermott.
Dermot Coffey
S. Pr[illegible]
E. C. Finch

Non Members.
Muireo Ó Raghallaigh
Mary Kelly

E. C. Finch

He extended the space for physics into what became the adjoining Dixon Laboratory, formerly the Dixon Hall. The Physics syllabus was greatly updated, many more tutorials were introduced, and the final-year research project, a concept that still exists and is very popular with both staff and students, was introduced. He also strongly supported the founding of the Dublin University Physical Society, the present-day PhySoc.

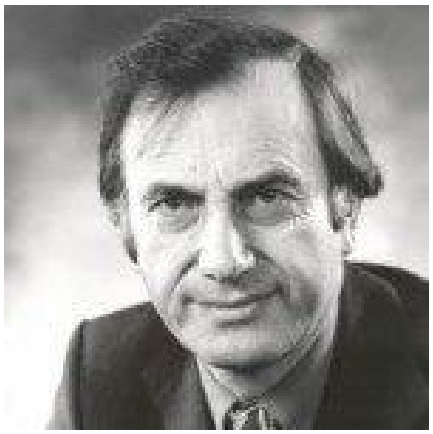
In 1976 Henderson became a Fellow of Trinity College, and three years later he earned a ScD from Dublin University (i.e. Trinity). He was elected to membership of the Royal Irish Academy in 1981.

In his very direct, non-nonsense way, he told me shortly after my arrival in autumn 1983, that he really loved Bavarian food. …And would it not be nice to call out to our house for a dinner of Wiener Schnitzel?... We duly obliged and decided to have Leberknödel Suppe, liver dumpling soup, as traditional starter. I still remember the face of the butcher in Bray when he saw the minced beef liver come out of his machine. For us, coming straight out of student life, giving a dinner party was a new experience. The evening with Sheila and Brian Henderson, Mary and Cyril Delaney, and Lisette and Robert Barklie turned out to be a great occasion with the discussion concerning everything from Trinity affairs to music (both Brian and I played the piano) to international soccer.

Brian resigned in 1984 to take up a professorship at Strathclyde University in Glasgow, but he retained a life-long affection for Trinity. He was eventually elected to an honorary fellowship. Following his funeral in Yorkshire in 2017, Brian was buried not in a churchyard or cemetery but most unusually in a specially authorised grave shared with his late wife Sheila on her family farm.

Professor Daniel Bradley (1928-2010)

When asked why I ended up in Trinity College Dublin, I usually point to the little brown booklet that is my Dr rer nat Thesis from 1983: Reference 2 is DJ Bradley *High Power Pulsed Lasers* Science Progress 1969, followed by numerous other references with the same coauthor. Thus, when I saw an advertisement for a British Petroleum Venture Research Fellowship with him in Laser Focus World, I immediately applied. And to my great surprise, a few weeks later, our – bright orange – phone rang and a voice with what I now recognise was a strong Northern Irish accent said *'Why don't you come over for an interview?'* So we put our 3 ½ year old son into the car and drove the 2000 km from Regensburg to Dublin – and the rest is history.



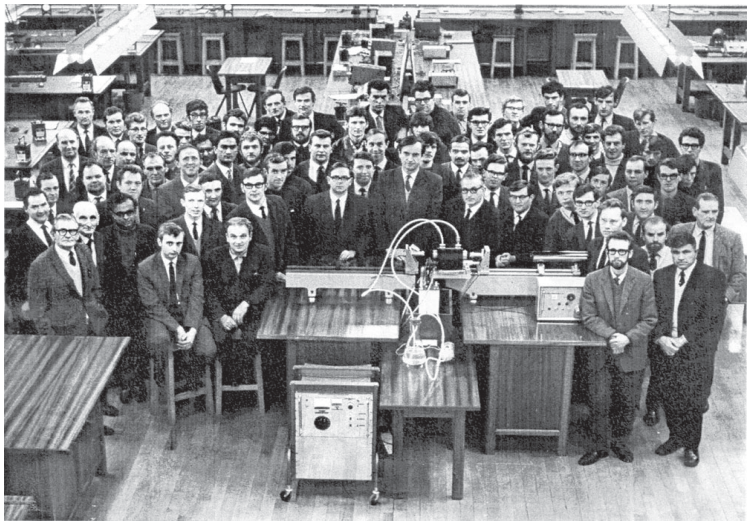
Daniel Joseph ('Dan') Bradley was born in Derry city on 18th January 1928, the son of John Columba Bradley, a Post Office worker, and his wife Margaret (née Keating), one of ten daughters from a farm near Cashel, Co. Tipperary. He was the second-born of four surviving children, with an elder sister and two younger brothers. Notably, Dan's paternal grandfather, William John Bradley, was Head Postman for the Derry postal area and also an alderman, between 1920 and 1923, in Derry Corporation, at a time when the city had its first Catholic majority council and mayor.

After completing the first and second parts of the technical school examinations in electrical engineering, Dan worked for three months as a telegraph boy. He subsequently enrolled at Lumen Christi high school Derry, where he obtained his secondary-school senior certificate (1945), surprisingly not taking physics, with a satisfactorily high standard to warrant a university scholarship. As the scholarship for Queen's University Belfast was a half-scholarship and therefore insufficient to cover all costs, he did not take up a place at QUB but instead enrolled with a full King's scholarship at St Mary's teacher training college in Belfast. He then started working as a primary school teacher in Derry (1947-53), while he also studied part time for a B.Sc. special degree in mathematics with the University of London. As his degree allowed him also to go to London to teach in secondary schools, he moved there in 1953. And in October he enrolled at Birkbeck College to study part time for the B.Sc. special physics degree becoming a Ravenscroft exhibitioner (1954–7) and college exhibitioner (1956). He originally wanted to do another maths degree but because he already had a

maths degree from the University of London he wasn't able to sign up for that. They suggested he should do physics instead, and then the question of not having studied physics at leaving certificate arose. It appears that he simply ignored the written requests from the Registrar to confirm that he had studied physics and *he did well enough when he got there that it didn't matter in the end* (Donal Bradley). One other thing was that he caught TB and had to spend time in a sanatorium on what was called the Scholars Ward whilst he recovered, and studied at the same time. Only his final, honours year, was spent in full time study at Birkbeck and he graduated in 1957 as top of the year for the whole of London University.

An assistant lectureship at Royal Holloway College enabled him to undertake a Ph.D. research programme under the supervision of Professor Sam Tolansky, FRS immediately afterwards. The topic of his chosen research programme was the scanning Fabry-Perot interferometer. In the late 1950s there was considerable interest in developing such scanning techniques to simplify the recording of emission spectra. At Royal Holloway, Dan met Winefride O'Connor, a 1951 botany graduate from the University of Liverpool, who was also an assistant lecturer. They married in 1958 and had five children: Sean (b. 1959), Mairead (b. 1960), Donal (b. 1962) (who became a distinguished physicist and was elected FRS (2004) and appointed CBE (2010)), Ronan (b. 1965) and Martin (b. 1972).

With an increasing international reputation, Bradley was promoted to a readership at Royal Holloway in 1964. He continued research and development on Fabry-Perot devices and their applications, and introduced a particularly novel device, which was later used to tune short-pulse, broad-band lasers and was successfully commercialised. During that period, his interests moved increasingly towards ultrafast electron-optical technology, laser development, diagnostics, and applications, just 4 years after the first experimental demonstration of a working ruby laser by Ted Maiman.



His appointment as professor and head of the department of physics at QUB in 1966, remarkably only five years after obtaining his Ph.D., allowed him to establish one of the most influential and largest laser research groups worldwide, with research outputs interspersed by many world firsts. The photo shows Dan in 1969, centre, with his research group totalling around 80 people, including support staff and a flashlamp-pumped, mode-locked, dye laser, removed from the research laboratory to the undergraduate teaching laboratories for the purposes of the photographic record. The Bradley group was particularly noted for the development of dye lasers, which allowed the generation of wavelength tuneable pulses of picosecond duration that became very important in medical applications only a few years later. Pulses of a few picoseconds (10^{-12}s) were routinely achieved, and Bradley was also instrumental in the formation of one of the first laser spin-out companies, helping establish Electro Photonics Ltd in Belfast, who rapidly commercialised the outputs from the research group. Bradley was also internationally distinguished for his innovation and development of the pulsed electron-optical streak camera that is the only technique for the direct measurement of picosecond and femtosecond optical events, that are particularly important in

molecular and biological processes. Streak camera technology was commercialised by Hadland Photonics in the UK and by Hamamatsu Photonics in Japan.

Unfortunately, the increasing instability and political violence of the early 1970s effectively obstructed his plans to build a government-funded national laser facility in Northern Ireland, and it ultimately went to Rutherford Lab in Oxfordshire. During 1972 more than 500 people lost their lives, over half of whom were civilians. With neighbours affected by the violence, by 1973 Winefride (who told me during a dinner in the Provost's House) and Dan became increasingly concerned for the safety and well-being of their young family. On the funny side, however, they decided, given that Dan was travelling extensively to international conferences throughout this period, that a good watch dog would be a sound investment with respect to family safety. Much against the advice of several colleagues in the Physics Department at Queen's, Dan decided to get a Kerry Blue Terrier, a breed generally known for their dynamic temperament, exuberance, and aggression! Yet when Dan made his mind up, no amount of dissuasion could change it. The dog, called Bluebeard, however, did not last long. After it had seriously bitten both neighbours and family members, it had to go. Eventually, the Bradleys decided to move away and Dan to accept the chair of optics at Imperial College that October. Quite a lot of people moved with Dan to Imperial and became leaders in the UK (and international) laser community, including Henry Hutchinson, Geoff New, Wilson Sibbett, and Roy Taylor.

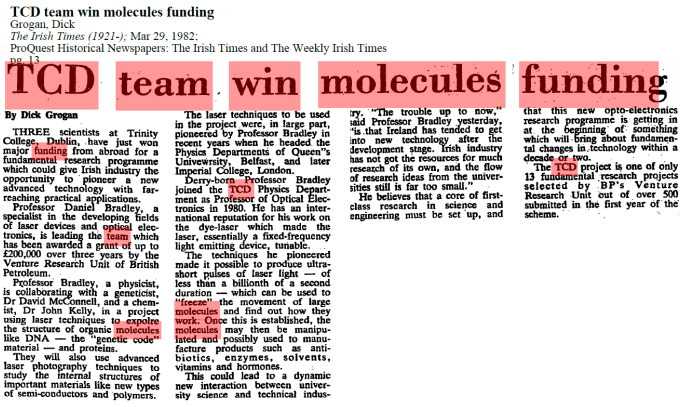
At Imperial, Bradley built and rapidly expanded a successful laser research group of major international importance from small beginnings. He initiated major programmes on e-beam excitation of gaseous excimer and exciplex lasers for ultraviolet light generation, as well as mode-locked, semiconductor lasers for application in communication and switching. All these areas have by now become important parts of our daily lives, ranging from microelectronic fabrication to fibre-optic communications, biomedical sensing to numerous medical technologies.

By 1979, Dan, by then Head of Department, had become increasingly frustrated by administrative problems, especially those relating to the processes and limits on promotion and appointment of young staff. He felt that the College was not fairly distributing the limited positions that were available for promotion, naturally believing that Physics had better cases than some other departments. Hence, when he was approached by Brian Henderson regarding a new personal chair at TCD, he accepted. By doing so, he would free a post for someone else to become a professor. As Dan mentioned in personal conversation, his decision was made easier by Margaret Thatcher's policies to offer extra incentives to senior academics for leaving academia. He had, of course, maintained close connections with Ireland both professionally and personally. For some time he had been assisting the National Board of Science and Technology as an assessor of grant applications and they had approached him to become more actively and directly involved in their activities, with particular emphasis on developing links with European and UK science programmes. He also for many years had a family holiday home near Ardmore Pier in Cill Chiaráin, a Gaeltacht area of Galway. And in October 1980, he took up the newly established chair in optical electronics.

Dan's plan in establishing a new major research group in Trinity was to address two principal themes: the application of semiconductor laser devices, primarily directed towards optical communications and optical logic; and the application of ultrafast lasers to investigate the dynamics of molecular, polymeric, and biological species, in which field he also proposed the application of synchroscan streak cameras as, in fact, the only real-time diagnostic with ultrafast resolution. It is worth pointing out that, nearly twenty years later, Science Foundation Ireland selected optical communications and the biosciences as the country's two major development themes and funding avenues.

In 1981 Professor W. A. (Bill) Watts, who had become the Provost at Trinity that year, asked the Board of the College to agree to his nomination of Dan as Bursar. A requirement for the appointment, however, was that the nominee was a Fellow of the College. Consequently, to meet Watts's request, the immediate assent of the Fellows was required by the Board to elect Dan to a Fellowship. It has been pointed out (EC Finch p.211) that it is extremely unusual for such an election not to occur on a Trinity Monday, yet, following the expedited election to Fellowship, Dan was appointed Bursar. Some Fellows did voice concerns that there might be undue diversion of Dan's time from his research activities, and he only occupied the post for 18 months as he pursued a punishing schedule to build up his laboratories and re-establish an internationally competitive research reputation in what were new areas for him.

The establishment of the research group in Trinity was difficult. Internally, the funds were simply not available for the laboratory facilities that Dan intended. To recruit students, he insisted on teaching in the undergraduate laboratories, where he knew he would meet the complete student population and where his personality, flair and teaching skills would, as it had done in the past, attract potential recruits to his research group. He also procured funds to convert two Dublin Georgian houses on 23 and 24, Westland Row on the periphery of the Trinity College site into a suite of laboratories.



TCD team win molecules funding
Grogan, Dick
The Irish Times (1921-); Mar 29, 1982;
ProQuest Historical Newspapers: The Irish Times and The Weekly Irish Times
pg. 13

TCD team win molecules funding

By Dick Grogan

THREE scientists at Trinity College, Dublin, have just won major funding from abroad for a fundamental research programme which could give Irish industry the opportunity to pioneer a new advanced technology with far-reaching practical applications.

Professor Daniel Bradley, a specialist in the developing fields of laser devices and optical electronics, is leading the team which has been awarded a grant of up to £200,000 over three years by the Venture Research Unit of British Petroleum.

Professor Bradley, a physicist, is collaborating with a geneticist, Dr David McConnell, and a chemist, Dr John Kelly, in a project using laser techniques to expolre the structure of organic molecules like DNA — the "genetic code" material — and proteins.

They will also use advanced laser photography techniques to study the internal structures of important materials like new types of semi-conductors and polymers.

The laser techniques to be used in the project were, in large part, pioneered by Professor Bradley in recent years when he headed the Physics Departments of Queen"s Univewrsity, Belfast, and later Imperial College, London.

Derry-born Professor Bradley joined the TCD Physics Department as Professor of Optical Electronics in 1980. He has an international reputation for his work on the dye-laser which made the laser, essentially a fixed-frequency light emitting device, tunable.

The techniques he pioneered made it possible to produce ultra-short pulses of laser light — of less than a billionth of a second duration — which can be used to "freeze" the movement of large molecules and find out how they work. Once this is established, the molecules may then be manipulated and possibly used to manufacture products such as antibiotics, enzymes, solvents, vitamins and hormones.

This could lead to a dynamic new interaction between university science and technical indus-

ry. "The trouble up to now," said Professor Bradley yesterday, "is that Ireland has tended to get into new technology after the development stage. Irish industry has not got the resources for much research of its own, and the flow of research ideas from the universities still is far too small."

He believes that a core of first-class research in science and engineering must be set up, and that this new opto-electronics research programme is getting in at the beginning of something which will bring about fundamental changes in technology within a decade or two.

The TCD project is one of only 13 fundamental research projects selected by BP's Venture Research Unit out of over 500 submitted in the first year of the scheme.

A major achievement was the award of a very substantial British Petroleum Venture Research Grant, aimed at undertaking blue-skies, high-risk research programmes. The Venture Research Unit (VRU), established and managed by Don Braben, was an initiative from 1980 to 1990 that provided £20 million in research funding to about 30 researchers and small teams from Europe and North America. It aimed to fund determined researchers who had identified significant gaps in existing knowledge or questioned current scientific thinking. Trust and freedom were considered essential aspects of the VRU approach. Dan's proposal to utilize ultrafast laser technology to investigate reaction pathways and to probe the structure of biomolecules perfectly met such an objective and the proposal 'Fundamental opto-electronic studies of semiconductors and DNA with ultra-short laser pulses' was initially funded at the level of IR£150,000. Together with Prof John Kelly, Chemistry, and Prof David McConnell, Genetics, he began establishing a team to carry out this programme. A particularly futuristic plan included using two-photon excitation techniques to analyse base sequences in DNA as a novel way to rapid sequencing. This work later led to a very successful broad series of experiments undertaken over many years that were carried out by JM Kelly and collaborators.

By the end of 1983, Dan had sourced funding to appoint several postdoctoral research fellows to accelerate the research development. However, on 21 October 1983 he suffered a severe debilitating stroke. One of the recently appointed postdoctoral researchers, Kristina Johnson, arrived just days after this tragic event, while another, Lawrence Reekie, was still negotiating his contract. Coincidentally, Kris was appointed as the US Under Secretary for Energy and Environment by President Obama in 2009 and awarded an honorary D.Sc. by TCD in 2010. A third, today's speaker, had arrived just before and was left with the others to work tirelessly in the lab to keep the extremely complex and futuristic laser system operational and to initiate the funded research programmes. It came as an immense shock when Brian Henderson called us into his office that Friday afternoon to tell us about

Dan's illness, but the real severity only sank in when we visited him in the hospital during the following week. Out of the blue, Brian appeared at our door on Sunday afternoon (it took over a year to get a telephone at the time, so personal visits were the only mode of rapid contact) with a bunch of transparencies asking me to take over Dan's JF Engineering lectures on the next day at 10 a.m. in the Physics large lecture theatre. Without much experience of both teaching large classes and of English per se, I must have completely stunned the students with trying to explain the Einstein model of specific heat to them, at a level that was probably 10-100 times higher than what they were used to. Coincidentally, one of the students in the class was a certain Patrick J Prendergast, the future 14th Provost of Trinity.

As a result of the stroke, Dan's mobility was restricted and his speech severely impaired, and he retired in 1984. He continued to travel extensively and participate at numerous national and international conferences. In time, illness restricted his travels and in his latter years he was cared for in Bloomfield Care Home in Rathfarnham and died in Tallaght Hospital on 7 February 2010. A bench is placed in his memory outside the Fitzgerald Building.

I hope that you agree with me that, building on 3 centuries of Natural Philosophy research and teaching in Trinity College, both Brian and Dan were instrumental to the current day research reputation and successes of the School of Physics, its high quality, up to date teaching programmes and its outstanding esprit de corps. Their legacies still endure in the College's strength in optoelectronics, nanotechnology, and advanced materials. Hence, it was not surprising that at one time around the millennium, the school had no less than four Fellows of the Royal Society.

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