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Physics in Perspective

Karl George Emeléus and Physics in Belfast 1927–66

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Karl George Emeléus (1901–1989) was educated at Cambridge and after a short period at King's College, London, he spent the remainder of his career as lecturer (1929–33) and then professor (1933–66) of physics at Queen's University, Belfast. At Queen's, he set the direction of experimental research in gas discharge and plasmas for a generation and oversaw the growth of the department. He also acted as a spokesman for physics in Northern Ireland and was involved in public responses to concerns about the use of nuclear weapons and nuclear energy in the late 1940s and 50s. This paper summarises Emeléus's life and work and sets it in the context of physics at Queen's University in the mid-twentieth century.

Key words: Queen's University, Belfast; Cavendish Laboratory, Cambridge; Gas discharge; Nuclear energy; Nuclear weapons.

If ever there was a right time for a physicist to be born, surely it was at the beginning of the twentieth century. It was to be, as Phillip Morse titled his autobiography "In at the Beginnings."[1] The twin foundation stones of modern physics—quantum mechanics and relativity—were laid, and the structure of the atom was being probed and unravelled on a path that was, as Abraham Pais said, relentlessly "inward bound."[2] Thus, for Emeléus to be born in 1901, and educated at Cambridge in the 1920s, was a very fortunate state of affairs.

During the 1920s and 30s, the Cavendish Laboratory at Cambridge, under the leadership of Ernest Rutherford, produced many physicists who went on to have hugely significant careers at the cutting edge of science. Others, like Emeléus, while still being prolific researchers, went on to find themselves behind the front lines of physics and devoting their careers to educating a new generation of physicists in a provincial university. Thus, Emeléus's life and work provide a window into what some might consider a more prosaic aspect of the history of physics in the United Kingdom. Prosaic is, however, a loaded word. As this paper

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seeks to show, Emeléus led a fascinating life and lived through equally fascinating times.

Family Background and Early Education

Karl George Emeléus's father, Karl Henry Emeléus, was a Finn of Swedish ancestry born in the coastal town of Vaasä. He graduated in pharmacy from the University of Helsinki and then went to America, (re-qualifying as a pharmacist) and then to England (having to qualify a third time) where he married Ellen Biggs. The couple first lived in Poplar, London, where Karl George and his brother Harry Julius were born in 1901 (August 4) and 1903 respectively. In the autumn of 1903 the family moved, settling in a pharmacy in Battle, Sussex. Three more children followed (Christina Emilia, Maya Elizabeth and Gustaf Antony Alfred) with the youngest, Anthony, eventually taking over the pharmacy, as did his son Robert after him.

Harry stated, "Our life as children was idyllic. We had a very happy home, though money was always tight. There were no luxuries—certainly no bicycles—but we explored the countryside for miles around on foot."[3]

All three brothers attended Hastings Grammar School, a school for boys which was a five-mile train journey from Battle. George attended from 1914–19, Harry from 1914–21 and Anthony from 1921–27. The three Emeléus boys were notable enough to each have several entries in the index of *The History of Hastings Grammar School 1916–1966*.[4] When it came to sport, all three boys won at shot put[5] and Harry and George were both good cricketers.[6] As late as 1954 George was still playing cricket in a friendly on the Queen's University staff team.[7]

During the First World War, Emeléus and another boy, C. W. Stokes, "obtained valuable maths coaching" from Fred Sergeant, Vicar of Udimore who had links with the school up to 1930.[8] Many years later, Emeléus and his brother both paid tribute to their science master, E. G. Hole, in a message sent to an Old Hastonians reunion dinner,[9] but nothing more is known of the specifics of the teaching that Emeléus experienced at Hastings.

Stokes, Emeléus and his brother Harry were all very strong students. While at school all passed the London Intermediate BSc examinations, which would have allowed them to complete a degree course at London in two years (something which Harry did indeed do before going on to a notable career in inorganic chemistry).[10]

Emeléus was awarded the school Beagley Medal at Speech Day on December 11, 1917, and also received prizes for his performance in mathematics and chemistry.[11] At the 1919 Speech Day on December 17, he was listed as head boy (for 1918–19) and was awarded a scholarship prize for mathematics and science.[12] Emeléus was also an accomplished pianist and had a lifelong love of literature, with one colleague at Queen's recalling "he could effortlessly recall a passage from Shakespeare or Kipling or Shaw to underscore a point he was making or recite a verse of poetry learned in school long since, to characterise someone."[13] In later life, he claimed in an address on speech day at the Rainey Endowed School in Magherafelt, County Londonderry, that he had only failed one examination in his life, which was senior physics.[14] Despite this failure, at the end of his time at Hastings, Emeléus won an exhibition to study natural sciences at St. John's College, Cambridge.

Cambridge

Emeléus entered St John's in October 1919 as part of a year swelled by the return of servicemen after the First World War. As a grammar school boy he was in the minority, but as a student of natural sciences he was part of the largest subject group in the college.[15] His academic career started well. In 1920 he gained a first class in the inter-collegiate examinations in science, and in 1921 a first in part I of the natural sciences tripos in chemistry, physics and physiology. This success resulted in St. John's awarding him a Foundation Scholarship, the Hare Exhibition and the Hockin Prize for physics.[16]

Alas, in 1922 in part II of the tripos, he was awarded a second. In writing a reference for Emeléus for the lectureship at Queen's, Belfast, in 1927, George Udney Yule, the Cambridge statistician and Director of Natural Sciences stated "it was felt that this result by no means did him justice, a view which has been fully confirmed by his subsequent work."[17] St. John's clearly agreed, having extended his Foundation Scholarship and awarded a Slater Scholarship, which lasted for a year to be replaced by a more valuable Hutchinson Studentship in 1923. In 1924 St John's went on to award him the Henry Humphrey's Prize.[18] During 1923 and 1924 his research studies were also supported by a grant from the Department of Scientific and Industrial Research.[19]

In his résumé Emeléus states that his post-graduate work at Cambridge ran from July 1922 to December 1924 and was "Research in Experimental Physics under Professor Sir E. Rutherford, O.M., P.R.S., etc., in the Cavendish Laboratory."[20] However, it is not clear that Rutherford had any significant first-hand dealings with Emeléus. Guidance appears to have come from James Chadwick and Edward Appleton.

Emeléus began his research career helping Chadwick build a cloud chamber to investigate the Compton effect (the scattering of X- and gamma-rays off electrons). Rutherford had expressed no enthusiasm for the idea, so Chadwick was buying some of the parts to construct the cloud chamber with his own money. The cloud chamber had been invented by C. T. R. Wilson in 1911 and Chadwick recalled that:

> […] one day C.T.R. Wilson came round. I told him what we were about to do. 'Ah, that's just what I'm doing'. Well, it was and it wasn't, because he was doing it with X rays at quite low levels […] I was interested in the higher energy. And

> I knew that he would take far better photographs than I would. In any case, he was doing it. So we dropped it, and we did some very trivial experiments on the delta rays, as they were called, produced by alpha particles and their passage through gases—that is, the collisions of alpha particles with electrons. But I wasn't interested. It was perfectly obvious what was going to happen. There was no difficulty about it. But I had to give Emeléus something to do.[21]

Despite Chadwick's dismissive remarks the work on delta rays resulted in a joint paper[22] which made up about a quarter of Emeléus's PhD thesis (one of four chapters). Significant help from Chadwick capturing the cloud chamber images in another chapter meant that his supervision covered about 40% of the thesis. Much of the rest of the thesis was based on a paper with Appleton and another PhD student, Miles Barnett.[23] Emeléus notes of Appleton that:

> He was not my research supervisor during the […] three years when I was in the Cavendish, but I saw a great deal of him, particularly in the latter half of this period. This happened because one of my problems was to find out how the Geiger particle counter worked. Appleton was the Cambridge authority on circuitry and Rutherford suggested that I should consult him. Using the one cathode ray oscilloscope then available in the Cavendish, we (mostly Appleton) established the role of capacity and resistance in the operation of the counter, giving, I think, the first estimate of maximum counting rates.[24]

The "Geiger particle counter" was the version developed by Rutherford and Geiger in Manchester in 1908.[25] As Appleton, Emeléus and Barnett noted in their paper, while it was a tool which was widely used in experiments, there was no detailed explanation of how it worked and there were "many points about it which seemed to be a little obscure."[26] More directly Jeff Hughes notes that "erratic and temperamental, the counters were no less problematic than the scintillation screen, their actual mode of operation remaining something of a mystery, even to their inventors."[27] The counting of scintillations, a standard technique which required patience and eyes well acclimatised to darkness, was at the root of the Cambridge–Vienna controversy which ran from 1923 to 1928. This controversy very publicly cast doubt on the accuracy of results coming from the Cavendish.[28] While the Cambridge team was ultimately vindicated, the controversy resulted in a move away from reliance on scintillation counting towards Geiger counters (with an improved counter being developed by Geiger and Müller in 1928[29]) and cloud chambers. Appleton, Emeléus and Barnett's work came early in this controversy and thus the idea for the investigation may not have been causally linked to it. Nevertheless, the authors gave a thorough investigation of the counter, investigating not only—as Emeléus noted above—the role of capacitance and resistance, but also the effect of pressure variation in the counter chamber. They also provided a simple mechanism for how the counter reset after a detection allowing it to be ready for another particle.

In the Michaelmas term of 1924 Emeléus was working as an assistant supervisor in physics in St John's and as an assistant demonstrator in the Cavendish. As noted above the grant from the Department of Scientific and Industrial Research ran for two years, so this end of funding, and the move of Appleton in 1924 to take up the Wheatstone Chair of Physics at King's College, London, probably combined to explain Emeléus's move to King's in January 1925 to take up the role of demonstrator in physics at the Wheatstone Laboratory. He completed his Cambridge PhD in 1926, and by 1927 was seeking to advance on the academic ladder by applying for a lectureship in experimental physics at Queen's University, Belfast.

In writing his reference for Emeléus's application for the job at Queen's, Appleton praised his teaching ability:

> He has now worked in the Physics Department of King's College for over two years, and during that time I have formed the very highest opinion of his capacity as a teacher. He has had under his control the organization of the Practical Class for our second year honour students and in this connection has devised many new experiments suitable for such laboratory work. He has proved a most enthusiastic and successful teacher and the happiest relations exist between him and his students. Dr. Emeléus' teaching experience has included lectures to both Honours and Elementary students. He is a clear and convincing lecturer with a special enthusiasm for simple ways of explaining things.[30]

This ability as a teacher was a hallmark of the rest of his career. Robin Coulter, who was a student and later colleague of Emeléus at Queen's recalled that:

> [...] it was as a teacher that KG (as he was affectionately known to his colleagues) will be best remembered. In that sphere he had few equals: as an undergraduate, it was a joy to attend his lectures, which were models of their kind and delivered with virtually no recourse to notes. His ability to present a difficult topic in an interesting and captivating way was envied by his colleagues and is something that all his students remember. Many of today's medical consultants who took first year physics at Queen's seem to be more interested in discussing Emeléus and his superb lecturing style than in dealing with one's aches and pains.[31]

A further indication of his skills as a communicator is to be found in a significant number of talks aimed at wider audiences given throughout his career in Belfast to organisations such as the Belfast Natural History and Philosophical Society.[32]

In writing his reference, Appleton also noted the range of Emeléus's research, which by 1927 had extended from his work on δ-rays and the behaviour of the counter used to detect α-rays ("In giving an explanation of the action of the counter he has solved a problem of many years standing."[33]) to the investigation of gas discharge with cold electrodes, an area where "He is also full of ideas and plans for future work."[34] This latter remark was certainly borne out by the direction of his subsequent work at Queen's.

Appleton concluded by stating "I sincerely hope that Dr. Emeléus will be elected to the post of Lecturer at Belfast for no one more fully deserves promotion, but his leaving us will be a most serious loss to our department."[35]

George Udney Yule was equally enthusiastic: "Of his personal character I can speak in the highest terms: an able, modest, and thoroughly capable man who will get on well both with students and colleagues, I am sure that he should be a very strong candidate for the post."[36]

Emeleus was one of thirteen applicants for the lectureship at Queen's. He was interviewed on June 3, 1927 and, as was standard in Belfast at the time, was appointed for a period of seven years, with eligibility for renewal, at a salary of £450.[37]

Florence Chambers: From Junior Lecturer to Wife

Although his first impression of Belfast from the boat carrying him up the lough was of a damp and forbidding city,[38] Emeléus seems to have settled into life in the town quickly. William B. Morton, the professor of physics, gave his staff "a free hand and good support"[39] to develop research and access to his large private library.[40] But more significantly still, Emeléus met the junior lecturer in physics, Florence Chambers* (figure 1).

Florence entered Queen's in 1918, in a first-year cohort of 237 students and a university with a total student body of 888.[41] In later life, she recalled that there were about twenty-five students in first-year physics and that most were women, as many of the men had joined the armed services. She had initially intended to study mathematics, but as she later stated that "the lectures of Professor Dickson were very uninspiring (and sometimes unintelligible) so I decided to change to Physics—where Professor Morton lectured in both Physics and Mathematical Physics. He was an inspired and inspiring lecturer. I am sure I was wiser to take physics, as I always had a practical bent!"[42]

In 1921 she graduated with a first in physics and mathematical physics and then spent a further year as an MSc student. She joined the staff as a demonstrator in physics in 1923 and was promoted to junior lecturer in 1926.[43] At that point, the physics department consisted of four members of staff: Morton, John Wylie, Raynor C. Johnson and Florence Chambers. Florence's MSc was on the topic of the vibration of strings and she published three papers on the subject between 1924–28.[44] She was also acknowledged by Morton on a fourth for the evaluation of

* Florence Mary Chambers (1901–1993) was the eldest daughter of Robert M. Chambers, one of the three founding brothers of Chambers Motors, which ran from 1904–29 and was the first automobile manufacturer in Ireland. Examples of the cars produced by the company can be seen in the Ulster Folk & Transport Museum and the Ulster Museum.

Fig. 1. Florence Mary Chambers circa 1925. *Courtesy*: George Emeléus

numerical results related to fluid flow.[45] At some point after Emeléus arrived in Belfast Florence suggested that "[…] he should get a return ticket to Warrenpoint and I would take one to Newcastle and we would meet in the middle of the mountains and then go our own way after that. We did that about twice and then we went together […] no one could help liking him because he was very courteous. He was very civil to everybody and he had a great sense of humour."[46] And so commenced a courtship between a very bright young lady and a very bright young gentleman.

In suggesting walking, Florence was tapping into one of Emeléus's great loves. While a student at Cambridge he would sometimes get off the train at Tunbridge

Wells and walk twenty-two miles home to Battle. After their marriage family holidays would include extensive walking in North Antrim, Donegal, and later in Austria and Norway.[47] They were married on the November 30, 1928 in Lisburn, and on December 4, the day the marriage was announced in the press, students "ragged" the event with the wedding being re-enacted at Belfast City Hall complete with a cabbage for a bouquet and a curtain pole ring.[48] The Emeléuses went on to publish one paper together on the spectrum of negative glow in oxygen,[49] but the most significant result of the marriage for Florence was that she was forced to leave the staff at Queen's. At least one member of staff objected to having a man and his wife working in the same department. It was, unfortunately, the spirit of the age. As Patrica Fara has shown, while doors into science and technology temporarily opened to women during the First World War, they rapidly slammed shut when the soldiers returned from the front.[50] The set view that a married woman's place was to be at home changed very slowly. As an example, shortly after the end of World War II an appointments panel at Queen's was brave enough to recommend one married woman for a lectureship, but even then they were at pains to point out to the Senate that she had no children. By the 1960s rates of appointments of women to lecturing posts across Queen's were still below 5%, and it wasn't until the end of the century that they reached 25%, and even then, the majority were in arts and social sciences.[51]

By 1930 Emeléus and Florence were starting a family. Henry was born in 1930 (1930–2017) followed by Vera (1934) John (1938) and George (1941). During the 1940s and 1950s the children appear repeatedly in the Belfast press, obtaining school prizes or giving musical performances at Methodist College, Belfast or for examination performance at Queen's (Vera and Henry) or Oxford (where George was an undergraduate and both George and Henry were DPhil students).

During the 1930s and 40s Florence had limited links with Queen's apart from attending functions with her husband. But as her family responsibilities lessened this began to change. In 1955 she served as president of the University Women's Club[52] and in 1963 and 1964 she served as vice president and then president of the Queen's Women Graduates Association.[53] It was probably her involvement in these societies that led Emeléus to give talks to them in the late 1950s and early 1960s.[32] She also used her profile to make the case for the importance of women having an independent life. In an address to Princess Gardens School Old Girl's Association in 1954 she noted that "A woman […] could quickly lose all her originality and even her own personality if she followed to the uttermost her inclination to be absorbed into family life. Somehow she must struggle to preserve and foster her individuality […] if [women] lost their zest for things other than the domestic round they would be very unhappy indeed."[54]

In an address to the Queen's Women Graduate Association in 1961 she defended the importance of higher education for women against claims that it was "wasted on a woman who was going to get married." She noted that "the most obvious flaw in this argument is that one does not know whether a woman is going to get married or not." A university-educated mind led to "hard thinking about abstract ideas" and she noted that "I would not have made such a good job of running the house and bringing up my children without those years of study [...] Although for a long time I felt extremely discontented."[55]

The last sentence of the above quote gives an insight into the sustained emotional impact of losing her job at Queen's almost a third of a century earlier. While rarely talking about the matter, she carried a sense of loss and frustration at being unable to continue as an academic for the rest of her life.[56]

Publishing a Book

The year 1929 saw the publication of Emeléus's *The Conduction of Electricity through Gases*, in the popular Methuen's Monographs in Physical Subjects series. The series was a set of small-format short texts aimed at giving accessible introductions to a wide range of undergraduate topics in physics. The review of the book in *Nature* by one of Emeléus's student contemporaries at Cambridge, Herbert Skinner,* was brief, but positive. After noting that the subject of conduction in gases is experimentally complex and theoretically not fully understood, the review concluded that "Dr Emeléus has presented fairly the present stage of development of the subject, and, therefore, we welcome his little work even though we may regret that he has not had more space to develop his views; For then the book would have been more readable as well as more informative. But in compensation it is very cheap, and since, within its limits, it is extremely well written, we have no hesitation in recommending it."[57]

While second and third editions were published in 1936 and 1951, Emeléus made very few additions to either revision and in reviewing the 1951 edition, the *American Journal of Physics* stated that "It leaves something to be desired in that it ignores, for the most part, the advances in basic understanding that have occurred since 1936."[58] As we note later, the Second World War caused Emeléus's research output to drop considerably during the 1940s and so perhaps he was unable to update the volume in the ways he would have otherwise wished.

Replacing Professor Morton

William Blair Morton (1868–1949) had been professor of experimental physics at Queen's since 1897.** He was born in Belfast and educated at Belfast Royal Academy, entering Queen's College, Belfast in 1886 to study mathematics. After

* Herbert W.B. Skinner 1900–1960 entered Trinity Cambridge in 1919 to read natural sciences and mathematics, graduating in 1922. He stayed at the Cavendish to do a PhD and in 1927 moved to Bristol. After war work, he moved to Liverpool in 1949 as professor of physics.

** More accurately he was professor of natural philosophy from 1897–1909, and then professor of experimental physics thereafter.

graduating in 1889 he went to St John's, Cambridge, coming eighth wrangler in 1892. Although intending to stay on at Cambridge, Joseph David Everett, who held the chair of natural philosophy in Belfast from 1869–97, tempted Morton back to be his assistant, and ultimately his successor. When Morton succeeded to the chair "there was no department of natural philosophy as such, only a classroom which served as both laboratory and lecture room" and students "had a reputation for unruly behaviour at lectures; those less interested cheered and hooted at the success or failure of 'experiments' from the back and on occasion seized the porter and threw him out of the room."[59] During his tenure, Morton oversaw the growth of the physics department and the erection of a new building. He also carried a heavy teaching load in both experimental and mathematical physics and published around forty papers, mostly in electricity and hydrodynamics.[60]

When Queen's advertised for Morton's replacement in 1933, Emeléus was not even in the country. In 1932 he had been awarded Rockefeller Fellowship for the academic year 1932–33 and was spending it in the physics department at the University of Michigan. Thus, while Emeléus was one of fifteen applicants for the chair and was appointed to it, he was not interviewed. The University Senate minutes simply noted that "most of the members of the Board were fully aware of his academic and personal qualifications."[61] He returned to Belfast in the autumn of 1933 aged thirty-two to take up the chair and a doubling of his salary to £900. Election to the Royal Irish Academy followed the next year.

An Evolving Curriculum

As previously noted, Morton had been responsible for teaching both experimental physics and mathematical physics, but on his retirement, the University decided to split the role and employ a lecturer in mathematical physics. The appointment of Harrie Massey (1908–1983) in the summer of 1933 was to be the beginning of a long, and world-leading, association of Queen's with theoretical atomic physics. Massey, who had just co-authored the seminal *The Theory of Atomic Collisions*[62] was appointed from stiff competition, including with Rudolph Peierls (1907–1995), Viki Weisskopf (1908–2002), Bertha Swirles (1903–1999) and Louis Rosenhead (1906–1984).[63]

The official description of the experimental physics syllabus at Queen's during the 1930s and 40s is sparse. In year one, lectures were "on mechanics, sound, properties of matter, heat, magnetism, electricity, atomic physics and optics," with year two being simply described as "more advanced lectures" on the subjects of the first-year syllabus. Third-year lectures were on "advanced Classical and Modern Physics." Each year had liberal lab time with two afternoons per week in year one and two, and access to labs for four days per week in year three.[64] By the 1950s slightly more information was given on the year two course, stating that it covered thermodynamics, statistical physics, wave-motion, electricity and atomic physics, and the final year course is listed as covering "the principles of relativity and quantum mechanics, and their exemplification from the electrical thermodynamical and statistical properties of matter and radiation, electronics, optical and X-ray spectroscopy, magnetism, nuclear physics and cosmic rays."[65] By the mid-1960s there was more detail for the first-year course showing that the teaching of relativity, quantum mechanics and nuclear physics had become embedded at the introductory level.[66]

Mathematical physics underwent a similar evolution. In the 1930s the curriculum covered statics, dynamics and hydrostatics in year one; statics, dynamics, hydrodynamics, elasticity and methods of mathematical physics in year two and analytical dynamics, hydrostatics and electricity and magnetism in year three. In the 1940s statistical mechanics and "modern theoretical physics" were included in the final year. By the mid-1960s vector algebra and vector field theory appeared explicitly in the first year, along with the solution of partial differential equations and numerical analysis in the second year, with the final year including relativity, tensor field theory and quantum theory.

Two other curriculum changes are of note. By the end of the 1930s the University had recognised a need to extend the physics curriculum and appointed Eric Mervyn Lindsey (1907–1974) of Armagh Observatory as a part-time lecturer in astronomy. Secondly, in 1950 the University Senate decreed that mathematical physics was to be renamed applied mathematics and experimental physics was to be renamed physics.[67]

Research Focus

While Emeléus's PhD studies at Cambridge had been in radioactivity, when he moved to King's College London he began working on the conduction of electricity through gases, and it was this area that he pursued vigorously for the rest of his career. During his lifetime he published 171 papers (figure 2). Of these forty-eight were single-author works, with the remainder done in collaboration. While at Queen's, most of his co-authors were also based in Belfast. But he also published with academics in London (UCL and King's), Oxford, Dublin (University College Dublin), the US (Michigan and California), Australia, Canada and Germany. In only two of these cases did the link result from the collaborator starting in Belfast and then moving further afield (Australia and Canada), indicating that Emeléus and his work had international currency.

Figure 2 illustrates three notable features of Emeléus's research output. The first is the huge dip in the 1940s, where the war and its immediate aftermath meant that he published only four papers. Of these, two appeared in 1949, one in 1940 and the last was not a research paper, but an obituary for his predecessor, William Morton, who died on August 12, 1949. The second is a spike over the period 1965–69. This corresponds to his retirement in 1966 and perhaps indicates a push to complete a number of research projects. Over the period 1965–66 sixteen papers were published, with a further fourteen during 1967–69. Finally, post-retirement

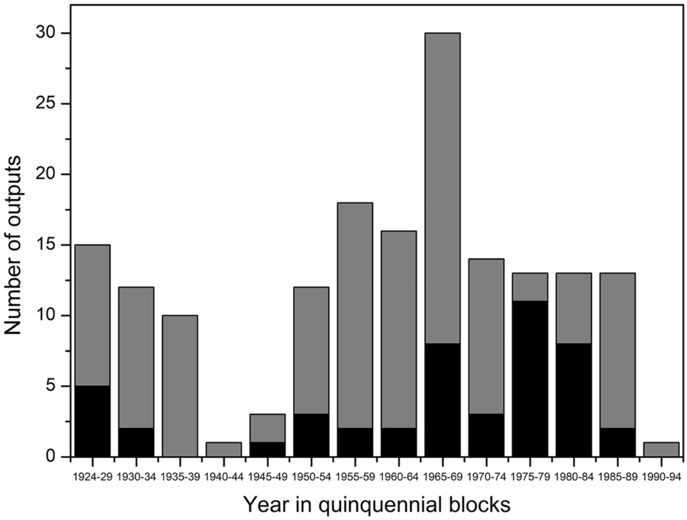

Fig. 2. Karl George Emeléus's research output. Black: single-author papers, grey: multiple-author papers. Using Google Scholar, 171 distinct papers are returned with Emeléus as author. The greatest variation in publication rate occurred during the 1940s when, due to the war, only four outputs were recorded, and the second half of the 1960s, when the peak output corresponds to the time around his retirement in 1966. Data excludes the author's two books, *The Conduction of Electricity through Gases* (Methuen & Co, 1929) and *Discharges in Electronegative Gases*, ed. with Gerry Woolsey (Taylor & Francis, 1970)

Emeléus, though lacking a lab, continued working on the theory side of discharge, publishing on average just below three papers per year until the end of his life. His last paper, co-authored with his colleague at Queen's, Roblin Coulter, was submitted to the *International Journal of Electronics* less than three weeks before his death in June 1989.

By the end of his life, the area of gas discharge had long since run its course as a subject at the forefront of physics research. The topic of plasmas was still an important one, but the centre of gravity was no longer within atomic physics. In the second half of the twentieth century it moved to the study of space plasmas and the much higher energy regime of (the still elusive) controlled thermonuclear fusion.[68] Emeléus did publish a small amount of work on space plasmas (auroral radiation) before and after the war, and gave a number of popular talks on the topic, but it was not an area he developed further.[69]

This is not in any way to denigrate the steady, consistent research that Emeléus did. But that it was not considered "leading edge" is evidenced by the fact that while he was a candidate for Fellowship of the Royal Society from 1948–57, he was not elected. His proposers included James Chadwick, John Cockcroft, and Edward Appleton (all of whom were Nobel laureates by 1951) and past colleagues from Queen's, Harrie Massey and William Hunter McCrea.[70]

World War II and the 1940s

On Sunday September 3, 1939 at 11:15 am Emeléus was upstairs in one of the bedrooms of his house at 6 Upper Green, Dunmurry, south-west of Belfast, when he heard on the radio that war had been declared. He got onto his bike and cycled the four miles into Queen's through a thunderstorm. He passed a man speeding out of town with a gas mask on, who "must have thought the thunder was bombs being dropped"[71] and when he arrived at the University a large flash of lightning struck the ground. It was a portentous day.*

Though too young to fight in the First World War, Emeléus and his brother Harry had both served as teenage orderlies at a hospital for wounded soldiers returning from the front.[72] Emeléus had seen school friends go off in uniform to continental Europe never to return, and like many of his generation he watched the beginning of another war with disbelief and dread: "It was a nightmare from the beginning."[73]

Prosaically, Emeléus found himself as a night fire watchman at Queen's and "was convinced some of his university colleagues took their turn, not so much to safeguard university buildings, but rather to prevent the theft of vegetables from their dig-for-victory plots which had been dug in the quadrangle lawns. He liked to recount that one very irate professor was convinced that his potatoes were being stolen, not by intruders, but by colleagues."[74]

He found himself on duty on the night of the second raid of the Belfast Blitz: Easter Tuesday, April 15, 1941. It was the single most deadly night raid outside London during the campaign. Incendiaries fell on Rugby Road, a stone's throw from the main university site, but nothing came closer. He heard the fire engines coming down Lisburn Road all the way from the Republic of Ireland to help, and then got two hours of sleep on campus before giving "lectures to a few people who turned up and then I got on a bus at 1:00 o'clock"[75] and went home.

Thankfully the only war casualty for the Emeléus household was the family car. Petrol rationing made it uneconomic, and after the war it never returned. The youngest son, George recalls that "This meant that during my growing up years we all used public transport and/or bicycles, or walked, and when necessary had a car and driver come from Elwood's, who had their premises on the main street […] in Dunmurry."[76]

The war effort affected more at Queen's than simply digging up the quad. Forty staff members went into national service,[77] and with a total student body in 1939–40 being 1,555, rising to 2,012 in 1944–45[78] the loss of staff made a significant impact. The strain was reflected in senate minutes in 1943 where it is noted that more teaching assistance was needed in the departments of mathematics,

* My mother, Margaret McCartney, (née Bell), who shares her birthday with Emeléus, was born in 1927 and raised in Hilden, seven miles from Belfast. She would frequently describe a sky sullen with clouds as being "like the day war broke out."

experimental physics, extra-mural studies, geography, engineering and economics.[79] Six-month courses for RAF, Royal Artillery and Royal Engineers cadets were also being given, with the vice-chancellor informing a meeting of the University Guild in December 1942 that "not less than half of all the education by lectures and classes given to men and women of the services in the Province was provided by the university and its staff."[80]

Emeléus commented that "in the university we had to make more use of the ladies on the staff than usual. We could not have carried on with a lot of emergency teaching we were asked to do, if much of it had not been done for us at the time by the Technical College."[81]

The Technical College here refers to the Belfast College of Technology which at this stage was a significant part of Queen's Faculty of Applied Science and Technology. From the creation of the Faculty in 1920 to the 1950s much of the teaching in electrical and mechanical engineering was carried out by the College, with civil engineering remaining at Queen's.[82] Emeléus was Dean of the Faculty for thirteen years.[83]

A letter written during the war to a fellow Johnian, Frank Kendon (1893–1959), gives an insight into Emeléus's thoughts on his life at Queen's: "I have been here now for 17 years, apart from one year in America, and like yourself, I'm happy with my work (although there is too much at present). I think my students will never let me fossilize—they are a mixture of Scots and Irish, and an able and lively crowd."[84] Later in the same year (1943) that Emeléus was writing this letter the total student body at Queen's was 2,031. Of these, 495 (sixty-five of whom were female) were enrolled on courses in experimental physics, taught by a department with four members of staff (one of whom was a part-time lab demonstrator).[85] Not all of these students would have been studying for a degree in physics. Many were taking the subject as part of their engineering or medical degrees. However, the high student-to-staff ratio and lab-intensive nature of the subject, indicate the heavy teaching load in the physics department both during and after the war. It was a problem that was to be eased in 1944 with the appointment of additional lab demonstrators.[86]

After the War

During World War II Emeléus did work on noise sources for the Admiralty, but it was the final actions of the war, with the dropping of nuclear bombs on Hiroshima and Nagasaki which increased his public and Northern Irish Government profile considerably.

While the information about the dropping of the bombs on Japan was controlled and sanitised, the Hiroshima bomb (which fell on August 6, 1945) was reported in all three of the Belfast newspapers (*Belfast Telegraph*, *Northern Whig* and *Belfast News Letter*) the day after the event.[87]

The front page of the Northern Whig led with “ATOMIC POWER HARNESSED: 10 lb. bomb hits Jap city like 20,000 tons of T.N.T.” In the article, Hiroshima is described as “an important Japanese army base.” On the same page is a piece titled “Belfast man helped to split atom” which noted the contributions of Ernest Walton, who as a schoolboy had boarded at Methodist College Belfast between 1915–22. Also on the front page was an article about Neils Bohr: “DANISH EXPERT FOILED NAZIS.”[88]

On Thursday October 25, 1945 Emeléus gave an illustrated lecture closely related to the topic of the bomb, “The Nucleus of the Atom,” at the first meeting of the 125th session of the Belfast Natural History & Philosophical Society. This lecture does not appear to have drawn unusual attention, but when on February 13, 1946 Emeléus gave a lecture on “Atomic Energy” at the Belfast Museum & Art Gallery, there was a queue four abreast to get in. The *Northern Whig* reported that even though an overflow was set up in the lobby outside the lecture theatre “a vast number had to go away disappointed” and that to accommodate demand the lecture was to be repeated the next Monday. Commenting on the lecture itself, the report stated that “Those who were fortunate enough to get inside the hall or to find a vantage point outside heard a scholarly resumé of the history of atomic research. They were given no promises of a fantastic wonder-world, nor were they introduced to scientific nightmares of wholesale, universal chaos. Professor Emeléus was studiously moderate in his picture of the possibilities of the utilisation of atomic energy and his audience seemed all the more appreciative because of that. ”[89]

Two months later Ted Allibone came to Belfast College of Technology on Tuesday April 30 to give The Institution of Electrical Engineers NI Faraday Lecture entitled “Atoms, electrons and engineers.” The lecture was advertised as “a popular one and includes many interesting demonstrations.”[90] Allibone, or “Bones” to his friends, was a physicist and electrical engineer who had been part of the UK team sent to the Manhattan Project in 1944 and was just about to become research director at Associated Electrical Industries research labs at Aldermaston Court in Berkshire. The report in the *Belfast News Letter* stated that Allibone “dealt with the use of Atomic Energy in times of peace.” He painted an optimistic picture stating that “Atomic Energy appears to be on the doorstep, at least for the generation of steam for central station engineering and district heating,” with use for industrial purposes being possible “this side of 1950.”[91]

The lecture was considered significant enough for the Prime Minister of Northern Ireland, Basil Brooke, to be in the chair. In proposing a vote of thanks, Emeléus said that the lecture raised the question of the use of such energy locally, and of whether industrial methods were improving rapidly enough in the province. He also added that Belfast’s engineers were being trained to keep them up to date and that important research work was being done on the electronics side. On this last point, he was probably referencing the work of his own research group on discharge tubes.

In 1948, Emeléus found himself part of the new Council for Scientific Research and Development. Its purpose was to advise the Northern Irish Ministry of Commerce on natural resources, encourage the application of scientific research to industrial problems, and promote science in the province. The Council was chaired by the vice-chancellor David Keir and had other relevant professors from Queen's* along with representatives from the College of Technology, Harland and Wolff and other companies, as well as the Northern Irish Government. The province was one where the dominant industries were still the shipbuilding and linen of the nineteenth century. At the first meeting the Minister of Commerce, Roland Nugent, addressed the Council stating that while in the past peat had been too expensive compared to coal "Now however, the gap is smaller, and, possibly combined with some other process which produces a high-priced product, the production of peat as fuel might become an economic possibility. This is but one instance, there are no doubt many others which the council will consider."[92] While the use of peat as fuel was sensible in an Irish context, it must have felt a long way from Allibone's talk of atomic energy "this side of 1950."

In 1950 members of the University Guild visited the physics department and were informed by Emeléus of ongoing research. The *Belfast News Letter* reported that "The most important new work now being done was unquestionably the so-called atomic work, more properly called nuclear, Professor Emeléus said. This work was, however, so costly that it could scarcely be undertaken by other than Government institutions. The University, like most others, had therefore to undertake less pretentious researches."[93] The visitors were told that Queen's concentrated its research on the behaviour of electricity in gases and lab recreation of aurora. It was also relayed by the eager reporter that although Queen's was not active in nuclear research "naturally nuclear research was a main part of the teaching and was followed by everyone in the place." By the end of March, it was announced that the Guild had donated £1,500, matched by the Government, to buy an electron microscope. However, it was argued that the current research foci at Queen's would not make use of it, nor be able to support the specialist staff need for its operation, so the money was spent on spectrographic equipment instead.[94]

At the end of 1950, an antidote to Allibone's (perhaps forgotten) optimism came when John Cockcroft, the director of the Atomic Research Station at Harwell, gave a lecture on atomic power to a capacity crowd at the Whitla Hall on the evening of Tuesday November 28. Cockcroft suggested that it would be ten years until there were accurate estimates of the contribution of atomic power to electrical supplies, but he doubted that there would be a significant difference in costs.[95]

* J.K. Charlesworth, Prof. of Geology; D.C. Harrison, Prof. of Biochemistry; A.R. Ubbelohde, Prof. of Chemistry; K.S. Isles, Prof. of Economics; R.G. Baskett, Prof. of Agricultural Botany & A.H. Naylor, Prof. of Civil Engineering.

Dropping a Bomb on Belfast

In January of 1950 there were reports in the Belfast press about the development of the hydrogen, or H bomb. Quoting a report from the *New York Times* on the previous day, the *Belfast News Letter* stated:

> Mankind was faced with just two choices, it said. The nations could reach an agreement not to make and use the hydrogen bomb, or they could enter into a race which would wreck civilization. "It would not be pleasant to live in a world in which our own country was compelled to slaughter millions of people in other countries by use of the 'H' bomb. It would, however, be just a little pleasanter than having our own people slaughtered by 'H' bombs thrown in from the outside." The decision rested with the Russians. "They must accept—as we have accepted—international ownership and control of atomic energy before this nightmare can pass—not because we say so, but because nothing else will work."[96]

This is almost certainly part of a propaganda agenda. According to Kenneth Ford, who was involved in the American H bomb project, in 1950 "there had been no breakthrough, and the likelihood of success in building an H bomb was at best clouded."[97] The basic science was clear however: a fusion-based H bomb would release energy equivalent to megatons of TNT, whereas the fission-based bombs released in Japan had been only kilotons. Nevertheless, progress was swift and as early as March 1951 Ed Teller and Stan Ulam at Los Alamos were making technical strides. On November 1, 1952 a bomb (codenamed "Mike") was tested "at scale" releasing 10.4 Mt and destroying Elugelab Island on the Enewetak Atoll in the Pacific.[98]

As concern about nuclear warfare grew across the western world, coverage in the Belfast press also increased. There are clear peaks in press reports in 1950 and 1954 (figure 3). The 1950 peak corresponds to initial reports of the possibility of the H or "super" bomb, while the 1954 peak corresponds to the aftermath of an American bomb test which did not go according to plan. On March 1, 1954, the American "Castle Bravo" test was significantly larger than initially predicted. The bomb was expected to yield five to six megatons, but it yielded fifteen. Radiation levels were higher than predicted and the declared danger zone was too small. In particular, the twenty-three-man crew of a Japanese fishing boat *Lucky Dragon,* which was eighty-five miles from the test site, all experienced radiation sickness. Not only did this story inevitably reach the press, but by the end of the month Lewis Strauss, chair of the American Atomic Energy Commission, and special advisor to President Eisenhower, stated, in answer to a question from a journalist, that an H bomb could be made "as large as you wish […] large enough to take out a city." Under further questioning, he confirmed that New York could be destroyed. The headline in the New York Times the next day, "H-bomb can wipe out any city" was predictable, and anxiety spread rapidly across the West.[99]

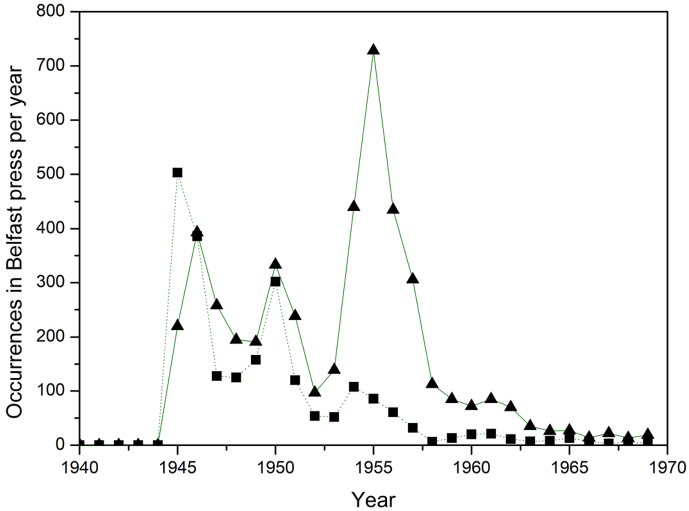

Fig. 3. Search for phrases "atomic bomb" and "atomic energy" in the Belfast press. Phrase "atomic bomb": squares joined by dotted lines; "atomic energy" triangles joined by solid lines. The peaks around 1945, 50 and 54 correspond respectively to the Hiroshima & Nagasaki bomb drops; concerns about the development of an H bomb; and the reports of American and Russian H bomb tests. Search carried out using the British Newspaper Archive with location filter 'Belfast, Antrim, Northern Ireland'. This returns results for three daily papers (*Belfast Telegraph, Belfast News Letter* and *Northern Whig*) and two weekly papers (*Ireland's Saturday Night* and *Irish Weekly and Ulster Examiner*)

There were calls in the Belfast press for a halt to H bomb research,[100] or to simply ban the bomb,[101] with the Northern Irish Government being called on by the Belfast & District Trades Union Council to abolish all weapons of mass destruction.[102]

On October 27 the *Northern Whig* reported that the American Atomic Energy Commission had revealed that since mid-September there had been a series of Russian nuclear tests.[103] Two days later the news headline in the *Whig* read "HANNA H-BOMB STATEMENT AFTER CHRISTMAS" with the accompanying article stating "A detailed statement on "Northern Ireland and the hydrogen bomb" will be made on behalf of the Ulster Government in December or early January by Mr George B. Hanna, Minister of Home Affairs, the Northern Whig political correspondent learns. Mr Hannah, I understand, will go to London early in December to discuss the position with the new Home Secretary, Major Gwilym Lloyd George, who will visit Ulster early in the New Year."[104] An H bomb in Belfast would, the article stated, destroy not just the city but the surrounding towns of Bangor, Newtownards and Lisburn.

The *Northern Whig* article of October 29 also noted that in the House of Commons in London on October 28, a Civil Defence Bill was given its second reading in an attempt to create an adequate defence strategy for the UK in the event of another war. It was clear that the armed forces alone would not be sufficient, and a well-organised civil defence was deemed to be needed. The only specific national provision reported by the article was for three new training centres for firefighters at an estimated cost of £375,000. Some members of parliament felt that the British Government were fooling themselves and attempting to fool the public. The *Whig* concluded with a quote from H.B.W. Morgan, (Labour member for Warrington) who stated bluntly to a silent House: “This present civilisation in my opinion is doomed.”

It is at this point that Emeléus wrote an open letter, as Professor of Physics, to the *Northern Whig*, *Belfast Telegraph* and *Belfast News Letter* which appeared on Saturday October 30, 1954.[105] Referencing the recent press reports on the Home Secretary & NI Minister for Home Affairs, and noting that he and colleagues from Queen’s “act as scientific advisors to the Government” he stated that:

> A single atomic attack centred on Belfast could devastate almost everything round the shores of Belfast Lough and in and near the Lagan Valley between Carrickfergus and Holywood in the east and Lisburn in the west, and cause substantial damage far beyond this. The attack might take the form of a number of the earlier type of bomb used in Japan or a single so-called hydrogen bomb, or a combination of both. After the attack parts of the area whose exact location could not be predicted in advance, and possibly some other areas, would be lethally radioactive for a time. If this terrible thing ever happened to us, I am sure that no one will dispute that the first consideration would be to prevent people from being hurt and killed to the greatest possible extent. The only way to do this that I can see is by rapid and orderly evacuation during the days of warning that we might reasonably hope to have.

After pointing out that such evacuation will have to be planned for, he goes on to state:

> One may well ask whether it is not the proper thing, under present circumstances to call a halt to building, particularly of dwelling houses, within the area which would have to be evacuated, and to speed it up outside. Large scale dispersal of the industries and other activities of a capital city and its environs is simply not practicable during the few years ahead, after which one likes to think that the threat of war will have gone for good, but a good deal could probably be done in the way of dispersal of essential supplies and facilities during the period of warning. Most people have now seen or heard of the civil defence units for which they are being asked to volunteer. It is not an unnatural thing that many should feel that the position is so hopeless that it is not worthwhile their participating. Everyone must take his or her own decision in this matter.

> My personal feeling on which I have been acting is that I should do what I can, little though it may be, and I have reached this not only from the belief that there would be work worth doing on the margin of the worst affected areas, and in rehabilitation, but from the conviction which I have tried to convey in this letter that casualties may be kept small due to forethought.

In a brief follow-up article on Wednesday November 3 entitled "Ulster's H-bomb problems" the *Northern Whig* stated that it understood that the area described by Emeléus "would be largely evacuated to portions of the province to be designated as 'shelter areas.' In these areas all suitable buildings would be liable to be taken over for the sheltering of hundreds of thousands of displaced persons. Billeting in private houses would be compulsory. In an actual emergency, the government will take all powers necessary over people and property, and the introduction of conscription for Civil Defence services is possible."[106] When, two weeks later, the *Northern Whig* reported on a conference to discuss Belfast's "slum clearance" and the erection of blocks of flats, it referred back to Emeléus's comments on halting building plans in Belfast, suggesting that "The Ulster Cabinet may have to adopt this policy if world conditions should not improve as hoped for."[107]

A year later Emeléus matched his words on civil defence with action: September 26–29 (Monday–Thursday), 1955 saw him as one of the experts teaching on a four-day training course for men who would work in civil defence as "technical reconnaissance officers."[108] Emeléus spoke on Wednesday on "The elementary physical basis for physiological effects of radiation."[109]

The following year, on Tuesday and Wednesday of September 25–26, 1956, Emeléus was one of several people teaching a course on nuclear energy at Queen's to 170–200 representatives from the three armed services. The event concluded with a talk on "The military aspects of nuclear energy" by Capt. Cyril Falls, former Chichele Professor of Military History at All Souls, Oxford, and past pupil of Portora Royal School, Enniskillen. He stated that as an old infantryman, while the Navy would eventually go under the sea and the RAF would leave the sky to launch missiles from the ground, "The Army is the oldest of the Services, and I venture to think it would last the longest."[110] Perhaps the seventy-seven-year-old veteran of World War I, eminent historian though he was, had not quite grasped the meaning of the term "megaton."

An Atomic Reactor for Ulster

The panic about possible nuclear warfare gradually dissipated in the press, almost disappearing as a matter to be reported on by 1958. But scarcely had 1954 ended and another atomic matter was back in the press: that of nuclear energy. While Allibone's prediction of nuclear power by the end of the 1940s had been wildly optimistic, by the mid-1950s it was fast becoming a reality.

At the beginning of 1955, under the title "PLEA FOR ATOMIC REACTOR FOR ULSTER" the *Northern Whig* reported that Brian Faulkner, MP for East Down, had suggested that an Atomic Energy Committee should be set up by the Northern Irish Government. Referring to the soon-to-be-completed Calder Hall nuclear power station in Cumbria, Faulkner stated that "For two and a half years I have been pressing for atomic work to be done in the Province […] We have the highest unemployment [in the UK], and we are dependent on sea-borne coal from Britain, which we have to import at high cost. I am told Calder Hall will be operating by 1956. Has Northern Ireland not greater need of it than Cumberland?"[111] The voices from Queen's quoted within the article were more reserved. Both the vice-chancellor, Eric Ashby, and Emeléus stated that while Queen's was in close contact with relevant British research, they had reservations about whether the idea was economically viable for the province.

Despite the reserved voices from Queen's, the Northern Irish Government pressed ahead. By 1956 they had appointed an engineer to be trained in atomic energy in Britain and Emeléus had been appointed as "honorary adviser on nuclear physics" to the Minister of Commerce, Lord Glentoran. The *News Letter* reported that Emeléus would assist with the writing of a white paper on atomic energy in the province and that the engineer in training "will be one of the top men in charge of the practical progress of the Government plan, while Professor Emeléus will be overall head of the theoretical side."[112] A brief article on Emeléus in the *Belfast Telegraph* pointed out that Emeléus "emphasises" that he is not active in nuclear research but rather works on gaseous electronics and that this is one of the main focuses of research at Queen's.[113]

During the rest of the 1950s there were local press reports on the proposal of a power station, with the total costs reported between £66 million[114] and £25 million.[115] Allibone was back in Belfast in March 1957 to give a lecture at Queen's Whitla Hall suggesting that by 1975 half of Northern Ireland's electrical power could come from a local nuclear station. In June of the same year it was reported that Emeléus was at a three-day conference at Harwell for "secret talks" on nuclear power[116] and in April 1958 John Cockcroft came to Belfast reportedly for "informal discussions" on the building of a power station which was to be in operation by 1963 or 64.[117]

For all the repeated press association between Emeléus and nuclear power in Northern Ireland, he was not a supporter of it. His son George recalls that, "He did not favour it, and I remember him saying that to be economical it would need to be all-Ireland, and also that as it would require a lot of cooling water, Lough Neagh would be a likely site, and that Lough Neagh was too important for community and agriculture to disturb it (with an element of risk) for a nuclear power station."[118]

Presumably, his advice was a strong contributor to the whole idea disappearing by the end of the 1950s. In 1957 a site on the south-west shores of the Lough Neagh was being favoured, but by the end of 1958 Lough Neagh had been dropped as a location and it was proposed that a coastal site should be used as it would be safer to allow discharges to open sea rather than a closed lough. By 1958 it was also proposed that a pumped hydro station should also be built behind Cave Hill, north of Belfast, to raise water at night using the nuclear station and then use hydro-electric power during the (higher use) daytime hours to augment the nuclear supply.[119]

By March 1959, the Northern Irish Minster of Commerce, Lord Glentoran was suggesting to the Unionist Conference that perhaps the idea of a nuclear power station may not be economically viable, with the *Belfast Telegraph* "Viewpoint" column stating that "an atomic station may never be a really economic proposition for Northern Ireland. If a power cable link between Ulster and Scotland is feasible—as some experts now suggest—it would be cheaper to feed power here from large atomic stations in Great Britain."[120] After this point there is little more in the press until 1965, and then again in 1969, when the idea of a reactor being built briefly resurfaces.[121]

A Steady Building of a Department

Despite his public involvement in nuclear matters, Emeléus's research in gas discharge continued as normal during the 1950s. During the academic year 1955–56 Norman Lee Oleson from the United States Naval Postgraduate School in Monterey, California, spent the year with Emeléus in Belfast working on striations in discharge tubes.[122] The visit ended with Emeléus in return spending six weeks in the US visiting the school at Monterey and MIT.[123] There was also a growing flow of grant income over the late 1950s and 60s for research in experimental physics,[124] though it was considerably smaller than the amounts being brought in by the flourishing applied mathematics group headed by David Bates.[125]

During the twenty years from the end of the war in 1945 to 1965 Queen's doubled in size[126] and while there was more than a doubling in staff across the university to match this, Senate minutes indicate that at points both physics and mathematics struggled to attract and retain staff. Application numbers were typically in single figures, and at one stage in the early 1950s the minutes noted that the university had advertised lectureships in physics over three years with no success.[127]

The year 1962 saw the opening of a new physics building on the Queen's main site at a cost of £750,000. Physics had been cramped since the early 1940s. After the end of the war, the department had expanded into several "huts" on or near the main site, and into a property on University Square. Emeléus stated that "these have served well, but dispersed the department more than is desirable—and in any case the huts have to be pulled down soon."[128] The department was teaching around 1,000 students at the time, 580 being first years, 290 second years, and 115 third and fourth years. Given that in 1962 there were a total of 4,239 students at Queen's[129] the figure of 1,000 is impressive, though as noted earlier, this number includes significant levels of "service" teaching to other disciplines.

When the members of the Belfast Association of Engineers came to the new physics department in September 1962 "Professor Emeléus said the university had no cause for complaint about the quality of the men and women coming to it. There was an increase in the number of students who were prepared to work hard, but the number of geniuses have not increased proportionately."[130] The comment on genius was perhaps an ungracious, though doubtless revealing, slip of the tongue.

In 1965, approaching the end of his career, Emeléus was awarded a CBE in the Birthday Honours list.[131] And perhaps in a fitting conclusion to his nuclear involvements in the 1950s, in early 1966 he went, for two weeks on behalf of the British Council, to the USSR under an Anglo-Soviet cultural agreement.[132]

Conclusions

In July 1966 the *Belfast Telegraph*, in an article on some of the changes in staff at the university, noted Emeléus's retirement and made a perceptive comment on his long-term commitment to Queen's:

> Professor K K [sic] Emeléus is retiring after more than 30 years in the chair of physics. He has helped to steer his department and the university through profound changes: no one else on the staff can remember Queen's without him and will find his absence strange, but even the most recent of his colleagues on academic council will carry a memory of his never-failing courtesy […] a healthy university, indeed needs two kinds of members of staff. It needs those, like Professor Emeléus, with a deep loyalty to the institution, who carry its traditions and accumulated wisdom over the years. And it needs those whose devotion to their subject bids them follow wherever it leads them.[133]

Despite the incorrect initial it was a good summing up of Emeléus's significance. Some do indeed follow career ambitions and new research opportunities across countries and institutions, and others settle to make a lasting difference where they are. Emeléus was in the latter category, and physics in Belfast was almost certainly the richer for it (figure 4).

Though Emeléus had retired, he didn't leave Queen's. Writing in 1972 to J.A. Ratcliffe, a contemporary from his Cambridge days, he explained why he was using Department of Applied Mathematics and Theoretical Physics rather than Department of Physics headed paper: "The reason that I have this address is that when I retired in 1966, David Bates, with great kindness (and the agreement of Queen's) offered me a room here if I would like to keep on with non-experimental work. He, and my successors in physics could not have been kinder, and I hope that the papers I have been publishing are some little return and 'thank you' to them."[134] As noted earlier, his research continued unabated to the very end of his

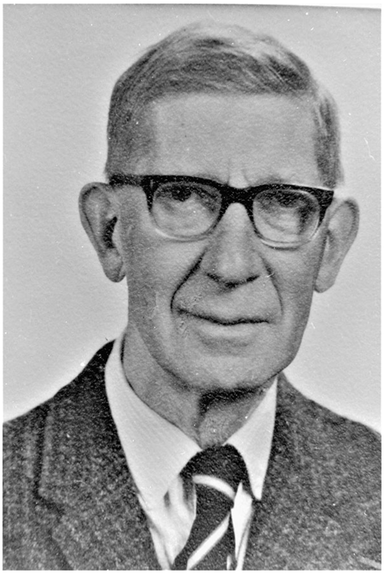

Fig. 4. Karl George Emeléus, around the time of his retirement in 1966. *Courtesy*: George Emeléus

life. When I was an undergraduate studying mathematics and physics at Queen's in the 1980s I have at least one recollection of seeing an elderly and somewhat unsteady Emeléus in a light-coloured trench coat, supported by his much younger colleague, Robin Coulter. And when I commenced my studies as a postgraduate in October 1988, the room that I and fellow student, Ian G. Young, were allocated had just been vacated by Emeritus Professor K.G. Emeléus, CBE, MRAI. He died the next year on June 18, 1989.

Acknowledgements

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10. Baines, Coinisbee and Bygate, *Hastings Grammar School* (ref. 4), 209; Greenwood, *Emeléus* (ref. 3), 126.

11. *Hastings and St Leonards Observer*, Saturday December 15, 1917, 2.

12. *Hastings and St Leonards Observer*, Saturday December 20, 1919, 5.

13. Robin Coulter, "Professor K.G. Emeléus: An Appreciation," *Queen's Letter* **6**, no. 1 (1989), 13.

14. *Mid-Ulster Mail*, Saturday December 9, 1950, 7.

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16. The Hochin Prize consisted of "books to the value of £13 awarded to the best student in any of the three years for some branch of physics." *Hastings and St Leonards Observer*, Saturday August 13, 1921, 7.

17. Karl George Emeléus, "Application of Karl George Emeléus for Lectureship at Queen's University, Belfast," (1927). Original in possession of Emeléus's son George.

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[19.] Details in this paragraph are taken from G.U. Yule's reference in the Belfast Application (ref. 17).

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[28.] See Roger Stuewer, *The Age of Innocence: Nuclear Physics between the First and Second World Wars*, (Oxford: Oxford University Press, 2018), chapter 4. Maria Rentetzi, *Trafficking Materials and Gendered Experimental Practices: Radium research in early 20th century Vienna*, (New York: Columbia University Press, 2008), chapter 5.

[29.] Hans Geiger and Walther Müller, "Das Elektronenzählrohr," *Physikalische Zeitschrift* **29** (1928), 839–41. Hans Geiger and Walther Müller, "Elektronzählrohr zur Messung schwäster Aktivitaten," *Naturwissenschaften* **16** (1928), 617–18.

[30.] Emeléus, "Belfast Application" (ref. 17).

[31.] Coulter, "Emeléus" (ref. 13).

[32.] From notices in the Belfast press these are: "Atoms, Electrons and X-Rays," Belfast Museum November 25, 1931; "The Development of Physics in the Twentieth Century," Belfast Natural History and Philosophical Society (BNHPS), April 29, 1935; "The Aurora Borealis," BNHPS, March 15, 1939; "The Nucleus of the Atom," BNHPS, October 25, 1945; "Atomic Energy," Belfast Museum, February 13, 1946, repeated February 18; "Cosmic Rays and Radioactive Effects," Belfast Museum, January 7, 1948; "On the Origin of some Solar Spectra of Astrophysical Interest," Irish Astronomical Society, March 5, 1948; "The Production of Auroral Light" University College Dublin Scientific Society, March 10, 1950; "Science and Humanity," Belfast branch of the Business & Professional Women's Club, March 13, 1956; "The Early Scientific Work of Albert Einstein," BNHPS, March 12, 1957; "The Elements of Atomic Structure," Belfast College of Technology, October 17, 1957; "The Atomic Nucleus," Queen's Women's Graduates Association, April 1, 1958; Untitled lecture at the Downe Society, Downpatrick, April 25, 1958; Untitled address to University Women's Club, Belfast, March 29, 1962 and April 20, 1964. Emeléus also presented an edition of the Ulster Television program "Midnight Oil" on physics in the summer of 1962, but the recording has been lost.

[33.] Emeléus, "Belfast Application" (ref. 17).

[34.] Emeléus, "Belfast Application" (ref. 17).

[35.] Eméleus, "Belfast Application" (ref. 17).

[36.] Emeleus, "Belfast Application" (ref. 17).

37. Minutes of Senate, June 15, 1927, Queen's University Belfast Archives, QUB/3/2/1/1/12.

38. Coulter, "Emeléus" (ref. 13).

39. Alan Garscadden, "Karl George Emeléus," *Physics Today* **43**, no. 11 (1990), 106.

40. Karl George Emeléus, "Prof. W.B. Morton," *Nature* **164**, no 4171 (1949), 604.

41. T.W. Moody and J.C. Beckett, *Queen's Belfast 1845–1949: The History of a University*, two volumes, (Faber & Faber, 1959), 663.

42. Letter from Florence Emeléus to Alf McCreary (26th February, 1992), Queen's University of Belfast Archive, QUB/I/1/B/3.

43. Senate Minutes for June 16, 1926 notes recommendation "that a Junior Lectureship be instituted in the Department of Physics, and that Miss F.M. Chambers be appointed to hold it." Queen's University Belfast Archive, QUB/3/2/1/1/10.

44. Florence Mary Chambers, "Application of a Thermionic Valve to the Measurement of the Damping of Vibrations of a Steel Wire." *Philosophical Magazine S6* **48**, no. 286 (1924), 636–45; William Morton and Florence Mary Chambers, "On the Combined Vibration of a Bar and String, and the 'Wolf-Note' of a Stringed Instrument," *Philosophical Magazine S6* **50**, no. 297 (1925), 570–88; Florence Mary Chambers, "Notes on the Resonances of a Violin," *Philosophical Magazine S7* **5**, no. 27 (1928), 160–66.

45. William Morton, "On the Discontinuous Flow of Liquid Past a Wedge of Small Angle," *Philosophical Magazine S6* **48**, no. 285 (1924), 464–76.

46. Transcript of interview of Florence Emeléus with Alf McCreary (1992), Queen's University Archive, QUB/I/1/B/3.

47. George Emeléus, "Karl George Emeléus—Memories," private communication with the author, June 2021.

48. *Belfast Telegraph*, December 5, 1928, 3. *Belfast Newsletter*, December 5, 1928, 7.

49. Karl George Emeléus and Frances Mary Emeléus, "The Spectrum of the Negative Glow in Oxygen," *Philosophical Magazine S7* **8**, no. 50 (1929), 383–92.

50. Patrica Fara, *A Lab of One's Own: Science and Suffrage in the First World War* (Oxford: Oxford University Press, 2018), chapter 15.

51. L.A. Clarkson, *A University in Troubled Times: Queen's Belfast 1945–2000*, (Dublin: Four Courts Press, 2004), 119–20.

52. *Belfast News Letter*, Tuesday February 1, 1955, 3.

53. *Belfast Telegraph*, Thursday January 31, 1963, 7. *Belfast News Letter*, Tuesday November 17, 1964, 7.

54. *Northern Whig*, Monday September 24, 1956, 4.

55. *Belfast Telegraph*, Saturday January 7, 1961, 3.

56. Private email from George Emeléus August 10, 2021.

57. Herbert Skinner, "The Conduction of Electricity through Gases," *Nature* **125**, no. 740 (1930), 740.

58. J.A. Hornbeck, "The Conduction of Electricity through Gases," *American Journal of Physics* **20**, no. 6 (1952), 382.

59. Enda Leaney and Patrica M Byrne, "Morton, William Blair," in *Dictionary of Irish Biography* (Dublin: Royal Irish Academy, 2009).

60. Emeléus, "W.B. Morton" (ref. 38), 604.

[61] Minutes of Senate, Wednesday April 19, 1933, Queens University Archives, QUB/3/2/1/1/13. Perhaps the most remarkable other applicant for the chair was Lewis Fry Richardson, then at Paisley Technical College in Scotland. Despite being a Fellow of the Royal Society he was not even selected for interview.

[62] N.F. Mott and H.S.W. Massey, *The Theory of Atomic Collisions* (Oxford: Clarendon Press, 1933).

[63] Minutes of Senate, Friday July 14, 1933, Queen's University Belfast Archives, QUB/3/2/1/1/13. There were a total of eleven applicants for the post. Massey pipped Rosenhead at the post to be appointed, but Rosenhead went on to be appointed professor of applied mathematics at Liverpool later the same year. By 1937 Peierls was professor at Birmingham and Weisskopf professor at Rochester in New York.

[64] A sample of the university calendar for 1935, 1940 and 1945 gives identical wording for the experimental physics curriculum. See for example *The Queen's University of Belfast Calendar 1940–41* (Belfast: Mayne, Boyd & Son, 1940), 244–45.

[65] *The Queen's University of Belfast Calendar 1950–51* (Belfast: printed by Marjory Boyd, 1950), 237–38. The form of words is unchanged in the 1960–61 Calendar.

[66] *The Queen's University of Belfast Calendar 1965–66* (Belfast: printed by Marjory Boyd, 1965), 320

[67] Minutes of Senate, June 28, 1950, Queen's University Belfast Archives, QUB/3/2/1/1/19.

[68] Richard F. Post, "Plasma Physics in the Twentieth Century," in *Twentieth Century Physics Volume III*, eds. Laurie M Brown, Abraham Pais and Brian Pippard, (London: IOP Publishing and AIP Press, 1995), 1617–690.

[69] For example, Emeléus gave a talk at the Belfast Natural History and Philosophical Society on "Aurora Borealis" on Tuesday March 14, 1939 (*Belfast News Letter* March 13, 1939, 6); spoke to the Irish Astronomical Society on the "Origin of Some Solar-Spectra of Astrophysical Interest" on March 5, 1948 (*Belfast News Letter*, March 4, 1948, 4) and at the inaugural meeting of the University College Dublin Scientific Society on "The Production of Auroral Light" on March 10, 1950 (*Irish Independent*, March 9, 1950, 6.)

[70] *Royal Society Candidates Book* (1952), 13 and (1957), 16.

[71] Catherine Fegan, "Interview of Karl George Emeléus," (undated, post 1966), 1. Catherine Fegan was Emeléus's neighbour and carried out the interview as a school assignment. Transcription privately communicated by George Emeléus.

[72] George Emeléus, "Memories" (ref. 45).

[73] Fegan, "Interview" (ref. 69).

[74] Coulter, "Emeléus" (ref. 13).

[75] Fegan, "Interview" (ref. 69).

[76] George Emeléus "Memories" (ref. 45). Elwood's was a "Complete Funeral Furnisher" who also provided "Superior Motor Cars for Visiting, Weddings, &c" (Advertisement in *Belfast News Letter* Monday December 1, 1947, 1)

[77] Brian Walker and Alf McCreary, *Degrees of Excellence: The Story of Queen's Belfast 1845–1995* (Institute for Irish Studies, 1994), 67.

[78] Moody and Beckett, *Queen's Belfast* (ref. 39), 663.

[79] Minutes of Senate, June 23, 1943, Queen's University Belfast Archive, QUB/3/2/1/1/17.

[80] *Belfast News Letter*, Wednesday December 2, 1942, 2. The University Guild had been created in 1930 with its first meeting taking place in the City Hall chaired by the Lord Mayor. The guild

was not restricted to graduates, and it was hoped that it would raise both interest in and funds for Queen's (Moody and Beckett, *Queen's Belfast* (ref. 39), 496)

81. Fegan, "Interview" (ref. 69).

82. Clarkson, *Queen's Belfast* (ref. 49), 28.

83. Coulter, "Emeléus" (ref. 13). Emeléus first appears on the University's annual university report as being paid an extra £25 per annum as Dean of the Faculty of Technology in 1940. The faculty was renamed Applied Science and Technology in 1950, (at which point the payment is £75) after which the budget line for payment disappears from the accounts.

84. Letter from Karl George Emeléus to Frank Kendon January 6, 1943, Cambridge University Archive, GBR/0012/MS Add.9251/E/7.

85. Minutes of Senate, November 24, 1943, Queen's University Belfast Archive, QUB/3/2/1/1/17

86. In Senate minutes of November 1944, 1945 and 1946 four demonstrators are listed each year. Of the six distinct names listed over the period five are female: Minutes of Senate, November 22, 1944, November 21, 1945, Queens University Belfast Archive, QUB/3/2/1/1/17. Minutes of Senate November 27, 1946, Queen's University Belfast Archive, QUB/3/2/1/1/18.

87. For a wider assessment of how the British press reported and reflected on the Hiroshima and Nagasaki bombs, as well as the evolving threat of nuclear warfare in the 1950s see Adrian Bingham, "'The Monster'? The British Popular Press and Nuclear Culture, 1945–Early 1960s," *British Journal for the History of Science* **43**, no. 4 (2012), 609–34; Jonathan Hogg, "'The Family that Feared Tomorrow': British Nuclear Culture and Individual Experience in the Late 1950s," *British Journal for the History of Science* **43**, no. 4 (2012), 535–49.

88. *Northern Whig*, Tuesday August 7, 1945, 1. To give a feel for the level of press interest in the dropping of the Hiroshima and Nagasaki bombs, between August 7 and the end of 1945 there are thirty-six days when the word "Hiroshima" occurs in the Belfast press and on many of these days it occurred multiple times. Search carried out using the British Newspaper Archive with search word "Hiroshima" and location restriction "Belfast, Antrim, Northern Ireland".

89. *Northern Whig*, Thursday February 14, 1946, 1.

90. *Northern Whig* Monday April 29, 1945, 2.

91. *Belfast News Letter*, Wednesday May 1, 1946, 2.

92. *Belfast News Letter*, Tuesday January 20, 1948, 5.

93. *Belfast News Letter*, Thursday January 29, 1950, 3.

94. *Belfast News Letter*, Thursday March 23, 1950, 3.

95. *Belfast Telegraph*, Wednesday November 29, 1950, 2; *Northern Whig*, Wednesday November 29, 1950, 5.

96. *Belfast New Letter* Monday January 30, 1950, 4.

97. Kenneth W. Ford, *Building the H Bomb: A Personal History* (Singapore: World Scientific, 2015), xiii.

98. Lorna Arnold, *Britain and the H-Bomb* (Basingstoke: Palgrave, 2001), 17.

99. Arnold, *H-Bomb* (ref. 95), 18–20.

100. *Belfast Telegraph*, Monday April 5, 1954, 1.

101. *Northern Whig*, Monday August 9, 1954, 2.

102. *Belfast Telegraph*, Friday October 8, 1954, 7.

103. *Northern Whig*, Wednesday October 27, 1954, 1.

104. *Northern Whig*, Friday October 29, 1954, 1.

[105.] *Northern Whig*, Saturday October 30, 1954, 1; *Belfast Telegraph*, Saturday October 30, 1954, 4; *Belfast News Letter*, Saturday October 30, 1954, 4.

[106.] *Northern Whig*, Wednesday November 3, 1954, 1.

[107.] *Northern Whig*, Thursday November 18, 1954, 1.

[108.] *Belfast Telegraph*, Monday September 26, 1955, 7.

[109.] *Belfast News Letter*, Wednesday September 28, 1955, 6.

[110.] *Belfast News Letter*, Thursday September 27, 1956, 8.

[111.] *Northern Whig*, Saturday January 15, 1955, 1.

[112.] *Belfast News Letter*, Thursday July 5, 1956, 5.

[113.] *Belfast Telegraph*, Wednesday July 11, 1956, 4.

[114.] *Belfast News Letter*, Wednesday October 17, 1956, 4

[115.] *Belfast Telegraph*, Friday April 11, 1958, 1.

[116.] *Belfast Telegraph*, Friday June 21, 1957, 3

[117.] *Belfast Telegraph*, Friday April 11, 1958, 1.

[118.] Private email from George Emeléus, July 6, 2021.

[119.] *Belfast Telegraph*, Tuesday December 9, 1958, 1.

[120.] *Belfast Telegraph*, Monday March 9, 1959, 1.

[121.] *Belfast Telegraph*, Wednesday May 26, 1965, 6; *Belfast Telegraph*, Monday September 1, 1969, 2.

[122.] *Belfast Telegraph*, Wednesday September 28, 1955, 7.

[123.] *Belfast Telegraph*, Wednesday February 20, 1957, 4.

[124.] In the Senate minutes for May 16, 1951 (QUB/3/2/1/19) it is noted that the department of physics is continuing work for the Admiralty (though no figures are noted); on June 25, 1958 it is noted that a £4,500 grant from the Atomic Energy Authority has been awarded for research on plasma dynamics (QUB/3/2/1/1/22); in 1962 grants of £6,000 for plasma research from the US Air Force and £1,570 from the British Admiralty (QUB/3/2/1/1/26, 3); in 1963, £700 from the Central Electricity Generating Board for work on ionisation waves, £9,370 from the Admiralty for work on hot cathode discharges, £1,000 from Clarke, Chapman & Co. Ltd for shock tube apparatus (QUB/3/2/1/1/27, 230); 1964, £1,200 from the Rutherford Laboratory for research in nuclear science (QUB/3/2/1/28, 286); 1966, £1,500 from Clarke, Chapman & Co. Ltd, £8,900 from the Science Research Council, £9,200 from the Rutherford Laboratory (QUB/3/2/1/1/30, 181).

[125.] As an example, in 1963 the applied mathematics group received four grants totalling over £27,000, and the next year a further four grants totalling over £100,000 (QUB/3/2/1/1/27, 5,71,125; QUB/3/2/1/1/28, 121).

[126.] Total student enrolments in 1945 were 2,121, by 1965 they were 4,890: Clarkson, *Queen's Belfast* (ref. 49), 205.

[127.] Minutes of Senate June 24, 1953, Queen's University Belfast Archive, QUB/3/2/1/1/20.

[128.] *Belfast Telegraph*, Tuesday April 3, 1962, 7.

[129.] Clarkson, *Queen's Belfast* (ref. 49), 209.

[130.] *Belfast Telegraph*, Thursday September 13, 1962, 3.

[131.] *Belfast Telegraph*, Saturday June 12, 1965, 9.

[132.] *Belfast Telegraph*, Friday January 28, 1966, 13.

[133.] *Belfast Telegraph*, Wednesday July 20, 1966, 5.

[134] Letter from Karl George Emeléus to John Ratcliffe, July 27, 1972, Churchill College Cambridge Archives, GBR/0014/RACL 4/9.

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