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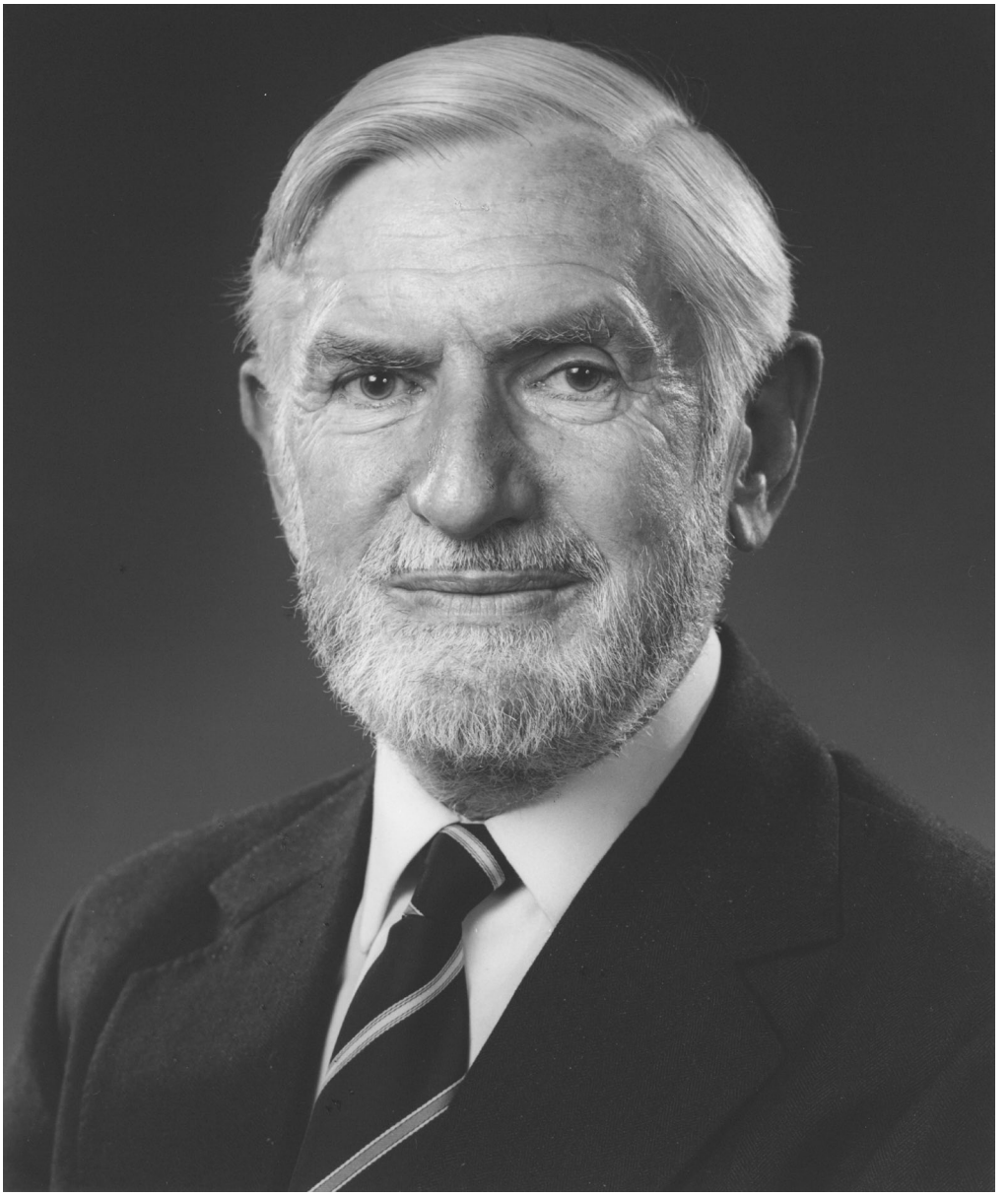
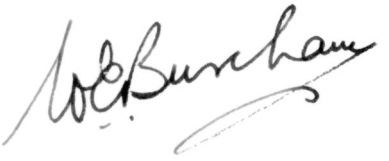
Biogr. Mems Fell. R. Soc. **57**, 63–78 (2011)





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Elected FRS 1957

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William Ernest Burcham, known almost always as Bill, was an experimental nuclear physicist whose research was chiefly concerned with nuclear reactions and with radioactive β-decay. As an undergraduate, research student and postdoctoral student he worked in the Cavendish Laboratory in Cambridge during the last few years of Lord Rutherford's life. During World War II he was one of those who pioneered the use of centimetre wavelengths in airborne radar. As a university teacher after the war, first in Cambridge and then in Birmingham, he helped for more than 30 years to re-establish nuclear studies as an academic discipline in the UK.

Early life

Bill Burcham was born in 1913 in Wymondham in Norfolk. His father, Ernest Burcham, was a booking clerk at Wymondham station of the Great Eastern Railway, and his mother, Edith (*née* Pitcher), had been an assistant in the post office in the town. His grandfather, William Burcham, was a farmer and cattle dealer in South Norfolk. Both Bill's parents left school at the age of 14 years. Bill's father might well have gone into farming, but it seems that he may have been encouraged by Bill's grandfather to take up clerical work, in which he proved conscientious and efficient. As a railway employee, Bill's father was exempt from military service during World War I, and in 1916 he became a relief booking clerk based at Thorpe Station in Norwich, a city in which Bill lived until he went to university. Bill had one brother, Jack, born in 1920, who studied physics at Birkbeck College and became an experimental officer at the Culham Laboratory of the Atomic Energy Authority, and who died in 1985. Apart from his brother no member of Bill's family exhibited noticeable scientific ability, although for many of them their limited educational opportunities would hardly have allowed it.

http://dx.doi.org/10.1098/rsbm.2010.0020 This publication is © 2011 The Royal Society

Bill's formal schooling started in Thorpe Hamlet Elementary School, where the emphasis was on English and arithmetic; an emphasis also on neatness seems to have had a lasting effect and was always evident in Bill's subsequent work. This school did little to encourage any interest in science, which for Bill was generated first by his friendship with a boy, G. F. Smith, who lived next door. At the age of 12 years Bill won a place at the City of Norwich School, having narrowly failed to gain admission to the King Edward VI Grammar School in Norwich. Bill enjoyed his secondary school, feeling that he had received an exceptionally good education from very talented teachers, who might in later years have had the opportunity to pursue other careers. He did well at school, and his performance in the Cambridge Local School Certificate examination led the school to persuade his parents, in spite of their limited means, to allow him stay on to the sixth form. Here the very fine teaching, especially from F. G. Bell, was exciting and stimulating, and led Bill's interests firmly in the direction of physics. A distinguished performance in the Higher School Certificate examination after one year in the sixth form was followed in the subsequent December by the award of an entrance exhibition at Trinity Hall in Cambridge. The failure to be awarded a scholarship seems to have been due to a poor performance in chemistry. Bill met Sir Joseph (J. J.) Thomson FRS for the first time during the practical examination associated with the Cambridge Scholarship examination, and Thomson was disappointed to learn of Bill's dislike of football. Bill made close friends at school, with whom he remained in contact by letter for many years.

At Cambridge, Bill read first for Part I of the Mathematical Tripos, and then for Part II Physics in the Natural Sciences Tripos. His teachers in Part II were scientists of the greatest distinction: J. J. Thomson FRS, Lord (Ernest) Rutherford FRS, F. W. Aston FRS, Sir Arthur Eddington FRS, J. D. (later Sir John) Cockcroft (FRS 1936), M. L. E. (later Sir Mark) Oliphant (FRS 1937), J. A. Ratcliffe (FRS 1951), P. M. S. (later Lord) Blackett FRS, N. Feather (FRS 1945), P. Kapitza FRS, C. T. R. Wilson FRS and P. I. Dee (FRS 1941). At that time many were involved in discoveries of great importance, but Rutherford nevertheless insisted that they contribute fully to the teaching. Bill felt that the two years he was allowed to spend on Part II gave him time for many other activities, including essay writing on a range of general topics, which Bill greatly enjoyed and which won him a number of college prizes.

Cambridge, 1934–40

On graduating in 1934, Bill, in his self-deprecating way, was disappointed in his performance in the examination, but nevertheless he was recommended for a Department of Scientific and Industrial Research (DSIR) research studentship and joined the Cavendish Laboratory Nuclear Physics programme under the general direction of Rutherford. Bill was very keen to extend the accelerator-based nuclear transmutation work, which was the centre of great excitement at the time. Initially he was supervised by J. (later Sir James) Chadwick FRS, but put to work on a high-vacuum problem. When Chadwick left for Liverpool in 1935, Bill's supervision was transferred to M. L. E. Oliphant, under whom he worked on high-voltage rectifiers and nuclear detection methods. These were days when it was normal for physicists to have to solve their own engineering problems. In late 1935, however, Bill was able to join W. B. Lewis (FRS 1945) on nuclear transmutation experiments using the Cockroft–Walton accelerator.

The Cockcroft–Walton equipment was of rather low energy. To initiate nuclear reactions on elements much beyond carbon required higher beam-energies to overcome the Coulomb

repulsion of the nucleus. In 1936 a donation from Sir Herbert Austin allowed the Cavendish Laboratory to build a new accelerator based on a 1.25 MV Philips high-tension generator. Bill was delighted to be personally invited by Rutherford to work on the installation of this new equipment. With the expiry of his two-year DSIR studentship he briefly held an exhibition from the Goldsmith's Company, but was then elected to a Stokes Studentship at Pembroke College, which supported him up to the outbreak of war. Bill submitted his PhD thesis in 1937 and was one of the last students to be examined by Rutherford. In the same year, shortly before Rutherford died, Bill was able to demonstrate to him the first accelerated beam from the new machine. In the following year the laboratory was able to purchase a 2.0 MV generator, which Bill spent much of his time commissioning until the start of his war work.

Although Bill was so much concerned with the development of major equipment in this period, he nevertheless participated in a fruitful series of pioneering experiments yielding a variety of results of fundamental importance and producing nine publications. It is worth recalling one particular experiment (1)*, which was the detection of β-delayed α emission after the decay of ^{8}Li. Using a deuteron beam the team created ^{8}Li via the reaction ^{7}Li(d,p)^{8}Li. It decays to ^{8}Be, which breaks up virtually instantaneously into two α particles, but the emission of these products is delayed by the β-decay of ^{8}Li, allowing the half-life of this decay to be determined as 0.8 s. Bill later described their first detection of this process as one of the most exciting events of his career. With the technology then available it was certainly a fine achievement, which formed a prominent part of his PhD thesis.

Much of Bill's experimental work in this period was conducted with nuclear emulsions to detect the charged particle products of reactions, but he also introduced a simple form of magnetic analysis to remove scattered protons from other products. Several reactions were studied on targets of nitrogen, oxygen and fluorine (2–5). In this work, resonant excitation of nuclei was observed and the quantum numbers of resonant states were established, showing for the first time that information beyond the mere energetics of reactions could be measured. This programme should be considered as the birth of true nuclear spectroscopy in which Bill took a prominent part. It was, however, all too suddenly interrupted by the outbreak of war.

Wartime, 1939–45

Bill's contribution to the war effort was interestingly diverse. In common with other members of the Cavendish he was first involved during the summer of 1939, but unlike others he did not immediately work on the development of radar. Instead he joined a small group under P. I. Dee, whom he greatly admired, working on other aspects of air defence, first and very briefly at the Royal Aircraft Establishment in Farnborough and then in the University College at Exeter, with the use of a small airfield at Haldon. The German attack on Poland had been accompanied by low-flying bombing attacks on airfields, and it seems that Dee had the idea that such attacks might be disrupted by lengths of cable, launched into the air around an airfield by coastguard rockets and held up for a sufficient time by parachutes. Although this scheme seems to have been successfully developed, Dee and his team came to feel that work on radar would be more useful and attractive, and they moved in May 1940 to become members of a larger group based in the Air Ministry Research Establishment that had just been moved to

* Numbers in this form refer to the bibliography at the end of the text.

Worth Matravers in Dorset from its original location (as the Bawdsey Research Station) in Dundee. The new group, led jointly by Dee and H. W. B. Skinner (FRS 1942), and located later at the Telecommunications Research Establishment in Malvern, worked on the development of an airborne interception system, to which Bill contributed fully, especially during operational tests. As the war developed, the need for airborne interception systems decreased and Bill expected to return to Cambridge in October 1944, having been elected at that time to a fellowship in Selwyn. Instead, however, he accepted an invitation to join the British team working in Canada on atomic energy, which allowed him to return to nuclear physics, which he found more satisfying than his work on radar. He spent 10 months at the Montreal laboratory of the National Research Council in Canada, the mission of which was to design and build a large nuclear reactor. Work there at the time was directed by J. D. Cockcroft, who asked Bill to devote the months that he spent in Canada to supervision of the construction of a 600 kV positive-ion accelerator, used subsequently for fission studies. Through a series of lectures organized by the Montreal laboratory, Bill was able to regain contact with nuclear physics, and discussions with Cockcroft helped to establish the directions in which UK research in nuclear physics would develop after the war, in Cambridge, in the new UK Atomic Energy Authority laboratory in Harwell, and elsewhere.

Cambridge, 1945–51

After the war, Bill was invited to return to Cambridge, first as a demonstrator and, in 1946, to a tenured post of lecturer, both alongside the fellowship at Selwyn College. He was immediately involved in a busy schedule of university and college teaching. The Cavendish High Tension Laboratory had survived the war and was capable of returning to pure research. A cyclotron of 8 MeV energy had been added to its facilities from 1935. However, the character of the group had changed completely and it lacked a strong guiding hand. Most prewar senior staff had left for appointments elsewhere, many of them founding nuclear physics groups at other universities or at establishments such as Harwell. Bill was, along with S. Devons (FRS 1955), the most experienced experimental nuclear physicist at Cambridge. A direct consequence of the ending of the war was an influx of many bright young research students from home and abroad, some being older candidates with experience drawn from war work, but all eager to participate in his field. He found himself with a burgeoning group to supervise, and others wishing to join, at a time when support for nuclear physics was expanding rapidly.

The experimental programme that Bill undertook was initially a continuation of his prewar nuclear spectroscopy work. Much of this centred on the detection of short-range (and hence low-energy) α particles produced by the proton bombardment of many elements. One of his students, Joan Freeman, reported in her autobiography (Freeman 1981) how she persuaded Bill to allow her to join his group by first reading his early papers in this field and then convincing him to let her develop the work on magnetic separation. With another of his students, A. S. Baxter, Freeman built a 90° focusing magnetic spectrometer and introduced scintillation counters to supplement ionization chambers and nuclear emulsion detection. Bill oversaw the development of fast timing techniques by two other students, J. O. Newton and C. D. Curling. He also had collaborations with other groups, for example working with D. H. (later Sir Denys) Wilkinson FRS and K. W. Allen on neutron absorption

measurements (6, 7) that were a legacy of investigations started during the war. It was this busy period, perhaps, that set Bill on the course that was to be the hallmark for the rest of his career—to inspire and encourage the work of his younger colleagues, while often declining to share in the credit.

It seemed in the late 1940s that nuclear physics was set to grow in Cambridge. There were ambitious plans to build further machines, and indeed Bill became responsible for an electron accelerator, taking this over from Devons, when the latter moved to Imperial College in 1950. Bill handed over his responsibility for the High Voltage Laboratory to Wilkinson and A. P. French. Two further planned accelerators were never built. Late in 1950 Bill received an invitation to fill a new chair at the University of Birmingham. This invitation came from P. B. Moon FRS, who had just succeeded Oliphant as Poynting Professor and head of department there. Although life in Cambridge was very attractive, Bill could see that experimental nuclear physics was in decline there, but expanding in Birmingham. He accepted the offer and moved in 1951 to become the Oliver Lodge Professor.

Birmingham nuclear physics, 1951–80

At Birmingham in the prewar era, Oliphant had initiated the building of a 60-inch cyclotron based on the designs of E. O. Lawrence and funded by Lord Nuffield. Operation of the machine had been delayed until the postwar period so that practical beams were achieved at about the time Bill arrived in 1951. He took over responsibility for the machine, which could accelerate light ions to energies of 10 MeV A^{-1} and produce internal beams of heavier ions. He thus had access to substantially higher energies than hitherto. At first the Nuffield cyclotron was not reliable, but an excellent technical team under W. C. Hardy was recruited and it became, in time, a reliable workhorse that ran for five decades, contributing to nuclear physics, applied nuclear science and medical isotope production. Bill's work, both there and at Cambridge, was recognized when he was elected a Fellow of the Royal Society in 1957.

Supported by Moon, Bill was also able to acquire the magnet from the defunct 37-inch Cambridge cyclotron, which was converted in Birmingham to a strong focusing configuration and became the Radial Ridge cyclotron, named after the configuration of its magnet pole tips. The conversion was performed by W. B. Powell and P. Waterman, who were brought in from the Hammersmith cyclotron facility. The Radial Ridge machine began operation in 1963 and ran for 40 years. From its early days it was equipped with a source of spin-polarized deuterons, and later a Lamb-shift source of polarized ^{3}He was added, both of which used a novel form of axial injection through the cyclotron magnet's pole. In addition to the two cyclotrons, members of Bill's group used external facilities, notably from 1959 the Proton Linear Accelerator at the National Institute for Research in Nuclear Science (NIRNS), later to become the Rutherford Laboratory, which was also equipped with a polarized ion source.

The cyclotrons could produce intense beams of fixed energy and moderate energy resolution. They were unsuitable for nuclear spectroscopy, but ideal for the study of nuclear scattering and direct reaction processes. Interest in this field received substantial theoretical support from the outstanding group of R. E. (later Sir Rudolf) Peierls FRS, then very active in the separate Department of Mathematical Physics at Birmingham. Early work on the Nuffield machine made use of nuclear emulsions to detect scattered particles. Bill collaborated with J. (later Sir Joseph) Rotblat (FRS 1995) and W. M. Gibson in a programme of nuclear

scattering and reaction measurements with the use of this method (8–13). When he moved from Cambridge, Bill brought G. W. Greenlees with him, whom he encouraged to form a group developing scintillation-counter detection. An extensive series of measurements of proton elastic scattering resulted, continuing for a decade until Greenlees left for Minnesota. This programme coincided with the development of the theoretical Optical Model of nuclear scattering. Work to explain elastic scattering revealed the importance of understanding the non-central spin–orbit interaction and led to polarized beam work based on the use of 18 MeV protons recoiling from the bombardment of hydrogen gas by 40 MeV α particles. At a recoil angle of 25° the protons are 100% polarized. Interest sparked by such experiments led the group to design polarized ion sources for the Radial Ridge cyclotron. It was a feature of the development of these facilities that Bill operated with a light touch, allowing his team to follow their instincts, but always ensuring that they were supported and substantial funding was found. If a member of the group had an idea for a new project, a brief conversation with Bill was sufficient to ensure its approval. The fact that someone found a problem interesting was justification enough for Bill.

Transferring the group's work from the Nuffield machine to the Radial Ridge in the mid 1960s heralded a most productive period. Scattering and reaction experiments with its 34 MeV ^{3}He beam opened up new areas of study. The polarized deuteron source gave the group an internationally competitive edge, which was renewed a decade later, when polarized ^{3}He became available (26). Work started on the few-nucleon problem, and triple scattering experiments were launched. Bill had an important role in guiding the programme. He often suggested specific experiments, but it was almost impossible to persuade him to share in the credit for positive results. Only rarely would he agree to allow his name to appear as a co-author on a resulting paper. Such a rare event was the revisiting of his early interest in the states of the unstable nucleus ^{8}Be in a study of the reaction ^{6}Li (d,α) ^{4}He with the use of polarized deuterons, which allowed the angular momentum of intermediate ^{8}Be states to be investigated (21). He may have been unwilling to take credit, but his generous support was widely recognized by his group, and his encouragement launched numerous successful careers for others.

Bill continued leadership of the Nuclear Physics group until 1973, after which he withdrew from his active management role, though continuing to be involved in polarization studies with ^{3}He (30, 33), which had interested him for many years. The group he had built continued to flourish, as it does to this day. Mainly he spent the remainder of his career devoting his time to administrative duties in the university and beyond. He served as Head of the Birmingham Physics Department from 1970 to 1974, following in the footsteps of M. L. E. Oliphant FRS and P. B. Moon FRS (figure 1). However, he had one more important influence on a developing research field. A small group had been set up by G. R. Isaak in 1972 to use the resonant interaction of light with alkali atoms to study tiny Doppler shifts in sunlight and hence to measure small velocity shifts of the solar surface. This work was started with university funds, but was struggling to get outside support. Isaak was also seeking to use resonant scattering of light in the entirely different field of atomic hyperfine structure, exploiting the recently invented tunable dye laser. Bill acted as guide and mentor to this embryonic group, taking on many administrative tasks and advising on the best approach to funding. Both lines of investigation eventually succeeded. The solar programme developed into a global observation network that revealed great detail about the spectrum of acoustic vibrations of the Sun. Studies of atomic hyperfine structure with lasers eventually proved valuable for studying nuclear sizes of unstable nuclei, so that this work returned in time to the Nuclear Physics group.

Figure 1. Heads of the Birmingham Physics Department from 1937 to 1981: from left to right, W. E. Burcham FRS, M. L. E. (Sir Mark) Oliphant FRS, P. B. Moon FRS and W. F. Vinen FRS. (Photograph taken by David James in about 1980, on the occasion of the hundredth anniversary of the appointment of J. H. Poynting FRS as the first Professor of Physics in Mason Science College, which became the University of Birmingham in 1900.)

Particle physics and Harwell

Bill had taken over from P. B. Moon the responsibility for the operation of the Birmingham 1 GeV proton synchrotron and research in experimental particle physics towards the end of the 1950s. He saw his role as mainly to ensure the survival of the machine until there was a proper transition of the scientific effort to the new 8 GeV NIMROD proton synchrotron at the Rutherford Laboratory, and sufficient external support to set up a major bubble-chamber track analysis facility at Birmingham to exploit data from the CERN 25 GeV proton synchrotron. His new involvement with the high-energy field prompted him to apply for a sabbatical year at the Rutherford Laboratory in 1962/63, the year in which NIMROD became operational. The laboratory offered excellent hospitality, including residential accommodation for university visitors. It also provided a full programme of discussions, lectures, working parties and the like in which Bill could take part.

Although he was acquiring a working knowledge of particle physics, Bill's heart still lay in the more familiar low-energy regime, and he soon made arrangements to spend about half his time in the Nuclear Physics Division on the adjacent Harwell site. The division, under Egon Bretscher, was undertaking a substantial amount of basic nuclear physics research to underpin the applied research required by the programmes of the Atomic Energy Authority. Among its accelerators was an impressive vertical tandem electrostatic generator that could deliver proton beams up to about 12 MeV, and the facility and its research were directed by Bill's former student Joan Freeman.

He chose to work with her and one or two others on an attempt to verify the hypothesis of Feynman & Gell-Mann (1958) of a Conserved Vector Current (CVC) in the weak interaction.

Weak decays such as nuclear β-decay had been shown to have a mixture of vector and axial vector couplings—the V–A theory—accounting for parity violation in the decay process. The proposal was that the vector coupling constant G_V should be the same in all weak processes whether purely leptonic, and therefore point-like, such as muon decay, or semileptonic involving strongly interacting particles that have structure. This is the case for the purely vector electromagnetic interaction to which an analogy was being drawn. The experimental test was to compare the basic rates of nuclear β-decay for transitions of the type $J^P = 0^+ \rightarrow J^P = 0^+$, where J and P are the nuclear spins and parities, which are mediated by a purely vector weak current, in different pairs of nuclei (for example $^{14}O \rightarrow {}^{14}N^*$ and $^{26m}Al \rightarrow {}^{26}Mg$). According to the CVC hypothesis, the basic decay rates should be the same independently of the nuclei concerned. In the end, a total of 10 different β-decays were measured and the hypothesis was confirmed (15, 17–20, 22–25, 27–29, 31, 32). The precise determination of the weak vector coupling constant in nuclear β-decay, when compared with the value obtained from muon decay, had an important influence on the understanding of the weak interaction. The small discrepancy between the two (about 3%) led Cabibbo (1963) to propose the current theory that explains the 20-fold lower weak decay rate of strange particles, and it is now part of the 'Standard Model' of particle physics. Bill's work on β-decay work is described in the autobiography of Joan Freeman (Freeman 1981), and is also covered in *Nuclear and particle physics* by Burcham and M. Jobes (35). It became a collaboration between the Atomic Energy Research Establishment, Birmingham, Oxford and Sussex, which included the theoretical contribution of R. J. Blin-Stoyle (FRS 1976). The measurements of G_V were sufficiently precise (less than 0.1% error) to be sensitive to electromagnetic radiative corrections (about 1%) to the decay rates, which include a contribution from the (then) postulated charged weak intermediate vector boson W. Blin-Stoyle realized that this could be used to place a lower limit on the mass of W of about 20 GeV (Blin-Stoyle & Freeman 1970). This conclusion was reached in 1970, 13 years before W was discovered at CERN with a mass of 83 GeV.

Bill played a full part experimentally in the collaboration, and as a visitor in 1962/63 he was able to concentrate on the experimental runs, discussions and analysis. In fact, the collaboration lasted until 1976, and Bill continued to contribute in spite of many other demands on his time. He included the work in the Rutherford Memorial Lecture of the Royal Society (34), which he gave in 1983; 'Rutherford would surely have been delighted to learn of this fascinating connection between β-decay and particle physics.' Bill also wrote a short article (16) on the relation between high-energy and low-energy nuclear physics during a short visit he made to Australia in 1964.

Public service

Bill was a member of the Papers Committee of the Physical Society of London from 1953 until 1960. In 1956 he became secretary of a Nuclear Physics Committee (under the aegis of the Papers Committee) charged with the duty of organizing regular national conferences on nuclear structure and particle physics. Eventually, this committee became the Nuclear Physics Sub-Committee of the main Meetings Committee of the Institute of Physics. Bill continued to serve the sub-committee as either secretary or chairman until 1968, by which time a highly successful and continuing pattern of meetings had been established that gave young researchers what was often their first opportunity of presenting a paper. He was regularly invited by

the local organizing committees of host institutions to chair appropriate sessions. The Papers Committee work led to his being appointed as Advisory Editor (UK) to the international journal *Nuclear Physics*. Over the years 1960–69 he read and forwarded to Copenhagen some 400 papers originating in Britain. From this work, and from complimentary copies of the journal that he received, he acquired much useful contact with what was happening internationally (particularly in Europe) in his field. Much later (1979–83) he performed a similar service for the new *European Journal of Physics*, a less specialized publication.

In 1957 NIRNS was set up to coordinate national efforts in the field, and in particular to provide universities with facilities too large to be operated locally. The DSIR retained control of grants for the smaller installations in the universities themselves. Because of the close relationship between the duties of the two bodies, a Joint Consultative Panel for Nuclear Research was set up in 1960 with a membership overlapping that of the Physics Committee of NIRNS. Bill served on both, and also on the Visiting Committee of NIRNS over the years during which the Rutherford High Energy Laboratory was growing to maturity and the Daresbury Nuclear Physics Laboratory was founded. In 1965, NIRNS and DSIR were absorbed into the new Science Research Council (SRC) and a new structure of subject boards was devised. Bill became a member of the Nuclear Physics Board at the beginning of the 1966/67 academic year. He remained a member until 1978, except for the years 1971–73, and was its chairman from September 1974 until September 1978; as chairman, he was *ex officio* a member of the council itself. For several years he was the Nuclear Physics Board's representative on the University Science and Technology Board's Physics Committee (later a committee of the SRC Science Board). At roughly the same time (1966–72) he became a member of the Physical Sciences Subcommittee of the University Grants Committee (UGC) under the chairmanship of Sir Arthur Vick, and was thus able to witness and take part in the dual support system for funding research in the universities. He enjoyed and valued taking part in the many visits to departments of physics throughout the country that were arranged by the SRC and UGC committees, and particularly interested himself in their aspirations for nuclear and particle physics.

The 1960s saw some rationalization of the national effort in low-energy or nuclear structure physics. Strong centres of research based on domestic accelerators in the 10–20 MeV range were established at Oxford and at Liverpool and Manchester, backed by the Rutherford and Daresbury laboratories respectively. The Proton Linear Accelerator (PLA) at the Rutherford Laboratory offered energies up to 50 MeV but with a poor duty cycle and therefore a limited useful life. After the success of the Birmingham cyclotron development group with the innovative Radial Ridge cyclotron, Bill together with Philip Moon prepared a proposal for a high-performance 65 MeV cyclotron to be located in the Midlands, possibly to become a national facility. Other universities, however, saw a large electrostatic generator as the next step in the national programme because it would provide a better heavy-ion performance. The nature and location of the future national machine were not settled until 1974, the PLA having closed in 1969. Part of the delay was due to the competition for resources between the particle physics and nuclear physics communities, and also to the uncertainty as to whether the UK should participate in the so-called CERN 300 GeV project, later to become the 400 GeV Super Proton Synchrotron accelerator. Bill, as proposer of the cyclotron and a member of the Nuclear Physics Board, was party to most of the discussions and in the end agreed that the best future machine would be a large home-built tandem generator with a terminal voltage of 20 MV. The Nuclear Physics Board gave its approval in January 1970 and recommended to the

council that it be sited at the Daresbury Laboratory. Final planning and approval procedures took until January 1974 before work on the new machine, known as the Nuclear Structure Facility (NSF), could begin. During the many years of waiting, time was made available on the reactors and accelerators of the Atomic Energy Authority, supported by the SRC. Bill chaired a small panel to process applications for running time, and this became a substantial activity towards the end of the period.

By far the greatest administrative task Bill ever undertook was his chairmanship of the SRC Nuclear Physics Board, which started in 1974, eight months after the final approval of the NSF. The board had responsibility for the UK effort in nuclear and particle physics using domestic and overseas accelerators. It was a period of rapid advance in understanding the basic structure of particle physics, after the discovery of the J/ψ particle (charmed quarks) in 1974 and the establishment of what is now the Standard Model. There was also strong pressure on the resources available to the field as competition from other areas of science and engineering grew. During his chairmanship, construction of the NSF laboratory and its machine started but faced a rapid and serious escalation of costs. This generated misgivings among particle physicists, who saw their future prejudiced by this commitment, and in any case were themselves under pressure because of the high cost of their own programmes. The outcome was that, under Bill's chairmanship, the board had reluctantly to agree to the closure of the electron synchrotron NINA at Daresbury and the proton synchrotron NIMROD at Chilton to make funds available for both the NSF and the continuance of the particle physics programme at CERN. In spite of these sacrifices, the pressures from the council to divert funds away from the expensive subjects of particle physics and space science continued, but effective use of the NSF was made into the 1980s with the discovery of super-deformation, and the UK played a full part in the discovery of the W and Z bosons, the carriers of the weak interaction, at CERN in 1983. His public service was honoured in 1980 with the award of the CBE.

Bill derived considerable pleasure from his service on the Council of the Royal Society from 1977 to 1979 as nominee of Sectional Committee 2, which he had previously chaired. Among other duties performed for the Society were membership and chairmanship of the Rutherford Memorial Committee (1960–82), and service as Royal Society representative on the Governing Board of Lanchester Polytechnic, later to become Coventry University. He was an Honorary Life Fellow of Coventry University.

The man and his personal life

Bill married Isabella Mary Todd in January 1942. Like Bill, Mary came from Norwich, and she was Dee's secretary. There were two daughters of the marriage. One married an American and lived in Kentucky until her death in 1998. She provided Bill with two grandchildren, who in turn provided him with two great-grandchildren. Mary died in 1981, shortly after Bill's retirement from the Oliver Lodge Chair in Birmingham. In 1985 Bill married Patricia Newton Marson, whom he met through his work with his local church. Pat had read Natural Sciences in Cambridge at the end of the war, and the two may have met at that time in the practical laboratories in the Cavendish. She was a highly regarded school mistress, becoming head of chemistry at Kings Norton Girls' School in Birmingham. In later years Bill's younger daughter became increasingly disabled, and he and Pat cared for her in a selfless way.

Figure 2. Bill Burcham relaxing after his retirement in the Norfolk countryside, which he so much enjoyed. (Photograph taken by Mrs Pat Burcham.) (Online vesion in colour.)

The Anglican Church was very important in Bill's life, especially after he went up to Trinity Hall in 1931. After the move to Birmingham, Mary and Bill became much involved with the Parish Church of St Mary in Selly Oak, Bill serving as a churchwarden for 22 years. He contributed much to St Mary's and to religious life in the university, and patients in Selly Oak hospital saw him as a regular and sympathetic visitor. As we have already noted, it was Bill's work for the church, and especially his interest in recording the history of St Mary's, that led him to his second marriage.

Bill remained deeply attached to the villages, small towns and countryside of East Anglia (figure 2), and in 1964 he and Mary built themselves a bungalow in Bacton-on-Sea, at which they and their family spent many happy times.

Bill developed wide interests, which were not widely known. He played the piano well enough to derive pleasure from it. He acquired an interest in East Anglian churches. He especially enjoyed writing on general subjects, with an elegant style, and in his later years he wrote articles relating to local and family history. He recorded in some detail for publication his memories of scientific developments with which he was personally familiar. He did not enjoy team games, but he enjoyed swimming into his nineties. He was exceptionally well organized, keeping detailed and very neat records of his various activities. He left detailed notes of his life, which he deposited with the Royal Society, and on which we have drawn freely in writing this memoir. Tasks that he was asked to perform, from the chairmanship of the Nuclear Physics Board to the setting of university examination questions, were conducted effectively and efficiently, so that his services were in demand on many committees. One of us (W.F.V.)

remembers that one evening he and Bill travelled back on a train to Birmingham after rather exhausting Science and Engineering Research Council meetings that had taken place during the day; W.F.V. sat back and dozed, while Bill spent the whole journey writing a detailed account of his day's work. His teaching was always meticulously prepared and delivered, even when he was under pressure; W.F.V. remembers his clear lectures in Part I of the Tripos, presented at a time when the Physics Department in Cambridge was experimenting with the idea of compressing the first two years' work into one, to allow more time for the advanced work of Part II. Bill wrote a well-known textbook, *Nuclear physics* (14), first published in 1963, and it is a good example of his meticulously careful and elegant writing. A later version, with M. Jobes, was published as *Nuclear and particle physics* (35) in 1995.

Bill saw himself as a private person who liked to be independent and who felt uneasy on social occasions. Although his reticence and modesty acted as a certain barrier, he was immensely kind, and he would take enormous trouble to help other people. Often he put the interests of the institution that he was serving ahead of his own personal ambitions. He was very calm in the face of difficulty or of shortcomings in his colleagues, and we can recall no occasion on which he showed any sign of anger. One of his early colleagues remembers his smile: 'everything and anything evoked a smile, sometimes just happy, sometimes wry, sometimes gently pitying.' He is remembered as a 'thoroughly decent chap'.

Acknowledgements

We are grateful to Bill's widow, Pat, for her help and support in writing this memoir. We are grateful also to Sir Denys Wilkinson FRS, Dr Godfrey Stafford FRS and Mr Ian Hunt for sharing with us their memories of Bill.

The frontispiece photograph was taken in 1985 by Godfrey Argent and is reproduced with permission.

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