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ABSTRACT: Denys Wilkinson's research, seminars, lectures, and other contributions to Brookhaven National Laboratory are reviewed.

It was 33 years ago, in the Fall of 1954, when Denys Wilkinson arrived at Brookhaven to spend a year as a guest scientist. His plan was to split his time between high-energy physics using the 3-BeV Cosmotron, and low-energy nuclear physics research using the 3.5-MV Van de Graaff accelerator. But, as fate would have it, after two years of successful operation the Cosmotron suffered a gigantic failure on November 5, 1954 when a short circuit occurred in one of the magnet quadrants and the copper windings melted down. This happened just after Denys arrived and repairs were not completed until the following April.

Too bad for the high-energy physics plans, but for us it meant that Denys could devote his full attention to our Van de Graaff which had just been rebuilt and was ready to go full steam ahead. All we needed were ideas. As his first task Denys drew up a list of problems that he thought might be both interesting and do-able on our machine--a list that came to 8 typewritten pages. The plan was to begin by using one of the few available experimental tools, namely a small NaI(Tℓ) scintillation detector for γ rays. To record the γ-ray spectrum we had a device called a gray-wedge pulse-height analyzer, a crude forerunner of modern multichannel pulse-height analyzers. As the first experimental job Denys proposed that we calibrate the γ-ray detector by using a so-called standard nuclear reaction, i.e. the bombardment of a fluorine target with low-energy protons, which was known to produce γ rays of 6 and 7 MeV. On the wall above my desk at Brookhaven is still tacked one of the first gray-wedge photographs, dated November 19, 1954, which shows this pulse-height spectrum.

In order to test the performance of the Van de Graaff, we ran the voltage up, taking spectrum photos as we went. But when we got above 3 MeV we noticed an extra γ ray of 2.8 MeV which did not fit into what was then known about the energy levels of the end nucleus oxygen-16. To condense a year of research into two sentences, Denys, Bert Toppel, and I spent that entire year working on what was supposed to have been just a calibration test. The results established a new energy level at 8.8 MeV in ^{16}O, and also a new energy level in the nucleus ^{19}F. But we actually never did get to a single item on Denys' list during his visit.

Over the years I occasionally pulled that list out of my file and checked off the problems that had been completed, at Brookhaven or elsewhere. I was always amazed at Denys' insight into where the interesting problems lay, and his wide and detailed knowledge of nuclear physics.

Perhaps partly to finally get to his list of problems, Denys started coming back to Brookhaven each summer and at periodic intervals in between. For the next 20 years Brookhaven became such a second home that Denys actually bought an automobile which he kept parked at the Lab for instant use when he arrived. Although I eventually became aware of the fact that Denys was something of a world traveler, I was always too timid to ask whether he had other automobiles similarly parked at laboratories from Seattle to Rehovoth.

Research with Denys was always characterized not only by the stimulation of his ideas, but by the unexpected, the unusual, and frequently the amusing event. During one summer we were working on the short-lived radioactivity ^{11}Be which required literally thousands of repetitive operations in transferring samples and switching the counting equipment on and off. It wasn't until many years later that we got around to building a rabbit target-transfer system and a timer-programmer to do all these operations automatically. But at that time our 'rabbit' was an energetic summer student who wore tennis shoes so he could run the samples back and forth more quickly. I can recall one long night of experiments when, as dawn approached, the summer student and I were close to exhaustion but Denys showed no signs of fatigue whatsoever. In fact, in between his switching operations, Denys had managed to read an entire novel during the course of the night's work.

A most memorable day occurred on Monday, December 12, 1960. Denys had arrived at his on-site apartment late on Sunday, just as the worst snowstorm of the winter was beginning. By Monday morning there was a foot of snow and an announcement on the radio that the Lab was closed for the day. With some difficulty I managed to drive in to the Lab and then climb through a big snow drift to get to the door. The only soul in the building was Denys, sitting calmly at his desk. After the usual greetings were exchanged we started to talk physics and Denys came up with an idea of testing the existence of an energy level reported in ^{12}C which he suggested was not real, but due to an instrumental effect. The proposed experimental test was quite simple, so while he embarked on some yield calculations, I set up the equipment for the measurements and turned on the Van de Graaff accelerator. After lunch it didn't take more than an hour to positively prove that Denys' idea was correct--the supposed level in ^{12}C at 9 MeV was false. With the experiment completed, we even started that afternoon to write up the results in a short paper. All of this happened before Denys had been in the country for 24 hours and on a day when the Laboratory had been declared officially closed.

Most of the problems were not that easy. Both in originality and in sheer numbers, Denys' contributions over the years to the research effort of our Van de Graaff group were enormous. His work included studies of the decay schemes of light radioactive nuclei, second-class currents in beta decay, parity conservation, and the spectroscopy of nuclear energy levels. Out of curiosity I went through my own reprint files and found that I was a co-author with Denys on a total of 44 papers, almost all of which were on problems that Denys originated. Another 31 of my papers were due to direct suggestions by Denys, or could be traced back to his earlier work. In addition, there were his papers with other members of the group, from his home institutions, and from other collaborations worldwide. A list of Denys' publications, provided by Fay Selove, shows a total of 282 titles.

In addition to his research contributions, Denys could always be counted on for delightfully interesting and stimulating seminars. When asked what subject he would speak on, Denys would turn the question around and ask about audience preference from a list of 7 or 8 topics that could be selected from, including such subjects as The Nuclear Shell Model, Isospin in Nuclear Reactions, Spin-flip Stripping, etc. But down the list was the title 'Bird Navigation'. When Denys later gave his fascinating talk on this subject we learned that in 1947, as a result of an overexposure to fast neutrons, he came down with radiation sickness, a blood count 25% of normal, and cataracts in both eyes. This was the only British example of such combined conditions and it led to a series of lectures by a medical doctor. At that point Denys had to give up physics altogether and since he had earlier developed an interest in bird navigation he used this time for further studies to see if any physical principles could help to explain the phenomenon. Characteristically, by the time Denys was allowed to return to the physics laboratory he had become a knowledgeable expert in this subject.

Denys also occasionally agreed to present a general interest talk, such as his Brookhaven Lecture in 1963 entitled 'The Nucleus Today'. It was my pleasant duty to make the introduction. In planning for this I asked Denys if he had ever prepared any biographical notes. He replied that he had recently been asked the same question by a reporter from the London Times, whose opening statement was 'Professor Wilkinson, we are preparing your obituary.' Not only was all the pertinent information requested, but even the name of a reference to whom they could turn once the event had taken place. Apparently, in England this kind of request is a sign that you have really arrived.

I learned that Denys was born in Yorkshire and entered Cambridge University in 1940. After his graduation in 1943 he became involved in atomic weapons research, first in Cambridge, then in Canada. At the end of the war he returned to Cambridge where he became a lecturer and a Fellow of Jesus College. In his administrative duties he was a socalled Praelector and his official title was 'Father of Jesus'. Denys commented that this was a title to which, in the normal course of events, he would not have aspired. In 1957 Denys made what he refers to as a 'forbiddden transition' --namely, a move from Cambridge to Oxford. There he was director of the Nuclear Physics Laboratory until his move to Sussex in 1976. As one of his many honors, Denys was knighted by the Queen in 1974.

Denys' contributions to Brookhaven, beyond his research, seminars, and lectures had yet another and most important aspect. Even before 1960 it was becoming evident that the future of our field lay in higher energy machines. By 1962 nuclear physics was in a golden age and I was advised that I could submit a proposal for a double MP Tandem Van de Graaff facility that would operate as a 3-stage accelerator and generate a beam of 36-MeV protons. It was natural for me to turn to Denys for advice. He very kindly helped by formulating 22 classes of problems that could be carried out with such a machine, almost all involving beams of either protons or alpha particles. His list of 22 items was the central theme of my proposal's section on scientific justification which was only 2-1/2 pages in length. The entire proposal was only 11 pages long. I can say that the Tandem project was completed within the $12M budget and met specifications on time in 1970, through the excellent work of Harvey Wegner who headed up the building construction and machine installation.

In looking back at the scientific part of the Tandem proposal, it turned out that only two of Denys' 22 classes of problems were ever worked on at Brookhaven. The reason for this was the discovery that tandem accelerators, because of the intermediate stripping process that makes them work, are superb machines for producing very energetic beams of heavy ions. Research using heavy ions formed the bulk of the work actually undertaken. In my own involvement, collaborating with David Goosman and others, we found that with heavy-ion beams many completely new radioactive isotopes could be produced. Other people such as Andy Sunyar and Trudy Goldhaber showed that heavy ions could induce a large angular momentum and thereby excite nuclear energy levels of very high spin. For the next 15 years the Tandem facility was used by both BNL staff and outside university users to generate many significant research results.

However, several years ago nuclear physics research at laboratories supported by the Department of Energy began to be looked upon with less favor, and budget cuts were being made. At Brookhaven there was actually a serious consideration of shutting down the Tandem facility. But to our rescue came the sudden world-wide physics community enchantment with the idea of using heavy ions to study the very origins of the universe. It was argued that if two very heavy atoms of enormous energy were smashed together, they might produce a quark-gluon plasma, or in popular parlance, 'quark soup'. This new form of matter could well have been the state of things during the first fraction of a second after the 'big bang'.

At Brookhaven the high-energy proton machine, Isabelle, later called the CBA or colliding beam accelerator, had been abandoned, but not before the construction of a tunnel 2.4 miles in circumference had been completed. By connecting the Tandem Van de Graaff to the Alternating Gradient Synchrotron, it was proposed that the necessary heavy ions could be produced for injection into the RHIC, or relativistic heavy-ion collider, that could be built in the now empty tunnel. The first part of the project, a 2000-ft long interconnecting tunnel from the Tandem to the AGS, has been completed, and within the past year beams of ^{16}O and ^{28}Si at 14.5 GeV/nucleon were being used by 60 scientists for the first research with such beams. A booster to extend the range of heavy ions from silicon up to uranium is now under construction. Feasibility studies for the complete RHIC facility are now in the budget and the prospects are optimistic that Brookhaven will some day have the presently estimated $330M to build it. But the reason for going into these details is to emphasize the point that none of it would have come to pass without Denys Wilkinson's invaluable assistance in getting the Tandem Van de Graaff project started. I believe that much more important than the list of problems in the proposal was the scientific reputation of nuclear physics research at Brookhaven in general, and the Van de Graaff group in particular, advanced in very large measure by Denys' strong and continuous leadership over many years. So, if and when 'quark soup' is made at Brookhaven, I hope that Denys will be there and that he will be given the appropriate toasts.

What of the future? When I asked Denys about a year ago when he was going to retire and what plans he might have, he first consulted his little black notebook that gave the countdown of weeks remaining before retirement. After that he indicated a probable return to fulltime research. It is certainly my hope that his visits to Brookhaven will resume in a research capacity, and that we can look forward to seeing much more of him than in his recent years of diversion into administration.

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