Departments of the Research School

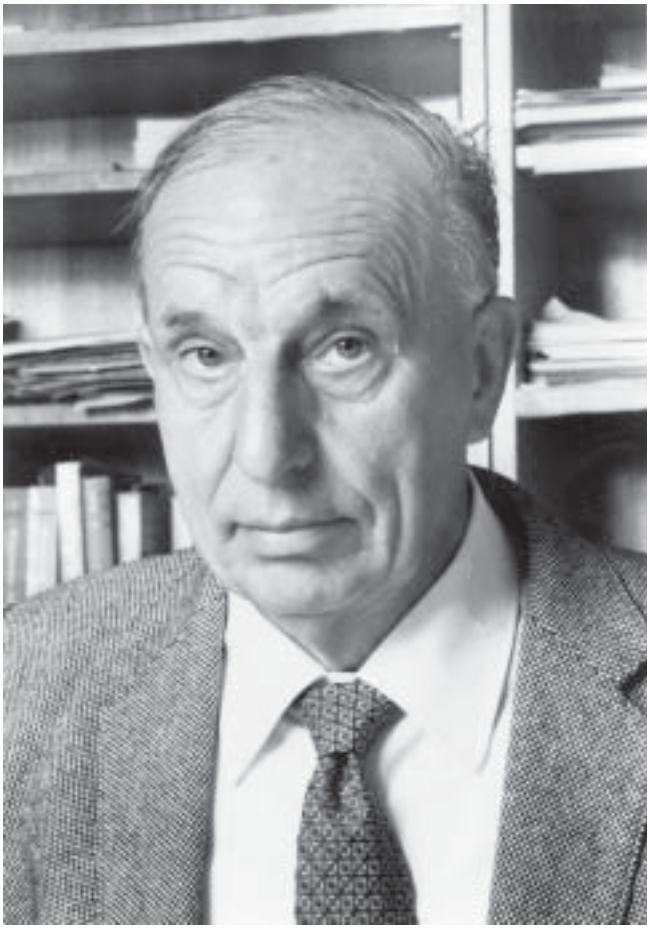
Theoretical Physics

The Department of Theoretical Physics was established in 1951 with the arrival of Dr Fred Barker, its initial interest being theoretical nuclear physics. Since then, the department has grown and diversified with the Research School. It now comprises an interdisciplinary group of theorists working on fundamental aspects of nuclear physics, particles and fields, statistical mechanics, plasma physics, solid state physics and non-linear dynamics. These studies overlap each other and have in common much basic theory and a number of mathematical techniques.

The foundation head of the department was Professor Kenneth Le Couteur, who retired at the end of 1985 after 29 years service to the University. Born in Jersey, in the Channel Islands, he was an undergraduate at St. John's College, Cambridge when World War II began, cutting him off from his family. In 1942 he joined other British scientists at the world's first radar establishment at Malvern.

After the war, he completed his PhD in Cambridge and spent a year at Manchester. From 1949 to 1956 he was at Liverpool University, where a synchrocyclotron was being built. There Le Couteur invented the 'regenerative' method of beam extraction, which effectively collimated the external particle beam, improving its intensity 100 to 1000-fold. This achievement must have reached the ears of Mark Oliphant, for Le Couteur was visited by Professor Titterton and invited to come to Canberra to head the Department of Theoretical Physics.

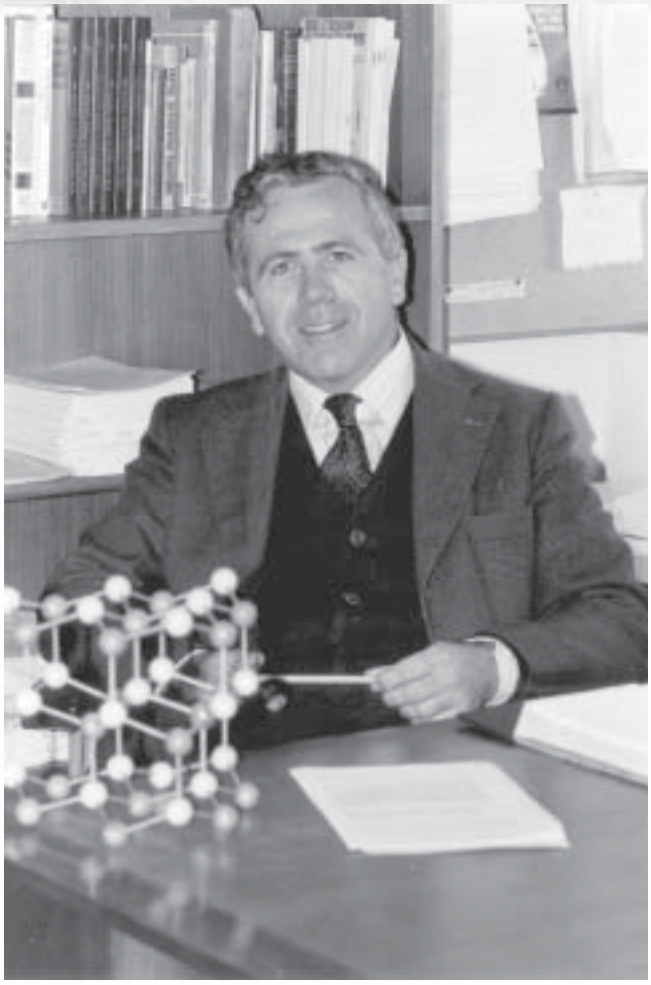
Le Couteur arrived in Canberra with his wife Enid and young daughters, Caroline and Penelope, in 1956. It was a much smaller and more intimate School in those days, with just five departments. Christmas socials were held in the tea room of the Cockcroft building, which was big enough to take all staff, including technicians and their wives! The department then numbered two, Le Couteur and Barker. It was located on the upper floor of the Oliphant (then Chifley) building, and if one came in on a Saturday or a holiday Monday, one's theoretical contemplations were disturbed by the sound of horses' hooves on the Canberra Racecourse below the window.



Ken Le Couteur, foundation head of Theoretical Physics (1956-1985).

Le Couteur played a very active role in the development of the School over the years. Always gracious and courteous, he was respected and liked by all who met him. He was one of the first members of the Australian Mathematical Society and was elected a Fellow of the Australian Academy of Science in 1960. He regards his main achievement, not as building a sailing boat by hand, but as building up the department to its later size, breadth and international reputation. He always encouraged strong interactions with experimental departments of the school, and himself at times worked closely with the nuclear, particle and plasma groups.

From 1959 to 1968, Le Couteur and Barker were joined by David Peaslee, Brian Robson, Kailash Kumar, Bill Woolcock and Lindsay Tassie, all of



Rodney Baxter.

whom worked mainly on nuclear, particle and atomic physics. Later, the department expanded its interests into statistical, condensed matter and plasma physics with the appointments of Rodney Baxter, Jay Mahanty and Bob Dewar, respectively.

During the headship of Brian Robson (1987-1995), the department initiated an annual three-week Physics Summer School. These schools commenced in January 1988 and provide intensive courses in important areas of physics which are not otherwise available for Australian postgraduate students and staff. To date, nine very successful schools have been held, and the lecture notes have been published by World Scientific Publishing Co. More recently (since January 1994), the department, with support from both the ARC and the ANU, has administered a 'pilot' National Centre for Theoretical Physics, which has run several research workshops on topical areas of physics. These have initiated useful collaborations among Australian and with international researchers.

The current head of the department, Rodney Baxter, was an early student and Research Fellow in the department. His field is statistical mechanics - the use of mathematics to model the governing physical forces between molecules or atoms and the statistics of large numbers of particles. In 1971 he made an exact calculation of the free energy of the two-dimensional eight-vertex model, which he found to exhibit unusual 'non-universal' critical behaviour. The method was based on a commutativity condition which is now known as the 'Yang-Baxter' relation. Baxter then extended the method to other models, notably the 'hard hexagon' model. The results for this model could be compared, with good agreement, with experiments on helium adsorbed onto a graphite surface. At the same time, the calculation turned out to involve the Rogers-Ramanujan and similar identities which have intrigued mathematicians for a century.

For this and related work, Professor Baxter was honoured with the Boltzmann Medal of the International Union of Pure and Applied Physics in 1980, the Heinemann Prize of the American Physical Society in 1987, and the Massey Prize of the British and Australian Institutes of Physics in 1993. He is a Fellow of the Australian Academy of Science and of the Royal Society of London.

Other notable achievements of staff of the department have included the following:

Until his retirement in 1995, Jay Mahanty led the group of theorists working on condensed matter physics. They made a number of significant contributions to the field: in particular in 1988 Das, Choy and He predicted on theoretical grounds that there could be two superconducting phase transitions in high-T_c superconductors, behaviour subsequently confirmed experimentally.

In nuclear physics, Brian Robson's book *The Theory of Polarization Phenomena*, published in 1974, was the first comprehensive and unified treatment of the theory of polarization phenomena. This was followed in 1976 by Ahmad and Robson's invention of the 'Iterative R-Matrix Method' for the calculation of reaction and scattering cross-sections from a model Hamiltonian.

Bob Dewar came to the department as a Research Fellow in 1974. A plasma physicist, he worked on the Lie transform method in Hamiltonian theory, and in 1976 developed a closed form of this method, applicable to systems where the transformation cannot be expanded in a power series. These ideas

have proved very fruitful. For this and his other work on Lagrangian and Hamiltonian methods in plasma physics, Dewar was elected to the Australian Academy of Science in 1992.

Peter Forrester was a PhD student in the department from 1982 to 1985, working on the statistical mechanics of systems with Coulombic forces. In 1986 his thesis earned him the J.G. Crawford Prize for academic excellence, and in 1992 he was awarded the Australian Mathematical Society Medal for distinguished research in the mathematical sciences.

One Research Fellow (a graduate of Nuclear Physics) who has prospered outside academia is David Rosalky; he was in the department in 1972 and 1973 working on problems in particle physics. He left to join the Public Service and is now Secretary of the Department of Industrial Relations.

Early computing

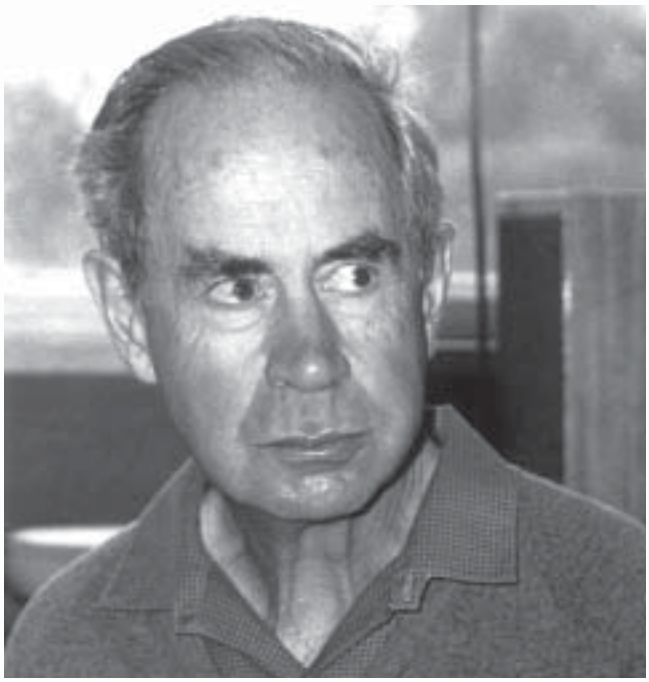
Many early graduates of the School will remember the ubiquitous green Facit hand-operated calculating machines and the subsequent blue Marchant electric calculators that were used for arithmetic computations in the 1950s and 1960s. Later, there were machines that carried out sequential arithmetic operations as specified by a program read progressively from a paper tape; Mt Stromlo had an IBM610 of this type, installed in 1960.

The first computer installed at the ANU (that is, a machine that could store a program as well as do the specified computations) was an IBM1620. This computer, which arrived on 2 January 1962, employed a high level programming language (FORTRAN), which was compiled to obtain a basic machine-language program. The 1620 memory could store up to 40,000 decimal digits at one time. The machine was controlled and operated by the Department of Theoretical Physics within the Research School of Physical Sciences from 1962 to 1965, with Brian Robson as the Officer-in-Charge; Professor Le Couteur was primarily responsible for its acquisition.

From the beginning, the IBM1620 was made available as a University resource, so that members of the University outside the department were actively encouraged and taught to use it. In the first few months, the IBM1620 was used in connection with research into nuclear scattering, nuclear stability, stellar atmospheres, rock magnetism, seismology, microbiology and for the work of the National Time Service. In the first year, the teaching of statistics to third-year undergraduates was supplemented by including some practical computer experience in their course.

In 1964 the University received a grant to upgrade its computing facilities, and it was decided to establish a Computer Centre, initially within the School, to provide a computing service to the University and to undertake teaching and research in computing science. This took place in late 1965, when the IBM1620 became the basis of the Computer Centre and six out of seven associated staff members formed the nucleus of its staff. Dr M.R. Osborne was appointed Head of the Computer Centre in December 1965.

In April 1966, the IBM1620 was replaced by a new IBM360/50 computer. The Computer Centre became independent of the Research School of Physical Sciences in 1968.



Fred Barker (1949-1990) was the foundation member of Theoretical Physics, continuing there as a Visiting Fellow after his retirement. Barker is internationally respected for his many theoretical contributions, involving both the shell model and R-matrix theory, that relate to the nuclear properties of light nuclei.

Rodney Baxter & Brian Robson