# RONALD PERCY BELL

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Ronnie Bell was a small quiet man always seen in a characteristic pair of wire spectacles often matched by a sizeable Havana; he was a most distinguished physical chemist and scientist. Born 24th November 1907 he attended Maidenhead County Boys' School before going up to Balliol to read Chemistry in 1924. After graduating in 1928, taking the Gibbs Prize for the best performance in Finals, he moved to Copenhagen, working with J N Bronsted before returning to Balliol as a Fellow in 1933. He then spent more than thirty years at Balliol, firstly as Fellow then as Tutor for Admissions, Senior Fellow and Vice-Master.

His many students at Balliol will remember his unique selection of tutorial topics, chosen to initiate them in their very first term as chemists. We explored the measurement of atomic weights in the greatest detail, for what seemed like all 92 elements, assessed the measurement and accuracy of the fundamental constants and left no corner of the library, no matter how dark, un-visited. Under his guidance we learned the importance of primary sources and their critical evaluation. At the time, with recent memories of basic training in national service, all this seemed unexceptional; with hindsight the determination and fixity of purpose that he instilled is as startling as it would be unacceptable today.

The many academic visitors who came to work in his laboratory did not escape the same rigour. His settled policy was that such visitors should work in an appropriately focused way so that at the end of their sabbatical year they could submit a DPhil thesis. Since Ronnie took pleasure in being Mr Bell, the appropriate stage in his career predating the introduction of this continental innovation at Oxford, this was a somewhat ironic position to maintain. Ronnie was equally inimitable in seminars. He always fell asleep – or so it seemed – but stirring at the end, asked the most penetrating of questions, often quietly exposing the uncertainties of interpretation and analysis carefully glossed over in the past fifty minutes.

Ronnie was a charming man. For some reason, possibly related to his sojourn in Scandinavia, he had a reputation for proving irresistible to the fair sex. A much enjoyed story concerns the conclusion of the PhD oral examination of a young lady. Wishing to draw the examination to a pleasant close Ronnie leant back and asked what her plans for the future were. Blushing prettily and no doubt influenced by his charm the young lady indicated that she had been planning to go home for supper. His many kindnesses to students and thoughtfulness for the many visitors to his laboratory, his love of music, hill-walking and the pleasures of life all speak to the rounded man.

In 1964 Ronnie Bell, having declined a Chair in Physical Chemistry at Oxford, was a strong candidate for the Mastership of Balliol but perhaps his quieter more intimate charm was thought less appropriate and in the event Christopher Hill was elected.

Asked to advise on the establishment of a Chemistry department by Tom Cottrell, the charismatic Principal of the newly created University of Stirling, he was excited by the new opportunities in what promised to be an innovative environment. Rather than merely advise, he accepted the Foundation chair in Chemistry at Stirling in 1967 and proceeded to establish a young and vibrant department. He became a wise counsellor serving as a member of the Academic Council and the University Court.

In 1975 the Faraday Division of the Royal Society of Chemistry held a Symposium on ‘Proton Transfer’ in Stirling to mark his retirement from the Chair. This Symposium also came exactly ten years after a previous Discussion Meeting of the Faraday Society entitled ‘Kinetics of Proton Transfer’ at which Eigen and Bell had both been principal speakers.

Ronnie retired to Leeds and his beloved cottage in Buttermere, continuing his connection with Chemistry by becoming an Honorary Research Professor at Leeds University.

He was a prolific scientific author of more than 230 scientific papers, at first sight on a surprisingly diverse range of topics. At one level his work is strongly focused on the chemistry of the proton. This is an interesting species. As the lightest chemical species its transfer kinetics include some of the fastest known and govern the most important class of chemical reactions: the neutralisation of acids and bases. The large mass ratio between hydrogen and its deuterium isotope also means that these systems show the largest differences of all in their chemistry. These isotope effects are manifest in both the equilibrium and kinetic, time dependent, behaviour of the proton. As a final challenge, the low mass of the proton means that the kinetics of proton transfer reactions are likely to show the largest quantum effects of any chemical system. The proton is also unique in having no stereo-chemistry.

These properties are all of the greatest interest in their own right and RPB explored them all. However, it is possible to discern a higher ambition in his work not so much with these phenomena themselves as with the insight they provided into the ‘transition state’, that most chemical of concepts which attempts to encapsulate the full complexity of the proton transfer itself including the motion of the donor, acceptor and solvent molecules. Information of this type is hard won and, even today with modern resources, real insight is limited to a handful of the simplest reactions in much simpler gas-phase systems.

The first stage in such work was to isolate the specific proton transfer process from the many interfering processes which would otherwise make interpretation impossible. No simple matter with the experimental capability of that time. Here Ronnie enjoyed the application of relatively simple experimental techniques which in carefully chosen combination and thorough analysis in his hands yielded great insight. A number of special techniques were developed for this purpose including an electrode to measure bromine concentrations and time dependent measurements of the heat of reaction, the latter involving a peculiarly temperamental apparatus that incorporated cascaded optical galvanometers in the measurement system.

With hindsight it is possible to see that this delight in simplicity made him reluctant to exploit fully the potential of post-war electronics and particularly of the relaxation methods brilliantly exploited by Manfred Eigen and for which he won the Nobel prize for Chemistry in 1967.

A recurring concern was the empirical Bronsted relation of which the Balliol couplet had it:

*My job is to refute the fallacies*
*In Bronsted's acid–base catalysis*

This linked the thermodynamic free energy change in the proton transfer process to the free energy of the transition state. While by no means perfect, these correlations were sufficiently good to suggest an underlying simplicity. A large number of examples were studied and interpreted to yield insight on the effective barrier height in the transition state and the role of the solvent. Further information on the transition state was gained by studying kinetic isotope effects. These effects were particularly related to the 'bending' motions in the transition state and gave information on the width and curvature of the effective potential in the transverse direction to the motion over the barrier.

Perhaps the most influential of Ronnie's contributions was in the development and understanding of quantum tunnelling, or the 'tunnel correction' as he would prefer, in proton transfer processes. His first paper on this topic was in 1933, the earliest days of quantum theory. His model based on a parabolic form of the barrier between reactants and products became the standard picture. It was shown that tunnelling behaviour would manifest itself as an anomalous temperature dependence of the proton transfer rate, in other words the 'Arrhenius plot' would be curved. These effects would be most pronounced at low temperatures although it was realised that other causes for such curvature were possible. These predictions motivated a large international effort to identify systems showing such behaviour. Clear evidence was finally obtained by Bell, Fendley and Hulett in 1956. A significant number of examples were ultimately uncovered and using the parabolic barrier model the width or curvature of the barrier along the direction of reaction in the transition state was established.

In combination, these individually rather indirect approaches then provided the height, and curvature in several dimensions, of the potential surface operating in the transition state – a masterly display of the indirect approach in scientific strategy.

Much of this work is summarised in his monographs: "the little book", *Acids and Bases*, and his "big book", *The Proton in Chemistry* – the latter in particular remaining a significant scientific resource. His work was recognised by many honours. He was awarded the Meldola medal of the Royal Institute of Chemistry in 1936 and was Tilden Lecturer of the Chemical Society in 1941. He was elected to the Royal Society in 1944 and served on its council. He served as President of the Faraday Society in 1956 and as Vice-President of the Royal Society of Chemistry in 1958 and was elected to the Royal Society of Edinburgh in 1968, serving on Council 1974–78. He was elected a Foreign Associate of the National Academy of Sciences in the United States in 1972 and an Honorary Member of the American Academy of Arts and Sciences in 1974. He died on 9 January 1996.

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MALCOLM FLUENDY