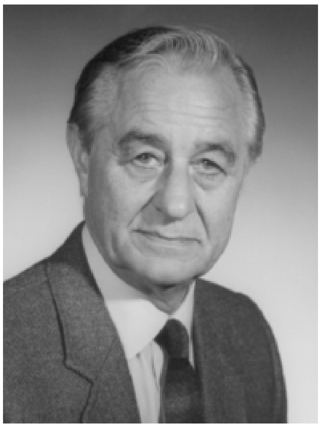

Figure 1. Professor Lord Porter O.M. F.R.S. (Copyright © Godfrey Argent Studio, London, UK)

George Porter (1920–2002): Kinetics Research and the Public Understanding of Science

George Porter (Figure 1) made fundamental contributions to our understanding of fast reactions between atoms and molecules. His promotion of the public understanding of science and scientific research was of national and international importance.

Much of chemistry is concerned with the study of the transition from reactants to products in a chemical reaction. The conventional and traditional method was to measure the kinetics of reactions by mixing reactants and observing the changing concentrations of reactants and products with time. Reaction intermediates and transition states were inferred only as suggestions of the reaction mechanisms. In photochemistry and photophysics, one is dealing with a spectrum of lifetimes which spans seconds (free radicals and "forbidden" excited states) to micro- and nanoseconds ("allowed" excited states) to femtoseconds (molecular dissociation and fragmentation). It was to the relentless pursuit of these targets of observation that Porter dedicated his life in science.

Porter was a Yorkshireman and, as a boy, absorbed in chemical experiments at home. His father recognized and encouraged the interest but felt that studies of "bangs" were best done in a mobile "laboratory" rather than in a kitchen! Porter left his secondary education to read science at Leeds University where the Professor of Physical Chemistry, M. G. Evans, had a profound influence in directing Porter's interest in chemical kinetics. That interest had to be suspended until he was released, in 1945, from his wartime service in the Royal Naval Volunteer Reserve. That service gave him a long-lasting taste for sailing but, perhaps above all, for a recognition of the signal–sensor relation in the form of a flashing searchlight and message processing by the eyeball.

He now applied to work at Cambridge and was accepted by Ronald G. W. Norrish, a recognized authority in photochemistry. A postgraduate studentship at Emmanuel College allowed Porter to complete his doctoral thesis, the subject of which, at least judged by unfolding events, was conventional. The exciting new technique of flash photolysis did not emerge until 1949, which coincided with his appointment as a Demonstrator in Physical Chemistry at Cambridge. The first experiments could measure chemical reactions lasting a few milliseconds or so and were based on a bank of war surplus electrical condensers which passed large electrical currents of short duration through vessels (pumps) containing rare gases; intense pulses of light "pumped" atoms or molecules in a reaction chamber into electronically excited states. The monitoring and analysis of short-lived species, photolytically generated, were effected by a second "probe" flash illuminating the reaction vessel over timed intervals after the "pump" flash. Absorption spectra of transients were recorded photographically.

And so the technique of flash photolysis was launched and, over three years or so, pioneering studies covered reactions ranging from the explosive combustion of hydrogen in oxygen (already the subject of intensive experimental and theoretical studies), the photolytic fragmentation of simple organic molecules and, worthy of special mention, of chlorine dioxide. The probe techniques had evolved to measure shorter timescales and showed that the photolysis of chlorine dioxide produced the diatomic radical chlorine monoxide and atomic oxygen. The chlorine monoxide fragments decay as a result of reactions (1) and (2). Some 30 years

$$O + ClO_2 \rightarrow ClO + O_2 \quad (1)$$

$$ClO + ClO \rightarrow Cl_2 + O_2 \quad (2)$$

later came the demonstration that the chlorine monoxide radical plays a role in the formation of the hole in the ozone layer above Antarctica.

A year after leaving Cambridge (1954), Porter accepted the Chair of Physical Chemistry at the University of Sheffield. At Sheffield, he established a powerful group in photochemistry and, through inspired appointments and over a period of eleven years, placed the University in a very strong position across the spectrum of chemical sciences. Within a few years of his arrival, flash photolysis had achieved observations in the microsecond time domain and Porter's researches had three main themes:

- the observation of electronically excited triplet states of a number of organic molecules,
- observations of highly reactive, often elusive, molecules such as benzyne, and
- acid–base properties of excited states.

The foundations of our understanding of the structures and reactivities of excited states were laid down and Porter left Sheffield in 1966 to assume the Directorship of the Royal Institution (RI); one year later he shared the Nobel Prize for Chemistry, jointly with Ronald G. W. Norrish and Manfred Eigen.

His acceptance of the directorship reflected his interest in devoting more of his time to research but also to the public understanding of science. Porter was a superb lecturer. In the grand traditions of Humphry Davy, Michael Faraday, William Henry Bragg, and William Lawrence Bragg at the Royal Institution, he prepared his lectures meticulously, he rehearsed his lecture demonstrations repeatedly so that they would not fail him at the critical moment, and, in addition, he chose his words carefully, so as to induce a sense of awe among his audience. One of us (J.M.T.) still recalls how, to a lay audience, he got across the notion of the minuteness of a nanosecond, by declaring—in the best style of a seasoned poet—"There are as many nanoseconds in a second as there are seconds in a man's life."

So far as Porter's research was concerned, it took a major leap forward with the advent of the visible-light ruby

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laser that was capable of producing high-intensity light pulses of only a few nanoseconds in duration: Timescales could be foreshortened by a factor of a thousand or so compared with the pulse lengths of flash lamps. The development of the optical delay unit was vital for the laser that serves both roles of pump and probe. The laser beam is split: Light is partly reflected into the reaction vessel with the remainder passing through the beam splitter towards a mirror mounted on a movable stage. The distance between the beam splitter and mirror determines the extra path length that the probe beam must travel and, obviously, the time delay between the photolysis and probe pulses; after reflection the probe pulse passes into a scintillation solution and the resulting fluorescence provides the white light for monitoring the absorption spectra of the reacting or activated species.

In 1970, Porter and Topp determined the lifetime of the excited singlet state of triphenylene as 45 ns. This and related work, which was later extrapolated to the picosecond regime, set totally new levels of the investigation of intermediates in chemical reactions. He retired as Director of the RI in 1985. At Imperial College, he was instrumental in founding the Centre for Photomolecular Sciences. Porter's main interest there was focused on photosynthesis where the primary process is the capture of photons, the consequential movement of electrons and protons across the biological membrane and the production of carbohydrates from carbon dioxide and water. The exchange of energy between two excited states on either side of a membrane was maintained and the time for the energy redistribution process (equilibration) determined. Inevitably, perhaps, Porter's curiosity led him to explore photochemical and photophysical processes as alternative energy sources.

Porter's predecessor at the RI, Sir Lawrence Bragg (Nobel Laureate), was an enthusiastic promoter of the public understanding of science. The educational traditions of the RI include the Christmas Lectures (Figure 2), a Schools' Lecture Programme and the Friday Evening Discourses. To these, Porter brought new impetus and broadened the topics of scientific interest. His initiatives owed much to his experience as an inspirational lecturer at Sheffield and to his 1965–1966 television series Laws of Disorder; the latter was an outstanding success with challenging concepts such as entropy being lucidly explained to the proverbial "man in the street" who should have been better equipped to engage in discussions of the Second Law of Thermodynamics! Successive television series (Young Scientist of the Year, 1966–81; Time Machines, 1969–70; Controversy, 1971–75; Natural History of a Sunbeam, 1976–77) were very well received and illustrated his commitment to innovative presentations of science. At the RI, he and the Professor of Physics, Ronald King, recreated the original Faraday Laboratory, of great historical significance and with great appeal to schoolchildren.

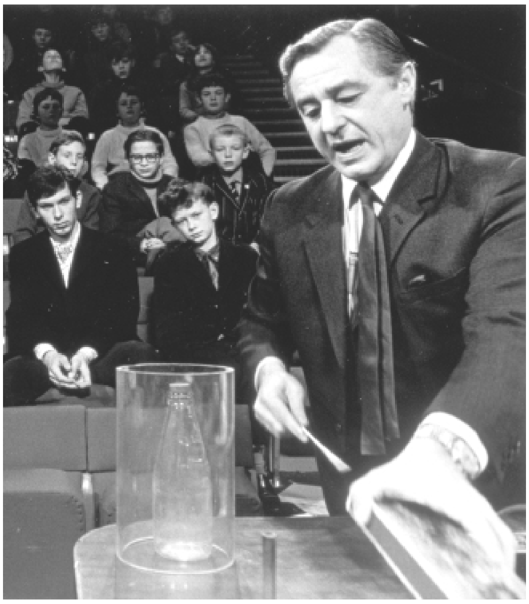

Figure 2. George Porter delivering the Christmas Lecture at the Royal Institution (1976). Copyright © The Royal Institution (London), Bridgeman Art Library.[*]

George Porter became President of the Royal Society in 1985, the same year as he led the British Association for the Advancement of Science. Both were platforms which he used to express his concern for what he saw as inadequate funding of science and the consequent effects on national scientific capabilities. These concerns were echoed in the House of Lords after he had been created Lord Porter of Luddenham in 1990. At the Royal Society, the Committee on the Public Understanding of Science (COPUS) was formed after Porter's initiative of convening a high-level meeting of interested parties. The sponsorship of COPUS by the Royal Society has had considerable success in raising the awareness level of issues and roles of science in the public domain. Relatedly, another presidential initiative resulted in the formation of a Royal Society group dedicated to "Scientific Aspects of International Security" which promoted discussions between the Society and sister academies in Europe and the United States. In a similar vein, Porter traveled extensively during his presidency, enhancing exchange visits between national academies. A visit of a Soviet delegation to London led Margaret Thatcher, then Prime Minister, to express interest in meeting members of the delegation in order to demonstrate her willingness to "do business" with President Mikhail Gorbachev; that, of course, before the tumultuous events of 1990.

Porter's distinguished career, scientific and educational contributions, brought wide recognition and honors. Nobel Prize (1967), Knighted in 1972, Order of Merit (1989, personal gift of the Sovereign), Life Peerage (1990), many honorary degrees, awards, and prized lectureships. He was for many of us, as Tam Dalyell once wrote, "a life enhancer".

Sir Ronald Mason (Weedon, UK),
Sir John Meurig Thomas (Cambridge, UK)

[*] We have been unable to trace the photographer and would be grateful to receive any information as to his or her identity.