A.R.J.P. Ubbelohde (1907–1988)

A.R.J.P. Ubbelohde, who died on 7 January, was an exceptionally versatile scientist and a man of broad cultural tastes. A pig farmer, a keen fisherman, an enthusiastic swimmer, a collector of antiques, a connoisseur of wine and a classical scholar of no mean distinction: he was all these and more, but his scientific reputation rests on his extensive contributions, principally experimental, to a wide range of physico-chemical topics encompassing the behaviour of solids, liquids and gases. Only a small circle knew him as Paul Ubbelohde. To many he was "Ubbelbubble", a description he silently approved as it recognized his perpetual effervescence, boundless enthusiasm and enormous intellectual energy.

He was born on 14 December 1907, and was educated at St Paul's School and Christ Church, Oxford. In the early 1930s, he spent a year at Göttingen where he saw at first hand the impressive physicochemical legacy and continuing efforts of the great German physical scientists including Nernst, Planck, Eucken and Clusius. But, as he often declared, the most formative period of his scientific life was spent at the Royal Institution (1935–40), where William Bragg allowed him and a galaxy of gifted contemporaries (including K. Lonsdale, J.M. Robertson and H.A. Jahn) to roam freely into whichever field took their fancy — a far cry from the present-day ethos of target-orientated, interdisciplinary research centres.

His publications at that time reveal his unusual range of interests, most of which he pursued later: hydrogen uptake by metals, which led to refinements of the phase rule; melting and crystal structure, the subject of one of his many books; the ferroelectric behaviour of Rochelle salt; the influence of isotopic substitution upon crystalline properties; and occurrence of induction periods in the combustion of hydrocarbons. Ubbelohde, although a junior among his associates — he referred to himself as "the Benjamin of the family" — was capable of mobilizing the interest, skills and energy of all around him. His first book, *Modern Thermodynamics*, was published during this period.

At Queen's University, Belfast (1945–54) he built up a vibrant department of physical chemistry. His own research included transport properties and the combustion of gaseous hydrocarbons; the diffusion, ultrasonic dispersion and viscosity of liquids; and the interaction of alkali metals with aromatic hydrocarbons. He also studied the intercalation of guest species by graphitic hosts, a phenomenon discovered in West Germany in the early nineteenth century, and resurrected by U. Hoffman and others at Heidelberg immediately after the Second World War. Ubbelohde's contributions to graphite and the crystalline solids it forms with many guests are of lasting value. Apart from recognizing the enormous range of electrical and magnetic properties exhibited by these intercalates, he also stimulated others to prepare synthetic analogues of graphite, like stress-annealed pyrographite, which opened a new chapter in the design of layered solids with advantageous thermal and mechanical properties. In 1954 he was appointed professor of thermodynamics and, from 1961 until his retirement in 1975, head of the department of chemical engineering and chemical technology at Imperial College, London.

Ubbelohde's presence at a scientific meeting always made it interesting. He spoke in clarion, authoritative terms often with humour and generally with reference to arcane events usually of Greek or Roman provenance. There were, however, occasions when he lapsed into obscurantism for which he could be forgiven. But those who listened to him always felt that they were the better upon hearing his views.

He knew how to capture an audience both in the spoken and written word. His books contain evocative passages. Thus in introducing *Melting and Crystal Structure*, he remarks: "Traditionally the interest of the early Directors of the Royal Institution in the effect of pressure on melting stems from Humphry Davy's prowess as a skater". And in *Man and Energy*, he illustrates the second law of thermodynamics with the quip that "An untidy nursery at the end of the day will not tidy itself up spontaneously", and the moral dilemma of the scientist with the recollection that "It is notable that Leonardo was so concerned about possible abuses of his invention of a submarine by tyrants that he took pains not to publish it". Ubbelohde was a natural stylist. He did and said things in a memorable way.

J.M. Thomas

J.M. Thomas is Director of the Royal Institution, 21 Albemarle Street, London W1X 4BS, UK.

Daedalus

Abstract concrete

Concrete, says Daedalus, is an embryonic fractal material. Its cheap, coarse gravel particles pack tightly together; their interstices are filled with almost equally cheap sand; the expensive binding cement is needed only to fill the residual space between the sand grains. So Daedalus is taking this logic to its ultimate conclusion. He is devising a graded range of particles from the coarsest gravel to the finest imaginable dust. Each grade of particle will pack neatly in the interstices of the grade above, while providing in its own interstices a tight fit for the particles of the grade below. At each stage of packing the unfilled volume diminishes, and in the ultimate mathematical limit it approaches an unimaginably tortuous fractal web of infinite surface area but zero volume. The final concrete, therefore, contains 100 per cent of cheap aggregate and 0 per cent of expensive binder.

In fact, of course, one is prevented from pursuing this reticulated logic to its final nightmarish conclusion by atomic dimensions and by the limits of fine-grinding. About seven or eight grades of nesting particle sizes span the feasible technological range, and their packing poses some intriguing statistical problems. But the final fractal lattice will have only a few parts per million of free volume between its close-packed tiers of nesting particles. So little binder will be needed that expensive, high-tenacity types like epoxy, cyanoacrylate or even polyimide will become economic.

Fractal concrete cannot be made in the traditional way, by adding the liquid to the solid and stirring. Viscous binding and drag between the closely packed particles would make the mixture far too stiff to stir. Instead the solids must be mixed dry and compacted in place. The calculated small volume of binder should then be poured on. The enormous capillary attraction of the atomically close particles will suck it in and distribute it evenly around the tortuous but tiny free volume between them. It will soon set, giving a concrete of unprecedented strength and resistance.

Many other composite materials could be improved by a similar approach. A fractal fibreglass, for example, in which small fibres nest in the hollows between big ones, and smaller ones still in the hollows between them, should be much stronger than any monodisperse array. Daedalus is even devising an ultra-healthy fractal muesli, whose carefully sized grains of nut, fragments of cereal and fine vegetable fibres pack so densely in the bowl that they can be fully wetted with the absolute minimum volume of saturated-fatty milk.

David Jones