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SAADIA AMIEL AND THE RENAISSANCE OF RADIOCHEMISTRY

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The scientific activity of Professor SAADIA AMIEL is discussed.

AMIEL came on the scene when radiochemistry seemed to have reached a plateau – not because its problems were intractable or its resources inadequate but because everything seemed to have been done.

The early radiochemists – SODDY, HEVESY and PANETH – were men of genius and their work constitutes a major triumph of 20th century chemistry, though their achievements have been somewhat overshadowed by enthusiasm for developments in organic synthesis and corresponding advances in techniques for the determination of molecular structure.

The arrival of radioactive materials, around the turn of the century, provided exciting opportunities for enterprising chemists. They were now able to obtain minute but accurately measurable amounts of elements and compounds, of exceptional purity. Extremely small amounts of any substance do not behave in the same way as larger amounts. Exploiting the concurrent radioactive emissions, which could (with some difficulty) be detected and measured, the early radiochemists learned a great deal about surface chemistry, diffusion and reaction kinetics. Even more important were the discoveries by radiochemists of isotopes and of free organic radicals – and the development of tracer techniques.

All of this work was done with rather limited resources for, until the 1930s, radiochemistry was confined to the study of the naturally occurring radioactive elements which, because of their positions in the periodic table, would not otherwise have been of great interest to chemists. By the mid-1930s artificial disintegration of nuclei and associated advances in high-voltage engineering brought a supply of atomic artillery which the physicists fired at a great variety of targets to produce new radioactive nuclides. The detection and measurement of radiation were

also much improved. The early experimenters, who had to sit for hours by their electroscopes or spinthariscopes, would have welcomed the Geiger counter – though it is unlikely that they would have achieved more than they did – and the arrival of fission products in the 1940s provided fresh impetus. Though most of the basic techniques were already established, the scintillation counter considerably extended their range in the 1950s.

A distinctive by-product of nuclear technology was activation analysis. By the early 1960s, nuclear reactors were at work in many parts of the world, providing neutrons in great abundance at low cost and allowing almost every element to be produced in radioactive varieties. The arrival of γ-ray spectrometry and other improvements in the detection of radiation and particles encouraged the development of extremely sensitive analytical procedures which were widely exploited – sometimes with more enthusiasm than wisdom – in medicine, engineering and biology as well as in the physical sciences. For a while, technical sophistication and ingenuity outran scientific insight, so that activation analysis appeared to be a solution in search of a problem – as in some laboratories it still is.

When, in the early 1960s, AMIEL began the work which I we now want to discuss, radiochemistry was heavily encrusted with ingenious technology but was not moving very fast. AMIEL brought it to life again in the spirit of SODDY, HEVESY and PANETH. He was a complete master of all of the relevant technology, but the significance of his contribution to radiochemistry lay in the depth and sharpness of the insight with which he identified scientific problems and the economy of effort by which he produced elegant solutions.

His work[1] on the analytical uses of delayed neutrons, published in 1962, provides a good example of his ingenuity in shaping new ideas out of existing knowledge and in applying them to practical problems.

Most of the fission products produced by neutron bombardment of uranium or thorium emit beta-particles – often, of course, accompanied by gamma-radiation. A few of them are also neutron emitters, with half-lives between 0.17 seconds and 56 seconds. Fission neutrons are emitted promptly but the fission products just mentioned produce the delayed neutron emission. This effect was known even before fission was discovered; early in 1939 ROBERTS and others observed that uranium and thorium, when bombarded by neutrons, went on emitting neutrons for some time after the bombardment ceased.

The delayed neutrons are of course very important in the control of nuclear reactors. AMIEL was the first to exploit their possibilities in chemical analysis. The estimation of uranium or thorium, for example in ores, is an important but difficult task. The traditional fluorometric methods are slow, complicated and of doubtful accuracy at low levels. Though 8 or 10 samples can be dealt with simultane-