OBITUARY

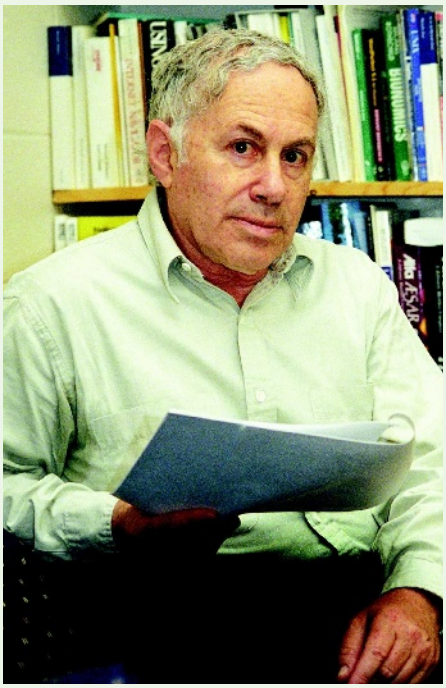
Anatol Zhabotinsky (1938–2008)

Pioneer of oscillating chemical reactions.

Anatol Zhabotinsky, the father of nonlinear chemical dynamics, passed away on 16 September after a brief illness. In many ways, his scientific career represents a microcosm of the history of Russia in the second half of the twentieth century. Born in Moscow at the height of the Stalinist purges, Zhabotinsky was able to enrol in the prestigious Moscow State University in 1955, during the brief window that opened for Jews in the years following Stalin's death in 1953. Although not a religious man, Zhabotinsky was proud of his Jewish heritage and refused to change his surname to "something more Russian", even when other members of his immediate family did so to improve their prospects in an anti-Semitic society.

It was as a graduate student at Moscow State that Zhabotinsky first learned of the phenomenon, now known as the Belousov–Zhabotinsky (BZ) reaction, for which he was to become famous. In the early 1950s, Boris Belousov, a military research chemist studying the effects of poison gases and radiation on humans, had stumbled upon the fact that a mixture of potassium bromate, citric acid and cerium ions exhibits periodic colour changes. These oscillations indicated that the chemical state of the system was changing in a rhythmic way, rather than proceeding monotonically from a starting point to an end point, as happens in most chemical reactions. Belousov tried to publish his results in peer-reviewed journals, but eventually gave up after referees and editors insisted that such behaviour contradicted the Second Law of Thermodynamics. He instead published a one-page description of his observations in an obscure conference proceedings on radiation medicine. He circulated a recipe for the reaction as a sort of samizdat among colleagues in Moscow, and then, apparently, returned to more applied studies.

A decade after Belousov's discovery, Zhabotinsky was starting his doctoral research under the direction of the biochemist Simon Schnoll. Zhabotinsky wanted to study rhythmic behaviour in glucose metabolism, but Schnoll told him that the materials required were in short supply and suggested that he take a look at Belousov's recipe (which two earlier graduate students had had little success with). Zhabotinsky, with his characteristic experimental skill and care, was soon observing chemical oscillations. He improved the recipe by substituting malonic acid for citric acid, and showed that the source of the colours was the ceric ions, rather than bromine as proposed by Belousov. He wrote up his results and sent them to Belousov for



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comment, receiving a supportive note in return. Attempts to establish personal contact with Belousov proved unsuccessful, however, even after Zhabotinsky's work was published and Belousov's contributions were lauded. The two never met face to face, despite working only a few kilometres apart. Zhabotinsky always suspected that Belousov, who had lost many friends in the Stalinist purges and who was employed at a secret military establishment, was wary of establishing 'extracurricular' relationships. Belousov died in 1970.

The discovery of oscillating reactions revolutionized the way that scientists thought about chemical dynamics. Indeed, Ilya Prigogine — who received the 1977 Nobel Prize in Chemistry, in part for demonstrating that chemical systems far from equilibrium can exhibit periodic oscillations — regarded the BZ reaction as the most important scientific discovery of the twentieth century, surpassing quantum theory and relativity. Whether or not one accepts this assessment, it is clear that the discovery of a 'simple' chemical reaction that displays periodic temporal and spatial behaviour had far-reaching consequences, even leading to a greater understanding of the processes that underlie life itself, such as biological clocks and morphogenesis.

Zhabotinsky's role was to make the scientific world aware of the importance of a phenomenon that might have been relegated to an intriguing parlour trick or lecture demonstration. He discovered early on that a thin, unstirred layer of BZ solution gives rise to beautiful spiral patterns of chemical concentration (see, for example, http://heracles.chem.wvu.edu/gallery.html), which were later observed to resemble those seen in aggregating slime moulds, newly fertilized frog egg cells and fibrillating hearts. At a conference on biological and biochemical oscillators held in Prague in 1968, only weeks before Soviet tanks rolled into the city, Zhabotinsky brought the BZ system to the attention of Western scientists, and the field of nonlinear chemical dynamics was born. Together with Belousov, Genrikh Ivanitsky, Valentin Krinsky and Albert Zaikin, he received the 1980 Lenin Prize, at that time the Soviet Union's highest scientific award, for his work.

Perhaps because of his Jewish heritage, or perhaps because of his tendency to make politically incorrect remarks, Zhabotinsky was not allowed to travel outside the Soviet bloc until the arrival of perestroika at the end of the 1980s. When I arranged a lecture tour of the United States for him, he was surprised to discover that a chemical ordered at the beginning of his 10-day visit could arrive by the end of that period. Impressed, he asked whether a longer stay at Brandeis University might be possible. A visit of one year was arranged, starting in July 1991, but he never returned to his home country.

At Brandeis, he pursued his interest in oscillatory chemical reactions, demonstrating, for example, that chemical waves in the BZ reaction obey the same laws of refraction at an interface as light waves, but that reflection of chemical waves is not perfectly mirror-like. He also returned to his initial fascination with biophysics, collaborating with neuroscientists such as John Lisman on models of synaptic transmission. With his vibrant intelligence and encyclopaedic knowledge, he was a major contributor to the education of a generation of students and postdocs, and was well known for his unwillingness to accept a vague response when a more exact answer could be dredged out by persistent questioning. When allegedly novel phenomena were described to him, he was frequently heard to remark "This was found in Russia by so-and-so thirty years ago", despite his alienation from his native land.

Like the complex chemical reactions that so intrigued him, Zhabotinsky's life — and that of his beloved and not-so-beloved Russia — underwent many ups and downs, occasionally becoming chaotic. The world of science is poorer today for his loss.

Irving R. Epstein
Irving R. Epstein is in the Department of Chemistry, Brandeis University, Waltham, Massachusetts 02454, USA.
e-mail: epstein@brandeis.edu