

BÉLA SZILÁRD'S RESEARCH IN CHEMICAL DOSIMETRY

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Received December 19, 1977

Presented by Assoc. Prof. Dr. G. BIRÓ

Béla SZILÁRD is known as one of the first Hungarian researchers in the field of radioactivity. He contributed to the spreading of scientific revolution at the turn of the century: by his investigations and popular scientific works, he promoted the dissemination of up-to-date knowledge in Hungary at the beginning of this century [1].

He had an excellent sense for the application of science: he designed instruments, applied for patents. His inventiveness ranged over quite different fields, from novel-type lightning conductors to instruments for discerning orient and cultivated pearls; from a new method of photographing to the suppression of electrical charges in textile factories, etc. The most important among them were electrometers of increasingly improved accuracy and widened applicability [2].

His scientific interest embraced similarly wide ranges. He was engaged in photochemistry but submitted a Doctor's Thesis in organic chemistry; he studied the chemistry of radio-active materials and in the meantime made a highly significant discovery in colloids. [3] There was perhaps a single subject interesting him throughout his career: the measurement of radiation intensity, winning him the esteem of the scientific community and his electrometers served this aim, too.

Here only a fraction of his oeuvre will be presented. His research in chemical dosimetry of moderate scientific value was only a prelude to his later, successful activity. In addition of being an unrevealed chapter in his complex, rich life-work, it merits a separate discussion since it is connected to the most significant turning point in his life. One of his papers on chemical dosimetry was the first link to the West-European scientific community of which he became a member later.

Paris was the theatre of Béla Szilárd's subsequent activity. He was among the first in the long row of emigrant scientists, featuring the entire history of 20th century science in Hungary. In 1907 he obtained a scholarship for a study-tour in Paris, worked as "travailleur libre" in the famous Curie Laboratory, the most important centre of radio-activity research of the time.

Although no direct co-worker to Mme Curie, he certainly knew her and attended her lectures at the Sorbonne. And of course, he made the acquaintance of other scientists and became a friend of some of them, e.g. A. Laborde. [4] He managed several times to renew his scholarship until 1910 when he finally decided to settle in France and died there in 1926 at the age of 42. [5]

It is no exaggeration to call his relations to chemical dosimetry decisive. These relations lured him finally abroad. Though he maintained his Hungarian relations — delivered lectures, spent his holidays at home, corresponded with his acquaintances — his scientific work and later his French family kept him abroad. [6]

At that time the main difficulty in chemical dosimetry was to find a reaction due exclusively to radiation. Generally, the fundamental condition of activity or dosage measurement is to trace a physical or chemical effect that is an unambiguous function of the radiation dose. The most obvious method is the air ionization effect, but early in this century, the low currents were extremely difficult to be measured.

In the first period of chemical dosimetry, from about 1910 to 1927, iodoform solved in chloroform was widely used. The reliability of measurements was, however, greatly reduced by the fact that the system does not only react to radio-active radiation, but also to light and even to temperature. A further difficulty is due to the spontaneous oxidation in the course of the reaction, and the evaluation suffers from the lack of a linear relationship between radiation dose and transformed material quantity. In spite of these drawbacks, the method of measurement by iodoform was rather popular, especially among physicians preferring chemical methods, anyhow there were no more suitable reactions available. [7]

In 1905, two years before his Paris journey, as a beginning scientist Szilárd encountered dosimetry problems. In conformity with Hungarian traditions of the history of chemistry, he analyzed mineral waters and tried to determine the radio-active component. He applied the system $\text{CH}_3\text{I} / \text{CH}_3\text{Cl}$ and determined the iodine formed by radiation by means of a $\text{Na}_2\text{S}_2\text{O}_3$ solution. [8] Apparently, he mistrusted the reliability of this method and soon began to examine the measurement method itself. He observed the reaction in darkness, i.e. by the exclusion of radio-active radiation and light had been continuing if once started. He applied reaction-kinetic test to determine the causes, and ascertained that an autocatalytic process was taking place. In 1906, his results were published in French and in German. [9]

His results on the auto-catalytic processes in the iodoform-chloroform system may have raised interest. It must have been due to this fact that they were presented at the French Academy, and later, printed in the *Comptes Rendus* of the Academy, where the majority of Szilárd's achievements were later published too. [10] The work was presented by no lesser personality than H.

Poincaré, one of the greatest French scientists of the time, keeping friendly relations with Szilárd also later on. [11]

These experiments were still carried out in Hungary, for his scholarship dated from 1907. His 1906 paper may have been a good recommendation for his Paris study-tour from which he had never returned. This paper was considered as a changing point in his life, but it did not make an end to his studies in chemical dosimetry.

During his activity in the Curie-Laboratory he made further attempts to apply iodine compounds in chemical dosimetry. He tried to replace the solvent chloroform by alcohol, then by ether. However the kinetic tests on these new systems did not meet the expectations. Now, iodoform was replaced by potassium iodide. He observed that upon pouring starch and potassium iodide solution on different minerals, starch indicated iodine separation. He hoped this system to be appropriate for dosimetry. In 1907, he published another study in *Comptes Rendus*, [12] that appeared in Hungarian in 1909. [13] In spite of the vivid interest, he could not clear the phenomenon for a long time.

His returning to the problems of iodine compounds was long hindered first by subsistence problems and researches in other directions, then by World War I. During the war he left France, but did not return to Hungary. For shorter or longer time he lived in different West-European countries to finally obtain permission to stay in Spain. Here he got into suitable working conditions and was able to continue his researches at the Instituto de Radioactividad of the Madrid University. He arrived in Spain in 1915 and, in spite of his doubtless achievements recorded in the newspapers of the time, he returned to Paris in 1920.

In the meantime, in 1917 he managed to come back to his old subject, oxidation of potassium iodide. He systematically examined what minerals were responsible for the reaction. But the result was a deception. Various non-radioactive minerals were found to cause iodine formation. [14] He attempted to reveal the cause but in vain. He seems to have been displeased since the system proved to be useless for dosimetry.

As mentioned before, Szilárd had more significant achievements in the electric methods of radiation measurement, but these and his results in other fields cannot be enumerated here. His experiments in chemical dosimetry are but by-products of his work, with no special importance either for Szilárd or for the trend of the research. These only have an importance from the point of view of the history of chemistry and of the role they played in the author's life who, one of the few who understood, propagated and cultivated some disciplines of the scientific revolution. There were few such Hungarian scientists at the beginning of this century.

Footnotes, references

1. Authored one of the first Hungarian small monographies on radioactivity (SZILÁRD, B.: Radium Radioactivity. Budapest, 1905. H. Mai and son) and his abstracts, popular scientific papers were published in medical and chemical reviews.
2. His patent specifications are not known only some of his papers on the subjects. It is taken for granted that beside his 15 French patents he had some Hungarian, German and Spanish ones, too.
3. On the initial stage of his activity see Palló G.: Work by Béla SZILÁRD in Photochemistry. (First period of the activity of Béla Szilárd.) Technikatörténeti Szemle. 1973, 19—36
4. A. Laborde discovered the continuous energy-emission by radioactive substances in collaboration with P. CURIE, raising vivid interest, since it was considered as the refutation of the principle of energy-conservation.
5. Collecting the biographic data of Szilárd is mainly due to the indefatigable work by the since deceased Dr. István DARVAS. Thanks to his family for making them available for me.
6. SZILÁRD married the daughter of the French M. P. Compère-Morel.
7. See e.g. in VERESHTCHINSKY, I. V.—PIKAEV, A. K.: Introduction to Radiation Effect Chemistry.* Műszaki Könyvkiadó, Budapest 1967, 362—363.
8. SZILÁRD, B.: Radioactivity in the Igmándi Aperient Water Lecture in the Session of the Chemical Section of the Hungarian Royal Scientific Society, March 28, 1905.
9. SZILÁRD, B.: Über die durch Licht bewirkte Zersetzung des in Chloroform gelösten Jodoform. Zts. f. wissenschaftl. Photographie, 1906, Heft 4.
10. SZILÁRD, B.: Sur l'autocatalyse et décomposition d'un système photochimique. Comptes Rendus, 142, 1906, 1212—1214.
11. In addition to some letters, this relation is best demonstrated by the fact that Szilárd translated Poincaré's most famous book into Hungarian. Poincaré, H.: Tudomány és Föltevés ("Science and Hypothesis"). (Translation and preface by Béla Szilárd, notes by Győző Zemplén.) Published by Hung. Roy. Nat. Sci. Society, Budapest, 1908.
12. SZILÁRD, B.: Sur l'action de quelques corps sur l'iodure de potassium. Comptes Rendus, 144, 1907, 433—435.
13. SZILÁRD, B.: Néhány test hatása jódkálium oldatára (Effect of Some Bodies in Iodine Potassium Solution.) M. Chem. F. 1909, 6—7. füz.
14. SZILÁRD, B.: Sur une certaine motiuité chimique de quelques corps. Boletin del Instituto de Radioactividad. 1917.

Summary

Béla SZILÁRD's lifework was an important contribution to the dissemination of the scientific revolution in Hungary at the beginning of this century. SZILÁRD was mainly engaged in the field of radioactivity, achieved considerable successes with his precise electrometers constructed for activity-measurements. His works in chemical dosimetry have a great significance in his biography: by the help of an article on this subject he entered into relation with the French scientific community; after some years, when he settled down in Paris, he became a member thereof. It is this aspect that SZILÁRD's researches on chemical dosimetry are detailed here.

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* In Hungarian.