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THE POLISH CONTRIBUTION TO MATHEMATICAL AND PHYSICAL SCIENCES IN THE YEARS 1918—1970

The subject is so vast that it seems more suitable for a work in several volumes than for a short conference. I am therefore obliged to confine myself to an outline illustrated by examples taken at random. This review has thus inevitably a somewhat subjective nature.

I shall begin by a short reminder of the achievements of mathematicians whose results are of foremost importance in the fifty odd years under consideration. It is not an accident that this subject has received such intensive study in Poland. The results achieved owe more to man's intelligence than to expensive apparatus. This latter has always suffered from a constant lack of funds but there has been no lack of mental activity.

In 1920 Wacław Sierpiński, Zygmunt Janiszewski and Stefan Mazurkiewicz founded "Fundamenta Mathematicae" in Warsaw. This journal concentrated efforts on the theory of sets and its neighbouring fields such as the theory of functions of real variable, topology, mathematical logic. This review rapidly became one of the most important in the mathematical world. It gave rise to the celebrated Warsaw mathematical school. At the same time Hugo Steinhaus and Stefan Banach founded an excellent centre for research in the field of functional analysis at Lvov. The spaces defined by Banach and called throughout the world Banach's spaces are now currently used in mathematics. At Cracow between the two world wars classical mathematics were above all cultivated: Stanisław Zaremba worked in the field of differential equations, Franciszek Leja contributed to the progress of the theory of analytic functions. At Vilna Antoni Zygmund undertook research of trigonometric series.

After the second world war the Lvov and Vilna centres no longer existed in Poland but an important mathematical centre replaced it at Wrocław and continued the work of the Lvov school. In 1948 under the direction of Kazimierz Kuratowski, and with the collaboration of Karol Borsuk and Andrzej Mostowski, a State Mathematical Institute was founded, which was later incorporated into the Polish Academy of Sciences. One of the successes of this institute has been the widening of the mathematical research field to include analysis, algebra, calculus of probability and different applications.

The Polish mathematical school has had for several generations counted many excellent mathematizicians amongst its members. Professor Sierpiński, who died 21.X.1969 liked to say that Dean of the Mathematical and Physical Faculty of the Warsaw University, Helena Rasiowa, was his scientific great grand-child. She prepared her doctorate under Mostowski, Mostowski under Kuratowski, Kuratowski under Sierpiński. This chain still continues because she has many of her own pupils. Many disciples from Polish mathematical school occupy chairs in the foremost American universities. Amongst them are: Stefan Drobot, Samuel Eilenberg, Marek Kac, Otto Nikodym, Jerzy Spława-Neyman, Alfred Tarski, Stanisław Ulam and Zygmunt already mentioned above.

Although not a professional mathematician, probably the most eminent Polish Astronomer after Copernicus, Tadeusz Banachiewicz, founded Cracovian calculus which is a kind of matrix calculus. This method, which commemorates the name of the former Polish capital, is applied above all in astronomy and geodesy. Banachiewicz was concerned with celestial mechanics, theory of eclipses, photometry, etc.

The study of astronautics is a branch that has sprung from astronomy in the last few years. It happens that in this field, too, one of the foremost names is that of a Polishman, Ary Szternfeld, born at Sieradz who worked formerly in France, and is now in the Soviet Union. He has elaborated the theory of multiple stage rockets and has calculated the parameters of orbits of artificial planetoids and interplanetary trajectories. The agreement between the results of his calculations with the characteristics of orbits used for the launching of Soviet and American artificial planetoids thirty years later, is remarkable.

The other field close to mathematics is that of theoretical physics.

When at the end of 1917 Marian Smoluchowski died unexpectedly, there seemed to no be physicist-theoretician of worldwide status in Poland. But in 1918 there appeared in "Physikalische Zeitschrift" a paper by a young man Wojciech Rubinowicz who at that time was assistant to the great Arnold Sommerfeld at Munich. In this paper selection rules for radiative transitions fundamental to quantum mechanics, were formulated for the first time. Rubinowicz's second publication at almost the same time, which is also a historical document in physics, concerns the theory of diffraction of light. The principal ideas of these two papers from the central theme of Rubinowicz's later scientific activity undertaken at Chernovtsy near his birthplace, than at Ljubljana in Yugoslavia, after at Lvov (first in the Institute of Technology and afterwards at the University), and after the second world war, at Warsaw University.

Theory of multiple radiation was born from the work on selection rules. Rubinowicz made a detailed study of selection rules for electric or magnetic dipole, quadrupole, octopole radiation, etc.; that is to say radiation emitted by a system of two, four, or eight respective electric or magnetic charges. Some of his research was carried out with his disciple Jan Blaton who later met a tragic death in 1948 in a fall in the Tatra Mountains. One of Rubinowicz's most well-known achievements is the explanation of the green spectral line in the aurora borealis. This line must be forbidden line for electric dipole radiation and Rubinowicz identified this line as allowed transition in electric quadrupole radiation.

His research in the field of diffraction Rubinowicz led to elaboration of the theory of boundary wave. In our days this theory still continues to give very efficient complements despite its age (W. Rubinowicz died 13.X.1974).

Rubinowicz's research is widely known and appreciated. But the almost unknown of a Polishman in theoretical physics must not be forgotten. In the last few years in connection with laser development important research in holography has been carried out. Holography is relief photography without lens in coherent light. The first results given by this method in 1949 came from Dennis Gabor, a British physicist of Hungarian origin. But few people remember that thirty years earlier, that is to say in 1920, a Polishman, Mieczysław Wolfke, who was working in Zurich, published the basic theory of this possibility of photographical registering of an image.

Wolfke later worked in Warsaw in the field of experimental physics, especially research at low temperatures. In 1928 in the famous cryogenic centre at Leyden with W. H. Keesom he discovered phase transformation in liquid helium. Helium II is the only known superfluidity liquid.

To return to theoretical physics we must not overlook Władysław Natanson at Jagellonian University, the author of very fine work on optics and on the thermodynamics of irreversible processes, and also Czesław Białobrzeski who was at Warsaw University.

Normally Eddington is recognized as having introduced in 1916 radiation pressure into the theory of the structure of stars. In fact, Białobrzeski, three years earlier, was working in the same way, a fact which many scientific historians forget.

The great accomplishment of Białobrzeski in the inter-war period was the creation at Warsaw University of an experimental laboratory within the Department of Theoretical Physics. Ignacy Adamczewski and Włodzimierz Ścisłowski studied dielectrics conductivity in this laboratory. The former is continuing this work at the Gdańsk Institute of Technology. Stanisław Mrozowski initiated optical research in Białobrzeski's laboratory. The research on spectral lines of mercury is particularly important. Later, in the United States he became well-known for his studies on coal.

Some other physicist-theoreticians of merit could be mentioned.

In contrast to the field of mathematics, even though some eminent scientists were working in theoretical physics, including some who had a few pupils, there was not in Poland at that time (that is to say, before the second world war and in the years immediately following), anything that could be called a scientific school. The creation of such a school is owed to Leopold Infeld. As a junior lecturer he collaborated with Rubinowicz at Lvov and then left Poland before the second world war. He worked with Einstein and Born, with whom he published highly appreciated papers on the theory of relativity and quantum mechanics. Following his return to Poland in 1950 he set up a magnificent centre of theoretical physics at Warsaw. His role, there, was, above all, that of an organizer, initiating research, instructing young research workers. The principle field of study was the theory of gravitation. The main achievements in this field were those of such of Infeld's disciples as Jerzy Plebański or Andrzej Trautman. Infeld's school is not limited to this field only. Józef Werle, for example, is concerned with theoretical nuclear physics, Włodzimierz Kołos with quantum chemistry, etc.

Infeld's activity in theoretical physics after the second world war can be compared to that of Stefan Pieńkowski (which had even greater importance) in experimental physics after the first war. In 1921 he set up at Warsaw University a Department of Experimental Physics which afterwards grew into the Warsaw experimental school. Two branches of research were followed; atomic and molecular optics and X-ray physics. The former of these two branches yielded the most important results, in particular in research on the fluorescence of vapour and gas and on the photo-luminescence of different aromatic compounds. Aleksander Jabłoński, now Emeritus Professor at Nicholas Copernicus University at Toruń, has become well-known for his explanation of the mechanism of glowing colouring matter in solutions. Several foreign scientists came to the Warsaw department to work under Pieńkowski. The proof of the importance of this establishment was the organisation in Warsaw in 1936 of the first international congress devoted to photoluminescence.

The Warsaw laboratories, destroyed in the second world war, were reconstructed and extended by Pieńkowski's own force and initiative. In addition to those fields of research previously undertaken, were added new subjects such as the physics of solids, developed above all by Leonard Sosnowski, and nuclear physics in their broadest sense, to which we shall refer later. Structural research with the aid of X-rays is now continued using, in addition, the method of neutron diffraction. In particular Bronisław Buras, now working in Copenhagen, has elaborated a method of crystal structure investigation called the time-of-flight of the neutron method.

The dielectric research, which started in Warsaw between the two world wars, has been continued by Arkadiusz Piekara and his pupils in Gdańsk, Poznań and Warsaw successively. On the other hand the dielectric research begin before the war in Cracow by Konstanty Zakrzewski and his collaborators Mieczysław Jeżewski, Marian Mięsowicz, Stefan Rosental (the latter afterwards worked with Bohr) and others, was discontinued. In addition to Piekara and his pupils — Jerzy Małecki in Poznań and August Chełkowski in Katowice who are now specially concerned with dielectric saturation, several physical chemists undertook dielectric research. Amongst them are Lucjan Sobczyk in Wrocław and the author of this present work in Warsaw, especially in application to molecular structure determination and to study of molecular interactions.

The subject of several studies undertaken in the between-war period and initiated by Stanisław Ziemecki was that of cosmic rays. This was mostly because the equipment was relatively easy to get. After the war more and more complicated counter techniques were used. Mięsowicz set up a research centre working at a very high level at the Academy of Mining and Metallurgy in Cracow. An excellent type of large counter was elaborated with the necessary electronic plant. Mięsowicz with Jerzy Gierula, Leopold Jurkiewicz and Jerzy Massalski have made very interesting discoveries on cosmic rays at great depths. Following this, they have studied the structure of cosmic rays showers. Cracow research scientists have shown that highest energy level collision of two nucleons is produced with the emission of secondary particles from two centres approaching one another. In this way they have created the two centre models called the fireball model. In passing it may be mentioned that

Geiger counter and electronic techniques elaborated during the of cosmic ray research are used in geological exploration of oil deposits.

A great success of Aleksander Zawadzki and his collaborators at Łódź was finding in primary cosmic rays of photons with extremely high energy of the order of 10^{15} electron-volts, by the use of multi-detector hodoscope systems.

Nevertheless, we cannot, of course, consider nuclear research without remembering the contribution of Maria Skłodowska-Curie who founded the bases of the science of radioactivity. In the period after the first world war she was principally concerned with chemistry of polonium, the first radioelement discovered by her, with her husband. It must be noted that later research by other scientists has contributed very little more to the initial work done in his field by Maria Skłodowska-Curie. In addition to polonium she also studied at that time actinium and ionium — one of the theorium isotopes.

In her Paris laboratory she trained with particular care Polish physicists and chemists who passed on the science and knowledge thus obtained in the scientific institutes of their own country. Amongst them can be mentioned: Alicja Dorabialska, Henryk Herszfinkiel, Henryk Jędrzejowski, Zygmunt Klemensiewicz, Cezary Pawłowski, Jerzy Starkiewicz, Ignacy Złotowski. Moreover up to the time of her death she sponsored the Mirosław Kernbaum Radiological Laboratory founded in 1913 in connection with the Warsaw Scientific Society. This laboratory was under the direction of Ludwik Wertenstein, one of the most brilliant disciples of Maria Skłodowska-Curie and also of Ernest Rutherford. Despite the fact that material conditions were very difficult in the laboratory a great contribution was nevertheless made to the science of radioactivity. I should like first of all to recall the work of Wertenstein himself concerning nucleus recoil in the course of alpha desintegration and beta decay; this research was a continuation of work carried out in Paris. Under three months later after Irène and Frédéric Joliot-Curie had discovered in Paris artificial radioactive nuclei, Marian Danysz and Michał Żyw in the Warsaw radiological laboratory, by bombardment of nitrogen by alpha particles obtained radioactive fluorine and in the same way radioactive scandium from potassium. But probably the most important achievement in this laboratory in the same year 1934 was the discovery of the inelastic scattering of neutrons, that is to say, not only do the neutrons change their velocity they also enter into the nuclear reaction. The great Enrico Fermi, who was working at that time in Rome and who had at his disposal almost a whole gram of radium in order to obtain neutrons, maintained that neutrons could not provoke cobalt radioactivity. On the other hand, in the Warsaw laboratory Józef

Rotblat, having only 30 milligrams of radium in solution, obtained radioactive cobalt which now plays a very important part in scientific research, in technical work, and in therapy. He also obtained some other radioactive nuclides.

The discovery in 1938 by Otto Hahn and Fritz Strassmann of fission of uranium by the effect of neutrons had no technical use until it was realised that new neutrons are formed in the process; this is thus a chain reaction. This phenomena was discovered in the Warsaw laboratory as early as the beginning of 1939. But due to the limited source of neutrons, experiments had to be repeated for two months and consequently Frédéric Joliot's results preceded those of the Polish scientists.

The Kernbaum Laboratory existed until October 1939. Most of the laboratory staff, including Wertenstein, met their deaths during the war. Only a few survived. Rotblat, who left Poland in 1939 to take up a foreign grant, took part in the following years in the development of nuclear uranium bomb in Los Alamos. At this point we must also recall another Polishman, the eminent mathematician Ulam, already mentioned above, who played an important role in the calculations of thermonuclear hydrogen reaction.

Rotblat, now a Professor in London, afterwards reorientated his studies to the application of physics in medicine and biology.

Danysz, who was also a product of Wertenstein's laboratory, took part in the probably the most important Polish post-war discovery in physics. In 1952 Danysz and Jerzy Pniewski, by the photographic emulsion method, discovered the hypernucleus. This is a nucleus in which alongside the nucleons (protons and neutrons), the usual components of an atomic nucleus, an unstable neutral elementary particle — lambda hyperon (Λ) is found. The discovery of the hypernuclei opened a new chapter in physics, which is now studied in many laboratories in different countries. Several species of hypernuclei are now known for example: ${}^{3}_{\Lambda}H$, ${}^{4}_{\Lambda}H$, ${}^{4}_{\Lambda}He$, ${}^{5}_{\Lambda}He$, ${}^{7}_{\Lambda}Li$, ${}^{9}_{\Lambda}Be$. In 1962 the discoverers of hypernuclei announced the possibility of the existence of so-called hyperisomers i.e. hypernuclei for which a noticeable fraction of lambda decays are observed from the excited states. The following year the same scentists and Janusz Zakrzewski and some younger collaborators discovered the double hypernucleus, that is to say, containing two lambda hyperons: beryllium 10. A little later the American physicist, D. Prowse, found another double hypernucleus, helium 6. Hypernuclear physics, which are developing at great speed, and at the forefront of which can be found Polish scientists, now study lambda binding energy, the lifetime, mechanism and efficiency of the production of hypernuclei, decay modes and other characteristics. The information obtained enables conclusions to be drawn on the interactions between hyperons and nucleons and, on the other hand, greatly increases knowledge of the physics of "ordinary" nuclei. Almost twenty years have passed since the discovery of the first hypernucleus and during that time several hundred papers have been published in the field of hypernuclear physics.

Nuclear research of many different aspects was initiated by Andrzej Sołtan and continued by his disciples, after his death, in the Institute of Nuclear Research, founded in 1955, in particular in the Świerk centre near Warsaw. Henryk Niewodniczański created another important centre — the Institute of Nuclear Physics — at Cracow. One of his disciples, Jerzy Janik, is now studying the properties of molecules of liquids by the scattering of neutrons. Andrzej Hrynkiewicz, from the same centre, has been employing magnetic nuclear resonance method and Mössbauer effect in studies of solids and liquids.

Even before the first world war, Stanisław Kalinowski founded a Magnetic Observatory at Świerk near Warsaw. His greatest achievement in the between-war period was a magnetic chart of Poland. This observatory then undertook, in addition, research on atmospheric electricity and on other geophysical fields. It is now named after its founder. The head of the observatory is the daughter of Stanisław — Zofia Kalinowska.

On the borderline between physics and chemistry is physical chemistry.

Wojciech Świętosławski was one of those most responsible for forming the characteristics of Polish physical chemistry in the first half of this century. It is therefore worthwhile considering his scientific profile in more detail.

His scientific career began in Russia, first in Kiev, and then in Moscow. Already as a young assistant he had crystallised his scientific interests. He started thermochemical studies of certain organic compounds.

In 1918, when Poland became once more independent he came to Warsaw where he was named Professor of physical chemistry at the Warsaw Institute of Technology. Here in his thermochemical research he used a new measurement method — microcalorimetry. Two of the microcalorimeters, made in this laboratory in contact with Maria Skłodowska-Curie, were used in Paris to study the heat given off by certain radioactive substances.

It seems to me that the outstanding particularity of his scientific way of thought was his constant search for accuracy of measurements. Absolute measurement, in order to be accurate, necessitates very precise apparatus, carefully calibrated and also introducing many corrections, for example, in calorimetric measurements over twenty are necessary.

Only highly qualified specialists can carry out such measurements. To simplify measurement technique Świętosławski conceived the principles relating to the application of comparative physicochemical measurements. As a thermochemical standard with known heat of combustion Święto-sławski proposed benzoic acid. This proposal was approved in 1922 by the International Union of Pure and Applied Chemistry (IUPAC).

Using the standard, absolute measurement is carried out. The corresponding quantity, in the particular case of heat combustion has been determined by highly qualified scientists, in a laboratory well equipped with high precision instruments, very carefully calibrated, and taking into account all corrections. On the other hand comparative measurement can be made by ordinary research workers using simple equipment, who under identical conditions, determine for example, heat of combustion of the standard and heat of combustion of the substance being studied, and by comparison they obtain the exact value of the quantity under research. This method enables: 1) the number of corrections to be reduced and even, in certain cases, to be totally eliminated; 2) errors in measurements to be diminished and 3) the simplest and therefore the cheapest apparatus to be used. Moreover the results obtained by different scientists using different methods and applying different apparatus are comparable.

One of the most important parameters which characterize a substance is boiling temperature. The ebulliometers formerly used to determine this gave indications which were a little too high because of overheating of the liquid. Thus Świętosławski who tried constantly to eliminate, if possible, all experimental errors, with Witold Romer (later Professor of phototechniques in Wrocław) in 1925 prefected the apparatus now called the Świętosławski ebulliometer, enabling boiling temperature to be measured both simply and accurately. In this way a whole ebulliometric school was founded in Warsaw. It must be noted that Świętosławski knew how to carry out his projects using the simplest of means.

In 1934 IUPAC, also at Świętosławski's suggestion, adopted water as a standard in ebulliometry and tonometry.

In passing it may be noted that Świętosławski was honoured by election as Vice-President of IUPAC, a position he occupied for several years. He was also Chairman of the IUPAC Standing Commission on Thermochemistry and Chairman of the IUPAC Commission on Physico-chemical Data.

Świętosławski proposed a purity scale of substances based on the difference between boiling and condensation temperatures. The ebullio-metric method of testing the purity of a liquid substance cannot be applied in the case of azeotropy. An ebulliometer enables: this phenomen to be detected easily and the composition of an azeotropic mixture to be determined. In this way the field of research in vapour-liquid equilibria, led by Świętosławski's school, was greatly extended. Working during the second world war at the Mellon Institute of Industrial Research in Pittsburgh, Pennsylvania, and after the war in Warsaw again with numerous collaborators (amongst them Andrzej Orszagh and Kazimierz Zięborak) Świętosławski discovered new types of azeotropes and polyazeotropes. He chose coal tar and the oils derived from it as the principal subject of his research. Systematic azeotropy and polyazeotropy research led to the elaboration of original fractional distillation methods which permit the separation of the components of this complex mixture. Thus the quantity of important coal-tar products considerably increased including, above all, naphtalene and pyridine bases, which are used especially in pharmaceutical industry. Coal is no longer the principle raw material for the chemical industry and coal-tar interests scientists to a lesser degree, but the results produced by Świętosławski's school can still be applied to other organic raw materials.

Research into chemical kinetics between the two world wars was led above all by Jan Zawidzki — disciple of Wilhelm Ostwald. In the Warsaw Institute of Technology he developed the theory of autocatalysis, elaborated previously by Ostwald. One of Zawidzki's pupils, Edward Józefowicz continued kinetic research at Łódź (he died 19.I.1975).

The centre of colloid chemistry was founded at Poznań between the two wars. The most eminent scientists were Stanisław Glixelli and Antoni Gałecki. Antoni Basiński is now continuing this line of research at Toruń.

The colloid research instigated by Gałecki concerned, amongst other things, silver hydrosol. This work was connected with research on photosensitivity. Amongst the photochemists of the younger generation can be named Zbigniew Grabowski at Warsaw.

After the war physicochemistry of solids developed in Poland. Particularly active in the field are Włodzimierz Trzebiatowski and many collaborators at Wrocław who are interested in alloy structure and intermetallic compounds and equilibria in metallic and oxide systems. Another centre exists at Cracow where Adam Bielański and his disciples, Jerzy Dereń and Jerzy Haber, carry out research especially on solid catalysts. Trzebiatowski and his pupil Bohdan Staliński have also contributed to magnetochemistry by discovering, amongst other things, new cases of ferromagnetism.

When speaking of the achievements of Polish physical chemistry Kazimierz Fajans must not be forgotten, who though he has never worked in Poland, has many connections with the land of this birth. Fajans worked in Germany and in England and is at present in the United States at Ann Arbor. This scientist, famous above all for his discoveries in radiochemistry, is not to be found amongst the Nobel laureates, probably as a result of an oversight or a misunderstanding.

During the period in which we are interested Fajans devoted himself to theoretical and experimental research on a molecule and crystal structure. He links ion and molecule polarizability to refraction. In recent years he has elaborated a very interesting electrostatic theory of chemical binding which he has called quanticule theory. This theory supposes that electronic system of a molecule or crystal is subdivided into groups of definite quantization (quanticules) and that all interactions are due to electric forces acting between the nuclei and electrons within and between the quanticules. Despite his age he is still pursuing his research in this field.

On the other hand a few centres of quantum chemistry were set up in Poland after the war. Above all must be mentioned an important group created at Cracow by Kazimierz Gumiński. This centre is also concerned with theoretical research in the field of chemical thermodynamics, principally with the irreversible process. This line is also followed by Bogdan Baranowski in Warsaw. Henryk Buchowski has obtained interesting results in solution thermodynamics in Łódź. Witold Tomassi, in Warsaw, carries out thermodynamic research in application to electrochemistry, especially to powder electrodes.

Polish electrochemistry developed intensively at Cracow, where in 1920 the chair of physical chemistry at Jagiellonian University was occupied by Bohdan Szyszkowski, a disciple of Wilhelm Ostwald and Arrhenius. He can be esteemed a pioneer, at a international level, in the field of strong electrolyte theory. In 1932 Bogdan Kamieński succeeded him. With his pupils he undertook research into electric phenomena in interface and into the adsorption linked to it. One of his pupils, Andrzej Waksmundzki, instigated this line of research at Lublin after the war. Amongst present-day electrochemists must not be forgotten Stefan Minc, who first at Gdańsk and now at Warsaw studies electrolyte structure. We must also remember Michał Śmiałowski, who worked at Gliwice immediately after the war and is now in Warsaw, and who is interested in electrode process, particularly those which intervene in corrosion.

One division of electrochemistry is polarography, which was created in Czechoslovakia by Jaroslav Heyrovsky. Amongst his disciples is Wiktor Kemula. Before the war he worked in Lvov and afterwards in Warsaw. He is founder of the Polish polarographic school which has an international reputation. One of the pupils of this school, for example, is Jerzy Chodkowski. The greatest achievements of Kemula and his collaborators are the linking of polarography to chromatography to give chromatopolarography, and elaboration of the method of the hanging mercury drop electrode. These are very sensitive analytical methods. Kemula, along with his other work, has also contributed to the development of analytical chemistry. It may be noted that he is now President of the IUPAC Analytical Chemistry Division.

Another earlier eminent analyst was Tadeusz Miłobędzki who was head of the Department of inorganic chemistry, at different times, at Poznań University, Warsaw Agricultural College, and the Warsaw Institute of Technology. His university manuals on qualitative and quantitative analysis are generally known. Between two world wars and immediately after-wards he made an important contribution to the chemistry of phosphoric and hypophosphoric acids.

Amongst inorganic chemists now alive I should like to mention Bogusława Jeżowska-Trzebiatowska, who founded a great centre for coordination chemistry at Wrocław, Włodzimierz Hubicki at Lublin, who is interested in the chemistry of rare elements, and Włodzimierz Rodziewicz at Gdańsk who is developing the chemistry of silicon compounds. In Warsaw Mieczysław Taube was studying the chemistry of transuranium elements but he is now in Zurich.

Organic chemistry has and has always had eminent representatives in Poland.

The study of chlorophyll and the realisation of its structural analogy with haemoglobin had already made Leon Marchlewski's name famous at the beginning of the present century. When he was nominated Professor of physiological chemistry at the Jagiellonian University Faculty of Medicine he founded a centre with a world-wide reputation for research into vegetable dyes.

Another important centre of organic chemistry existed at the same university and was headed by Karol Dziewoński. He became well-known for the synthesis of coloured polynuclear hydrocarbons, in particular acenaphthene, the products of its polymerisation and its derivatives. Jan Moszew, who recently died, and who succeeded Dziewoński, continued his work. Another of Dziewoński's disciples, Jerzy Suszko, studied similar problems at the Lvov Institute of Technology and afterwards at Poznań University, where he also instigated alkaloid research and studies of the symmetry of aromatic compounds.

Amongst other alkaloid scientists I should like to mention Osman Achmatowicz, who worked before the war in Vilna and Warsaw, and after the war in Łódź and Warsaw once more; Zofia Jerzmanowska in Łódź; and Rufina Ludwiczak in Poznań. Achmatowicz also made an important contribution to the chemistry of carbonyl cyanide. Research in this field is led at present in Warsaw by Jerzy Wróbel, one of Achmatowicz's pupils. Another of his disciples, Jan Michalski, has obtained significant results in the field of the synthesis of organophosphorous compounds in Łódź.

Alkaloids are not the only group of natural compounds which interest Polish organic chemists. Henryk Kuczyński in Wrocław and Witold Zacharewicz in Toruń were studying terpens; Leon Kamieński (who died) in Gdańsk and Jan Świderski in Warsaw were interested in sugars; Marian Kocór, first in Wrocław and now in Warsaw, is concerned with steroids.

Synthetic polymers are the subjects of research of amongst others Stanisław Porejko in Warsaw, Zbigniew Jedliński in Gliwice and Łódź physical chemists, Marian Kryszewski and Eligia Turska.

Between the two world wars a centre of organic chemistry at Lvov, headed by Stefan Niementowski, undertook research into the synthesis of heterocyclic compounds. From this school came, amongst others, Edward Sucharda who worked in Lvov before the war and afterwards in Wrocław. Sucharda, in addition to synthesis, also studied the analysis of organic compounds. With Bogusław Bobrański he elaborated a method of quantitative analysis, which requires only a very small quantity of the substance under analysis. Bobrański, at present in Wrocław, is also working on the synthesis of heterocyclic compounds, some of which are used as medicines. Significant work in the field of pyridine chemistry was carried out in Wrocław by Edwin Płażek, now deceased.

Tadeusz Urbański at Warsaw Institute of Technology leads work of international importance in the field of the synthesis of nitro-compounds and studies their structure. In the same Institute Wanda Polaczkowa has obtained valuable results in theoretical organic chemistry.

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This very incomplete review of the activity of Polish mathematicians, physicists and chemists in the fifty odd years under consideration, is an effort to extract those results which represent a significant part of the world's scientific treasure from amongst a multitude of different scientific achivements. This paper deals with the accomplishements of scientists dead or alive, working in Poland or obliged by one thing or another to work abroad. This paper also concerns individual people or whole scientific schools. It object is to underline the continuity of tradition. I have mentioned many names, but there are many others, perhaps no less eminent, whom I have been prevented from discussing by the limits of this papers.

The team of eminent pre-war scientists, the majority of whom were replaced by their disciples has now, in its turn, given way to the younger generation. In all the fields under consideration, from mathematics through astronomy, theoretical and experimental physics to the different branches of chemistry, despite often difficult conditions of work and frequent obstacles in the way of organisation. Amongst these younger scientists, there are already many names of which Polish science may be proud. Their existence is a source of encouragement.