GYULA RADNAI

REZSŐ KUNFALVI

PHYSICS IN BUDAPEST

A SURVEY

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Gyula RADNAI – Rezső KUNFALVI

PHYSICS IN BUDAPEST
A SURVEY

Lett volna itt tehetség, csak
nem tudtuk felhasználni....

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1. The very beginning

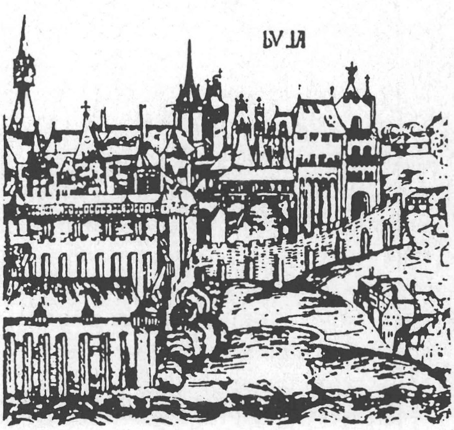
The name Budapest, as we know it, is not very old – in fact it is not much more than a hundred years old.

It was only at Christmas 1872 that Buda and Óbuda, the two towns spread over the hills on the right bank of the Danube, were officially united with Pest, a town spread over the plain of the left bank.

Óbuda was an important castra of the Roman legions as well as a junction point and cultural center. On various occasions and particularly more recently, many of its ruins and remnants have been explored and turned into interesting sightseeing spots. The remnants of an important crossing point from the 3rd century next to the Erzsébet bridge are worth visiting.

On the Pest side the crypt of the Rókus Chapel was built in the 10th century.

The original royal palace on the Castle Hill was built in the gothic style. The royal court became an important cultural centre in the 15th century, and King Matthias Corvinus



Buda castle in the Middle Ages.

The 15th century renaissance king Matthias Corvinus surrounded by scholars of his time in his court. A Károly Lotz fresco in the Assembly Hall in the Palace of the Academy.

Ruins of the Roman Fortress guarding the crossing over the Danube.

Regiomontanus (Johannes Müller), astronomer (1436–1476).

was a true renaissance monarch. He invited to his court, among others, Regiomontanus, i.e., Johannes Müller von Königsberg (1436–1476) who, after finishing studies at Leipzig and Vienna, stayed in Italy and while there, translated the Almagest, a manual of astronomy by Ptolemy, from the Greek. The translation was then used by Copernicus and by Galilei. In Hungary Regiomontanus pursued astronomical observations and made some instruments. The king had copies made of his books and obtained from him tabulated observations which could be, and were in fact, used for making horoscopes.

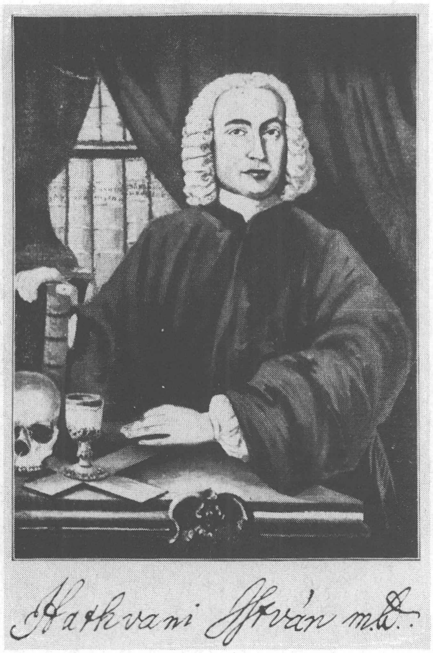
Johannes KEPLER (1571–1630) included in the design of the cover plate of the astronomical tables made for the emperor Rudolph the portrait of Regiomontanus who had merited the honour of being included in the company of Ptolemy, Copernicus and Tycho de Brahe. As a Lutheran, Kepler had to leave Graz within 24 hours in 1598, and fled to Hungary where he spent some time.

Of the many disasters in the history of Hungary the sixteenth and seventeenth century stand out as particularly difficult times. Buda had been taken by the Turks in 1541 and it was not before 1686 that they could be expelled. In the east Transylvania – an independent principality – had to struggle hard for her survival. In the west the Hungarian Royal Crown was worn by the emperors of the Habsburg House. For two centuries the kings were crowned in Pozsony (now Bratislava in Czechoslovakia) which – only thirty miles from Vienna – was Hungary's capital at the time.

At that time, as in other difficult periods in Hungary's history, the monastery schools and the protestant colleges attempted to keep in contact with the West. As Professor of the Graz University (1598–1600) Cardinal Péter PÁZMÁNY still lectured on Aristotle's physics.

Kepler's draft for the frontispiece of his book. The second from left is Regiomontanus.

Cardinal Peter Pázmány (1570–1637). He founded the University in 1635.

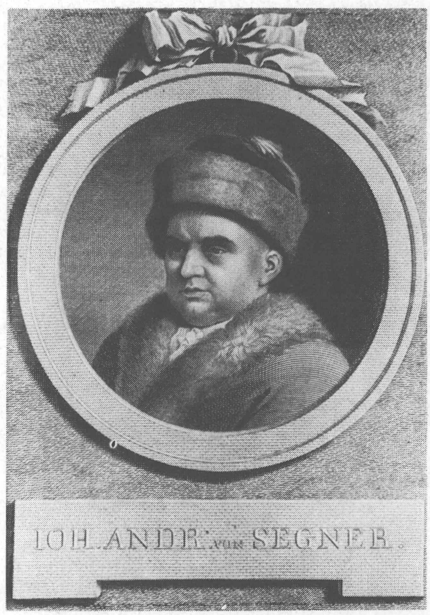


Istvan (Stephen) Hathvani (1718–1786) taught Physics, Chemistry, Medical Sciences.

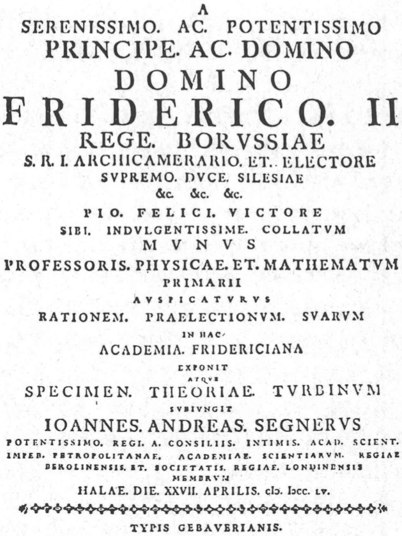
István (Stephen) HATHVANI (1718–1786) a Professor of the Debrecen College and scientist of high renown, went on foot (together with his friends) to Basle. There he became a pupil of Johann and Daniel Bernoulli. In Leyden he had the opportunity to observe the electrical experiments of Musschenbroek. He had been offered several University Chairs in Western Europe but he returned home to the Debrecen College where he taught mathematics and subjects of natural science. He also practised as a physician and successfully cured and healed patients who came from far-off regions.

János András (John Andrew) SEGNER (1704–1777) was born in Pozsony but obtained his medical degree at the Jena University in 1729. After spending two years in Hungary he returned to Jena where he studied and taught mathematics. In 1735 he was already professor of mathematics, physics and chemistry at the Göttingen University which was founded at the time. He remained there for twenty years before moving on to Halle as a professor of physics, mathematics and astronomy.

His most significant achievements in physics were attained in the dynamics of fluids and of rigid bodies.



János András Segner (1707–1777) taught Physics, Mathematics and Astronomy in Göttingen and Halle.



A
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FRIDERICO. II
REGE. BORVSSIAE
S. R. I. ARCHICAMERARIO. ET. ELECTORE
SVPREMO. DVCE. SILESIAE
&c. &c. &c.
PIO. FELICI. VICTORE
SIBI. INDVLGENTISSIME. COLLATVM
MVNVS
PROFESSORIS. PHYSICAE. ET. MATHEMATVM
PRIMARII
AVSPICATVRVS
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EXPONIT
ATQVE
SPECIMEN. THEORIAE. TVRBINVM
SVBIVNGIT
IOANNES. ANDREAS. SEGNERVS
POTENTISSIMO. REGI. A. CONSILIIS. INTIMIS. ACAD. SCIENT.
IMPER. PETROPOLITANAE. ACADEMIAE. SCIENTIARVM. REGIAE
BEROLINENSIS. ET. SOCIETATIS. REGIAE. LONDINENSIS
MEMBRVM
HALAE. DIE. XXVII. APRILIS. clↄ. Iↄcc. LV.
TYPIS GEBAVERIANIS.

Front page of Segner's book (by courtesy of Professor Iván Abonyi).

Miksa (Maximilian) Hell (1720–1792), astronomer, observed the transit of Venus in 1769.

These achievements caught the attention of Leonhard Euler (1707–1783) who later on based his equations on the papers of Segner. Segner wrote mathematical textbooks on the level of those times, and was engaged in studying gyroscopes and the stability of uncoupled axes. He established observations in Göttingen and Halle. In 1971 a successful search was undertaken by a Hungarian scientist for Segner's grave in Halle.

Miksa (Maximilian) Hell (1720–1792) was a famous Hungarian-born astronomer from the 18th century. He was responsible for the setting up of the Vienna observatory (1756) and in 1769 led an expedition to an island off the shore of Norway to observe the transit of the planet Venus in front of the Sun. As the phenomenon occurred at night, it could only be observed from a place where the Sun appeared above the horizon at midnight. From the measurements Hell obtained 8.70″ for the parallaxis of the Sun; and according to this the distance of the Earth from the Sun is 151.2 million km. The expedition brought about an important discovery in another field: Hell and his colleague established the relationship between the Hungarian language and that of the Lapps, as the first recognized proof of the Hungarian–Finno-/Ugrian relationship.

In 1780 Hell supervised the building of the observatory established for the University which at that time was transferred to Buda. This University today bears the name of Loránd Eötvös and was originally founded at Nagyszombat (today Trnava in Czechoslovakia) in 1635 by Péter Pázmány (1570–1637), because at that time Buda was still in the hands of the Turks.

In 1777, a hundred years after the Turks had been defeated, Maria Theresia, a most energetic Habsburg monarch, ordered the University to be moved to Buda. Farkas (Wolfgang) KEMPELEN (1734–1804) was appointed to carry out the transfer. Like Segner Kempelen was born in Pozsony. His name is remembered because of his world-famous chess playing machine, but he had some far more important inventions. His most significant scientific paper concerned the mechanism of human speech, a pioneer work in respect to physics, biology and linguistics alike. To confirm his theory Kempelen constructed a mechanical talking machine that uttered words fairly intelligibly as a child of 3–4 years would. Kempelen's qualities as inventor and architect have been recorded through the many devices he created.

It is a historical fact that the "rebuilding" of the country after the Turkish occupation required tremen-

Farkas (Wolfgang) Kempelen (1734–1804), inventor.

Napoleon is said to have played chess with Kempelen's automaton.

dous efforts. There was no lack of talent but the individual inventors and scientists had no organizations or institutions to assist them. There was also no industry and no national scientific language.. All this was still to be realized in the 19th century.

2. Struggle for independence in the 19th century

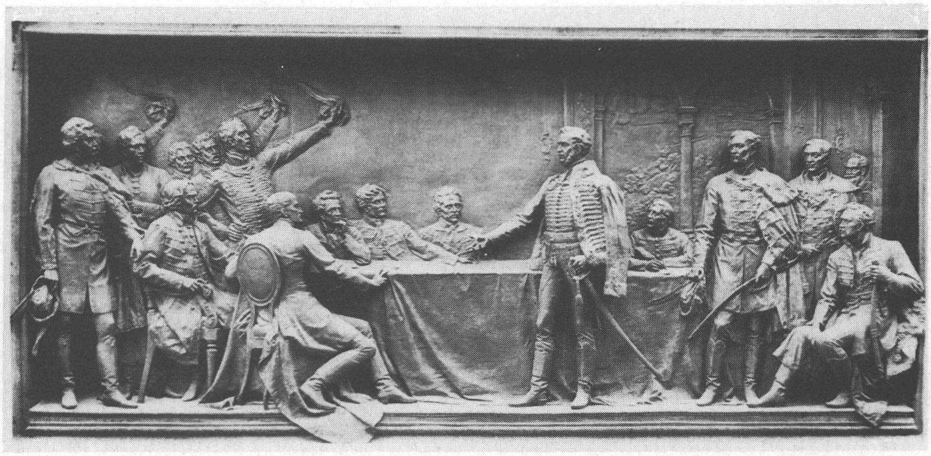
While recovering from the effects of the Turkish occupation, the country's commitments and bounds to Austria increased and strengthened.

All the important official institutions with one exception were located in Pozsony. The University was transferred to Buda because Maria Theresia did not want to use the Buda castle as her residence and moved the university to the castle instead. Her son Joseph II then moved it further to Pest. As regards its organizational structure – either in Buda or Pest – the University remained a "cadet" of the Vienna University or in fact a step-child in many respects.

Count István (Stephen) Széchenyi (1791–1860) "The Greatest Hungarian". Oil painting by Friedrich von Amerling, 1836.

In the first half of the 19th century count István (Stephen) SZÉCHENYI (1791–1860) had the clearest vision of the reforms necessary for the raising of the cultural standard, involving progress of industry, liberation from the hegemony of Austrian/German influence, and the evolution of a Hungarian scientific language. His actions suited his ideas: he offered one year's total income of his estates for the foundation of the Hungarian Academy of Sciences, foreseen at that time for the cultivation and improvement of the Hungarian language. This and some other donations enabled the Academy to commence its scientific functions. The first vice-president was Count Széchenyi himself.

It was Széchenyi who also started a regular service of steamships on the Hungarian section of the Danube and



Count Széchenyi founded the Hungarian Academy of Sciences in 1825. Relief by Barnabás Holló on the Akadémia street side of the Academy building.

the regulation of the river for better navigability with the aim of establishing a West–East link through direct, regular steamship service between Vienna and Constantinople. He had a shipyard built in Óbuda and laid on public lighting using gas lamps on both sides of the Danube. He initiated and promoted the building of the chain bridge "Lánchid" which bears his name and which was the first permanent bridge between Pest and Buda. He invited engineers and contractors from England in order to have the best experts and also to reduce Austria's influence. The experiences he gained in England and France were meant to be put to use in reforming Hungary's economic system. Széchenyi became the leader of the Hungarian reform movement, and Kossuth – politically representing much more radical views – named him "the greatest Hungarian". Széchenyi's personal fate was inseparably linked with that of the country. In 1848 when the reform movement led to the March revolution and in 1849 to the Hungarian war of independence, both were doomed to failure and disaster, the conflict with himself and the mental torment to which he was subjected brought about his suicide. The greatest Hungarian had been born in Vienna and died there.

Other important scientists were the PETZVÁL brothers who came from a German minority group in North Hungary but declared themselves Hungarians from the very beginning. Both obtained their diploma in engineering from the Pest University (formerly of Buda).

The elder brother József Petzvál (1807–1891), the more famous of the two, became professor of mathematics at the Vienna University and pursued theoretical and practical research in optics. His name has been kept alive by the Petzvál thesis on optical projection and by the Petzvál portrait objective. He was elected member of the Wiener Akademie der Wissenschaften but it was Voigtländer, a Vienna optician who made a fortune out of the Petzvál photoobjective.

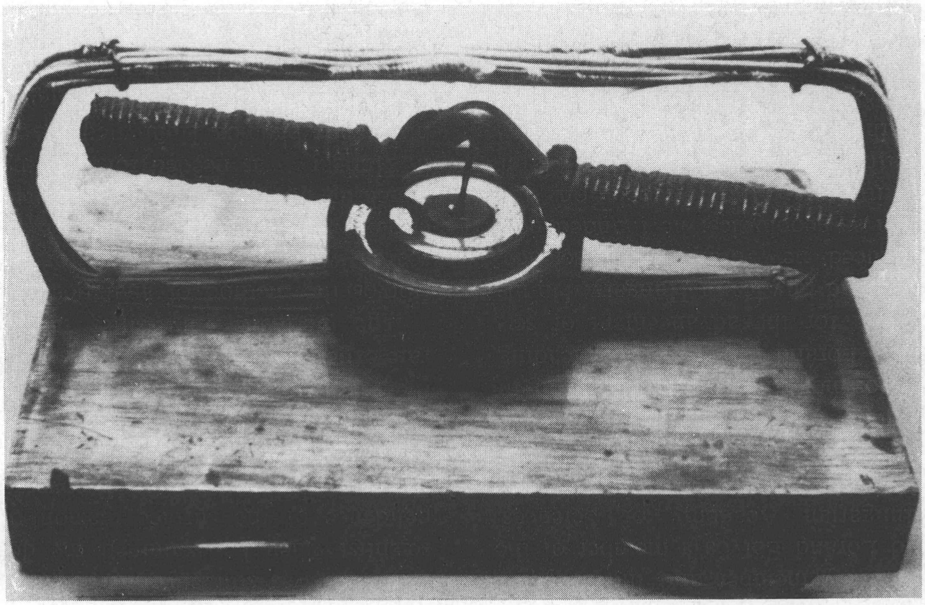
The younger brother Otto Petzvál (1809–1883) was professor of mathematics and of astronomy at the Budapest University. The language of of his lectures was at first Latin, then German and Hungarian, then exclusively Hungarian from 1860 onwards. On two occasions he received the highest prize of the Hungarian Academy for his textbooks.

Ányos István Jedlik (1800–1895) professor at the University, constructed the dynamo before Siemens, and built a machine to make diffraction gratings.

József (Joseph) Petzval (1807–1891) constructed photographic lenses.

The first real physicist among the members of the Academy was Ányos István JEDLIK (1800–1895). The talented child of a Hungarian farmer family near Pozsony, he became a Benedictine monk and a physicist, teaching first at the Győr secondary school of his Order, then at the Pozsony Academy of Sciences, and finally became Professor of physics/mechanics at the Pest University where he held this chair for almost forty years.

electric motor back in 1828, in which he used for the first time the mercury tank commutator that reversed each time at the right moment the direction of the current through the rotor of the device. His other innovation



The Jedlik Rotor.

was the use of an electromagnet instead of a permanent magnet.

Jedlik was the first true experimental physicist at the University. He was very impressed by the discoveries of Volta, Oersted, Ampère and Faraday and he made his own devices to repeat their experiments. While repeating the experiments of Oersted he came upon the idea of how one could use the magnetic effect of electricity to build a machine that can perform a continuous rotary motion. That is how he invented the "ancestor" of the

An experimentalist by nature, Jedlik was aware of the close link between chemistry and physics; this link was closer than between mathematics or engineering. His chemical experiments were most interesting. Among others, he constructed a machine producing soda water. He was also engaged in improving galvanic cells and batteries.

In the first decade of his professorship he improved and completed his laboratory equipment. It is interesting to note that at that time the Vienna University spent yearly 1100 florins on such expenses, while the Pest budget amounted to approximately 100 florins.

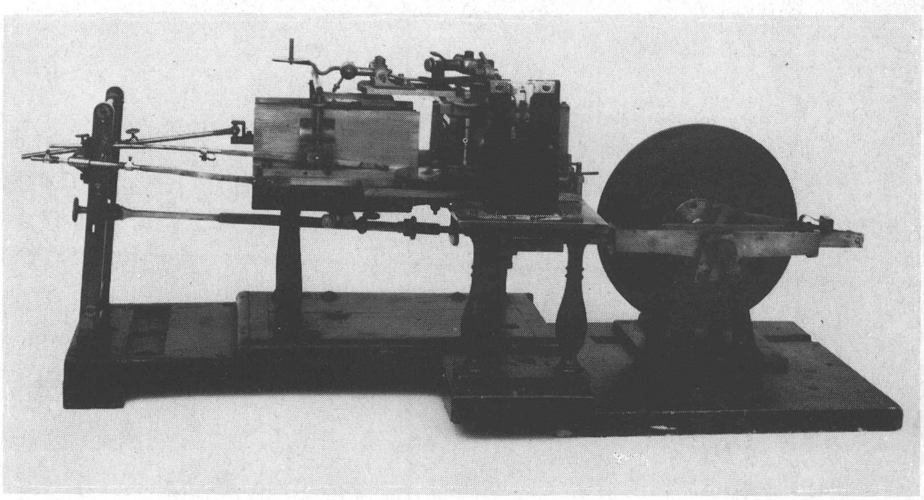
During the 1848 revolution Jedlik was dean. With the exception of Jedlik's lectures, most of the students did not attend classes. In 1849 when the guns of the fortress of Buda were trained on Pest, he personally carried all the instruments into the cellar of the university, along with the salvaged instruments of the much damaged Buda observatory.

3. Slow recovery after the disaster of 1849

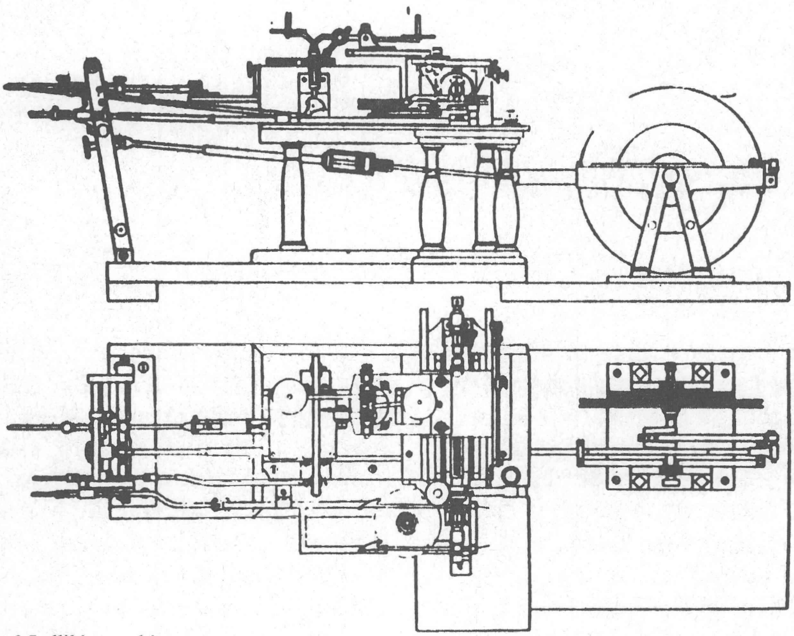
When the war of independence was suppressed in blood and followed by terror, Jedlik continued to lecture in Hungarian. He was fully engaged in research work and made many important discoveries. Among his inventions mention must be made of the machine to produce optical gratings, the result of twenty years' work. He used diamond to scrape parallel lines into glass – 1200 lines for each mm using a device driven by an electric motor.

Jedlik's most important discovery was the principle of the dynamo. In 1856 he had the idea that the performance of current generators could be perfected by using the current produced by the machine to feed their magnets. In fact, he observed that the very slight remanent magnetism present in the iron core of the electromagnets was sufficient to start the process of induction.

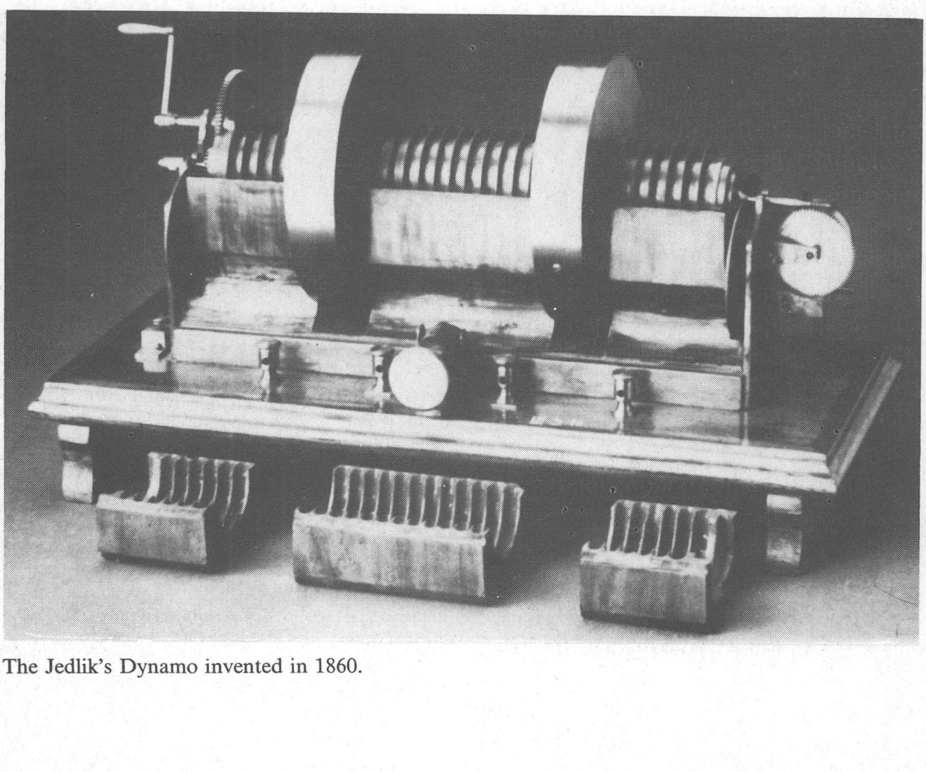
It is a recognized fact that the principle of self-excitation, i.e. of the



Jedlik's simple machine to make fine diffraction gratings.



Draft of Jedlik's machine.



The Jedlik's Dynamo invented in 1860.

dynamo, was financially exploited a few years later by Siemens and Wheatstone to whom Jedlik had not been known. So Jedlik had the same experience with the dynamo as Heinrich Hertz (1857–1894) with his discovery of the electromagnetic waves many years later; the same happens to Robert Pohl (1884–1974) with his transistor effect in the 20th century. It seems all these physicists had something in common....

Another interesting fact is that Jedlik had a great number of students attending his lectures, but few disciples and few assistants; in fact he did not even have an assistant at the university. No doubt, his retiring nature, his interest in things rather than people, played a part in this.

In 1858 when the Academy of Sciences could again convene after an interval of ten years, Jedlik was elected as member, and at the same time Alexander von Humboldt (1769–1859), Robert Wilhelm Bunsen (1811–1899), Sir J.F.W. Herschel (1792–1871) and Michael Faraday (1791–1867) were elected foreign members. The new vice-president Baron József (Joseph) Eötvös had a great influence on these events.

Baron József (Joseph) Eötvös (1813–1871) novelist and statesman, father of Loránd (Roland) Eötvös.

József (Joseph) Eötvös (1813–1871) was a prominent novelist who drew a shattering picture of the backwardness of the rural regions of Hungary. As a politician propagating progress and reform, he was Minister of Cultural Affairs in the first independent Hungarian cabinet. However, when the revolution shifted to the left, he fled with his family first to Vienna, then to Munich and returned to Hungary only two years later. This way – though representing Széchenyi's principles – he was relatively a more acceptable partner for the Austrian government. His farsighted, humanistic policy was particularly helpful in the sixties when the political compromise of 1867 was elaborated. From 1866 on he was President of the Academy. He took an active part in the preliminary proceedings of the compromise and was again Minister of Cultural Affairs in the new government. At the same time

Loránd (Roland) Eötvös in 1876.

he arranged that his son Loránd, who had been born shortly before the family's flight, should study in Heidelberg and not in Vienna.

Loránd (Roland) Eötvös (1848–1919) attended the secondary school of the Order of Piarists and then for two years studied law at Budapest University. At the same time, however, he took up science by private studies, and was taught by university professors, e.g., in mathematics by Ottó Petzvál. Finally his father permitted him to continue his studies in Heidelberg under Bunsen, Helmholtz and Kirchhoff. On the advice of Kirchhoff, he went to Königsberg for one term where, however, he found little to enjoy in the dry theoretic lectures in physics held by C. Neumann. He returned to Heidelberg out of reverence for his father, though he was strongly tempted by an opportunity to join an expedition to the North Pole. As it went, he graduated summa cum laude in 1870. He returned home and was soon appointed Professor at the University. When Jedlik retired in 1878 he took over the chair of experimental physics.

József Eötvös died in 1871, but while he was in office, he got the Act of Public Education (that had been already submitted in 1848) and the Act of Egalilty of Denominations through Parliament and as President of the Academy he prepared the foreign membership among others of Charles Darwin (1809–1882), William Thomson (1824–1907), Hermann Helmholtz (1821–1894), Gustav Robert Kirchhoff (1824–1887) and Rudolf Clausius (1822–1888).

The appointment of Clausius had been suggested by József (Joseph) Sztoczek (1819–1890) at the time Director of the Science Department and first Director of the Polytechnical College founded in 1857, where he wanted to set up a department for thermodynamics. His assistant professor was Kálmán (Coloman) Szily (1838–1924) who became one of the first rectors of the Polytechnical College when it was given the university status. Both Sztoczek and Szily were theoretical scientists and good

XIII.

JELENTÉS

AZ AKADÉMIA ÚJ VÁLASZTÁSAIRÓL.

A Magyar Tudományos Akadémia, alábbi napon tartott ülésén, megválasztotta

Igazgató tagnak:

Sztoczek József rendes tagot, a III. osztály elnökét.

Külső tagoknak:

Dr. **Clausius Rudolf**, természettanár Bonnban.

Sir **Charles Darwin**, Londonban.

Helmholtz Hermann, egyetemi tanár Berlinben.

Dr. **Kirchhoff Gusztáv**, heidelbergi tanár.

Ludwig Károly, lipcsei tanár.

Kelt az Akadémia 1872. május 24-én tartott nagygyűléséből.

Arany János,
főtitkár.

Contemporary announcement on the election of new foreign members of the Hungarian Academy of Sciences.

organizers. Sztoczek had papers published in Poggendorf's Annalen who refused to publish papers by Jedlik. Szily had studied under Clausius and he, like Boltzmann, searched for the mechanical foundations of the Second Law of Thermodynamics.

As First Secretary of the Society for Natural Sciences Szily restarted the periodical "Természettudományi Közlöny" (Journal of Natural Sciences) in 1869. He ran the periodical for thirty years and made it the most popular Hungarian periodical for Natural Sciences.

4. Eötvös the scientist

In 1873 when William Thomson was elected foreign member, Ányos Jedlik (at the time 73) became an honorary member and the 25 years old Loránd Eötvös a member of the Hungarian Academy of Sciences. Eötvös became President in the period 1889–1905 with Kálmán Szily as Chief Secretary.

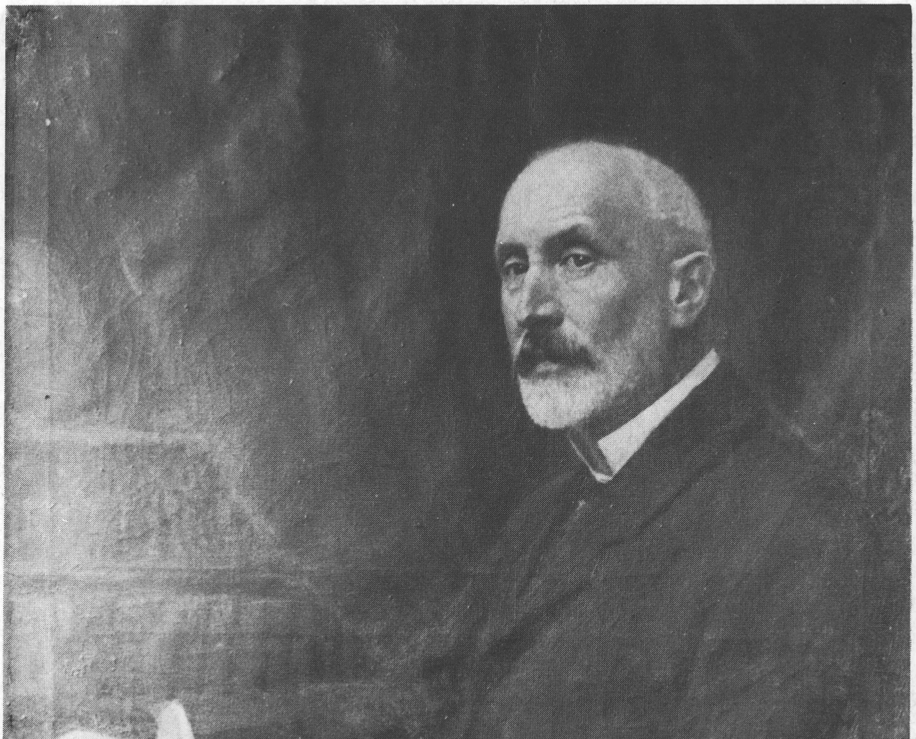
For more than 40 years, starting in 1872, Loránd Eötvös was the leading person for the advancement of science and physics in Hungary. He introduced new branches of science, such as geophysics; he founded new institutions: the Association for Mathematics and Physics (later Mathematical and Physical Society) in 1891 and the Eötvös College in 1896.

He was fond of situations in life in which he could test his own power of endurance both physical and intellectual. This explains his enthusiasm for mountaineering. As soon as his daughters were old enough he took them along to the Tyrol. Around Cortina d'Ampezzo there is hardly a peak that they left unclimbed – one of 2837 m height still bears his name.

In science the main challenge in Eötvös's life was gravitation. In this field he could test his best abilities. At the same time he had an exceptional sense for displaying refined effects. He was still a young research scientist when he examined the dependence of the surface tension of fluids on temperature; he discovered a general law that has been called Eötvös's law ever since. He checked the validity of this law by very accurate experiments.

The German Universities taught Eötvös the method of analytical research whereby his reverence for accuracy was strengthened. A skill which up till then was unprecedented in Hungary was needed for building his torsion balance. He invited a German mechanic Nándor (Ferdinand) Süss whose workshop then grew into MOM (Hungarian Optics) with several thousands on their payroll today.

A few words should be devoted to the reverence with which Eötvös approached science. In his opinion scientific research was an occupation of the highest ethical standard. This will explain why even in the late 20th century research scientists (like Fishbach and his team) have no doubts or misgivings when they rely upon the



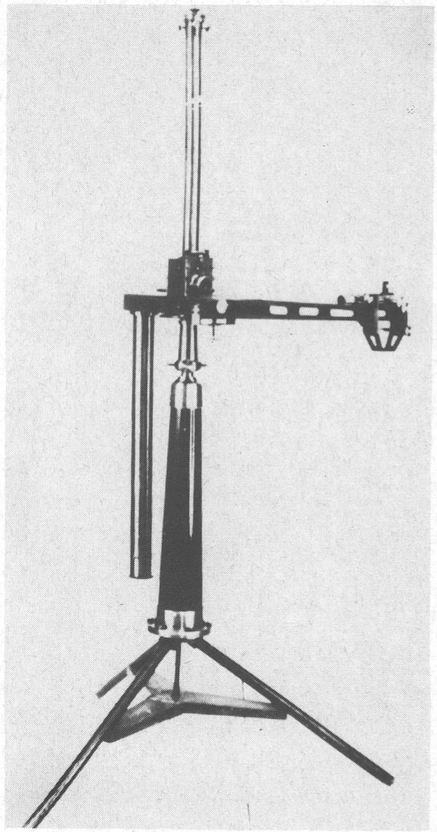
Baron Loránd (Roland) Eötvös (1848–1919) the Grand Old Man of Hungarian Physics.

Eötvös Memorial Tablet at the University of Science in Budapest.

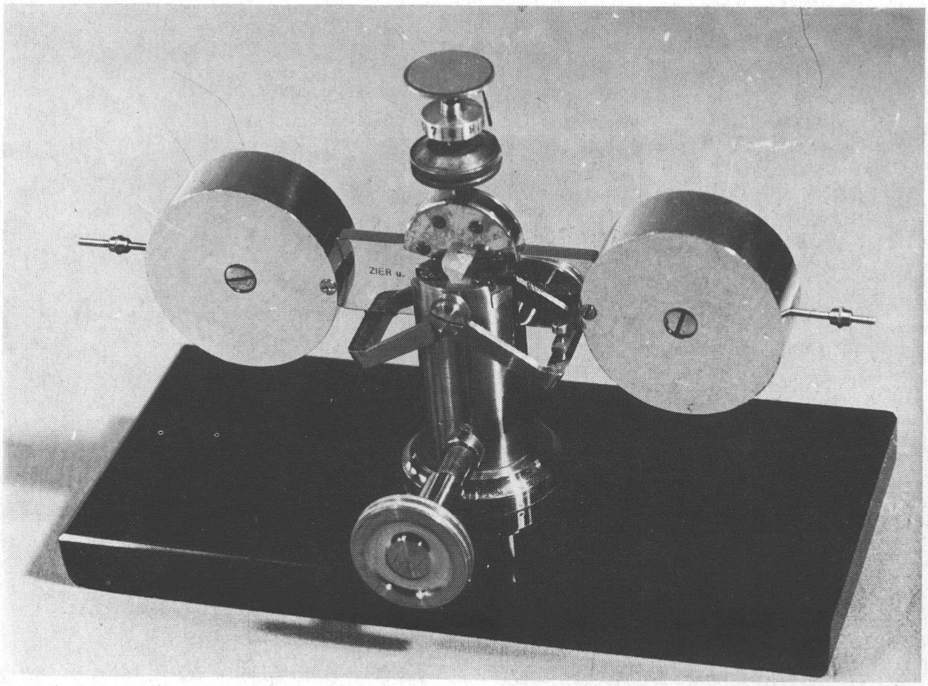
original measured values of Eötvös.

In 1906 the Göttingen University advertised a competition concerning experimental examination of the ratio of the gravitational and inertial mass of bodies. Eötvös and his team submitted the results obtained by their measurements designed and carried out based on experiments and experiences of many years. The prize was awarded to them in 1909.

Eötvös's experiments were based on the principle that on the rotating globe of our planet the weight of bodies consisted of two components. One is the centrifugal force proportional to the inert mass of the body and is thus independent of the quality of the material. The other is the force of gravitation acting on the body. Should this latter depend on the material quality, this would be valid also for the resultant of the two forces and could be demonstrated by an adequately sensitive instrument. The torsion balance designed by Eötvös and prepared in the workshop of Nándor Süss was such a device of appropriate sensitivity. A horizontal metal bar suspended on a torsional filament of 40 micron diameter had bodies of various materials suspended on its two ends. The whole apparatus was placed



An original Eötvös torsion balance.



The Eötvös rotating balance.

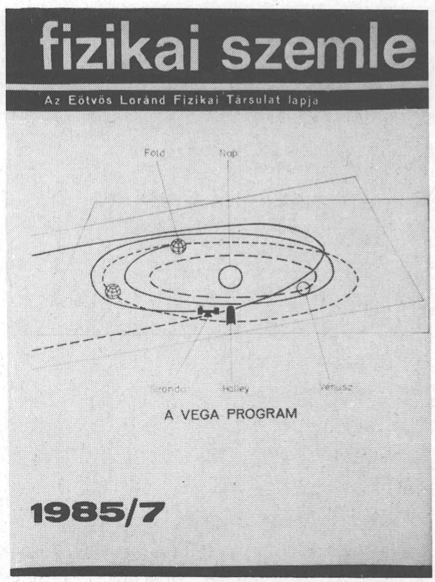
in a multiple casing. The position of the bar could be read off on a mirror scale by means of a telescope. If the direction of the weight of the two bodies is different the balance is moved by a torque. When the balance is turned round by 180°, the torque will likewise be reversed. The comparison of the two balanced positions will provide the result of the measurement.

The measurements performed by Eötvös are often referred to as the main experimental basis of the general theory of relativity. However, it is a fact in the history of physics that Einstein developed his theory independently of the experimental results of Eötvös. For Einstein, the inner harmony of the theory was more important than the coincidence with the results of the measurements of restricted accuracy. On the other hand, Einstein greatly appreciated Eötvös as scientist. In 1911 he published a paper in the Annalen der Physik about the Eötvös's law concerning surface tension, while in 1918 he approached Eötvös in a letter for his opinion and suggestion as to a person to be appointed as Director of the Potsdam Institute of Geodesy.

5. *Eötvös the science organizer*

Eötvös was engaged in a branch of physics which has in focus the exact experimental examination of phenomena. In this he was a worthy successor to Jedlik. However, his overall interest in science was not so extensive. He concentrated on fewer topics but he searched deeper. He had a more charismatic approach to mathematics as well as to people. He encouraged a closer link between physics and mathematics. In 1891 he changed a friendly professional circle into the Mathematical and Physical Society. The number of members grew to several hundreds. Since 1950 the

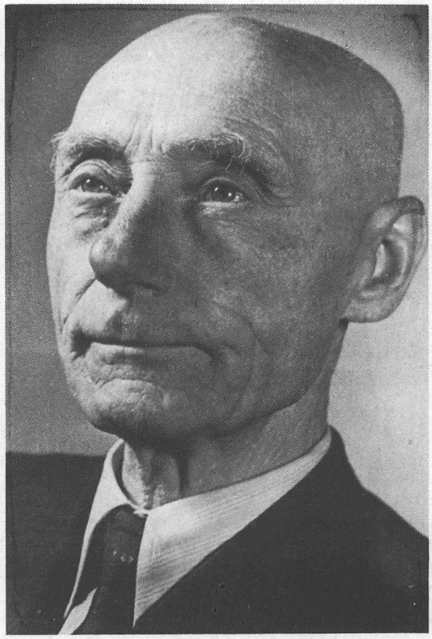
Relief of Eötvös and Jedlik in the Szeged Pantheon.



Journal of the Roland Eötvös Physical Society.

Physical Society bears the name of Eötvös who also launched the periodical of the society. Today, "Fizikai Szemle" (Review of Physics) is the successor to that periodical.

Like his father, Eötvös paid special attention to the education of masters in science. At the turn of 1894/95 he was for some months the Minister of Cultural Affairs. During this short time he prepared the plans for a Budapest College on the pattern of the École Normale Supérieure of Paris. This college bore his father's name from the time of its founding. One of its students was Károly Novobátzky (1884–1967), the founder of the Hungarian School of Theoretical Physics after World War II.



Károly (Karl) Novobátzky (1884–1967) Professor of Theoretical Physics in Budapest. Founder of the Hungarian School of Theoretical Physics.

The Eötvös College in Budapest founded by Loránd (Roland) Eötvös for talented young students.

Eötvös devoted full attention to the selection of his assistants and the members of his research team. He had an excellent intuition to recognize and choose gifted people and to direct their interest towards things he deemed important. Some of these scientists should be mentioned here.

Jenő (Eugene) KLUPATHY (1861–1931) completed his studies in physics and mathematics at the Budapest University in 1880. As soon as he received his degree, he became an assistant of Eötvös and joined the

Retraining course for teachers in 1895. R. Eötvös sitting in the centre. Behind him M. Beke and M. Kármán, second from right J. Klupathy, third J. Károly.

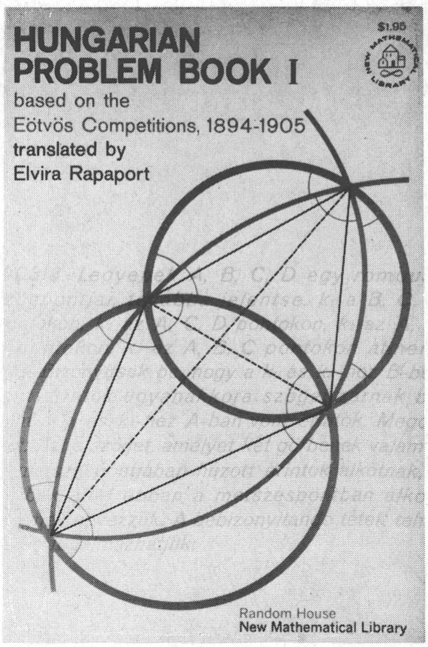
team investigating the surface tension of liquids. Eötvös soon sent him abroad for post-graduate studies in Germany, England, Italy and France.

In January 1896 Klupathy gave a successful lecture and demonstration of X-rays, discovered by Röntgen in November 1895 – in fact, science teachers and technicians with good technical qualities immediately commenced research on the medico-physical application of the X-rays. The first X-ray photographs were made in Szombathely by Jenő (Eugene) Gothard and in Nagyvárad by József (Joseph I.) Károly.

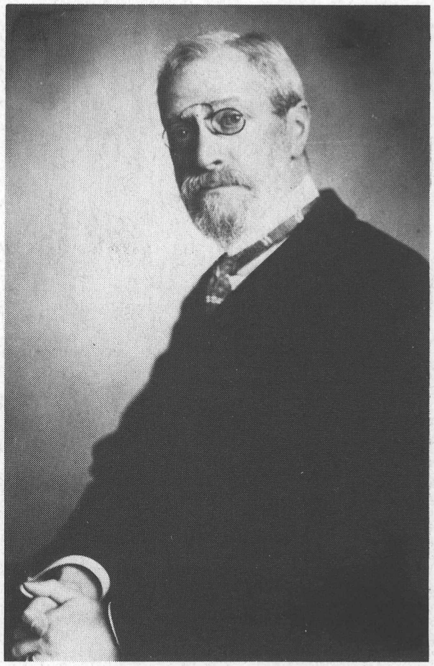
Eötvös had a high opinion of Klupathy's excellent practical sense and extensive knowledge of his subject. He successfully fought to obtain for Klupathy a third chair "Practical Physics" with the task of organizing and introducing laboratory experiments for the future teachers of physics, whose number increased so suddenly on the threshold of the 20th century.

Besides being good at experiments Klupathy also raised laboratory training at his University to a European level. He was also a fine lecturer. He founded a new society "Urania" providing scientific information to the general public: he was acting secretary and editor of the Society's periodical from 1900 to 1912, and was also the founder of BEAC (University Club for Athletics) and was its Professor-President up to 1912.

Jenő (Eugene) GOTHARD (1857–1909) had been one of the pioneers of astro-photography and discovered the central star of the annular nebula (NGC 6720) of the Lyra constellation – a sensational scientific achievement at the time! He also made a phonograph and recorded, among others, the voice of Jedlik.



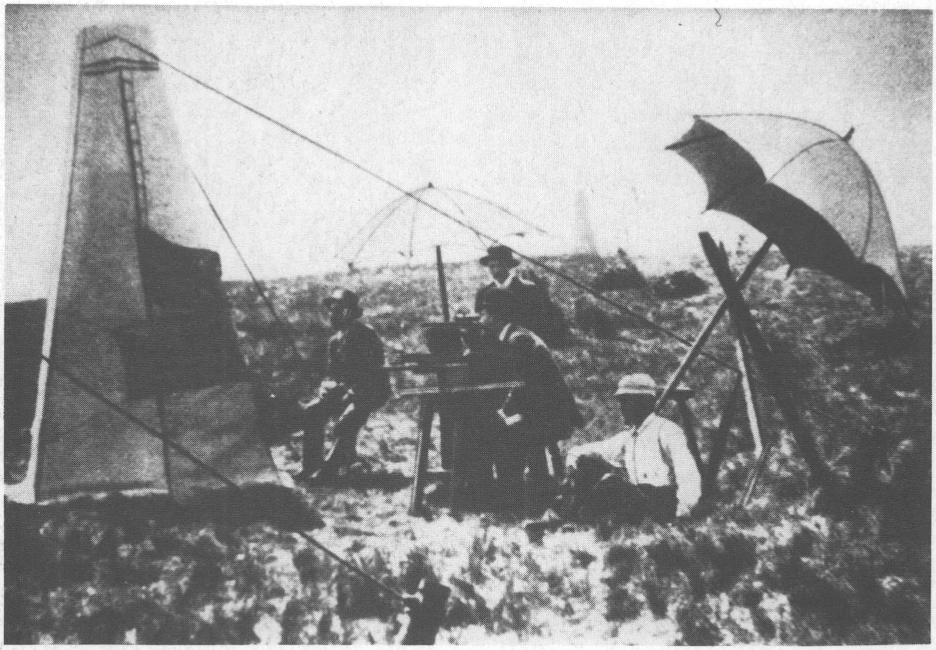
Hungarian competition problems, published in New York.



Radó (Rudolph) Kövesligethy (1862–1934) professor of Astronomy and Seismology.

József (Joseph I.) KÁROLY (1854–1929) was a science teacher, specialized in physics, who experimented with electromagnetic waves and invented a new type of coherer. In 1916 he made a substantial endowment to words organizing national student competitions in physics as was the case in mathematics. The first president of the jury was Roland Eötvös whose name these competitions have borne since 1950.

Another of Eötvös's discoveries was Radó (Rudolph) KÖVESLIGETHY (1862–1934) who had obtained his

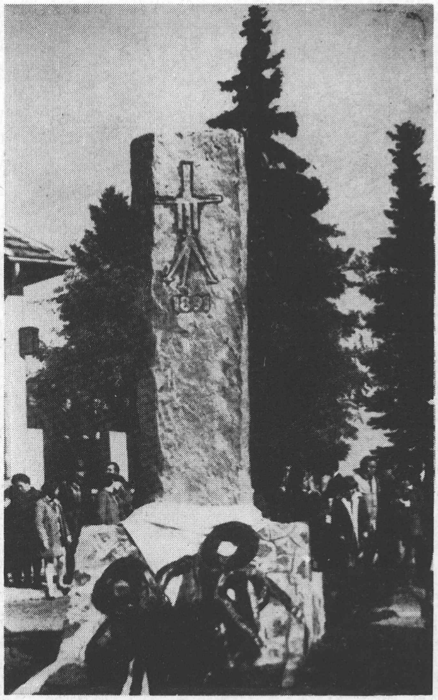


Open air measurements in Celldömölk (at the western part of Hungary). The torsion balance is in the tent, the observer is Eötvös himself, behind him stands K. Tangl, sitting on the ground is R. Kövesligethy.

degree at the Vienna University, his principal subjects having been mathematics and astronomy. In his Ph.D. thesis submitted in 1884 he already had a notion of the Displacement Law which Wilhelm Wien (1864–1928) arrived at only ten years later. Kövesligethy's paper was reported at the Vienna University by Josef Stefan (1835–1893) whose name is known from the Stefan–Boltzmann Law. Kövesligethy investigated the correlation between the spectral distribution of light radiated by the stars and their temperature. He worked alone at an observatory in the country when – in 1888 – Eötvös invited him to be his assistant as observer in the gravitation experiments with the torsion balance. With the torsion balance set up in the cellar of the building of the Academy they observed the effect of the mass of ships passing along the Danube. In 1891 – using a frustum of a cone-shaped basalt hill – they calibrated the torsion balance and then commenced to use it for the examination of subterranean mass distributions. This is how the balance became a scientific instrument in the exploration for oil. At a later date Kövesligethy set up the torsion balance on the side of Vesuvius to use it for forecasting eruptions.

Eötvös never had the torsion balance patented. As a scientist at heart, he held the same views as Marie Curie did when she discovered radium: results of scientific research should not be monopolized but should be used for the good of mankind.

Though further research of thermal radiation might have brought him universal fame, Kövesligethy abandoned this field and investigated earthquakes and their prediction. Through this his name became known all over the world. In 1906 he was elected first secretary of the Seismological Association, and he directed world-wide seismological research from Budapest over ten years, until the cataclysm of World War I swept away the entire international organization of scientists.



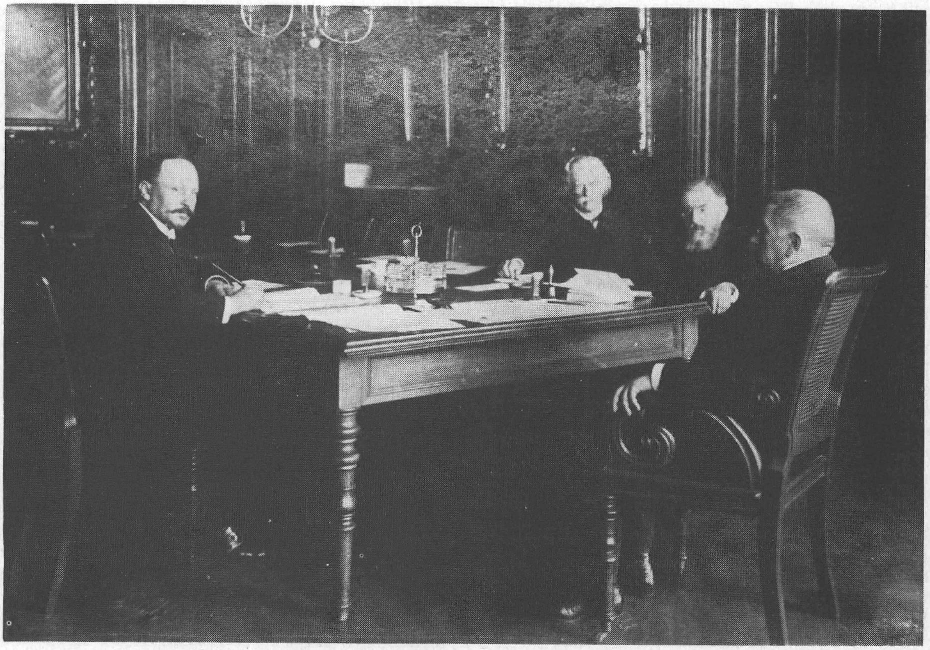
Commemorating Column in Celldömölk where the first measurements were performed with the Eötvös balance.

6. The hopeful turn of the century

At the turn of the century Budapest grew into a European metropolis and Hungary's scientific life attained European level. The Bolyai prize of the Hungarian Academy of Sciences helped to spread the reputation of Hungarian mathematicians.

János BOLYAI (1802–1860) was a genius of mathematics. To celebrate the 100th anniversary of his birth, the Academy established a prize to reward the "best work on mathematics published wherever and in whichever language". It was first awarded in

The old buildings of Budapest University of Science.



Academic Commission adjudging the Bolyai Mathematical Award in 1910. From left to right: G. Rados, G. Mittag-Leffler, H. Poincaré, Gy. König.

1905 to David HILBERT (1862–1943) and Henri POINCARÉ (1854–1912). On the second occasion, in 1910, Poincaré was a member of the jury. No third time came: the war had started.

For students talented in mathematics a monthly periodical was issued: "Középiskolai Mathematikai Lapok" (Journal for Secondary Schools) the second of its kind in the world. It was founded in 1894 by a science teacher Daniel ARANY (1863–1945). Today a mathematical competition bears his name. From 1896 on László RÁTZ (1863–1939) who taught mathematics at a Lutheran secondary school in Budapest continued as editor for twenty years. The publication of the journal was interrupted by World War I and revived only ten years later. It no longer appeared during the years of World War II and was published again after the war, and since 1959 with an independent column in physics. From the very beginning the paper published high-level mathematical problems and articles; also problems and articles in physics. Now, every year, the students who write the best solutions for these problems are appointed to represent Hungary at the International Students' Olympiads in mathematics and physics.

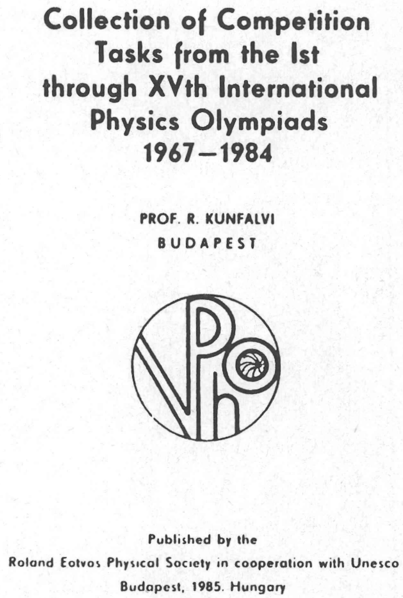
László Rátz (1863–1939) taught Mathematics in the Lutheran Secondary School.

Initially the physical problems to be solved and many other contributions were written by Sándor MIKOLA (1871–1945) who was a colleague of László RÁTZ. Mikola had been junior assistant under Eötvös, then teacher, later headmaster of the Lutheran school. He also lectured at the university, became corresponding member, then regular member of the Academy of Sciences. He worked not only with Rátz but also with Manó (Emmanuel) BEKE (1862–1946). In 1892 Beke had already learned the ideas of Felix KLEIN (1849–1925) in Göttingen concerning reforms in mathematics teaching. Upon his return home he became one of the initiators and most efficiently active promoter of the renewal of mathematics teaching in Hungary.

Beke and Mikola, apostles of advanced training of mathematics and science teachers, were active teachers themselves both at secondary schools and at the University. The best mathematics teachers are today awarded the Manó Beke prize, the physics teachers the Sándor Mikola prize.

Eötvös sent his favourite pupil Győző (Victor) ZEMPLÉN (1879–1916) to Felix Klein at Göttingen where he

Journal of Mathematics and Physics for secondary school students, published since 1894.

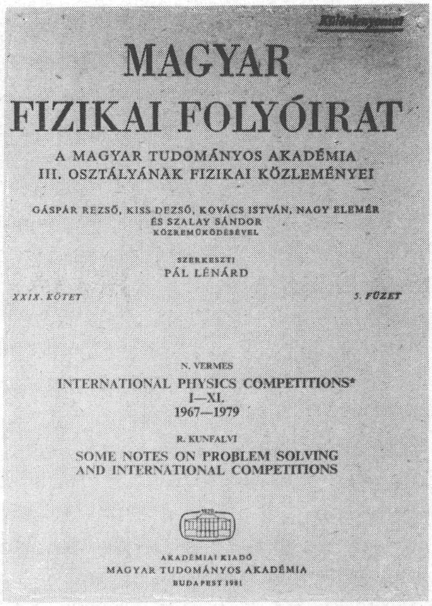


Collection of Competition Tasks from the Ist through XVth International Physics Olympiads 1967–1984

PROF. R. KUNFALVI
BUDAPEST

Published by the
Roland Eotvos Physical Society in cooperation with Unesco
Budapest, 1985. Hungary

An out-of-print publication of the Roland Eötvös Physical Society.



Különlenyomat

MAGYAR FIZIKAI FOLYÓIRAT

A MAGYAR TUDOMÁNYOS AKADÉMIA
III. OSZTÁLYÁNAK FIZIKAI KÖZLEMÉNYEI

GÁSPÁR REZSŐ, KISS DEZSŐ, KOVÁCS ISTVÁN, NAGY ELEMÉR
ÉS SZALAY SÁNDOR
KÖZREMŰKÖDÉSÉVEL

SZERKESZTI
PÁL LÉNÁRD

XXIX. KÖTET 5. FÜZET

N. VERMES
INTERNATIONAL PHYSICS COMPETITIONS*
I—XI.
1967—1979

R. KUNFALVI
SOME NOTES ON PROBLEM SOLVING
AND INTERNATIONAL COMPETITIONS

AKADÉMIAI KIADÓ
MAGYAR TUDOMÁNYOS AKADÉMIA
BUDAPEST 1981

Physical journal of the Hungarian Academy of Sciences.

Sándor Mikola (1871–1945) taught Physics in the Lutheran Secondary School.

Manó Beke (1862–1946) Professor of the University of Budapest, taught Mathematics also in the model-school of the University.

was imparted a sense for the problems of mathematics as well as education. At home he had investigated theoretically and experimentally the viscosity of gases – in Göttingen he elaborated the theory of shock wave propagation. He demonstrated according to the Second Law of Thermodynamics, that hydrodynamical shock waves can only be compression waves. He worked on the solution of nonlinear equations of hydrodynamics for the case of shock waves. He set up a new variation principle by which it becomes possible to uniformly discuss the continuous and discontinuous flow of liquids. He published his results in German and French during his stay in Germany and France. In June 1905 he was again in Göttingen from where he reported in a letter to Eötvös that he had just corrected the proofs of his paper for the Enzyklopädie der Matematischen Wissenschaften and showed it to Hadamard who read it and promised to introduce Zemplén to other mathematicians. "This is how I met – if only casually – Poincaré, thus nobody can say that I visited Paris without seeing him . . .". Zemplén, a contemporary of Einstein, started a successful scientific career. A chair for theoretical physics was established for him at the Technical University of Budapest. He was the first in Budapest to teach up to date theoretical physics, statistical mechanics and electrodynamics based upon the Maxwell equations. As early as 1906 he translated Mme Curie's book

Győző Zemplén (1879–1916) died on the Italian front during World War I. He was Professor of Physics at the Technical University Budapest and achieved important results in Hydrodynamics.

on radioactivity. He wrote a great number of popular-scientific papers and worked as executive secretary of the Mathematical and Physical Society on the reform of physics teaching in Hungary. Everybody considered him the spiritual heir of Eötvös. When the war started Zemplén was drafted, and like the Austrian Hasenöhrl and the English Moseley he ended up as one of the senselessly destroyed victims.

7. *World War I – lost illusions*

At the turn of the century it still seemed that Hungary would also participate in the accelerated industrial development and the evolution of a cultured middle-class that was taking place in Europe. World War I brought about not only the dissolution of the Austro–Hungarian Monarchy, and revolutions and counter-revolutions, but almost the total annihilation of Hungary. This situation is clearly reflected in the life history and career of Hungarian scientists born in the late 19th century.

Tódor (Theodore von) KÁRMÁN (1881–1963) studied at the "model" secondary school for the practical training of teachers. This model school was founded and organized by Kármán's father who had been sent on a scholarship to study the German Universities by József Eötvös, who was then Minister of Cultural Affairs. The teacher who taught Kármán mathematics at this model school was nobody else but Manó Beke himself! Kármán showed his talent in the early days by winning the national competition in mathematics. Three years later he got his degree from the Budapest Technical University. There he began his work with Donát BÁNKI (1859–1922), then went to Göttingen in 1906 with a state-scholarship and there became assistant of L. Prandtl (1875–1953). Kármán stayed for six years in Göttingen and while he was there, attained international recognition through his scientific work. In 1912 he published, together with Max

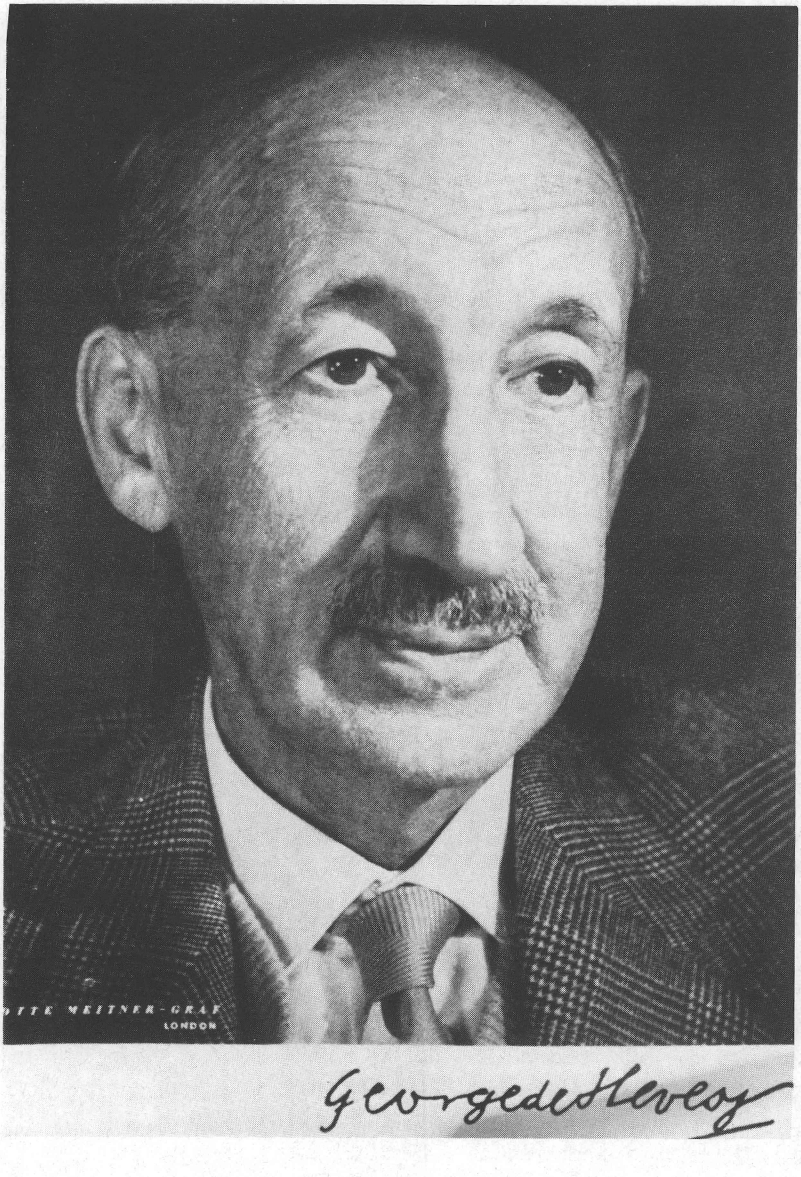
Tódor (Theodore von) Kármán (1881–1963) achieved important results in Aerodynamics.

After so many years... Professor Novobátzky welcoming professor Kármán in Budapest, 1962.

Born (1882–1970) an original method for the determination of the specific heat due to oscillations in a three-dimensional crystal lattice.

When the war broke out he was called up. Luckily he had trouble with his hearing which made him unfit for combatant service. In "Hinterland" service he was engaged in research on aviation technics. At the end of the war the Hungarian revolutionary government entrusted to him the plans for a reform of high-level technical training. When the revolution was suppressed, Kármán – with his mother and sister – left the country and stayed away for forty years. Yet in his life style and feelings he remained Hungarian, first in Aachen then in Pasadena – his mentality, his wise humour remained unchanged. In 1962 he spent two weeks in Budapest and received his honorary doctor's degree from the Budapest Technical University. This was his 27th – and last – degree. In 1963 he died soon after the President of the United States conferred upon him the highest honour awarded for scientific work and teaching.

György (George de) HEVESY (1885–1966) was also born in Budapest and studied at the Piarists

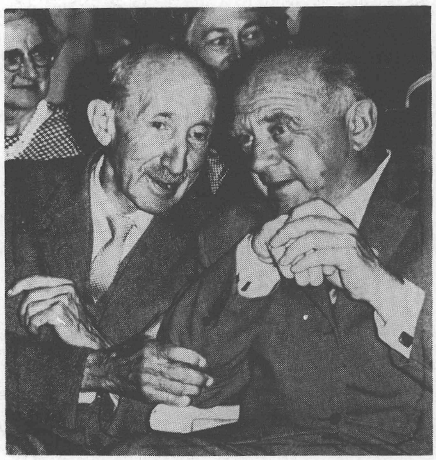


György (George de) Hevesy (1885–1966), Nobel Prize winner in 1943.

Gymnasium. Chemistry was not taught as a separate subject at the time in Hungary but even during his school years his main interest was the structure of matter. He began his study of chemistry in Budapest, continued it in Berlin and took his degree in Freiburg. Then he worked at various institutes of physical chemistry in Zürich and in Karlsruhe. Hevesy met Einstein in 1909 in Zürich. He was amused by a little episode: when he showed him a hydrogen electrode, Einstein was very much surprised because he had thought that it was only fiction. By 1911 Hevesy was already working in the Rutherford laboratory in Manchester where he met and became the lifelong friend of Moseley and Bohr. His friendship with Moseley lasted only a tragically short time, as he was killed in action in 1915.

Hevesy, like Kármán returned home at the beginning of the war. He served as technical consultant at the Ministry of War. During the revolution Kármán appointed him to the chair of physical chemistry but this appointment was annulled when the revolution was suppressed. Bohr's invitation to work with him in his newly established Copenhagen Institute reached him at the best moment. He left Hungary and got married in Denmark. When he discovered a new element he chose Hafnium as its name, from the old name of Copenhagen. He became a citizen of Sweden when he was awarded the Nobel Prize for his discovery of the radioactive isotope tracing. (This was the second

Niels Bohr, James Franck and György Hevesy in Copenhagen 1935.



Werner Heisenberg and György Hevesy in Lindau 1965.

Richard Zsigmondy (1865–1929), Nobel Prize winner in 1925.

chemical Nobel Prize won by a Hungarian-born scientist: Richard Zsigmondy (1865–1929) won it in 1925 for his ultramicroscope).

Hevesy and Bohr had the same age, no wonder they became great friends – like Kármán and Born who had shared a room at Göttingen and wrote joint papers in 1912. The same year Ortvay, another Hungarian engaged in theoretical physics, spent two months at Debye's laboratory in Zurich.

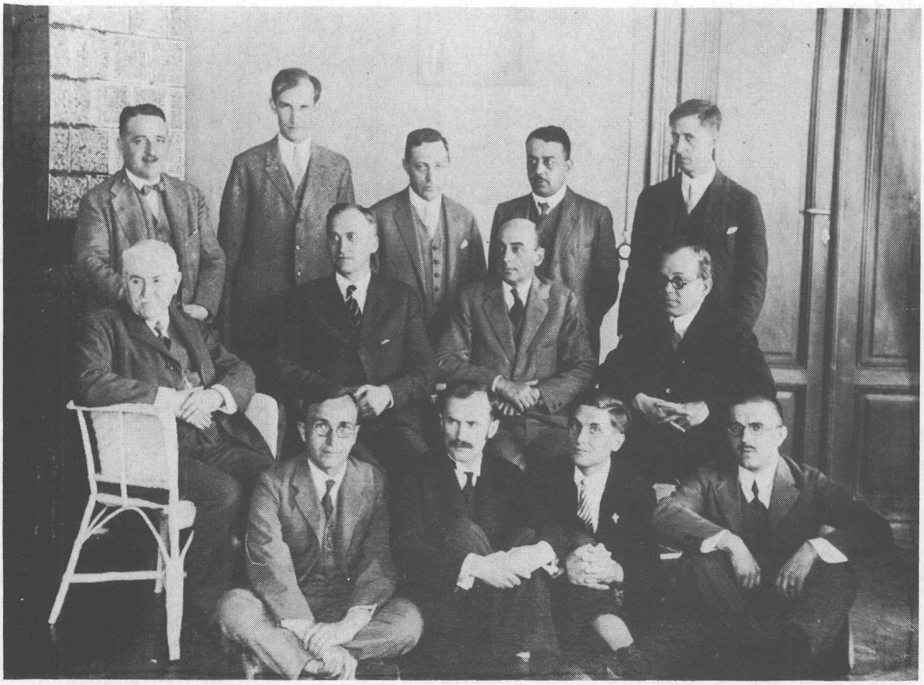
Rudolf ORTVAY (1885–1945) a typical representative of the Budapest physicists between the wars, was most susceptible to everything new, a fairly good organizer with sound judgement. It was a time when most of the Budapest-born physicists returned only for visits to Hungary – and this only while it was still possible. In this historical situation physics as a science was kept alive in Hungary by the famous "colloquia" organized by Ortvay.

Ortvay came from a secondary school, formerly called Royal Hungarian Catholic Gymnasium which had been annexed to the University; he studied medical biology at the University for two years. Then he changed to natural sciences – mathematics and physics – and took his degree in Göttingen. For the two months spent with Debye in Zurich he had a state scholarship. Next he stayed for two years in Munich, working with Sommerfeld. He was not called up for military service but spent the years of World War I in Hungary. In 1915 he took over the chair of Gyula (Julius) FARKAS (1847–1930) in Kolozsvár (today Cluj-Napoca, Rumania) University. Later in Szeged Ortvay was very active in launching scientific work. He also kept up correspondence with an increasing number of scientists such as Debye, Sommerfeld – with Hevesy whom he hardly met personally, he exchanged letters during twenty years.

In 1928 Izidor FRÖHLICH (1853–1931), then 75, retired and his chair at the Budapest University was given to Ortvay. With Ortvay as the head of the theoretical physics department,

Gyula (Julius) Farkas (1847–1930), professor of Theoretical Physics in Kolozsvár.

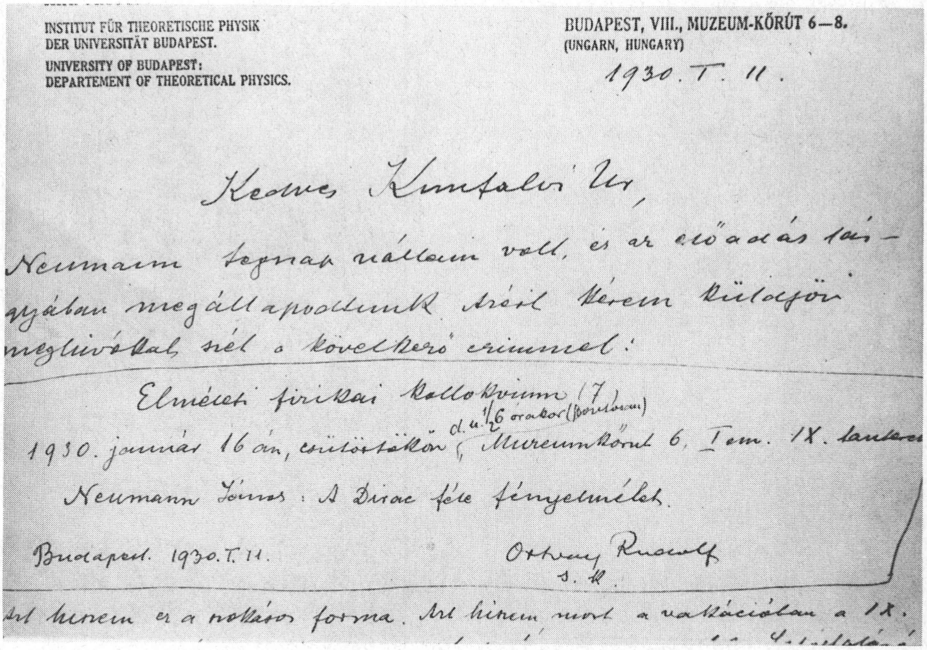
Rudolf Ortvay (1885–1945) pioneer of Modern Physics at the University of Budapest.



Mathematics in Szeged 1928. Standing from left to right: F. Riesz, B. Kerékjártó, A. Haar, D. König and R. Ortvay. Sitting from left to right: J. Kürschák, G.D. Birkhoff, O.D. Kelogg (guests from England) and L. Fejér. Sitting on the ground from left to right: T. Radó, I. Lipka, L. Kalmár and P. Szász.

A year in the twenties... Rudolf Ortvay and Rezső Kunfalvi (with their hats on), Tibor Neugebauer behind them.

science was awakened from its "sleeping beauty" slumber. The prince who did the awakening was Ortvay, he did it with a retinue of young collaborators: his assistants, correspondents, pupils – all the participants of the "colloquia". Meetings were organized by Ortvay where discussions were held on current topics in modern physics. Otherwise he was the typical absent-minded professor with his scarf and umbrella, of quick temper but easily reconciled, with his nervous, rapid speech – an old bachelor of legendary fame. With all this, he had a very attractive personality appreciated by those who knew him.



INSTITUT FÜR THEORETISCHE PHYSIK
DER UNIVERSITÄT BUDAPEST.
UNIVERSITY OF BUDAPEST:
DEPARTEMENT OF THEORETICAL PHYSICS.

BUDAPEST, VIII., MUZEUM-KŐRÚT 6–8.
(UNGARN, HUNGARY)

1930. I. 11.

Kedves Kunfalvi Úr,

Neumann tegnap nálam volt, és az előadás tárgyában megállapodtunk. Erről kérem küldjön meghívókat szét a következő címmel:

Elméleti fizikai kollokvium (7)
1930. január 16-án, csütörtökön d.u. ½6 órakor (pontosan) Múzeumkörút 6. I em. IX. tanterem.
Neumann János: A Dirac-féle fényelmélet.
Budapest. 1930. I. 11.
Ortvay Rudolf
s. k.

Azt hiszem ez a szokásos forma. Azt hiszem most a vakációban a IX.

Letter written by R. Ortvay announcing a lecture of J. Neumann in Budapest 1930.

8. Ortvay "colloquia" at the Budapest University of Science

At the Solvay Congress held in Brussels in 1924 the topic of discourse was the quantum-physical description of the electric conductivity of metals. Hevesy wrote to Ortvay from there: "...the outcome of the discussions has been that metallic conductivity is still surrounded by obscurity – all the same, these days in Brussels were interesting and instructive...". Six years later Ortvay asked Imre Bródy to give a lecture on "Electron theory of metals".

Imre Bródy (1891–1944), inventor of the electric bulbs filled with krypton gas.

Imre (Emery) BRÓDY (1891–1944) was born in Budapest, attended the University there, worked in Göttingen with Max Born in the years between 1920 and 1923. They elaborated together the theory of the thermodynamics of crystals. In 1923 Brody returned to Budapest and worked at the recently established Tungsram research laboratory. His task was to improve the light bulb. Brody's great achievement was the invention of the krypton bulb. With Mihály (Michael) Polányi they discovered an entirely new process for producing krypton out of air. Ortvay made it a point to invite outstanding theoretical physicists, engaged in the industry, to participate at his colloquia. He appreciated in the first place Brody's research work in quantum physics.

Mihály (Michael) POLÁNYI (1891–1976) graduated in medicine at the Budapest University, then worked in Germany and went on to England. He was professor of physical chem-

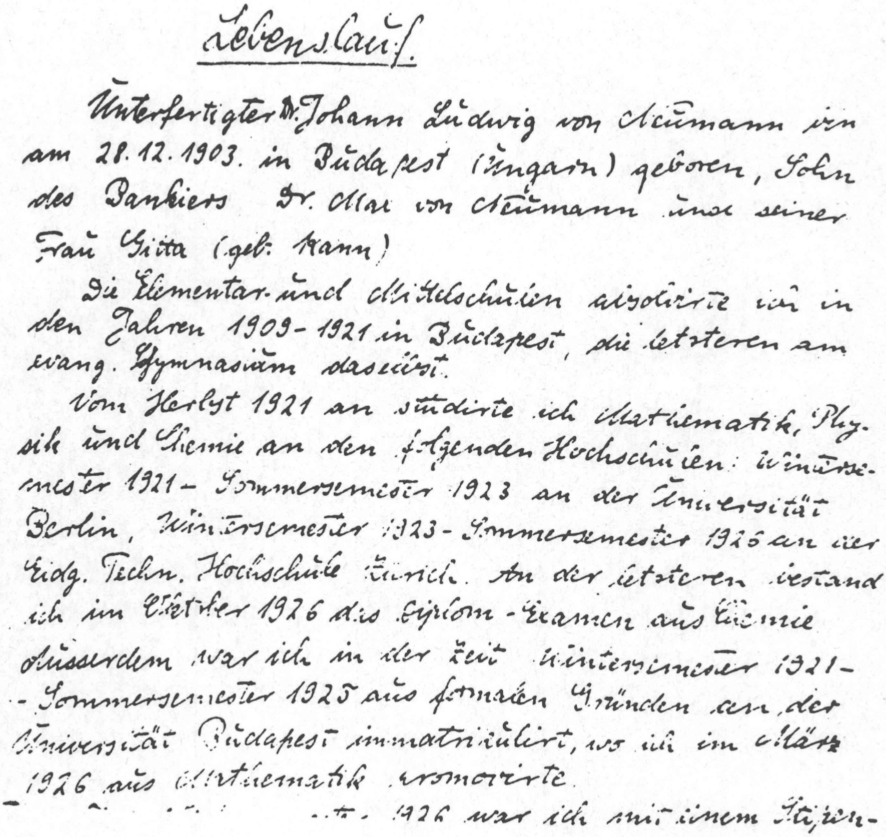
Jenő (Eugen P.) Wigner (1902–), Nobel Prize winner in 1963.

istry in Manchester when Bródy asked him for his cooperation. He introduced the concept of "dislocation" into solid-state physics at the same time as Taylor and Orowan. In the twenties, while still in Berlin, Polányi conducted researches in X-ray diffraction and reaction kinetics. His papers dealing with thermodynamics caught the attention of Einstein. During his years in Berlin Polányi also guided a young research scientist in his doctor's thesis. The topic was the quantum-theoretical explanation of the process of certain chemical reactions. The thesis was then worked into a joint paper. The talented young man was Jenő (Eugene P.) Wigner.

Jenő (Eugene P.) WIGNER (1902–) was a pupil at the school where Sándor Mikola taught physics and László Rátz mathematics. It is the latter whom the Nobel Prize winner Wigner remembers with special gratitude and reverence. Wigner obtained his degree in chemistry at the Technische Hochschule in Berlin where he also attended lectures in mathematics and theoretical physics at the university. By 1928 he was already teaching at the Technische Hochschule. Ortvay asked him to apply for the chair at the Szeged University which had become vacant. Wigner gave a courteous but negative reply. At that time he was already working on the group-theoretical approach to quantum theory. From time to time he came home on a visit – in fact in Hungary he wrote his book on group theory and its application to the quantum mechanics of atomic spectra. At the Ortvay colloquium he gave

The Lutheran Secondary School, where Rátz and Mikola taught, Wigner and Neumann studied.

János (John von) Neumann (1903–1957), one of the greatest mathematicians in our century.



Lebenslauf.

Unterfertigter Dr. Johann Ludwig von Neumann bin am 28.12.1903. in Budapest (Ungarn) geboren, Sohn des Bankiers Dr. Max von Neumann und seiner Frau Gitta (geb: Kann)

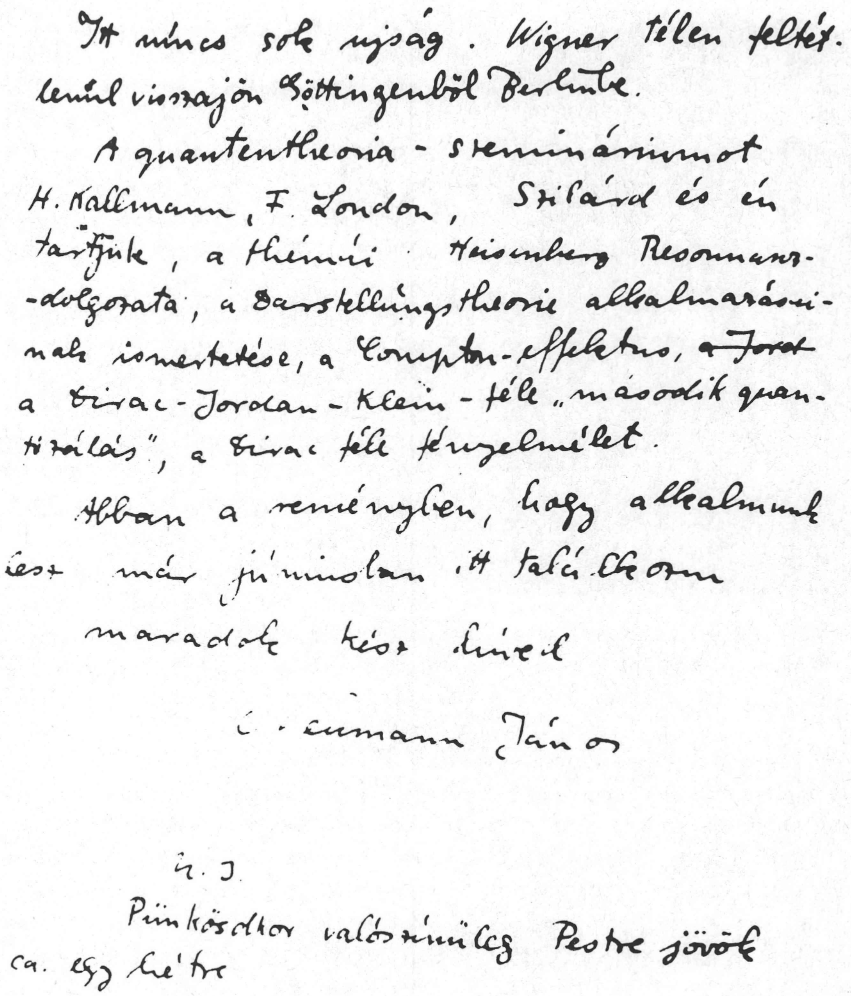
Die Elementar- und Mittelschulen absolvirte ich in den Jahren 1909–1921 in Budapest, die letzteren am evang. Gymnasium daselbst.

Vom Herbst 1921 an studirte ich Mathematik, Physik und Chemie an den folgenden Hochschulen: Wintersemester 1921 – Sommersemester 1923 an der Universität Berlin, Wintersemester 1923 – Sommersemester 1925 an der Eidg. Techn. Hochschule Zürich. An der letzteren bestand ich im Oktober 1926 das Diplom-Examen aus Chemie. Ausserdem war ich in der Zeit Wintersemester 1921 – Sommersemester 1925 aus formalen Gründen an der Universität Budapest immatrikuliert, wo ich im März 1926 aus Mathematik promovirte.

[illegible] 1926 war ich mit einem Stipen-

Curriculum vitae of J. Neumann submitted in Berlin for the Doctor's Degree.

a lecture on "Quantum theory of chemical bonds". In 1930 Wigner was invited to Princeton together with his former schoolmate János (John von) Neumann who by that time was also one of the guests giving lectures at the Ortvay colloquia. In the terms 1929/1930 he gave two discourses,


Itt nincs sok ujság. Wigner télen feltét-
lenül visszajön Göttingenből Berlinbe.
A quantentheoria - szemináriumot
H. Kallmann, F. London, Szilárd és én
tartjuk, a thémái: Heisenberg Resonanz-
-dolgozata, a Darstellungstheorie alkalmazásai-
nak ismertetése, a Compton-effektus, ~~a Jordan~~
a Dirac-Jordan-Klein-féle „második quan-
tizálás", a Dirac féle fényelmélet.
Abban a reményben, hogy alkalmunk
lesz már júniusban itt találkozni
maradok kész híved
Neumann János

N. J.
Pünkösdkor valószínűleg Pestre jövök
ca. egy hétre

Letter by J. Neumann to R. Ortvay, 1928, informing him about the Seminar on Quantum mechanics.

one entitled "Dirac equation, electron spin", the other "Dirac's theory of light".

János (John von) NEUMANN (1903–1957), one year younger than Wigner, also attended the Lutheran Secondary School. He too was discovered and assisted by László Rátz in evolving his talent in mathematics.

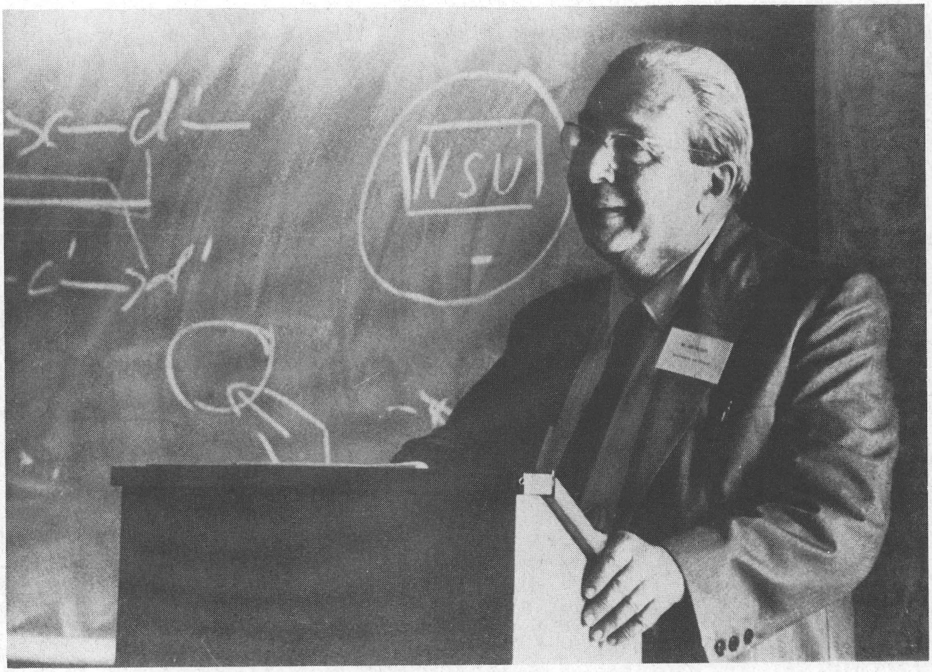
Szilárd's portrait from his lecture book at the Technical University in Budapest.

Already in his schooldays, Neumann was a welcome member to the society of mathematicians, where he was treated on equal footing. They held their meetings at a coffee house where Ortvay was also a frequent visitor. Rátz introduced Neumann to József (Joseph) KÜRSCHÁK (1864–1933) a mathematician of remarkable scientific and pedagogical talent, organizer of student competitions. Like Wigner, Neumann also entered upon a dual academic career. Complying with his family's wish he took a M.Sc. degree in chemistry in Berlin and a doctor's degree in mathematics in Budapest. He prepared his doctor's thesis at Professor Lipót (Leopold) FEJÉR (1880–1959) and at the same time became honorary lecturer (Privatdozent) of the Berlin University in 1927. In the same year he published with two other authors a paper on the mathematical foundations of the quantum theory. His coauthors were: David Hilbert (1862–1943) and Lothar Nordheim (1899–).

In Berlin Wigner and Neumann had frequent contact with another gifted Hungarian, a few years older and engaged in research in thermodynamics. Together with Einstein he had already patented a refrigerator without rotating parts based on liquid metals pushed by electromagnetic fields, a kind of MHD pump. Einstein who had once been a patent office executive in Bern found pleasure in cooperating with Szilárd, a young research scientist of brilliant intellect.

Leo SZILÁRD (1898–1964) had attracted attention by winning the second prize at the Hungarian student competition in physics in 1916: this was the first of such competitions. He commenced his studies at the Budapest Technical University and continued them in Berlin from 1920. He took his doctor's degree in 1922. His tutor in the subject was Max von Laue (1879–1960) Professor of theoretical physics at the Berlin University.

In his thesis Szilárd examined the validity of the Second Law of Thermodynamics for fluctuations. In 1929 he wrote his famous treatise discuss-

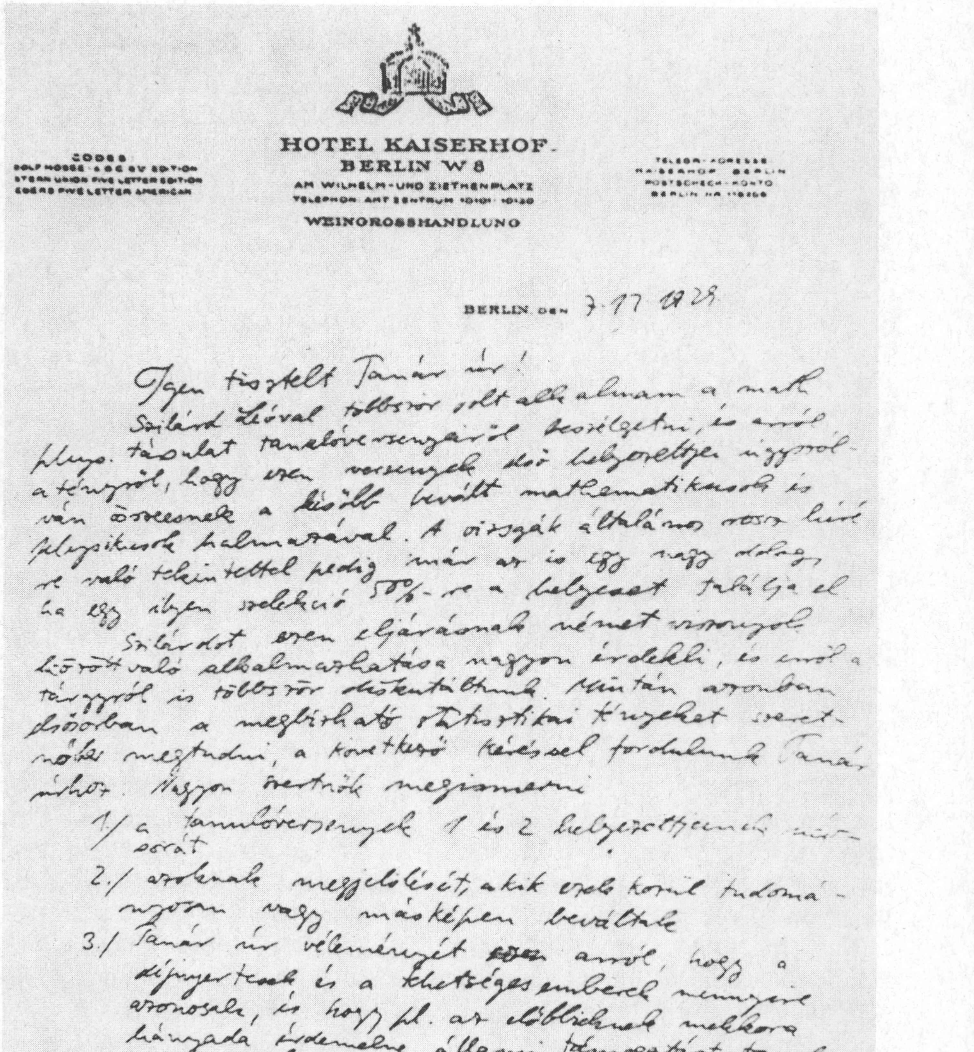


Leo Szilárd (1898–1964) talking at a conference.

ing the correlation of the information-producing role of the human intellect with the Second Law. The result of his research became a real topic several decades later.

Not so long ago Benoît B. Mandelbrot (1924–) related how important it had been for him to read the following remark in Neumann's book: "Mathematical Foundations of Quantum Theory": "When I think of statistical thermodynamics, I do so, of course, in the sense of Leo Szilárd's paper". Mandelbrot adds: "my work was in a certain sense a refining of Szilárd's theory, that is why it was the kind that Neumann liked".

When in 1929 Szilárd persuaded Neumann to write to Professor Ortvay and to inquire about the system of Hungarian students' competitions in physics, this was four years after the two latest "stars" had appeared among the prize winners: Teller (1908–) and Tisza (1907–). Ten years later, in 1939 Szilárd together with Wigner and Teller persuaded Einstein to write his famous letter to President Roosevelt. That was after Szilárd and Fermi had discovered that a chain reaction could be produced in a system consisting of graphite and uranium.



HOTEL KAISERHOF.
BERLIN W 8
AM WILHELM- UND ZIETHENPLATZ
TELEPHON: AMT ZENTRUM 10101-10120
WEINGROSSHANDLUNG

BERLIN, den 7. II. 1929.

Igen tisztelt Tanár úr!

Szilárd Leóval többször volt alkalmam a math. phys. társulat tanulóversenyeiről beszélgetni, és arról a tényről, hogy ezen versenyek első helyezettjei úgyszólván összeesnek a később bevált mathematikusok és physikusok halmazával. A vizsgák általános rossz hírére való tekintettel pedig már az is egy nagy dolog, ha egy ilyen szelekció 50%-ra a helyzetet találja el.

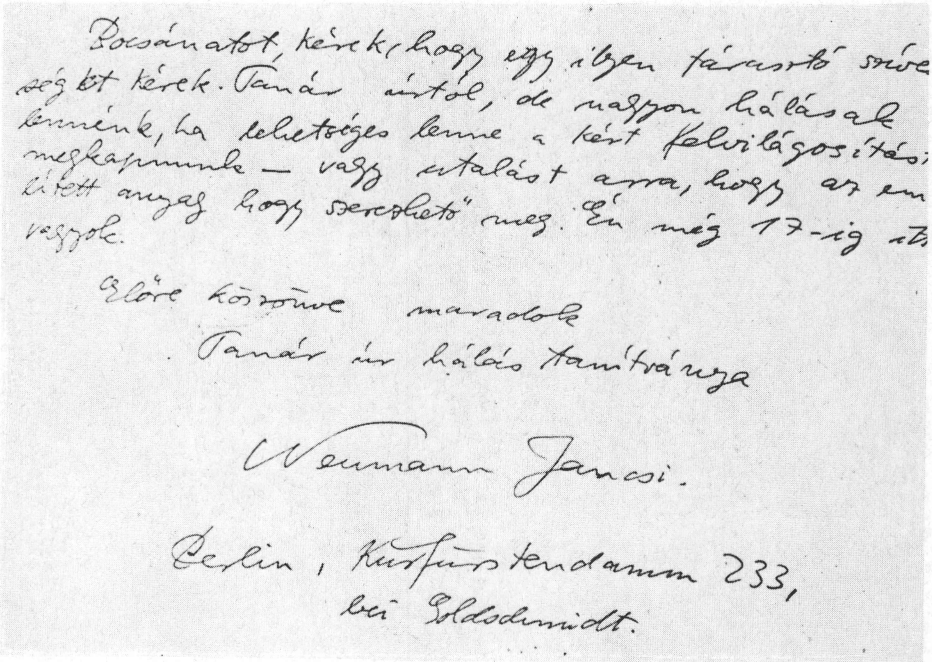
Szilárdot ezen eljárásnak német viszonyok között való alkalmazhatósága nagyon érdekli, és erről a tárgyról is többször diskutáltunk. Miután azonban elsősorban a megbízható statisztikai tényeket szeretnők megtudni, a következő kéréssel fordulunk Tanár úrhoz. Nagyon szeretnők megismerni

1./ a tanulóversenyek 1 és 2 helyezettjeinek névsorát

2./ azoknak megjelölését, akik ezek közül tudományosan vagy másképen beváltak

3./ Tanár úr véleményét arról, hogy a díjnyertesek és a tehetséges emberek mennyire azonosak, és hogy pl. az előbbieknek mekkora hányada érdemelne állami támogatást tanulmányai lehetségessé tételére.

Letter by J. Neumann to R. Ortvay, 1929, inquiring after the effect of student competitions in Hungary, concerning the search for talents.


Bocsánatot kérek, hogy egy ilyen fárasztó szíve-
ségét kérek Tanár úrtól, de nagyon hálásak
lennénk, ha lehetséges lenne a kért felvilágosítást
megkapnunk — vagy utalást arra, hogy az em-
lített anyag hogy szerezhető meg. Én még 17-ig itt
vagyok.

Előre köszönve maradok
Tanár úr hálás tanítványa

Neumann Jancsi.

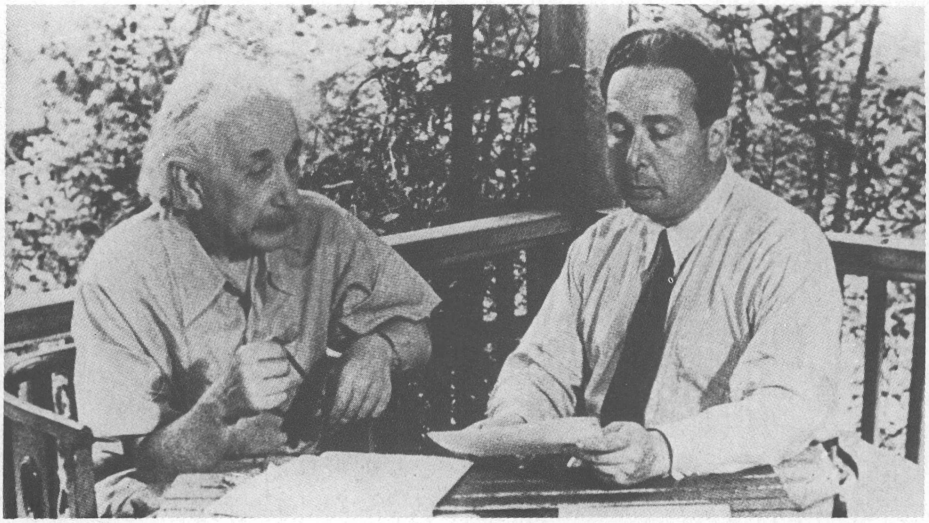
Berlin, Kurfürstendamm 233,
bei Goldschmidt.

The ending part of the letter. The signature shows the informal contact between Ortvay and "Johnny".

Ede (Edward) Teller (1908–) gave a lecture in 1930 at the Ortvay colloquium entitled: "The structure of two-atom molecules". Tisza discoursed on "The quantum-mechanical theory of radioactive decay". One was 21, the other 22 years old at the time, only a few years after both of them had won the national mathematical competition. Teller had won in that same year, 1925, the competition in physics as well.

Teller's lecture at the Ortvay colloquium and the discovery of the Jahn–Teller effect are not so far apart in time. Teller had come home from Leipzig to give that lecture, where he was working with Heisenberg and he also invited Tisza from Göttingen to join them.

László Tisza (1907–) who had originally wanted to become a mathematician, began his studies at the Budapest University and went to Göttingen in 1927 where Max Born (1882–1970) made him aware of and arose his interest in quantum mechanics. It was Teller who suggested to Tisza the application of group theory



Einstein and Szilárd discussing the historical letter to the President of the USA 1940.

for the calculation in the spectrum of multi-atom molecules as a thesis subject. Tisza submitted his thesis to Ortvay in Budapest and defended it in 1932. The idea came originally from Max Planck (1858–1947). Ortvay sent Tisza's thesis to Princeton to obtain Wigner's opinion.

Ortvay's ambition was to bring scientific research in theoretical physics in Budapest to the highest level in the world. Some fortunate circumstances coincided to help him. First of all the fact that a number of talented physicists born in Hungary were active in various parts of the world. Ortvay, too, as Eötvös before him, did his best to obtain scholarships for his best pupils and assistants. Luckily he was a great letter writer and main-

Ede (Edward) Teller (1908–) in the USA.

United States Patent Office

2,708,656
Patented May 17, 1955

1

2,708,656

NEUTRONIC REACTOR

Enrico Fermi, Santa Fe, N. Mex., and Leo Szilard, Chicago, Ill., assignors to the United States of America as represented by the United States Atomic Energy Commission

Application December 19, 1944, Serial No. 568,904

8 Claims. (Cl. 204—193)

The present invention relates to the general subject of nuclear fission and particularly to the establishment of self-sustaining neutron chain fission reactions in systems embodying uranium having a natural isotopic content.

Experiments by Hahn and Strassman, the results of which were published in January 1939. Naturwissenschaften, vol. 27, page 11, led to the conclusion that nuclear bombardment of natural uranium by slow neutrons causes explosion or fission of the nucleus, which splits into particles of smaller charge and mass with energy being released in the process. Later it was found that neutrons were emitted during the process and that the fission was principally confined to the uranium isotope U^{235} present as $1/139$ part of the natural uranium.

When it became known that the isotope U^{238} in natural uranium could be split or fissioned by bombardment with thermal neutrons, i. e., neutrons at or near thermal equilibrium with the surrounding medium, many predictions were made as to the possibility of obtaining a self-sustain- ...

2

is converted by neutron capture to the isotope 92^{239}. The latter is converted by beta decay to 93^{239} and this 93^{239} in turn is converted by beta decay to 94^{239}. Other isotopes of 93 and 94 may be formed in small quantities. By slow or thermal neutron capture, 92^{235}, on the other hand, can undergo nuclear fission to release energy appearing as heat and gamma and beta radiation, together with the formation of fission fragments appearing as radioactive isotopes of elements of lower mass numbers, and with the release of secondary neutrons.

The secondary neutrons thus produced by the fissioning of the 92^{235} nuclei have a high average energy, and must be slowed down to thermal energies in order to be in condition to cause slow neutron fission in other 92^{235} nuclei. This slowing down, or moderation of the neutron energy, is accomplished by passing the neutrons through a material where the neutrons are slowed by collision. Such a material is known as a moderator. While some of the secondary neutrons are absorbed by the uranium isotope 92^{238} leading to the production of element 94, and by other materials such as the moderator, enough neutrons can remain to sustain the chain reaction, when proper conditions are maintained.

Under these proper conditions, the chain reaction will supply not only the neutrons necessary for maintaining the neutronic reaction, but also will supply the neutrons for capture by the isotope 92^{238} leading to the production of 94, and excess neutrons for use as desired.

As 94 is a transuranic element, it can be separated from the unconverted uranium by chemical methods, and as it is fissionable by slow neutrons in a manner similar to the isotope 92^{235}, it is valuable, for example, for enriching natural uranium for use in other chain reacting systems of smaller overall size. The fission fragments are also

Patent application relating to nuclear fission in 1944 by Fermi and Szilárd.

tained contact with many Hungarian scientists as well as with other important members of the physics community. He exchanged letters with Hevesy in the period 1922–1943, with Wigner from 1929 to 1939, with Planck between 1936 and 1943, with Heisenberg in the years 1941/42. His correspondence with János (John von) Neumann lasted from 1928 to 1941. At Ortvay's suggestion the Hungarian Academy of Science conferred honorary membership on:

Arnold Sommerfeld (1868–1951) in 1930,

Arthur Eddington (1882–1944) in 1932,

Ch.V. Raman (1888–1970) in 1937,

Niels Bohr (1885–1962) in 1938,

Peter Debye (1884–1966) in 1940,

Max Planck (1858–1947) in 1940.

Except for the two "great old men" all the others had been born in the eighties and were therefore almost

Clipping from New York Times on Issue of Historic First Nuclear Reactor Patent (May 19, 1955).

THE NEW YORK TIMES, THURSDAY, MAY 19, 1955.

PATENT IS ISSUED ON FIRST REACTOR

Fermi-Szilard Invention Gets Recognition—A. E. C. Holds Ownership

Special to The New York Times.

WASHINGTON, May 18 — A historic patent, covering the first nuclear reactor, or atomic pile, has been issued by the United States Patent Office.

The inventors were Enrico Fermi, the Italian-born physicist who died last November, and Prof. Leo Szilard of the University of Chicago. The patent is owned by the Atomic Energy Commission.

Roland A. Anderson, patent counsel to the commission, classed the patent in importance with those issued to Eli Whitney for the cotton gin, to Samuel F. B. Morse for the telegraph and to Alexander Graham Bell for the telephone.

Licenses will \be issued under the patent (No. 2,708,656), but applicants will have to meet the other requirements for the civilian atomic industry prescribed by the commission on April 12.

Various improvements in nuclear reactors have been made since the basic invention covered by the Fermi-Szilard patent.

The patent discloses the method by which the inventors achieved their self-sustaining chain reaction. They and their co-workers succeeded in starting the reaction—which made the atomic bomb possible—on Dec. 2, 1942, in a pile at the University of Chicago.

The patent also describes an air-cooled reactor such as X-10, which has been in operation at the Oak Ridge national laboratory since 1943 and is now used for isotope production.

Issuance of the patent estab-

Reactor Inventors

Dr. Enrico Fermi

Prof. Leo Szilard

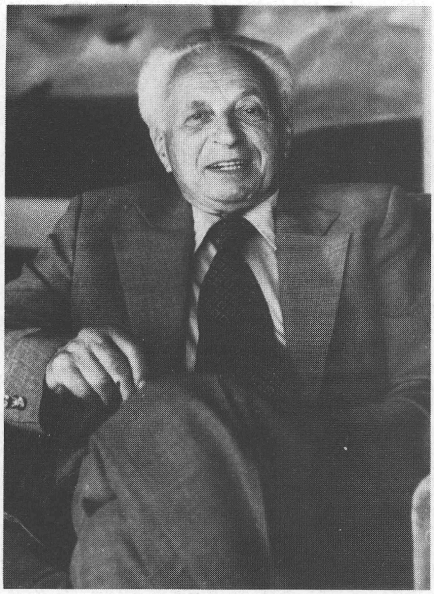
New York Times 1955 on the Fermi–Szilárd invention.

Ortvay's contemporaries. Three giants are missing from the list:

Erwin Schrödinger (1887–1961),
Max Born (1882–1970),
Albert Einstein (1879–1955).

In 1934 it was not possible, even for Ortvay, to have these three, nor Neumann, accepted for any academic honour.

The relations between Ortvay and



László Tisza (1907–) on a visit to Hungary.

worked as Professor at the Dublin Institute for Advanced Studies and retained this post till the end of his life. In his later years he frequently visited Budapest.

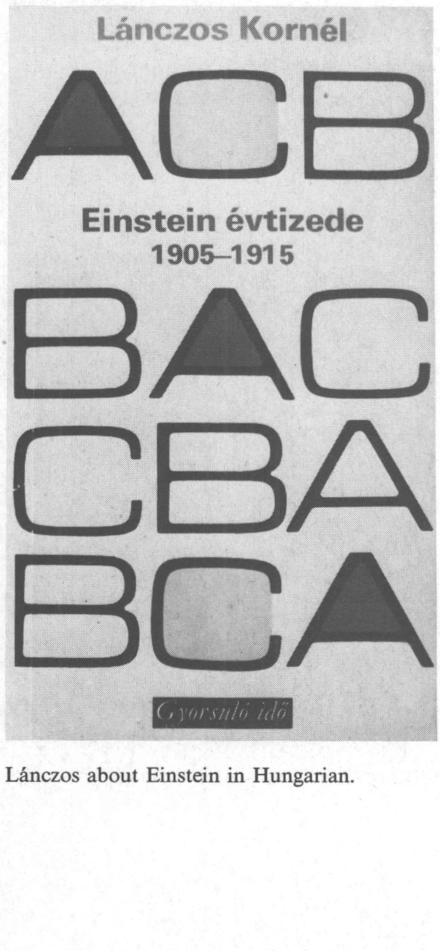
Lánczos had many important ideas as regards the theory of both special and general relativity. His results have significance from the point of view of the so-called "unified field theories", i.e., for the unification of gravitation and electrodynamics. His other field was the mathematical apparatus of quantum mechanics. Lánczos approached the problem of the eigenvalue not from the side of differential equations but from that of the integral equations. At the time his efforts provoked W. Pauli's criticism. At a conference in Triest in 1972, however, his ideas were acknowl-

Einstein were indirect only; the link was through an old pupil of Ortvay, one of the most profound thinkers among the theoretical physicists of the century who was a friend and private assistant of Einstein: Kornél (Cornelius) Lánczos.

Kornél (Cornelius) LÁNCZOS (1893–1974) took his doctor's degree in Budapest, then went to Berlin where he became the private assistant to Einstein. This cooperation grew into a friendship which lasted till Einstein's death. In the thirties Lánczos emigrated to the United States where he worked at the Purdue University. In the fifties he returned to Europe,

A. Sommerfeld with R. Ortvay in Budapest in 1930.

edged. B.L. van der Waerden (1903–) the renowned mathematician and enthousiastic scholar of the history of quantum mechanics demonstrated that the integral equation of Lánczos was mathematically equivalent to the Schrödinger equation which was published a month later. Van der Waerden had thought that Lánczos was no longer alive, it was therefore a most dramatic moment when the chairman of the conference pointed out to him that Lánczos – though approaching



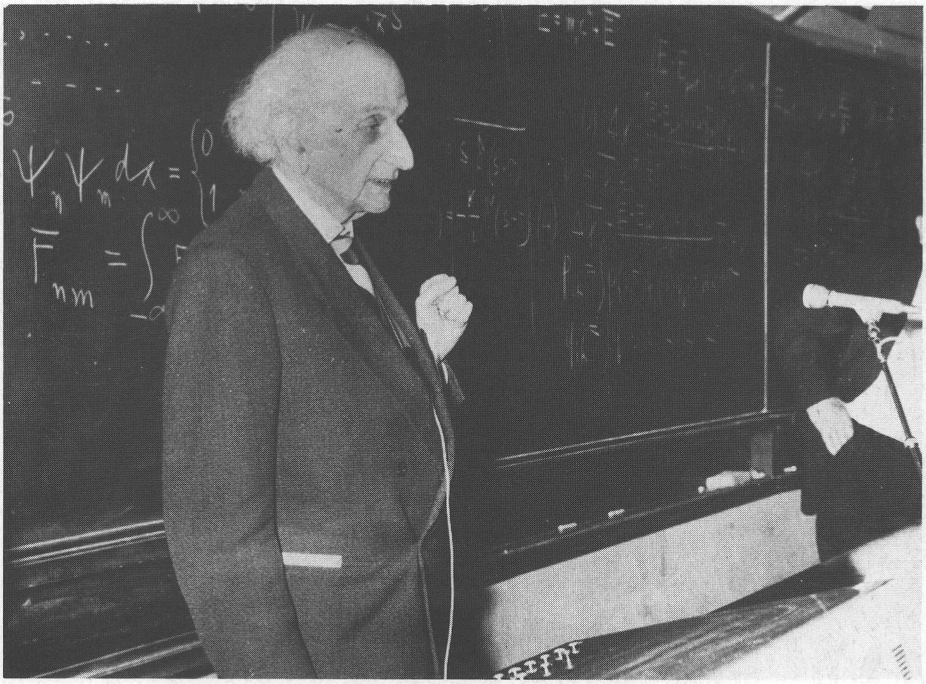
Lánczos about Einstein in Hungarian.

Imre Bródy and Cornelius Lánczos in their thirties in Budapest.

eighty – was present in the audience....

When Lánczos lectured at the Ortvay colloquium on: "The Stark effect in a strong magnetic field", Imre Bródy – closely acquainted with Lánczos and of about the same age – was there to hear him.

The aim that Ortvay had set for himself of not letting the physicists working in the industry and those doing research at the University lose contact with each other, can be demonstrated by many examples. Thus Ortvay made sure that invitations were sent for each colloquium to Otto Titusz BLÁTHY (1860–1939), the in-

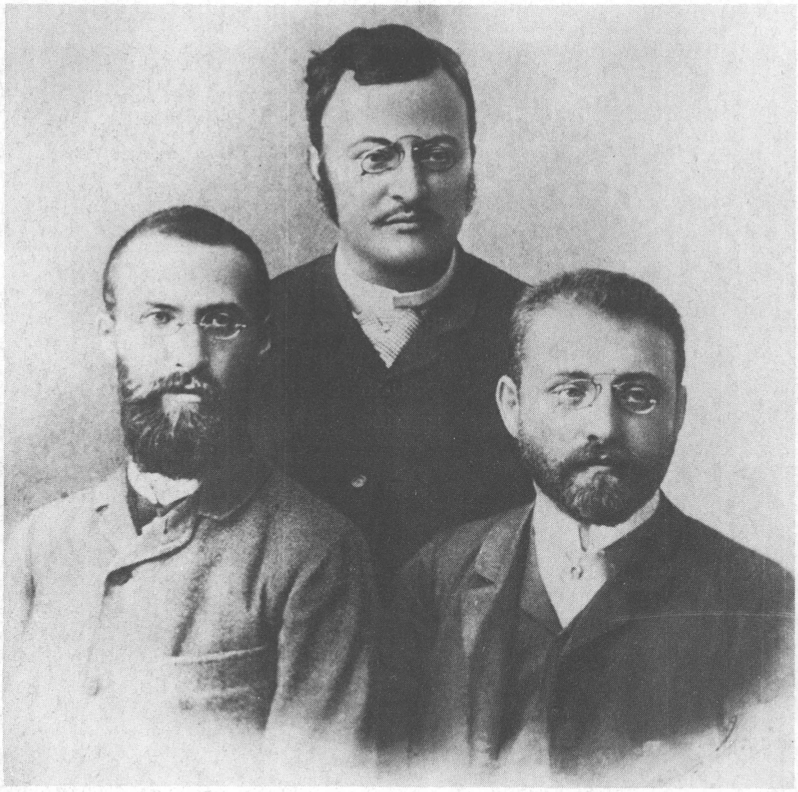


Cornelius Lánczos at the Conference in Trieste. The Conference was held in honour of Paul Dirac on his 70th birthday in September 1972.

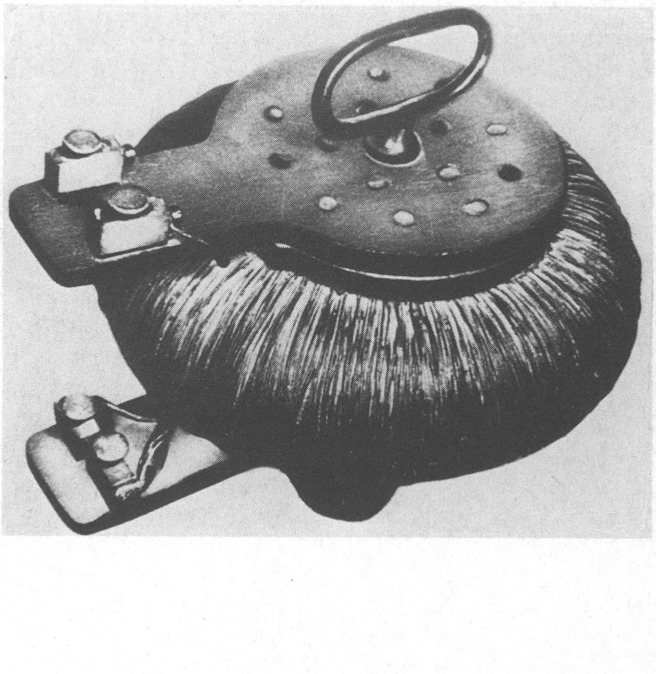
ventor of the transformer with gapless iron core. At the time of the Ortvay colloquium Bláthy was already more than seventy years old. Ortvay was not yet born when Bláthy took his M.Sc. degree. Electrotechnics had not even been one of the subjects at the University. Edison invented the carbon filament (incandescent) bulb about that time. The plan was to employ DC generators for the street lights. Three engineers at the GANZ Works: O.T. Bláthy, Miksa (Max) DÉRI (1854–1938) and Károly (Carl) ZIPERNOWSKY (1853–1942) invented in 1884–85 a new electric distribution system that permitted the use of AC generators. It was based on an induction apparatus that they called a transformer.

Bláthy was the first to design magnetic circuits by using magnetizing curves. He also improved the grade of efficiency of generators, electric motors and transformers.

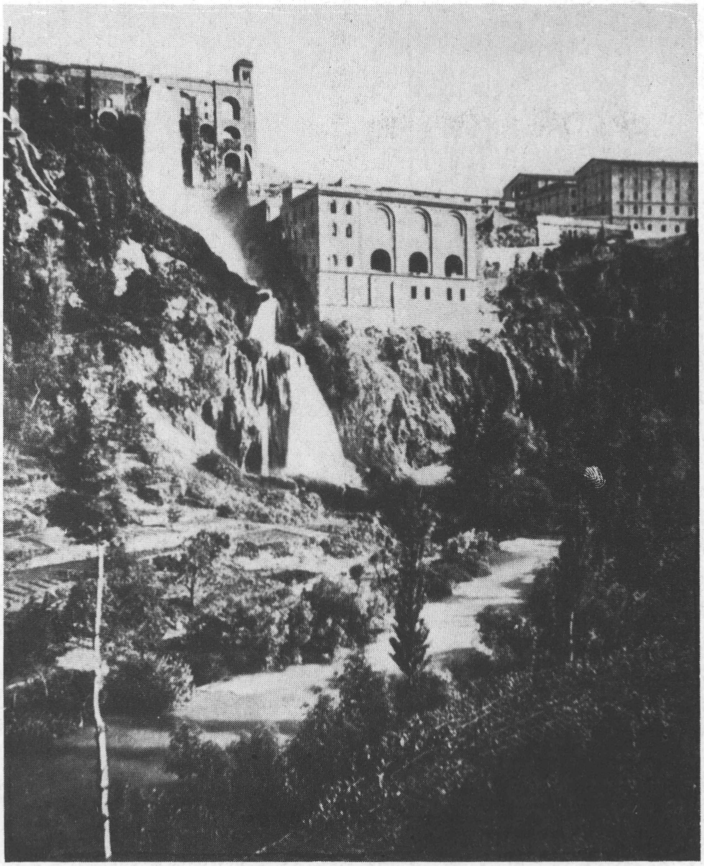
At the turn of the century, street lights in Rome were supplied by (electric) power stations based on a system of transformers that had been designed by Hungarian experts. The



Otto Titusz Bláthy, Károly (Carl) Zipernowsky and Miksa (Max) Déri: inventors of the transformer and designers of transformer stations.



One of the first transformers designed by Bláthy, Zipernowsky and Déri.



One of the first hydraulic power stations producing AC in Tivoli, not far from Rome, near the ancient villa of Maecenas.

automatic water turbine regulator designed by Bláthy allowed the machines at the Cerchi thermal power plant (supplying electric current for the city of Rome) to be connected, parallel with the machines of the Tivoli hydroelectric power plant, to one and the same network. Thirty years later, after the sudden death of Kálmán Kandó (1869–1931) Bláthy, then 70, completed the design of the phase converter of the Kandó electric locomotives.

Bláthy died in 1939, a month after the war broke out. Ortvay lived all through World War II in a state of increasing depression over all he had to witness. On the 2nd January 1945, one day after his 60th birthday he felt he could bear no more the horrors and hopelessness, and committed suicide. He had no faith in the revival of science in Hungary.

9. *After 1945*

When the siege of Budapest ended (February 1945), Szent-Györgyi has energetically undertaken to revive scientific work in Hungary. His name was well known in professional and political circles alike. During the war the Hungarian government sent him on a secret mission to Turkey to make contact with the Allied Powers. When the front reached Hungary he was hunted by the Gestapo upon the personal command of Hitler. He went into hiding in Budapest and survived.

Albert SZENT-GYÖRGYI (1893–1986) reached a great age and his creative powers were still undiminished at ninety. He attributed this and his good health among others to vitamin "C", for the discovery of which he received the Nobel Prize in 1937.

His medical studies were interrupted by World War I and he passed his examinations in 1917. He did research work in bacteriology, continued his studies in Hamburg and Berlin, then graduated in chemistry at Cambridge in 1927. After having worked in the United States and Holland, in 1930 he returned to Hungary and became a professor first at the Szeged and then at Budapest University. He was awarded the Nobel Prize in 1937 for research work done in Hungary. Under the leadership of Szent-Györgyi an Academy of Natural Sciences was founded which, however, after prolonged disputes was incorporated into the Hungarian Academy of Sciences. At the time, the president was Zoltán KODÁLY (1882–1967), and Szent-Györgyi was vice-president. Since 1868 the Academy has had three main divisions:

I. Linguistics and Arts

II. Philosophy, Social and Historical Science

III. Mathematics and Natural Sciences

In 1946, desirous to increase the scope of natural sciences Szent-Györgyi succeeded in setting up division IV under the title "Biology and Medical Science", while division III was changed to "Division of Mathematical, Physical and Chemical Science".

The new Academy elected among its members Manó Beke, the only surviving scientist of those who had been expelled from the Academy in 1920 on account of the role they played during the revolution. György

Albert Szent-Györgyi (1893–1986), Nobel Prize winner in 1937.

Zoltán Bay (1900–). The Roland Eötvös Physical Society celebrated the 30th anniversary of the pioneering moon echo experiments in 1975, by inviting Bay to talk about his reminiscences.

(George de) Hevesy – not resident in Hungary – was elected an honorary member. At the same time, the honorary membership of Phillip Lénárd (1862–1947) was withdrawn. Among others, regular membership was conferred upon Zoltán Bay, György Békésy, Pál Gombás, and correspondent membership upon Pál Selényi.

Zoltán BAY (1900–) was the chief supporter of Szent-Györgyi during his fight for the renewal of the Academy. They had met at the university in Szeged, where Bay was the successor of Ortvay when Szent-Györgyi was busy extracting vitamin "C" from the paprika of the Szeged region. They had many positive qualities in common: a democratic attitude, a sense of humour, the gift to formulate their thoughts clearly and convincingly – all these made them popular with a wide circle of people and created good understanding. Also, both of them had an exceptional gift: excelling in both theoretical and experimental research.

Bay who came from Debrecen, was

admitted to the Eötvös College in Budapest for which he retained fond memories even after becoming a world-famous scientist. His life and activity showed that the industry offered a good field for achieving significant results. He gave up his chair of Physics in Szeged and in 1936 became head of the research laboratory at Tungsram. He persuaded the general manager Lipót Aschner (1872–1952) to make a considerable endowment for the organization of a department of atomic physics at the Budapest Technical University. He became professor of this department and at the University used the electron multipliers developed in the Tungsram laboratory for counting particles.

When Hungary entered the War, the Ministry of War requested Zoltán Bay to set up a research team to develop a Hungarian radar system. The Germans had no confidence in the undertaking and therefore the team could not expect to receive any professional help. In an interview given in 1973 Bay recalled this attempt:

After all, what we did about radar was only what the team could achieve by theory and experiment; we had to find out everything that already had been discovered. However, I said to my colleagues: "if this is the task we have to work on, let us use it for getting some scientific result. Let us send signals to the moon and watch their return".

This is how the remarkable idea of the moon radar experiment was born. And this was the second time that the ships on the Danube had played an important part in physics research. The first occasion was when Eötvös and his team tested the sensitivity of the torsion balance in the cellar of the Academy. Fifty years later Bay and his team calibrated the sensitivity of the radar receiver placed on the roof of the Tungsram laboratory by means of the floats passing on the Danube. There was no time left for doing anything else. The two-month long siege of Budapest put a stop to all this.

The team commenced their experiments at the end of December 1945, sadly depleted in number and means, many distressed by personal losses and suffering from cold and hunger. Nevertheless, on the 7th of February 1946 Bay was able to report the success of the moon radar experiment.

The experiments were pursued without György DALLOS (1910–1945) designer of the receiver, who towards the end of the war was carried off by the fascists and driven to suicide in prison. The survivors were Ernő WINTER (1897–1971) and Andor BUNDECSEVITS (1902–), designers of the emitter tubes and mixing diodes, as well as Károly SIMONYI (1916–) and György PAPP (1912–1964) who did the theoretical calculations.

Pál (Paul) SELÉNYI (1884–1954), about the same age as Ortvay, was also among the survivors. He was a physicist of remarkable intuition who

Pál Selényi (1884–1954) with his electrographic machine. Research work in applied Physics.

spent twenty years in the Tungsram laboratory. When he finished his studies at the Budapest University, Jenő Klupathy employed him as assistant at the Institute of Practical Physics. Selényi obtained his doctor's degree in 1910. He was an excellent lecturer and a talented experimenter in training science masters, as well as carrying out scientific research. His wide-angle interference experiment refuted Einstein's hypothesis of needle radiation. Between 1912 and 1913 Selényi worked in Göttingen and Berlin. After World War I the revolutionary government appointed him Professor of Physics at the University, replacing Loránd Eötvös who had recently died. Inevitably he was removed from the University after the revolution. He took a job at Tungsram where many of his inventions were born.

One of the most interesting of these was the electrographical transfer on which the present-day xerox method is based. It is interesting to remember that Lipót Aschner was dissuaded from the industrial application of the invention by the same Zworykin who

György (George von) Békésy (1899–1972), Nobel Prize winner in 1961.

deemed the electron multiplier of Zoltán Bay totally unsuitable for particle counting. Bay stuck to his idea – Selényi retired from the dispute.

During the war Selényi was forced into retirement and was called up several times for labour service. Both his own son and his adopted son lost their lives in labour service. Selényi survived and became active again. From 1948 onwards he taught again at the University, becoming correspondent member of the Academy. He was commissioned to write a scientific biography of Loránd Eötvös and to prepare the publication of Eötvös's collected works. He was also one of the founders of the newly established Roland Eötvös Physical Society and initiated the renewal in 1949 of the Roland Eötvös student competitions in physics.

Selényi's experiments were simple but striking. Before him, there had been only one research scientist at Budapest University who could be considered a worthy successor following the system of experimental physics represented by Eötvös and then by Klupathy. This scientist was appointed in 1941 as head of the Institute of Practical Physics. His name was György Békésy.

György (George) Békésy (1899–1972). His father worked in the diplomatic service residing at various places abroad, thus Békésy attended schools in Munich, Istanbul and Zurich. He then studied at the University of Bern and obtained his doctor's degree in Budapest.

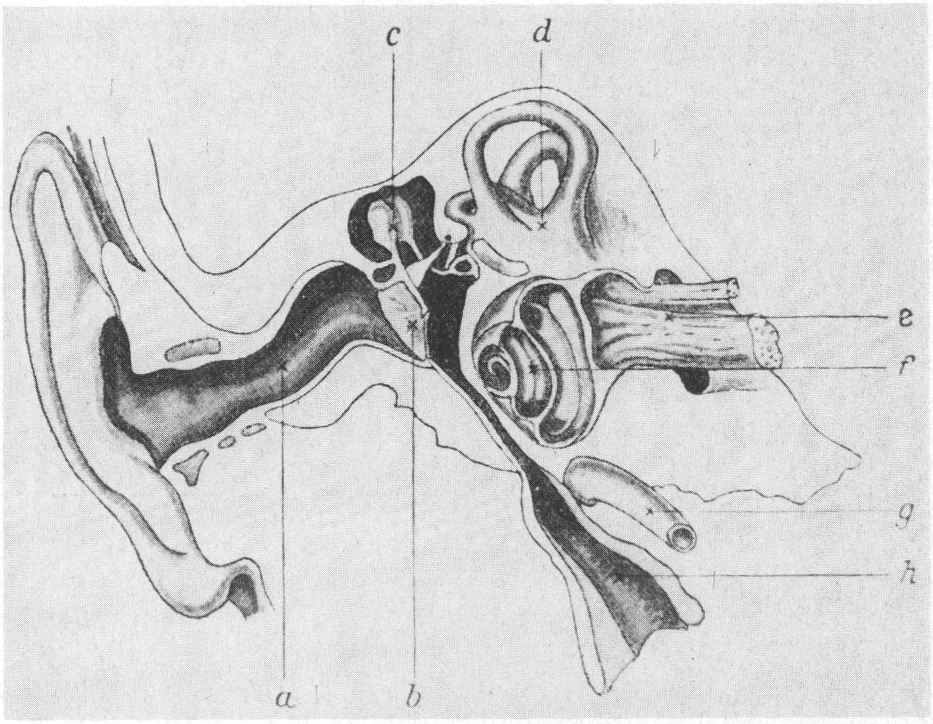
His opinion and assistance were frequently requested for the solution of problems in the industry. When undertaking such work, he always insisted that any fee due to him should be spent on new equipment, as a means of modernizing the Institute.

The University building suffered serious damage during the war. The big lecture hall and laboratory rooms were destroyed. Békésy managed to save the library, and with the help of the students found a hiding place for the majority of instruments before the siege of Budapest commenced.

In the summer of 1946 when inflation in Hungary broke all records, Szent-Györgyi won the highest prize of the academy. The second highest prize was given to Békésy – this was a diploma of acknowledged merit.

Békésy, realizing that at home he could not find the financial support or the means for his research, accepted an invitation from Stockholm. The following year he moved on to the United States to work at Harvard University. He spent 17 years at the well-equipped psycho-acoustic laboratory there and yet, when he won the Nobel Prize in 1961, said that he had done most of the research work acknowledged by the prize whilst still in Budapest.

With Dénes (Denis) Gábor (1900–1979) this was not the case. Though he too had commenced his work in Hungary and had been employed at the laboratory of Tungsram for some



Model of the ear by G. Békésy.

years, his really successful research work was done in England. He was born at the turn of the century, a hundred years after Jedlik. He worked out his theory of holography, for which he was awarded the Nobel Prize in 1971, between 1946 and 1951. He started afresh and was most successful in the stormy years after World War II.

Dénes Gábor was born in Budapest where he finished his schooling and started at the Engineering Department of the Technical College. After two years he continued at the Technische Hochschule in Berlin where he studied electrical engineering. Like Wigner and Neumann, he too, took various classes at the Berlin University in order to hear the "great ones". After obtaining his degree, he stayed in Germany; his doctor's thesis in 1927 was on the development of a high-velocity cathode ray tube. In 1934–35 he worked at the Tungsram laboratory on the construction of the plasma lamp. In 1936 he married an English woman and settled in Eng-

Dénes (Denis) Gábor (1900–1979), Nobel Prize winner in 1971.

land. His papers published between 1946 and 1951 enable us to follow the progress of his work on holography. From the sixties onwards he frequently visited Hungary. He was elected Honorary Member of the Academy in 1964.

Dénes Gábor, as we have seen, made a successful fresh start in London after the war. Recognition did not immediately follow. But scientists are strange people: they seem to be content if they are merely allowed to work in peace. But if not, they move on. That is why Békésy, and possibly others had left.

Szent-Györgyi realized soon enough that the country could not offer funds for his "science-saving" ideas. Lack of funds even made it impossible to hold a Mathematical–Physical Congress in Budapest, in honour of the 100th anniversary of the birth of Loránd Eötvös in 1948.

Szent-Györgyi announced his resignation as Vice-President of the Academy in March 1948 in a letter from Washington. Zoltán Bay was named as his successor. But by that time he, too, had left the country. He was giving lectures on the moon radar experiments at Berkeley, in Vienna, and Washington. In 1948 the Convention of the Academy elected a former pupil of Ortvay, Pál (Paul) Gombás aged 39 for the post of vice-president.

10. Founders of institutes, school-creating personalities

It is inspiring and encouraging to reflect on the fact that the final tragic pessimism of Professor Ortvay was proved wrong by his own pupils in Hungary.

Pál (Paul) Gombás (1909–1971) was a half-orphan whose hard-working mother was unable to bear the expenses of his higher education.

Gombás earned his living by working part-time while he was student. In 1933 Ortvay offered him unpaid work – this being the usual way of recruiting and testing new collaborators at that time – as second assistant. He accepted it because, as he said, it made it possible to do research work in physics at least in the mornings. During the six years he was thus engaged, he wrote nearly thirty publications, most of them appearing in the Zeitschrift für Physik.

When Gombás was elected Vice President of the Academy in 1948, he had already held the Chair of Physics at the Budapest Technical University for four years.

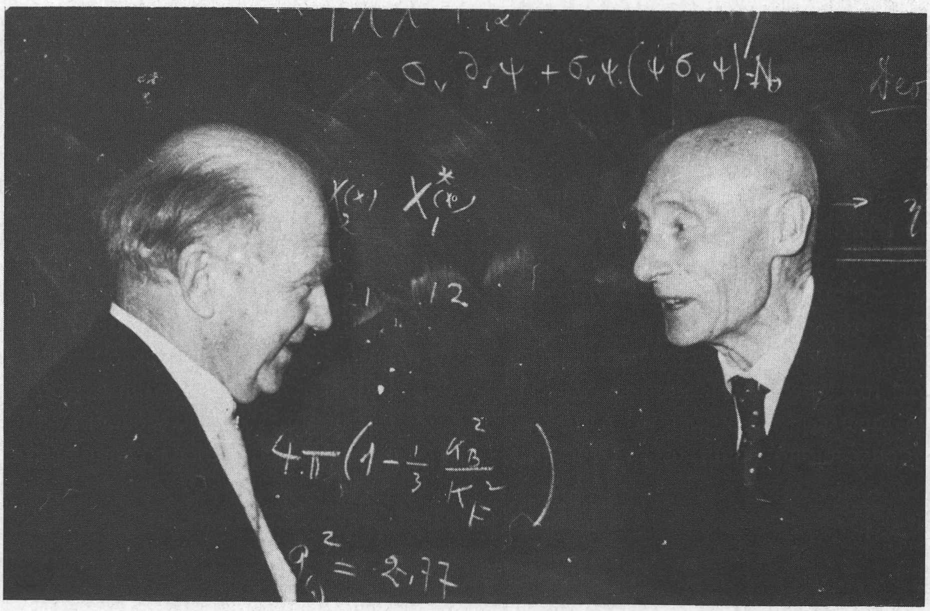
Gombás had already suggested in 1935, the possibility of examining the motion of valence electrons in a special potential field. The pseudo-potential, taking into account the role of the Pauli principle, proved a fruitful idea. It still plays an important role in calculations to determine the electron structure of solid bodies, the bonding energy of metals or Fermi surfaces. The work of Gombás was now recognized and appreciated in the scientific world. Gombás was invited to write the chapters on statistical theory of the atom for a new edition of the 'Handbuch der Physik". This was an honour that had not been conferred on a Hungarian scientist since the time of Győző Zemplén.

Gombás and his pupils refined the statistical atom model to a point where its accuracy approached that of the Hartree–Fock method. The most developed model of the atom in statistical mechanics is frequently quoted in the literature as the "Thomas–Fermi–Dirac–Gombás" model.

Gombás was Orvay's assistant and became Professor of Physics. Ortvay's own Chair was inherited by a science teacher from a secondary school and yet nobody was surprised by his appointment.

Károly (Karl) Novobátzky (1884–1967) was admitted to the

Werner Heisenberg visiting the Institute of Theoretical Physics of Prof. Novobátzky in Budapest. From left to right: I. Fényes, W. Heisenberg, K. Novobátzky, P. Gombás, K. Nagy and G. Marx.



Discussion in Budapest. W. Heisenberg and K. Novobátzky.

Eötvös College and took his teacher's degree of mathematics and physics at the Budapest University. He was a pupil of Eötvös and later a regular attendant of the colloquia of Ortvay who discovered his talent.

Novobátzky had given brilliant lectures on the new Einstein theory of relativity. Ortvay immediately arranged for him to give a course on this subject at the Teachers' Training College and ensured his free access to the library at the Institute of Theoretical Physics. Novobátzky, at that time a secondary school teacher, showed his gratitude by writing high-level scientific treatises. When Max Born, who always paid attention to the work of Hungarian scientists, read one of Novobátzky's articles written in 1938 he wrote to Ortvay: "I think it is a very brilliant paper, as this man has solved in a most straight-forward way a problem which has puzzled people like Pauli, Heisenberg and Fermi. And I think that his new commutation laws for the electromagnetic vector potentials may have important consequences. I should like to know something about him..."

Novobátzky was Professor of Theoretical Physics at the University (then already bearing the name of Roland Eötvös) from 1945 until his death in 1967, and in 1958 succeeded Pál Gombás as Vice-President of the Academy. His scientific work extended from the examination of the energy–momentum tensor of the electromagnetic field to the derivation (deduction) of the quantum-mechanical laws from variation principles.

Novobátzky's true greatness, however, was demonstrated in his training of young research scientists. Gombás wrote of him: "His attitude reflects the fatherly benevolence of great educators, inviting confidence and affection, making learning attractive and interesting". It was Gombás who first used the term "Novobátzky School" for the team of young research scientists working with Novobátzky. Amongst them were György (George) MARX and Károly (Karl) NAGY who continued Novobátzky's research of the electromagnetic field produced in dielectrics, while Frigyes (Frederick) KÁROLYHÁZY made progress in quantum electrodynamics and the general theory of relativity.

Today in Hungary – and not only in Hungary – several hundreds physicists are working who are proud to say that it was Novobátzky who taught them physics and human integrity.

In the fifties there was only one physicist besides Novobátzky of the older generation at the Department of Theoretical Physics. A scientist of remarkable qualities and all-round interest who had, in the early days, worked alongside Gombás in Ortvay's Department. This scientist was Neugebauer.

Tibor NEUGEBAUER (1904–1977) whose main interest as a young student was biology, as it had been for Ortvay, Polányi, Szilárd and Békésy. He studied biology at the Budapest

University but, even within this field, the laws of physics began to attract him, so he altered his curriculum and obtained his master of science degree in physics and mathematics. A few years after the birth of quantum mechanics, he was the first to offer an explanation for the chemical properties of numerous molecules in terms of the new theory. His lecture at the Ortvay colloquia bore the title: "Perturbation theory according to Schrödinger". His papers, attracting international interest, dealt with superconductivity, the explanation of geomagnetism, and the problems of nuclear physics. He had a reputation among the students for knowing "everything". Indeed, he investigated the interference colours of the wing of butterflies, but also gave a quantum-physical explanation on the origin of lightning balls. He correctly interpreted one of the basic phenomena of non-linear optics, that molecules perform an anharmonic forced oscillation and thereby radiate light of double frequency. He would always help anybody who turned to him.

There was a middle-aged physicist at the Department of Novobátzky who had been Gombás' assistant in Kolozsvár. His life was made difficult by many changes in circumstances and scientific antagonisms, but his kind smile and deep thoughts are our treasured memory:

Imre (Emery) Fényes (1917–1977) studied at the Universities of Budapest, Debrecen and Kolozsvár. His doctor's thesis dealt with the relation of the statistical model of the atom to the many-body problem of quantum mechanics. In 1974 he conducted a seminary course, together with Heisenberg, at Dubrovnik on the conceptual questions of quantum theory. His research work in thermodynamics is likewise significant. His was the first Hungarian course and the first book on irreversible thermodynamics. His results are frequently quoted by physicists, philosophers and engineers.

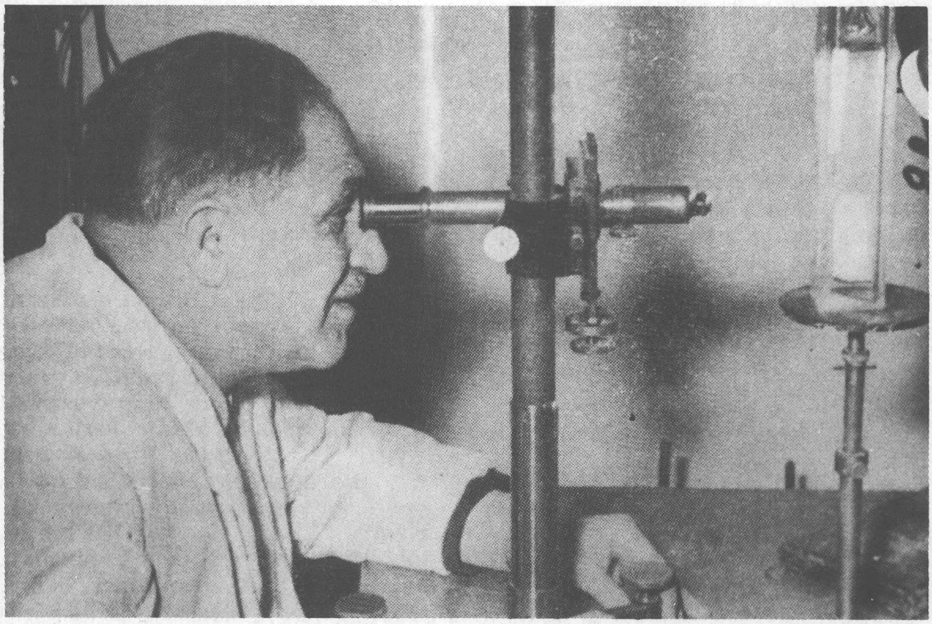
However the picture of physics in Budapest would be one-sided if we left out the experimental physicists. Between the two wars there was next to no possibility of following the venerable traditions of the last century.

Károly (Karl) Tangl (1869–1940) was fifty when he became Professor of Experimental Physics at the Budapest University. In the early part of the century he was Professor in Kolozsvár, after having worked as assistant to Eötvös. He had the same talent for selecting and promoting pupils. In 1908 he chose Ortvay as his assistant, then sent him to Göttingen. Aware of Ortvay's talent in mathematics, he guided him in the right direction. Through his help Ortvay spent two years working with Sommerfeld. Likewise, he cooperated with Ortvay when he obtained the Chair of Theoretical Physics at the Budapest University. Tangl started on

Károly Tangl (1869–1940).

the way of research on cosmic radiation Jenő (Eugene) Barnóthy (1904–) and his wife Magda Forró (1904–). In solid state physics Tangl took a remarkably successful step when, in 1909, he announced a competition for the investigation of the photo-effect. He then induced the prize winner to investigate the photo-effect in non-metallic materials. This student became later the initiator of the research in crystal physics in Budapest:

Zoltán GYULAI (1887–1968) took his master of science degree (mathematics and physics) in Kolozsvár in 1913. In 1914 he was called up for military service, but in 1915 he was taken prisoner of war and only re-



Zoltán Gyulai (1887–1968). Crystal defects, whiskers, a good sense of experimental physics.

turned from Russia in 1922. From 1924 to 1926 he worked with Pohl in Göttingen, investigating optical, electrical and photoelectrical properties of alkali-halogenide crystals. This was a fortunate meeting of two "thoroughbred" physicists. Pohl was 43, Gyulai 40 years old in 1927. Hevesy wrote to Ortvay (both aged 42): "Pohl has warmly praised Gyulai's scientific and other qualities – this is indeed pleasant to hear...". Gyulai's talent as experimental physicist can be best appreciated if we consider that he achieved his most important discoveries in solid state physics by the investigation of common salt. When in 1926 he radiated salt with X-rays he discovered the colour centers. In 1928 he compressed salt crystals and the conductivity of salt changed. He interpreted this effect by supposing defects in the crystal. He produced crystal whiskers from common salt. In 1951 in Budapest he prepared a micromanipulator by means of which he could measure the tensile strength of whiskers of 1 μm diameter. He measured and obtained values which are of the same order of magnitude as the theoretical value.

After Novobátzky and Gombás, Gyulai was for 15 years (from 1954 until his death) an esteemed President of the Loránd Eötvös Physical Society. In 1954 he became a regular member of the Academy and in 1962 correspondent member of the Göttingen Academy of Sciences. His most famous pupils were Tarján and Szalay.

Imre (Emery) TARJÁN (1912–) is at present chairman of the Mathematics and Physics division of the Hungarian Academy of Sciences. He followed in the footsteps of Gyulai, while Szalay pursued nuclear research on Gyulai's scientific level. Both Tarján and Szalay had been Eötvös Collegians. Szalay spent a term at Cambridge in 1936, and his life was determined by the months he spent at the Cavendish Laboratory under the guidance of Lord Rutherford.

Sándor SZALAY (1909–1987) was the founder of the Debrecen Institute for Nuclear Research. In 1947 he initiated the search for uranium in Hungary and his investigations led in 1954 to the discovery of uranium sites.

Sándor Szalay (1909–1987) discovered uranium-sites in Hungary. He established the School of Experimental Nuclear Physics.

In the same year he also organized the Debrecen Institute for Nuclear Research of the Academy. A photo was taken in the Wilson cloud chamber by Szalay – together with Gyula Csikai – demonstrating for the first time the recoil effect of the neutrinos in beta decay. This has become a classical illustrative material in textbooks on nuclear physics. His joint work with Dénes Berényi was the production of the thoroid-system beta spectrometer.

The Budapest school of molecular spectroscopy in the thirties had also a number of promising talents in its team.

Béla POGÁNY (1887–1943) studied and carried out research in optics, first in Budapest then in Göttingen. And while Gyulai together with Szalay and Tarján attempted to produce experimental physics out of just nothing at all in Debrecen, Pogány and his team at the Budapest Technical University already did high-level research in spectroscopy. They performed examinations of crystal structures and attempted to find contact with industrial plants. Pogány wrote textbooks for university students and thereby set an example for the generation succeeding him.

Rezső (Rudolph) SCHMID (1904–1943) was the head of the spectroscopic laboratory in the Pogány Institute – he studied under Millikan in Chicago in 1932. They examined with a Rowland grating of large resolution the microstructure of two-atomic molecular spectra. In the theoretical interpretation Loránd GERŐ (1910–1945), István (Stephen) KOVÁCS (1913–) and Ágoston (Augustus) BUDÓ (1914–1969) attained significant results. Budó worked from 1941 on in Szeged; Pogány and Schmid died in 1943, Gerő in 1945.

Béla Pogány (1887–1943), founder of the School of Spectroscopy.

In 1950 it seemed that Molecular Spectroscopy would receive an Institute in this field, because at that time Kovács was entrusted with the

Ch.V. Raman and L. Jánossy in Budapest.

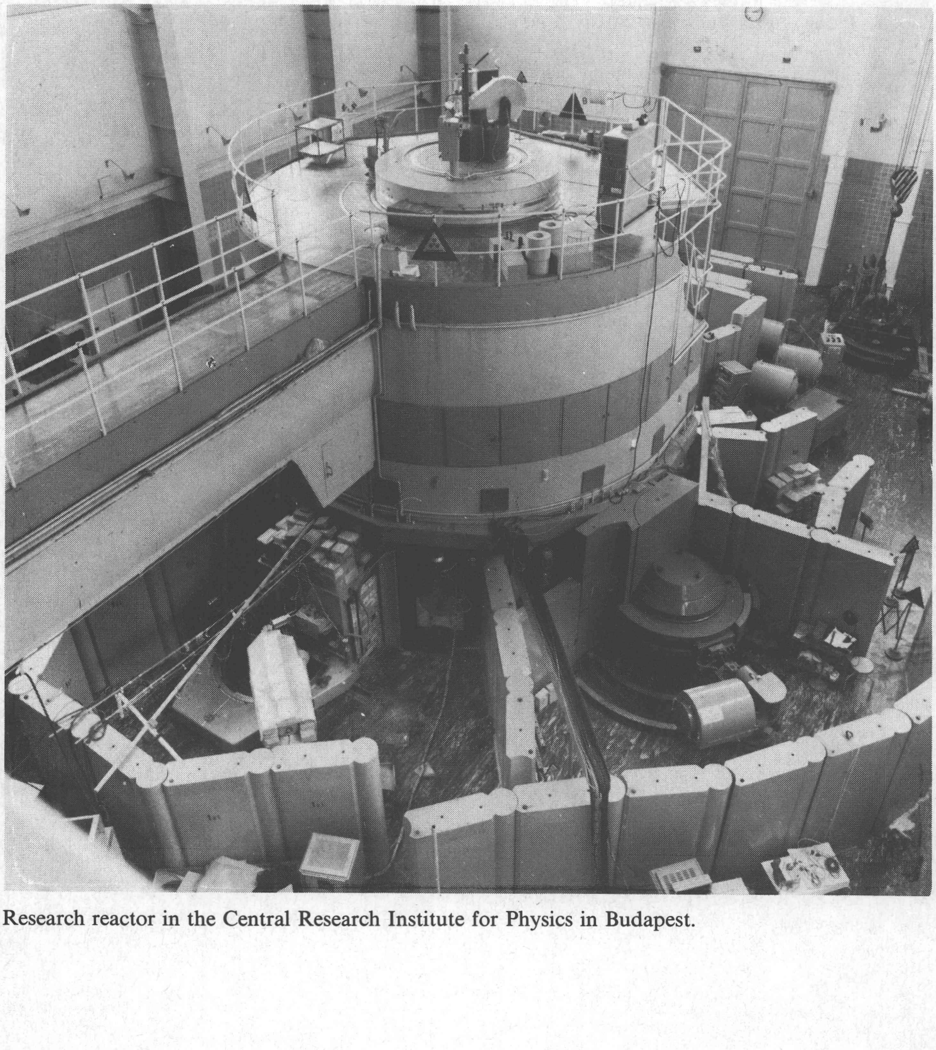
Rezső Schmid (1904–1943). Research in molecular spectroscopy.

organization of the Central Research Institute of Physics (KFKI) with a Department for Spectroscopy under Tibor MÁTRAI (1910–1987). The entire research profile of the Institute was, nevertheless, not determined by the molecular physicists but by a scientist called home from abroad.

Lajos (Lewis) JÁNOSSY (1912–1978) attended the University in Vienna and Berlin because the family had left Hungary when the 1919 revolution had been suppressed. At the age of 24 he went to London to work with Patrick S.M. Blackett (1897–1974).

Blackett proved the existence of positron–electron pairs produced in cosmic radiation by means of a coincidence cloud chamber. By the time he received the Nobel Prize in 1948 for this discovery, Jánossy was already head of the cosmic radiation laboratory of the Institute for Advanced Studies in Dublin. At the invitation of the Hungarian Government he returned to Hungary in 1950 and became Professor at the Budapest University, Department Head at the KFKl, member of the Academy and Vice-President of the Roland Eötvös Physical Society. His book on cosmic radiation gained wide recognition.

Within a few years Jánossy became Director of KFKI and held the Chair of Atomic Physics at the University. He played an important role



Research reactor in the Central Research Institute for Physics in Budapest.

in many fields of political and social life. He was also President of the Hungarian Philatelists' Society. Jánossy had a great influence not only on physics but on Hungary's entire scientific life. His views had been formed by the communist philosopher György Lukács (1885–1971) and he was encouraged by Blackett to take a stand against nuclear warfare. Like Schrödinger Jánossy questioned the Copenhagen interpretation of quantum mechanics. They became friends in Dublin and upon his return to Hungary, Jánossy continued to consult him by letter and informed him about the experiments which he designed to support a new interpretation of quantum physics.

Heisenberg is said to have stated of him: "Jánossy is not right but it is worth while to have a discussion with him". Jánossy's activities in Hungary became somewhat contradictory through his fighting the myth of authority by means of his own personal authority. He greatly shocked physicists by not accepting Einstein's interpretation of the theory of relativity. The dispute on this gained unnecessary significance in the physics world in the Hungary of the sixties.

In the late sixties attention was focussed on industrial research only, at a time when a new economic management system was launched. This trend slowed down in the seventies and only began on another upswing in the second half of the eighties.

Were he still alive with his sad smile, an engineer member of the Academy might give a nod of satisfaction to see that his lifework, the Research Institute for Technical Physics (MÜFI) had grown out of the research laboratory of Tungsram and the institutes that had branched off it. The target set by the Academy for MÜFI was to carry out research in the field of material science, the requirements of vacuum technique, telecommunication and the production of semiconductors. The founder and first Director of MÜFI was György (George) SZIGETI (1905–1978) who received his diploma in mechanical engineering at the Budapest Technical University and worked in the research laboratory of Tungsram, among others, with Ernő (Ernest) WINTER (1897–1971), Imre (Emery) Bródy and Tivadar (Theodore) MILLNER (1899–). His patent like with Zoltán Bay was the first electroluminescent light source, the ancestor of the photodiodes.

Szigeti and his team elaborated on the technology of fluorescent tubes. His scientific-organizational activity rendered important service to the cause of basic research in engineering. Szigeti was Vice-President of the Roland Eötvös Physical Society from 1949, then Acting Secretary, President and until his death Honorary President. He devoted much attention to strengthen the links between scientific research in Hungary and in other countries. He played an active role in starting up the European Physical

Zoltán Gyulai and György Szigeti – two former Presidents of the Roland Eötvös Physical Society.

Society (EPS). He used all his influence and capabilities to pave the way for physicists and engineers, both young and less young, who shared his views on the relationship between science and industry. The best of these people came to fill responsible posts of national importance.

At present the following physicists are members of the Division for Mathematics and Physics of the Hungarian Academy of Sciences:

BERÉNYI, Dénes (1928–), BOZÓKY, László (1911–), CSIKAI, Gyula (1930–), GÁSPÁR, Rezső (1921–), KESZTHELYI, Lajos (1927–), KISS, Dezső (1929–), KÓNYA, Albert (1917–), KROÓ, Norbert (1934–), KOVÁCS, István (1913–), LOVAS, István (1931–), MARX, György (1927–), MEZEI, Ferenc (1942–), NAGY, Károly (1926–), PÁL, Lénárd (1925–), SZÉPFALUSY, Péter (1931–), TARJÁN, Imre (1912–), SÓLYOM, Jenő (1940–), ZAWADOWSKI, Alfréd (1936–).

There is a sad hiatus in the list: the name of Géza Györgyi. He would still

Géza Györgyi with Cornelius Lánczos in Trieste 1972.

be one of the younger members, if he were still alive. He died about 15 years ago.

Géza GYÖRGYI (1930–1973) took his degree in physics at the Budapest University. He was a pupil of Novobátzky and György Marx. He began working at the KFKI, Department of Cosmic Radiation led by Jánossy. From 1956 he worked at the Department of Atomic Physics, and then became research fellow of the Nuclear Physics Laboratory. György Marx writes of him: "He accepted Wigner as his conceptual 'master'".

While working on his book: "Theoretical Nuclear Physics" Györgyi became a victim of polio. He mustered up exceptional willpower to fight the illness which spared his scientific mind but lamed his body. It took years before he could more or less walk again. From 1964 onwards he appeared again with his scientific publications which increased his reputation among the leading theoretical physicists. He investigated the application of group theory in physics. His doctor's thesis discussed the Kepler problem of quantum mechanics in the light of the dynamical symmetries. Wigner and Lánczos, with whom he kept up close personal relations, encouraged him to also take up the exploration of the sources of quantum mechanics. He prepared for publication Ortvay's correspondence with Neumann, Wigner, Planck and Heisenberg. Györgyi's work cleared many vague points in the history of Budapest physics. Had he lived longer, he might in addition have become one of the great figures involved in the research of the history of physical science in Hungary. While compiling his work, which brought more personal satisfaction than public recognition, Györgyi was guided by his reverence for the traditions of physics as well as his erudition and culture reaching far beyond the boundaries of physics. It is to be regretted that his allotted span of life was so short! Fortunately for Hungary and for the history of physics there is always somebody to whom the torch can be passed.

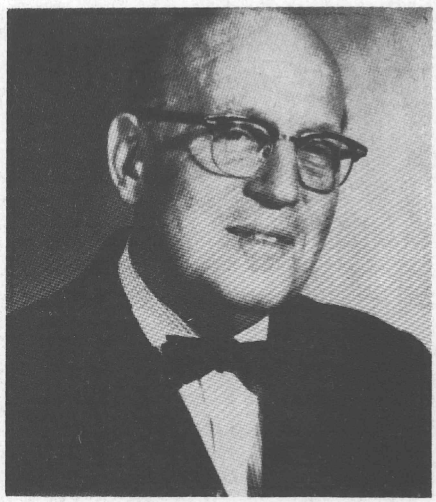
Károly SIMONYI (1916–) is a European humanist of high erudition who at one time had been assistant to

Zoltán Bay. His book: "Cultural History of Physics" deals on a high level with the history of physics as part of the universal history of human activities.

"Cultural History of Physics" by Prof. Károly Simonyi. Translation in German will be published.

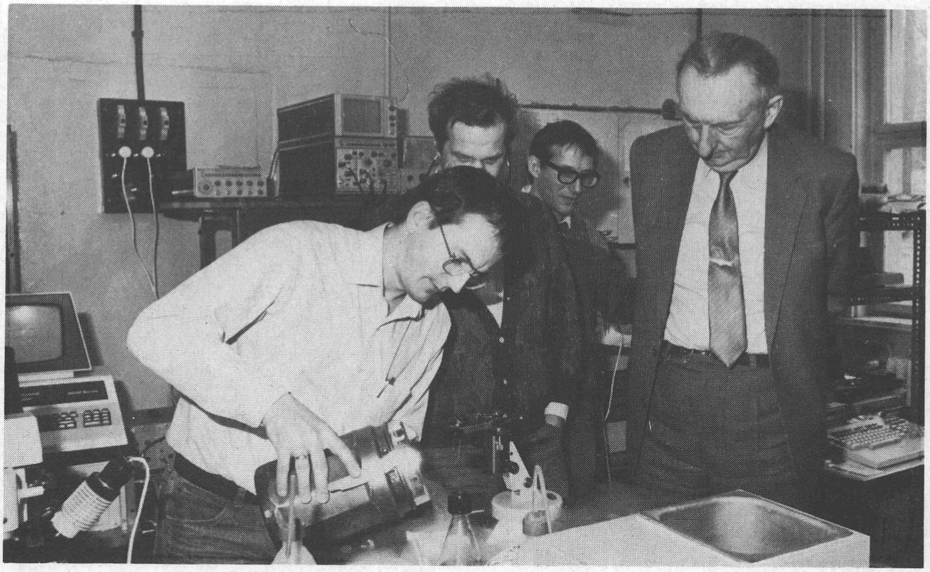
Whenever Hungary is granted a peaceful, fortunate period in her history, she always turned with receptive openness towards the world. Today Hungary expects and welcomes the visit of scientists who began their life and their career there. We might perhaps be allowed to enliven this survey of "Physics in Budapest" with a cheerful photo showing Miklós Kürti in the "Roland Eötvös" hall of the Budapest University talking on "Culinary Physics".

Miklós (Nicolaus) KÜRTI (1908–) was a pupil of the same secondary school (the training school of the University) where Tódor (Theodore von) Kármán and Ede (Edward) Teller had studied. He continued his studies for two years at the Sorbonne and then from 1928 to 1931 in Berlin. That is where he met Jenő (Eugene P.) Wigner, Leo Szilárd and Kornél (Cornelius) Lánczos. From Berlin he followed his professor Franz SIMON (1893–1956) to Breslau (now Wroclaw, Poland). When Hitler came into power they both left Germany. Simon was invited to the Clarendon Labora-



Miklós (Nicolaus) Kürti (1908–). Research in low temperature Physics.

Miklós Kürti, foreign member of the Hungarian Academy, showing his art in cooking at the University of Science in Budapest.

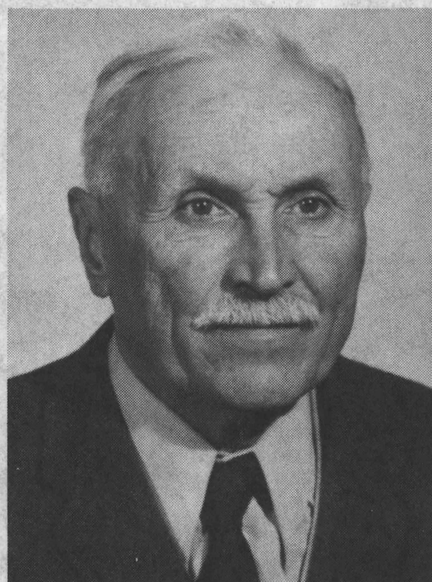


A.M. Prochorow, Soviet Academician, Nobel Prize winner, foreign member of the Hungarian Academy, visiting superconducting experiments in the Central Research Institute for Physics in Budapest.

tory at Oxford and he took Kürti along as his assistant. Kürti stayed on at Oxford where he still lives. In 1956 Sir Francis Simon and Nicolaus Kürti succeeded to bring the temperature of copper down to 10^{-5} K by nuclear cooling. After his honoured professor died, Kürti improved both method and equipment and arrived at 10^{-6} K temperature in 1960. Kürti is a frequent visitor in Budapest. Since 1970 he has been Honorary Member of the Academy. Wherever the economy of electrical energy transfer is a subject for discussion in his presence, he never misses the opportunity to mention the Hungarian example of a krypton factory built in 1935 in Hungary, based on the plans by Bródy and Polányi. The factory was built to produce Bródy's invention of krypton-gas-filled bulbs which resulted in the market price of krypton being reduced to one thousandth. Kürti declared at a conference in Budapest in 1975: "I think that such a thing can be repeated and I hope that if and when – as I am certain will be the case – a large amount of superconductors will be required, its price will drop".

In 1987 there are two research teams in Budapest taking part in the worldwide competition to produce superconducting ceramics of higher critical temperature: one at the Loránd Eötvös University, the other at the Central Research Institute for Physics. Both teams consist of young research scientists. Their generation will fill the pages of the sequel to this history.

Gyula (Julius) RADNAI (1939–) graduated from Eötvös University as a teacher of Mathematics and Physics. After completing his diploma work on the theory of colours, he began work at the Institute for Experimental Physics. Since 1970 he has been working at the Institute for General Physics and is engaged in teacher training. He is a member of the Groupe Internationale de recherche sur l'enseignement de la physique (GIREP). His fields of interest include Student competitions, Entrance exams in Physics, Interpretation of concepts in Thermodynamics, History of Physics. The latter interest resulted in his authorship of the present volume. His hobbies are, collecting scientific toys and having his mind improved by his two sons Márton and Károly, born in 1972 and 1975.



Rezső KUNFALVI (1905–) studied in Budapest and London (Imperial College of Science and Technology). He received his diploma in Mathematics and Physics from the Budapest University in 1928, where he was Assistant at the Institute of Theoretical Physics from 1928 until 1931. He has taught Physics and Mathematics between 1931 and 1965 in Secondary (Grammar) Schools. He is Associate Editor for Physics of the Journal of Mathematics for Secondary School Students (Középiskolai Matematikai Lapok) 1965–1975. He has written books on Physics, Photography and was one of the initiators and has been involved with the organization of International Physics Olympiads.

The illustrations of this book originate from his archive of photographic material on the History of Science.