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Historical Articles

Albert Ladenburg (1842-1911) – The Distinguished German Chemist and Historian of Chemistry of the Second Half of the XIX Century (To the 110th Anniversary of His Death)

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Abstract. Albert Ladenburg (1842-1911) was an outstanding German chemist and historian of chemistry of the second half of the 19th century. He ascertained the formula of ozone as O₃ and proposed a triangular prism structure for the molecule of benzene. He studied the structure of aromatic hydrocarbons and organic compounds of silicon and tin, and devoted his work to explaining the structure of alkaloids and their synthesis. The purpose of this paper is to familiarize readers with the important events in the life of Ladenburg and his writing and research activities, in particular some of his experimental results, as well as his selected publications.

Keywords: A. Ladenburg, Organic chemistry, Ladenburg's prism formula for benzene, Coniine, Germany – XIX century.

In the minds of all chemists now living, and of all those who, in the future, trace the development of the science of our time, the name of Ladenburg is, and always will be, closely associated with the chemistry of those interesting and wonderful products of nature's laboratory, the vegetable alkaloids.
Frederic Stanley Kipping (1863-1949).¹

1. THE IMPORTANT EVENTS IN THE LADENBURG'S LIFE

Albert Ladenburg was called a great man with high achievements, “who his life worthily devoted to the advancement of knowledge”,² and “an indefatigable worker and investigator”.³ One hundred and ten years have passed since his death, but in that time little has appeared in the literature about this eminent man. He went down in the history of chemistry as a researcher of the structure of aromatic hydrocarbons and organic compounds of silicon and tin. One of his achievements as an experimenter was the synthesis of alkaloids and the elucidation of their structure.⁴

Albert Ladenburg was born into a renowned Jewish family in Mannheim on July 2, 1842, as the second son of Dr. Leopold Ladenburg (1809-1889), a

lawyer, and his wife Delphine, née Picard (1814-1882).⁵⁻
⁶ His grandfather Wolf Haium Ladenburg (1766-1851) founded the private *Banking House Ladenburg* in Mannheim in 1785.⁷⁻⁸

At the age of 15, after study at a *Realgymnasium* at Mannheim, he continued his education (1857-1860) at the *Polytechnische Schule* in Karlsruhe. In 1860, at eighteen years of age, he went to Heidelberg, where his interest in chemistry was inspired and directed by Robert Bunsen (1811-1899). In the Bunsen's laboratory he met, among others, Carl Graebe (1841-1927), and Hermann Wichelhaus (1842-1927), who remained his close friends. Here he also met the British chemist Henry Roscoe (1833-1915), who often visited Bunsen. He also attended lectures on mathematics at the University and studied physics under Gustav Kirchhoff (1824-1887).⁹

On June 2, 1863, he "took the Ph.D. degree at Heidelberg University, *summa cum laude* in chemistry, physics, and mathematics."¹⁰ During this time, he met Emil Erlenmeyer (1825-1909), which led to a lifelong friendship between them. Then he worked in a small private laboratory of Georg Ludwig Carius (1829-1875), *außerordentlicher professor* at the University.

In the spring of 1865 he went to Ghent, where he spent a semester to work in the University Laboratory of August Kekulé (1829-1896).¹¹ Figure 1 is a photograph taken in Ghent.¹²⁻¹⁵ From left to right, standing: August Mayer (1844-?), Wilhelm Körner (1839-1925), Kekulé's private assistant and secretary, Esch, Semmel, Behrend,



Figure 1. Ladenburg with August Kekulé and the group of his assistants and students at the Ghent University (Public domain, from reference 12).

and Ladenburg. Seated, from left to right: Théodore Swarts (1839-1911), Kekulé, and Carl Glaser (1841-1935), Kekulé's private assistant.¹⁶

In 1866, after his stay in Ghent, he went briefly to London, where he visited the British chemist Edward Frankland (1825-1899), after which he moved to Paris.¹⁷ Following the advice of Kékulé,¹⁸ he asked Marcelin Berthelot (1827-1907) for permission to become one of his students. His "request was granted forthwith, but when he proceeded to inquire where he should work, he was shown a large, empty room, devoid of all fittings, of which he would be the sole occupant."¹⁹

However, he did not use Berthelot's offer and started work under Charles Adolphe Wurtz (1817-1884) in his laboratory at the *Faculté de médecine de Paris*. He met there, among other, Charles Friedel (1832-1899), Joseph Caventou (1795-1877), Alfred Joseph Naquet (1834-1916), and Armand Gautier (1837-1920). In the years 1866-1867, he worked for 18 months with Friedel. He carried out with him series of researches in the laboratory in the *École nationale supérieure des mines de Paris*.

After obtaining his habilitation, on January 8, 1868, he became *Privatdozent* at the University of Heidelberg. The British chemist and historian of chemistry Thomas Edward Thorpe (1845-1925) wrote about his stay in Heidelberg at that time as follows: "At Heidelberg, as in many other centres of chemical instruction, there was a small Chemical Society, composed of the Extraordinary Professors, the Privat-docenten, and assistants, together with the senior or more active students in the various laboratories who were elected into it by favour of the teachers. In my time it numbered amongst its members Erlenmeyer, Ladenburg, [August Friedrich] Horstmann [(1842-1929)], [Ernst] Ludwig [(1842-1915)], [Emil] Cohen [(1842-1905)] (the mineralogist), Rose, and [Adolph] Emmerling [(1842-1906)]. Its president was Bunsen, and the occasions on which he took the chair were the red-letter days of the session."²⁰

In the fall of 1868, Ladenburg attended the *Naturforscherversammlung* (Meeting of Naturalists) in Frankfurt am Main. There, he met Kekulé and the Russian chemist Aleksandr Mikhaylovich Butlerov (1828-1886), whom he "knew already from Heidelberg" and with whom he "had entered into closer relations at a dinner given by Erlenmeyer."²¹⁻²²

On March 30, 1870, he was appointed extraordinary professor at the University of Heidelberg, and on October 25, 1872 he went to Kiel²³ as full professor of chemistry and director of the new chemistry laboratory at the University. He became the successor of Karl Himly (1811-1885),²⁴ and he worked there for seventeen years. He "was presumably the first nonbaptized chemist who

received a full professorship in chemistry at a German university.²⁵⁻²⁶ In the academic year 1884/1885 he was the Rector of this University.²⁷

On September 19, 1875, he married Margarethe Pringsheim (1855-1909),²⁸ the daughter of the Nathanael Pringsheim (1823-1894), professor of botany at the University of Berlin.²⁹⁻³¹ The spouses had three sons: Erich (1878-1908), Rudolf (1882-1952) and Kurt (1884-1901).³²

On October 1, 1889 he went to Breslau in Silesia in the Kingdom of Prussia (now, Wrocław, Poland), where he started working as a professor of chemistry at the *Königliche Universität zu Breslau* (Royal University of Breslau). He, as the successor of Carl Jacob Löwig (1803-1890), became the director of the *Chemische Institut* (Institute of Chemistry).³³

In 1901, the Ladenburg's youngest son, Kurt, died prematurely at the age of 17. Seven years later, his eldest son Erich, a physicist³⁴ who made a scientific career at the Royal University of Breslau, died tragically. He drowned in a sailboat accident on Lake Müggel.³⁵⁻³⁶ His third son, Rudolf, became a German-American atomic physicist.³⁷

In 1905, he has had to undergo amputation of the right leg.³⁸ The German chemist Walter Herz (1875-1930), professor of physical chemistry at the University of Breslau, wrote about it as follow: "Ladenburg not only lost his right foot as a result, but also the whole right leg up to the middle of the thigh. His friends fearfully wondered whether this new, large wound would now heal and whether the now 63-year-old man would still be able to learn to walk with an artificial leg. The healing progressed slowly, but in the autumn of 1905 Ladenburg was ready to return to his office thanks to the loving care of his wife. Everyone who saw him was surprised at how well he had recovered from this severe blow."³⁹

Nevertheless, he continued the duties of his Chair until October 1, 1909, when he resigned from teaching due to illness. Towards the end of his life, he wrote a autobiography, which his son Rudolf published under the title *Lebenserinnerungen* in Breslau in 1912.⁴⁰ It is worth emphasizing that this book does not contain "a single mention of antisemitism or even prejudice".⁴¹ Ladenburg was not "practicing" Jew and was "fully assimilated" German. He "was in fact an atheist; for reasons that he does not explain, he finally underwent baptism in 1891."⁴² According to a document written by him two years earlier, dated November 16, 1889, and stored in the Archives of the University of Wrocław, he called his confession *Evangelisch reformierte* (Evangelical Reformed).⁴³

Ladenburg died on August 15, 1911 in Breslau. Herz in his obituary wrote: "When I went to the laboratory early on August 15, I first sent a telegram congratulations on the [Rudolf] Ladenburg wedding at a post

office. When I arrived at the laboratory, I had barely started my work when the telephone notification arrived that Ladenburg had gone to sleep on the night of August 14th to 15th (at 1:00 am). He did not live to see his son's wedding."⁴⁴

He was buried on August 18th. At his funeral, *der Geistliche der reformierten Hofgemeinde* (the Clergyman of the Reformed Court Community) Pastor Renner, the mineralogist Carl Hintze (1851-1916), and the Lord Mayor Dr. Georg Bender (1848-1924) spoke at his grave alternately.⁴⁵

Two of his obituaries were published in 1911 by anonymous authors in *the Chemical News*,⁴⁶ and *American Chemical Journal*.⁴⁷ Two year later, on October 23, 1913, the English chemist Frederic Stanley Kipping (1863-1949) delivered a lecture in memory of Ladenburg at a meeting of the Royal Society.⁴⁸

2. LADENBURG'S PARTICIPATION IN THE SCIENTIFIC CELEBRATIONS

In August 1877, he attended celebrations of the 400th Anniversary of the University in Uppsala (Sweden) as a representative of the University of Kiel.⁴⁹ Twenty-three years later in 1900, he visited Berlin to participate in the conference devoted to the 200th Anniversary of the *Königlich Preussischen Akademie der Wissenschaften* (Royal Prussian Academy of Sciences). Figure 2 is a photography made during this celebration.⁵⁰ The American biochemists Benjamin Harrow (1888-1970) inserted this photo on the one of first pages of his book entitled *Eminent Chemists of Our Time*. He also wrote that it "showing several eminent chemists was taken at one of the international scientific gatherings."⁵¹



Figure 2. Ladenburg with the group of the prominent chemists (Public domain, from reference 50).

Photograph was published by Harrow thanks to the kindness of the Dutch chemist Ernst Julius Cohen (1869-1944).⁵² Ladenburg is first from the left in the second row; to his left are the Danish chemist Sophus Mads Jørgensen (1837-1914), the Finnish chemist and historian of chemistry Edvard Hjelt (1855-1921), the German chemist Hans Heinrich Landolt (1831-1910), the German chemist Clemens Alexander Winkler (1838-1904), who discovered germanium in 1886, and T. E. Thorpe. Seated from the left to right in the front row are the Dutch chemist Jacobus Henricus van't Hoff (1852-1911), who won the Nobel Prize in Chemistry in 1901, the Russian - German chemist Friedrich Konrad Beilstein (1838-1906),⁵³ the Scottish chemist William Ramsay (1852-1916), who found neon, argon, krypton, and xenon in air and was awarded the Nobel Prize in Chemistry in 1904, the Russian chemist D. I. Mendeleev, who discovered the Periodic Law in 1871, the German chemist Adolf von Baeyer (1835-1917), who received the Nobel Prize in Chemistry in 1905, and the Italian chemist Alfonso Cossa (1833-1902).

Harrow in the further part of his book described certain incident, which happened during banquet given by the organizers in this occasion and involving Ladenburg. "In 1900 the Prussian Academy celebrated its two hundredth anniversary, and the University of Petrograd sent Mendeléeff as its delegate. At the banquet van't Hoff presided over one of the side tables, with Ladenburg (the Breslau representative) to the right, and Mendeléeff to the left over him. Mendeléeff was an inveterate smoker, and simply chafed because he could not smoke alternately. Ladenburg tells us that immediately after the soup Mendeléeff began to pump those around him as to whether he could be allowed to smoke. They answered him that was out of the question. But he repeated his question after the first, and after the second courses. Then dear old van't Hoff, who hated to see anyone suffer so, stepped in with the risky suggestion that he also would join in a smoke. And the two went to it, to the great relief of Mendeléeff, who from then on proved an enjoyable companion. But the sad side of the incident was that van't Hoff, who had begun to show incipient signs of tuberculosis, had been expressly forbidden smoking."⁵⁴

3. LADENBURG'S WORKS

The list of works published by Ladenburg includes 276 papers and books published over forty-seven years from 1865 to 1912.⁵⁵ The majority of these are the articles presenting the results of his experimental works, published in *Berichte der deutschen chemischen Gesells-*

chaft as well as in other German, French and British journals. Among them are his original articles devoted to the problems of the isomerism of benzene derivatives,⁵⁶ the researches on organic compounds of tin,⁵⁷⁻⁵⁹ the studies of ozone,⁶⁰⁻⁶⁶ as well as accurately determination of the atomic weight of iodine.⁶⁷⁻⁶⁸

A large number of the results of the experimental research carried out by him were published in *Justus Liebigs Annalen der Chemie*, *Zeitschrift für angewandte Chemie* and *Journal für praktische Chemie*. A few his articles were published in French in *Comptes Rendus Hebdomadaires Des Séances De L'Académie Des Sciences* and *Annales de Chimie et de Physique*. One of his articles entitled *Contribution to the characterisation of racemic compounds* was published in the *Journal of the Chemical Society, Transactions* in 1899.⁶⁹

His first paper in the field of organic chemistry entitled *Eine neue Methode der Elementaranalyse* (A New Method of Elemental Analysis) was published in 1865. There he described the results of several experiments, for instance, with naphthalene and with diethyl ether.⁷⁰ At the end of an article (p. 24), written in February 1865 in Heidelberg, he wrote thanks to Carius for making it possible to carry out experiments in his laboratory: "Finally, I would like to express my thanks to Professor Carius, in whose laboratory the experiments described have been carried out, for his assistance, which he has given me very generously."⁷¹

In the Kekulé's laboratory, he carried out two studies on benzene derivatives, the results of which were published in 1866, one on *Synthèse de l'acide anisique et de l'un de ses homologues* (Synthesis of Anisic Acid and One of its Homologues) and the other in collaboration with Fitz called *Sur quelques dérivés de l'acide paroxybenzoïque* (On Some Derivatives of Paroxybenzoic Acid).⁷²⁻⁷³ In the same year, from the Wurtz's Laboratory, he published with Carl Leverkus (1804-1889) a paper entitled *Sur la constitution de l'anethol* (On the Constitution of Anethol).⁷⁴

In the years 1866-1867, he and Friedel published several papers with the results of studies of the structure of aromatic hydrocarbons,⁷⁵⁻⁷⁶ and organic silicon compounds such as mixed silico-acetic anhydride,⁷⁷ silicochloroform,⁷⁸ and silicon chloroitydrosulphide.⁷⁹ One of the studies was devoted to revealing the analogy between carbon and silicon.⁸⁰

The experimental work of Ladenburg and Friedel was continued also in the years 1868-1870. The fruits of this collaboration were a three papers *Ueber das intermediäre Anhydrid von Kieselsäure und Essigsäure* (About the Intermediate Anhydride of Silicic Acid and Acetic Acid),⁸¹ *Einige Derivate des Radicals Silicoallyl* (Some

Silicoallyl Radical Derivatives),⁸² and *Sur l'acide silicopropionique* (On Silicopropionic Acid).⁸³

Ladenburg's research interests also focused around synthesis of alkaloids. In 1879, he carried out the artificial production of atropine (C₁₇H₂₃NO₃),⁸⁴ and in 1894, he and M. Scholtz synthesized piperic acid (C₁₂H₁₀O₄) and piperine (C₁₇H₁₉NO₃), which was the main alkaloid of black pepper.⁸⁵ In 1880, he also isolated hyoscyamine (C₁₇H₂₃NO₃),⁸⁶ and hyoscyne (C₁₇H₂₁NO₄) also called scopolamine.⁸⁷

In 1886, he for the first time synthesized in the laboratory an optically active compound identical with the alkaloid *coniine* (C₈H₁₇N) found in the hemlock plant.⁸⁸ Kipping wrote about this achievement of Ladenburg as follows: "The synthesis of *dl*-coniine, followed by the resolution of the synthetic alkaloid into its optically active components, the culminating point of these researches, was perhaps the greatest of Ladenburg's successes."⁸⁹

At a time when the Kekulé formula for benzene was the subject of much controversy,⁹⁰⁻⁹¹ Ladenburg 152 years ago, in 1869, proposed a triangular prism structure for the molecule of this compound,⁹²⁻⁹³ that was symmetrical, but didn't contain double bonds, and turned out to be erroneous.⁹⁴ In 1876, he summarized his views on the structure of the benzene molecule in his book entitled *Die Theorie der aromatischen Verbindungen* (The Theory of Aromatic Compounds).⁹⁵ Thirty-five years later, an anonymous author wrote: "His prism formula for benzene, although now practically universally rejected, has been of great use in the development of chemistry in that, as early as 1868, it showed the necessity of taking into account steric considerations in the formulation of the constitution of chemical compounds."⁹⁶

Experimental studies carried out in the 1970s confirmed that Ladenburg prism can be obtained in the laboratory. In 1973, a pure sample of "the simple molecule C₆H₆, known as prismane [tetracyclo[2.2.0.0^{2,6}.0^{3,5}] hexane], in which six carbon-hydrogen units are disposed at the corners of a triangular prism", was synthesized by the American organic chemists Thomas J. Katz, and Nancy Acton from the Department of Chemistry at Columbia University.⁹⁷

The chemical literature review results indicate an interest in Ladenburg's works, for instance, information about some of his articles appeared in the *Gazzetta Chimica Italiana* in 1872.⁹⁸ His experimental studies and their results were introduced to readers, among others by Ed. Willm and Maurice Hanriot (1854-1933) in 1889,⁹⁹ H. E. Roscoe and Carl Schorlemmer (1834-1892) in the years 1888-1890,¹⁰⁰⁻¹⁰² Julius Wilhelm Brühl (1850-1911), E. Hjelt, and Ossian Aschan (1860-1939) in 1900,¹⁰³ Amé Picket (1857-1937) in 1904,¹⁰⁴ as well as

Hans Meyer (1871-1942) in 1916,¹⁰⁵ and 1922.¹⁰⁶ In the 1960s, the results of selected Ladenburg studies in the field of organosilicon chemistry were discussed by Richard Müller from Institute for Silicone and Fluorocarbon Chemistry in Radebeul/Dresden (Germany).¹⁰⁷ At the beginning of the 21st century, these results were presented by Dietmar Seyferth from Department of Chemistry at Massachusetts Institute of Technology (U.S.A.).¹⁰⁸

4. OTHER WORKS OF LADENBURG IN CHEMISTRY

Ladenburg, at the age of 27, became famous for his book on the history of chemistry. It was published first in German and later in three other languages. In 1869, the first edition of his *Vorträge über die Entwicklungsgeschichte der Chemie in den letztem hundert Jahren* (Lectures on the History of the Development of Chemistry Over the Last Hundred Years) was published in Braunschweig.¹⁰⁹ One year later, the German chemist Hermann Kolbe (1818-1884) praised this book in his article published in the *Journal für Praktische Chemie*.¹¹⁰⁻¹¹¹ He wrote as follow: "Far from wanting to give a truthful, strictly scientific development of the chemical theories (which task young Ladenburg ... has recently undertaken with seriousness and diligence...)"¹¹²

The fourth German edition of this book appeared thirty-eight years later under the title *Vorträge über die Entwicklungsgeschichte der Chemie von Lavoisier bis zur Gegenwart* (Lectures on the History of Chemistry from Lavoisier to the Present Day). He dedicated the book from this edition to his wife.¹¹³

In 1900, the first English edition of Ladenburg's book was published with the title *Lectures on the History of the Development of Chemistry since the Time of Lavoisier*.¹¹⁴ The revised editions of this book appeared in 1911.¹¹⁵ The translator was the chemist Leonard Dobbin (1858-1952), lecturer on Chemical Theory and assistant in Chemistry at the University of Edinburgh.

In the preface to the English Edition of this book written in September 1899 in Grassendale, Southbourne-on-Sea, Ladenburg wrote: "Thirty years after the appearance of the first edition of this book, an English translation of it is now being prepared. I regard this as a favourable indication of the permanent value of the book, since it is evident that the standpoint then adopted is intelligible at the present day and is still unsurpassed. Moreover, it may be concluded that the exposition of the subject is not marred by national prejudices. ... The English edition is a faithful translation, and, so far as I am able to judge, it is written in a good style. For these features my best thanks are due to the translator."¹¹⁶

The first French edition of Ladenburg's *Histoire Du Développement De La Chimie Depuis Lavoisier Jusqu'à Nos Jours* (Lectures of the Development of Chemistry from Lavoisier to the Present Day) was published in 1909,¹¹⁷ and the second, in 1911.¹¹⁸ The translator was Arthur Corvisy (1855-1930), associate professor of physical sciences at the *Lycée Gay-Lussac* and *Professeur Suppléant* at the School of Medicine and Pharmacy.

In 1917, the first Russian edition of his *Lektsii po Istorii Razvitiya Khimii ot Lavuaz'ye do nashego vremeni* (Lectures on the History of the Development of Chemistry from Lavoisier to our Time) was published in Odessa. The translator of the fourth German edition of this book was Evgeny Semonovich Elchaninov (1879-1922), privat-docent of the Novorossiysk University.¹¹⁹

In the years 1882-1895, Ladenburg worked intensively on his *Handwörterbuch Der Chemie* (Concise Dictionary of Chemistry), which was published in thirteen volumes in Breslau.¹²⁰⁻¹²¹ The general register created on the basis of the registers of individual 13 volumes of this book was published in 1896. Among the co-authors are the names of 50 chemists who participated in the creation of this great work in different years during of thirteen years.¹²²

One of Kekulé's works was published by Ladenburg in 1904 in the *Ostwalds Klassiker der Exakten Wissenschaften* series.¹²³ In the years 1907-1910, three papers written by French chemists Louis Pasteur (1822-1895),¹²⁴ Wurtz,¹²⁵ and Berthelot and Léon Péan de Saint-Gilles (1832-1863)¹²⁶ were translated from French into German by Ladenburg and his wife and published in the same series.

5. CONCLUSION

Albert Ladenburg was one of the prominent chemist of the second half of the XIX century. In the years 1880-1910, he was elected a member of three academies of sciences. He became a member of the *Nationale Akademie der Wissenschaften Leopoldina* in 1880.¹²⁷ He was elected a corresponding member of the *British Association for the Advancement of Science* in 1887,¹²⁸ and the *Académie des sciences de Paris* on December 13, 1909.¹²⁹ On January 6, 1910, he became a corresponding member of the *Königlich Preussischen Akademie der Wissenschaften*.¹³⁰ He was a corresponding member of the *Philadelphia College of Pharmacy*.¹³¹ On April 26, 1892, he became an honorary member of the *Manchester Literary and Philosophical Society*,¹³² and on August 4, 1884, he was appointed Doctor *honoris causa* of Medicine at the University of Bern. On February 2, 1888 he became an honorary and foreign member of the *Chemical Society of*

London.¹³³ In the years 1901-1911, he was a foreign corresponding member of the *Académie Nationale De Médecine* in Paris.¹³⁴

In 1899, the *Pharmaceutical Society of Great Britain* awarded him the Hanbury Gold Medal for his work on alkaloids and their derivatives.¹³⁵ It is awarded every five years, in memory of the British botanist and pharmacologist Daniel Hanbury (1825-1875). "The medal was formally received by Baron [Wilhelm] von Mirbach [(1871-1918)], representing the German Embassy, and a letter was read from Dr. Ladenburg expressing his thanks for the honour done him, and regretting that he had been unable to be present to receive the medal personally."¹³⁶

In 1905, he was awarded the Davy Medal "for his researches in organic chemistry, especially in connexion with the synthesis of natural alkaloids."¹³⁷⁻¹³⁸ It is named after the English chemist Humphry Davy (1788-1829) and is awarded annually since 1877 to an outstanding researcher in the field of chemistry by the *Royal Society of London*.¹³⁹ Two years later, in 1907, he nominated Berthelot and Mendeleev for the Nobel Prize in Chemistry.¹⁴⁰ However, the award went to the German biochemist Eduard Buchner (1860-1917) "for his biochemical researches and his discovery of cell-free fermentation."¹⁴¹ Later, in 1909-1911, he worked at the University of Breslau.¹⁴²

After Ladenburg, not only his papers and books survived. In addition, several of his portraits were produced. One of them was included by the German chemist Richard Anschütz (1852-1937), professor of chemistry at the University of Bonn, in his biographical book on Kekulé.¹⁴³ Three other photo appeared in the articles written by Herz,¹⁴⁴ Kipping,¹⁴⁵ and Colin Archibald Russell (1928-2013).¹⁴⁶ The photographer Adèle Perlmutter (1845-1941) from Vienna photographed him in 1869,¹⁴⁷ and in the years 1870-1880 his portrait was taken by a photographer Emil Bühler in Mannheim.¹⁴⁸ Another two of his portraits can be found in the *Österreichische Nationalbibliothek* collection,¹⁴⁹ and in a book written by the American chemist Henry Monmouth Smith (1868-1950).¹⁵⁰

In 1911, the 100th Anniversary of the Royal University of Breslau was celebrated. On this occasion, a book entitled *Festschrift zur Feier des hundertjährigen Bestehens der Universität Breslau, Zweiter Teil, Geschichte der Fächer, Institute und Ämter der Universität Breslau 1811 - 1911* was published, in which one of the chapters written by Ladenburg and Buchner was devoted to the history of the Institute of Chemistry at the University. The authors also presented short biographical notes of chemists who obtained their habilitation there.¹⁵¹

The great achievements of Ladenburg in the field of alkaloids synthesis were noticed by English pharmacists. On October, 1899, William Martindale (1840-1902),

President of the Pharmaceutical Society of Great Britain said about it: “Dr. Ladenburg was best known to English pharmacists by his synthetic work in the production of homatropine.^[152] By splitting up atropine he obtained tropic acid and tropine as derivatives; the latter he combined with amygdalic acid to form a compound which is easily converted into oxy-toluyl-tropeine or homatropine, an artificial alkaloid which, with its salts, has proved of the greatest service to ophthalmic surgery.”¹⁵³

Walter Herz wrote about Ladenburg’s great achievements in chemistry as follow: “Like only a few, Ladenburg has been granted forty years of great success in developing his science. His contributions to the constitution of benzene, his investigations into the heterocyclic compounds, his successes in the synthesis of alkaloids will always be regarded as classic examples of great chemical achievements. His uncommon scientific versatility was evident in his work on racemy, his excellent treatises on ozone and iodine, and his critical-historical perspective in his valuable history of chemistry.”¹⁵⁴

It is worth emphasizing that Ladenburg was put “in the first rank of chemists as a theorist.”¹⁵⁵ Moreover, he was not only an experienced experimental chemist, but also an excellent pianist. His acquaintance with the great German pianists and composers such as Clara Schumann (1819-1896) and Johannes Brahms (1833-1897) began at his young age.¹⁵⁶ In a letter written to Schumann in Ischl, a city in Austria in June 1895, Brahms informed her about the meeting with Ladenburg: “... Professor Ladenburg from Breslau spent the Whitsun holidays here with his wife, we were very cozy together and talked a lot about you.”¹⁵⁷

This outstanding German chemist and historian of chemistry took forever a firm place in the history of chemistry. His name is associated with the beginning of intensive research in the field of organic synthesis. The results of his original experimental studies have been published in scientific journals in Germany, France and Great Britain. His *Vorträge über die Entwicklungsgeschichte der Chemie* has been published many times, not only in Germany but also in Great Britain, France and Russia. His multi-volume dictionary *Handwörterbuch der Chemie* has served many generations of chemists around the world. His name is given to “a distilling flask with bulbed neck”, the so-called *Ladenburg flask*.¹⁵⁸ For example, one of its varieties is a flask with three-bulb.¹⁵⁹

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