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# Wilhelm Conrad Röntgen

The Birth of Radiology

GERD ROSENBUSCH

ANNEMARIE DE KNECHT-VAN EEKELEN



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# Wilhelm Conrad Röntgen

The Birth of Radiology

 Springer

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ISSN 2365-0613

ISSN 2365-0621 (electronic)

Springer Biographies

ISBN 978-3-319-97660-0

ISBN 978-3-319-97661-7 (eBook)

<https://doi.org/10.1007/978-3-319-97661-7>

Library of Congress Control Number: 2019930418

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

*In grateful remembrance of  
Daniel de Moulin (1919–2002), one of the  
brave “Engelandvaarders” in WW II,  
Surgeon and Professor in the History of  
Medicine, Radboud University, Nijmegen,  
the Netherlands  
and  
Ad van Wylick (1913–1997), Radiologist,  
who described the life of Wilhelm Conrad  
Röntgen in the Netherlands*

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# Introduction

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## Wilhelm Conrad Röntgen: A European Citizen

On the evening of November 8, 1895, the world changed. Wilhelm Conrad Röntgen, Professor of Physics at the University of Würzburg in Germany, was working late. With the painstaking accuracy he used in all his experiments, he worked with a discharge tube producing cathode rays. But he noticed something else, a strange light which was not there before. Again and again he repeated his observations until he was confident that he encountered something that no one had noticed before, a new kind of rays. He named them X-rays as their nature was unknown.

Who was this professor? This book recounts the life of Wilhelm Conrad Röntgen, the only son of a well-to-do German cloth merchant born in the small town of Lennep in the Bergische Land near Cologne in Germany. His mother, born in Amsterdam, was Dutch. Röntgen spent his youth in the Netherlands, arriving in the town of Apeldoorn at the age of 3, leaving at 17 to start his studies at the Dutch Technical School in Utrecht. He continued his studies in Switzerland, obtained different academic positions in Germany, and finally retired as Professor of Physics at the prestigious Munich University. He lived the life of a true European.

In Utrecht, Röntgen lived with the family of Professor Gunning who set the conditions for his technical studies. Röntgen himself emphasised that—besides his parents—the Gunnings had been the most influential for his personal development. During his study time and before his marriage in 1872, Apeldoorn remained the place to return to during his holidays. His marriage with the Swiss girl, Bertha Ludwig, also took place in Apeldoorn. Even in his later life, Röntgen spoke Dutch fluently. Some people said that his German always had a bit of a Dutch accent. Before 1875, when he was nominated as professor in Germany, Röntgen had a Dutch passport and can be considered as a Dutch citizen.

Röntgen could not obtain a diploma from the Technical School. A study at a Dutch university turned out to be quite impossible. One of his friends gave him the advice to try his luck at the Polytechnical School [Polytechnikum] in Zurich, Switzerland, where one could enter without a graduation certificate. There, his future university career in physics started. In Switzerland, he found his wife, Bertha, his beloved one for more than 50 years. Many of his lifelong friends were Swiss. His favourite holiday country was Switzerland, where he enjoyed nature, hiking,

and company of friends. A holiday in Switzerland extended his life by an extra year, he used to say. During almost 40 years, he and his wife stayed in Switzerland during summertime. Röntgen considered Switzerland as his second homeland.

Röntgen's whole professional life took place in Germany. Strasbourg, where he was employed in the 1870s, belonged to Germany in those days. As a professor working in Germany, he had to acquire the German citizenship. Röntgen had the best time of his life in Giessen and Würzburg, where his work was successful and where he made friends for life. He supported the German cause in World War I as a true patriot.

Before 1895, Röntgen was not known as one of the outstanding physicists who dominated the scene at the end of the nineteenth century. His finding of the X-rays, for which he received the first Nobel Prize in Physics in 1901, changed his life dramatically. He, who had always lived a quiet life, found himself in the centre of a turmoil that made him even more withdrawn than he already was. It is said that the impact of his discovery was so overwhelming that he, who was 50 at the time, never recovered from it. His great discovery was a blessing to mankind but a heavy burden for the man who made it.

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## **X-Rays: A New Era in Medical Diagnostics and Therapy**

Medicine tries to heal a patient or at least to relieve the patient's ailment or disease. In the sixteenth century, when the anatomy of the human body had been studied in greater detail, the localisation of the disease could be determined more precisely. Physiological investigations and microscopic studies in the eras to follow increased the knowledge of the human body and, little by little, completed the picture of its structure and function.

Treatment of a patient always starts with a diagnosis, as precise as possible and excluding other possible causes of the disease. Only the exact diagnosis allows an appropriate therapy. Before the availability of instruments and laboratory tests, the medical doctor depended for his diagnosis on the anamnesis, palpation, inspection, and observation. The difficulty was how to get information about what happens inside the human body. Percussion is one of the early methods to determine an underlying structure by tapping on the surface. The usual technique is to lay the hand on the body, tap with the middle finger of one hand on the middle finger of the other hand. A publication by Leopold Auenbrugger (1722–1809) on percussion already dates from 1761. The method is derived from the winemakers, tapping the wine barrels to hear how full they are. More than 50 years later, René Laennec (1781–1826) published his study on auscultation, another new way to get a better insight of the structures of the human body. Auscultation means listening to sounds generated within the body, arising in the heart, lungs, pleura, blood vessels, intestines, or produced by the foetus, etc. One can hear these sounds directly by putting one's ear on the body, but Laennec felt uncomfortable placing his ear on women's chests, so he designed an instrument, the first stethoscope. This was a wooden, monaural tube. Laennec compared his auscultation results with findings at autopsy and tried to correlate the character of the sounds, heard through the stethoscope, with the pathology. Percussion and auscultation became important tools for the diagnosis and are still practised today. Usually the physician starts the examination of a patient using these techniques.



During the nineteenth century, other instruments were developed to examine the inside of the human body. Hermann von Helmholtz (1821–1894) became famous by his invention of the ophthalmoscope in 1851, allowing the study of the inner eye, especially of the ocular fundus. Scopes were introduced to observe the inside of the larynx and the vocal cords (laryngoscope), the urinary tract (urinary bladder endoscope, cystoscope), the stomach (gastroscope), and the rectum (rectoscope). At first, these scopes were rigid tubes that were difficult to apply, uncomfortable for the patient, and with limited view; flexible scopes were developed in the second half of the twentieth century. For inspection of the vagina, the speculum was used.

In the second half of the nineteenth century, important progress was made in pathology and clinical medicine. During his years as Professor of Pathological Anatomy in Würzburg, Rudolf Virchow (1821–1902) formulated his fundamental ideas on cellular pathology, declaring the cell as the carrier of disease. After the finding of bacteria as cause of infectious diseases, bacteriology—with Louis Pasteur (1822–1895) in France and Robert Koch (1843–1910) in Germany—changed the notion of causes and treatment of diseases. The introduction of anaesthesia in combination with asepsis or antisepsis created possibilities for extensive surgery that before would have been deadly. The physician was no longer the theoretically trained medical doctor who stood with his hands on his back watching the patient. His actions could be based on scientific knowledge, on anatomy, and on physiology, using the instruments at his disposal.

However, many organs and the skeleton could only be observed from outside. The medical dream was to make the human body transparent to look through it as through a jellyfish. This dream became true when Wilhelm Conrad Röntgen discovered a new kind of rays. On 28 December 1895, he presented his world-shaking paper, “Über eine neue Art von Strahlen. Vorläufige Mitteilung” (*On a new kind of rays. Preliminary communication*) to the journal of the *Physikalisch-medizinische Gesellschaft* in Würzburg. This discovery opened a complete new domain for medicine, which, after more than a century, still offers unknown opportunities. The discovery of the X-rays at the end of the nineteenth century coincided with a series of inventions. Today, we can no longer imagine a life without electricity, telephone, or cars. These were all new in that era. The importance of the X-rays for medical imaging was recognised immediately. With the use of X-rays, a whole new approach to the investigation of the human body became possible. This was the birth of radiology. Radiology has expanded. It includes both diagnosis and treatment, along with development of other imaging techniques. Röntgen’s finding added to the innovative research and application of all these new techniques that shaped our present life.

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## Röntgen’s Biographies

Röntgen was a complicated person. In this book, different aspects of his character are described. He dictated that his laboratory and personal notes as well as any scientific correspondence should be destroyed after his death. This causes major gaps in his biography, which can only be filled with secondhand information. The first extensive biography on Röntgen in German was published in 1931 (English translation 1934; German reprints 1959 and 1995), written by Otto Glasser (1895–1964), Professor of

Biophysics at the Cleveland Clinic Foundation, USA. A short English version was published in 1958. A biography written by W. Robert Nitske, a professional writer of German origin, provides extensive information on Röntgen in English. This book dates from 1971. When the X-ray discovery was commemorated in 1995, several papers and books on Röntgen and the history of radiology came out. Among the more popular books are the biographies written by Albrecht Fölsing, a physicist and scientific journalist, and by Angelika Schedel, a medical writer, together with medical historian Gundolf Keil. However, these two books are in German, as is the work on Röntgen in the Netherlands by the Dutch radiologist Ad van Wylick (1913–1997). This volume was also published in Dutch. Kurt Ritzmann published in 2001 an extensive overview in German of Röntgen's correspondence with many details on Röntgen's personal relations in Switzerland and Germany. Of course, there are numerous articles, also in English, dealing with Röntgen, and the impact of the discovery of the X-rays, but a recent biography of Wilhelm Conrad Röntgen in English is missing. This is our attempt to draw a picture of the man, his life and works, positioning him among his peers, giving him the credits he deserves.

## Chronology: The Life of Wilhelm Conrad Röntgen

1845–March 27	Wilhelm Conrad Röntgen is born in Lennep, Prussian Rhine Province, Germany, nowadays State of North Rhine-Westphalia
1848–May 23	His father Friedrich Conrad Röntgen and mother Charlotte, born Frowein, move with their 3 years old son to Apeldoorn, the Netherlands
1851–1862	Attends a primary and secondary school in Apeldoorn
1862–August 18	Enters the Technical School in Utrecht, the Netherlands, and lives in the house of Dr J.W. Gunning, an inspiring man for young people
1864–May 3	Receives his last school report and leaves the Technical School without a final certificate
1865–January 14	Fails his admission examination for the University of Utrecht. He follows some courses but is not allowed to take exams. His friend, Carl Thormann, advises him to continue his studies in Zurich, Switzerland
1865–November 23	Enters the Polytechnikum in Zurich as a student of mechanical engineering without taking the usual admission examination due to his good reports
1868–August 6	Receives the diploma of mechanical engineer at the Polytechnikum. His study friend, Ernst Ludwig Albert, introduces him to the Professor of Physics, August Kundt at the Zurich University
1869–June 22	Gets his PhD with the thesis “Studien über Gase” (Studies on Gases). He becomes assistant to August Kundt
1870–April	Follows Kundt as his assistant to the University of Würzburg, Germany. First publication in <i>Annalen der Physik und Chemie</i>
1872–January 19	Marries Anna Bertha Ludwig in Apeldoorn. He met her in Zurich in 1866
1872–April 1	Follows August Kundt as his assistant to the University of Strasbourg, Germany
1873–October 3	His parents move to Strasbourg to be near their son
1874–March 13	Gets his “Habilitation” and can become “Privatdozent” in physics
1874–April 1	Professor of Physics and Mathematics at the Agricultural Academy of Hohenheim, Germany
1876–October 1	Returns to the University of Strasbourg as Associate Professor of Theoretical Physics. Publishes seven papers, some together with August Kundt
1879–April 10	Professor of Physics in Giessen, Hesse, Germany. Publishes 18 papers. His parents join him in Giessen
1880–August 8	His mother dies at Bad Nauheim, Germany
1884–June 12	His father dies in Giessen. His mother and father are buried in Giessen. In this grave, Röntgen and his wife shall be buried too
1886	Declines the chair of physics at the University of Jena, Germany
1888	Declines the chair of physics at the University of Utrecht, the Netherlands
1888–October 1	Accepts the chair of physics at the University of Würzburg as a successor to Friedrich Kohlrausch. Publishes 13 papers until 1894
1890–December	Josephina Bertha Ludwig, the 9-year-old niece of Bertha Röntgen-Ludwig, comes to live with them. At the age of 21, she is adopted by the Röntgens, who had no children of their own
1894–May 21	August Kundt, who had become Professor of Experimental Physics and Director of the Physical Institute in Berlin, Germany, in 1888, dies at the age of 54
1894–1895	Rector magnificus of the Würzburg University

(continued)

(continued)

1895–November 8	Observes a strange phenomenon when experimenting with cathode rays
1895–December 28	Submits the paper “Über eine neue Art von Strahlen. Vorläufige Mitteilung” (On a new kind of rays. Preliminary communication) to the secretary of the “Physikalisch-medizinische Gesellschaft” at Würzburg for publication
1896–January 1	Sends reprints of his preliminary communication to a large number of colleagues in Europe. Some receive a set of X-ray pictures with the reprint; the hand of Bertha Röntgen-Ludwig is one of the photographs
1896–January 5	<i>Die Presse</i> , a daily in Vienna, reports about a sensational discovery. This news is cabled to the whole world
1896–January 13	Demonstrates the X-rays to the Emperor Wilhelm II and military staff in Berlin
1896–January 23	Delivers his only public lecture about the X-rays in Würzburg at the meeting of the “Physikalisch-medizinische Gesellschaft”. Professor Albert [von] Kölliker recommends calling the X-rays “Röntgen-Strahlen”, which was enthusiastically applauded by the audience. Declines all invitations for further lectures
1896–March 9	Submits his second communication to the “Physikalisch-medizinische Gesellschaft”
1897–March 10	Submits his third communication to the “Preußische Akademie der Wissenschaften”, Berlin, his last paper on X-rays
1899	Declines a professorship at the University of Leipzig. Receives the title of “Royal Geheimrat” from the Bavarian Government
1900–April 1	Accepts the professorship of physics at the University of Munich, Germany
1901–December 10	Receives the first Nobel Prize in Physics. Delivers no Nobel lecture
1904	Declines the presidency of the “Physikalisch-Technische Reichsanstalt” at Berlin-Charlottenburg
1904	Purchases a weekend house (“Jagdschloß”) in Weilheim, about 50 km south-west from Munich
1905–March 27	On his 60th birthday and to commemorate the tenth anniversary of the discovery of X-rays, a group of prominent physicists announce that a plaque shall be placed at the Institute of Physics in Würzburg
1906–September 8	Arnold Sommerfeld is nominated as a Professor of Theoretical Physics at the University of Munich
1908–December 20	Receives the title of “Excellency” from the Prince Regent of Bavaria
1912	Max [von] Laue, Walter Friedrich, and Paul Knipping discover the wave character of X-rays in the institute of Professor Sommerfeld
1914	Signs together with 92 famous German scholars, artists, and writers the chauvinistic “Aufruf an die Kulturwelt” at the beginning of World War I. Regrets his signature after the war
1915–June/July	Adolf Ritter von Hildebrand sculpts Röntgen’s bust, which was later placed in the Glyptothek in Munich
1919–October 31	Bertha Röntgen-Ludwig dies in Munich after many years of suffering of kidney stones and heart troubles
1920–April 1	Retires from the University of Munich
1923–February 10	Dies in Munich. His ashes are put to rest in the family grave in Giessen

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## Acknowledgements

To write an English biography of Wilhelm Conrad Röntgen was a long existing plan of the two authors. Already at the end of the 1960s, radiologist Rosenbusch started to collect literature on the history of radiology and on Wilhelm Conrad Röntgen in particular. Together with medical historian De Knecht-van Eekelen, he edited several books on the history of radiology in the Netherlands. When we were asked by the Springer Publishers for a biography of Röntgen, we gladly accepted the invitation to fulfil our long-existing wish. We thank the publisher for this granted opportunity.

For the commemoration of the 100th anniversary of the discovery of the X-rays in 1995, some books and many articles about Röntgen and his work were published. In 2020, it is the 125th anniversary of the discovery. Moreover, in 2020, it is also 175 years ago that Röntgen was born. That justifies to review Röntgen's life and work anew. There is an extensive literature, yet, the research of De Knecht-van Eekelen on the world wide web disclosed new sources, especially more data on his students and his scientific work. We were able to use literature that is only available in Dutch or German language and, therefore, hardly known in the English-speaking community. With this book, we hope to fill some gaps in Röntgen's biography and to show what influence he had on developments in medicine with the creation of the new field of radiology.

The authors are very grateful for the support they received from the Deutsches Röntgen Museum in Remscheid-Lennep, the birthplace of Röntgen. The Director, Dr Uwe Busch, and Ms Christina Falkenberg, responsible for the media archive, have been very helpful in providing information and photographs.

We have obtained important information from Ms Dr Eva-Marie Felshow, Head of the Archive, University of Giessen; Ms Cornelia Gräff, responsible for the medical-historical collection of the History of Medicine Institute, University of Würzburg; Mr Wilhelm Hörner, Institute für Landeskunde, Würzburg; Dr Claudius Stein, Head of Archive, Ludwig-Maximilians University of Munich; and Dr Adrian Thomas, British Society for the History of Radiology. We thank them all for their cooperation. Dr Stephan Popp, treasurer of the "Röntgenkuratorium e.V.", Würzburg, guided De Knecht-van Eekelen in Röntgen's laboratory in Würzburg, a visit that can be recommended to all. The same applies for the Deutsches Röntgen Museum in Remscheid-Lennep.

We thank the Sonnenborgh Museum and Observatory for lending us the historical diffraction picture of C.W. Wind with Röntgen's handwritten commentary.

We are very grateful that Mrs Sumedha Tabak-Mahajan found the time to review and correct our English.

We lived for several years with Wilhelm Conrad Röntgen and started already calling him "Willy", as if we were family. Yet, he remains an enigmatic person, who challenged our imagination. That made our research so fascinating. We wish the reader enjoys the book as much as we enjoyed writing it.

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## Illustration Credits

Deutsches Röntgen Museum, Remscheid-Lennep, Germany: Cover, and Figs. 1.1, 1.2, 2.2, 2.5, 3.6, 3.11, 3.12, 4.1, 4.3, 4.4, 4.6, 4.7, 5.4a, b, 5.6, 5.8, 6.1, 6.5, 7.1

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Knecht-van Eekelen A. de: Figs. 1.3, 1.5, 3.1, 5.11, 5.12, 6.3

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Sonnenborch Museum & Observatory, Utrecht, the Netherlands: Fig. 8.2

Zehnder L. W.C. Röntgen. Briefe an L. Zehnder, p. 174: Fig. 7.3

Other pictures from our personal archives.

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# Born for Business, Raised for Science (1845–1865)

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*Wilhelm Conrad Röntgen was born in Lennep, a town in the German Rhineland, on 27 March 1845. He remained the only child of the German cloth merchant Friedrich Conrad Röntgen and his wife, the Dutch Charlotte Constance Frowein. In 1848 the family moved to the Netherlands, to the village of Apeldoorn, where young Röntgen grew up. At the age of 17, he moved to Utrecht, a university town in the centre of the Netherlands, to enter the Technical School. This was a unique new type of education, preparing young boys for a technical or business career. Until 1865, he lived with the family of his teacher Dr Jan Willem Gunning. However, as Röntgen was compelled to leave the Technical School without a diploma, he could not enter the Utrecht University. When Gunning left for Amsterdam because of his nomination as Professor of Chemistry and Toxicology, Röntgen remained for a while in Utrecht but finally decided to continue his studies in Switzerland. Gunning had a major influence on Röntgen during his formative years.*

## The Röntgen Family

Röntgen's family originated from the city of Lennep in the German state of North Rhine-Westphalia. In the nineteenth century, Lennep was one of the capitals of the Duchy of Berg; nowadays it is a borough of the city of Remscheid. The Rhine region was an important area for the wool industry. In 1858, the number of weaving stools counted 11,815, while more than 16,000 people worked in the wool factories. Lennep, with a population of over 6000 people in 1837, was well-known for its woollen cloth trade, especially wool from the region of Hesse.

Johann Heinrich Röntgen (1759–1842), Wilhelm's grandfather from father's side, lived all his life in Lennep where he, just as his predecessors, was registered as a tradesman. Johann Heinrich and his brother Peter Mathias Röntgen (1765–1832) both married a girl from the Frowein family, also a Lennep family of

tradesmen. These families continued living in Lennep. Johann Heinrich had three sons, one of them being Friedrich Conrad (1801–1884), who married only 4 months after his father's death Charlotte Constance Frowein (1806–1880) in Amsterdam.

Why was this marriage in Amsterdam? The two Frowein sisters had a younger brother Johann Wilhelm Frowein (1775–1860) who had moved from Lennep to Amsterdam, where he married an Amsterdam girl in 1800. There the Froweins became a Dutch family. Johann Wilhelm Frowein had one son and two daughters, one of them being Charlotte Constance. So, Wilhelm's father married his niece, not uncommon in those days as it would increase the family's influence and capital.

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### **Birth and Early Childhood in Lennep (1845–1848)**

Wilhelm Conrad was born in Lennep on 27 March 1845, and he remained an only child. The house where he was born is shown in Fig. 1.1. His mother was already 39 years old at the time of his birth. In 1848, the family moved to the Netherlands, to the village of Apeldoorn. Little is known about the motives of their decision; no personal accounts can inform us. Perhaps the main reason why the family left Lennep was the uprisings during the German revolutions of 1848–1849, the opening phase of which is called the March Revolution. Activism for liberal reforms spread through many of the German states, inspired by the demonstrations in Paris, France, in February 1848. The revolutions, which stressed pan-Germanism, demonstrated popular discontent with the traditional, largely autocratic political structure of the 39 independent states of the confederation. North Rhine-Westphalia was at that time part of Prussia, and much of the revolutionary impulse was coloured by a strong anti-Prussian feeling. However, the revolution failed because of lack of unanimity between the middle class that was committed to liberal principles and the working class that sought radical improvements of their working and living conditions. Liberals were forced into exile to escape political persecution; several went to Switzerland and many immigrated to the USA, where the immigrants became known as the Forty-Eighters. Even years later, the USA was the land of new opportunities. One of Wilhelm's uncles, Ferdinand Röntgen (1806–1882), moved with his wife, son, and daughter to Wisconsin. Some correspondence between Wilhelm and his niece Louise Conradine Röntgen (1846–1929) in Indianapolis, USA, has been kept. Several other members of the Röntgen family moved to the Netherlands.

Wilhelm's father gave up his Prussian citizenship and was put on par with Dutch citizens, without having acquired the Dutch nationality, the only difference with Dutch nationals being the right to vote. This meant that Wilhelm did not have the Dutch nationality. However, he was conscripted into the Dutch army—as an only child he was exempted—and he did have a Dutch passport. We may assume that he again received the German citizenship when he was appointed as a professor in Hohenheim in Germany in 1875.



**Fig. 1.1** Wilhelm Röntgen was born in the house in the middle (Poststrasse 87, Remscheid-Lennep). Deutsches Röntgen Museum, Remscheid-Lennep, Germany

## Youth in Apeldoorn (1848–1862)

Apeldoorn, located in the eastern part of the Netherlands, was an agrarian village like there were many in this region. But Apeldoorn had something special. It housed the royal summer residence “Het Loo”. This made Apeldoorn rather popular among the wealthy, who enjoyed the charming environments. Röntgen’s father had a house built in Apeldoorn for which Wilhelm placed the first stone, with the inscription “W.C.R. 22.10.1850”. Being a retired, well-to-do merchant Röntgen Sr. belonged to the Apeldoorn society. He was active in local organisations. His presidency of the

**Fig. 1.2** Wilhelm Röntgen with his parents. Deutsches Röntgen Museum, Remscheid-Lennep, Germany



Musical Society “Harmonie”, established in 1850, is one of the few known activities. His wife was member of the Women’s Society, which is evident from an advertisement in the local newspaper, in which the women asked for goods to be sent to the victims of the “Enschede disaster”. The inner city of Enschede, a Dutch town some 70 km east of Apeldoorn, had been destroyed by an enormous fire on 7 May 1862. In the same year, Mrs Röntgen-Frowein was invited to become regent of the girls’ orphanage. Figure 1.2 shows young Wilhelm with his parents.

Wilhelm Conrad and his father were members of the Dutch Reformed Church, the mainstream Protestant congregation in the Netherlands, also the religion of the Dutch royal family. Röntgen’s mother, however, belonged to the much smaller Wallonian Protestant Church which since 1815 is a division of the Dutch Reformed Church. French was the language of their worship services.

Concerning his education, it has been indicated that young Wilhelm visited the private “French School” of M.H. van Doorn. A “French School” was an alternative for the “Latin School”, as no classical languages were taught, and education was more practically oriented. Subjects taught were generally writing, arithmetic, book-keeping, geography, history, one or more foreign languages (French, German, English), science, and music. This school was located at the “Oude Pasch”, close to his parent’s house. It was a day school for boys and girls and a boarding school for boys. The Dutch constitution of 1848 stated that public education should be available all over the country. On the other hand, everyone was free to establish a private school if it offered an adequate programme with qualified teachers of high morality,