

Roentgen and his Rays

If serendipity is defined as the ability to spot valuable things when they are not specifically sought or pursued, it can be said that serendipitous events take place in the lives of all scientists. The important thing however is to recognize the gift. This is often passed over or ignored since this is not what is 'expected'. It requires a trained mind and intuition to recognize the miracle. The great French scientist Louis Pasteur best summed up this when he said: "In the field of observation, chance favours the prepared mind." A scientist with a "prepared mind" possesses not only deep knowledge, but the ability to make astute observations while encountering any unexpected phenomenon. One such prepared mind was that of Wilhelm Conrad Roentgen whose name is synonymous with X-rays.

Undoubtedly, the discovery of X-rays in 1896 by Wilhelm Roentgen marks an important milestone in the history of scientific discoveries. This has heralded a revolution in the medical diagnostics and is the forerunner of several imaging methods that we are witnessing today. X-rays have proved to be an invaluable tool in spectroscopy, crystallography and in analytical chemistry. X-ray crystallography has indeed played a very important role in determining the structure of insulin and penicillin and above all of DNA which led to the unravelling of the genetic code.

Wilhelm Conrad Roentgen was born on 27 March 1845 in a small town of Lennep in the lower Rhine province of Germany. He was the only child of a cloth merchant and his ancestors were quite well-known persons in the town. During his third year, his parents moved to Apeldoorn in The Netherlands to adopt Dutch citizenship. In later years, Roentgen, of course, was awarded the honorary citizenship of Germany as he was considered as one of its most illustrious sons.

In Apeldoorn, he went to a boarding school where he did not exhibit any exceptional aptitude in studies. He was, however, full of passion for nature and this made him roam in the open country and forests. This quality also helped him to be at peace with himself in later years. He had a penchant for making mechanical devices, a characteristic which remained with him till the last. In 1862, he entered a technical school at Utrecht, from where he was however unfairly expelled, accused of having produced a caricature of one of the teachers! Though Roentgen knew the real prankster, he refused to identify the person.



Roentgen joined the university of Utrecht in 1865 to study physics, but as he did not possess the required qualification, he was not taken as a regular student. However, he later passed the entrance examination of Zurich Polytechnic in 1865 and enrolled as a student of mechanical engineering. He became a devoted student of Augustus Kundt, the professor of physics who had a great influence on his career. He got his PhD in 1869 on the properties of gases under the tutelage of Kundt. Roentgen could not however get a university professorship in spite of the best efforts of Kundt .

It appears that Roentgen's initial academic career was linked with that of Kundt as he followed him first to the University of Wurzburg and later to the newly founded University of Strasbourg in 1872. Roentgen married Anna Bertha Ludwig, daughter of an innkeeper at Apledoorn in 1872. Since they had no children of their own, they adopted Anne's niece.

Roentgen succeeded H F Weber as professor of physics and mathematics at Hohenheim Agricultural Academy in Wurtemberg, in 1875. Again he did not stay for long there. A year later he returned to Strasbourg as a professor of theoretical physics. He was to hold the chair of physics at Giessen University from 1879 to 1888. After declining several offers of university positions from other places, he returned to the university of Wurzburg as Professor and Director of the Physics Institute. Thus he achieved what was denied to him earlier. He succeeded the famous Kohlrausch in this position and had Helmholtz and Lorenz as his colleagues. After another six years, he was awarded the Rectorship, the highest office in the university.

At Wurzburg, his time was spent mostly on teaching during days and experimenting during nights. He started his experimental work in cathode rays, a rather hot field in those days. Earlier he worked on specific heats of gases and thermal conductivity of crystals and several other areas such as properties of quartz, refractive indices of various fluids, compressibility of water and other fluids and spreading of oil drop on water, etc. Among all the work, Roentgen's work using cathode tubes stands out, as it was instrumental in the discovery of X-rays. When he started his work with Crookes vacuum tube, he was trying to repeat some earlier experiments. In one of these experiments he covered the tube with a black card to mask the fluorescent glow in the tube. During this experiment, he noticed that some barium platino cyanide crystal nearby also became fluorescent. This was on the evening of Friday, 8 November 1895.

Roentgen became curious about it and was convinced that some rays emitted through



the Crookes tube induced fluorescence. He later found that a screen coated with some crystals of barium platino cyanide fluoresced and when a metallic object was held in between, it cast a shadow. During several days following this discovery, Roentgen devoted himself fully to study the nature of these rays. He seems to have made a rather cautious remark to his friend, "I have discovered something interesting but I do not know whether or not my observations are correct".

Since the nature of the rays was a puzzle, Roentgen simply called them X-rays. Roentgen's paper was presented to the physical and medical society of Wurzburg on 28 December 1895. This paper, which is a preliminary communication, was rich in details. It was translated into English and later published in *Nature* on 23 January 1896. Within weeks his fame spread all over the world. The work captured the imagination of scientists everywhere since the equipment necessary to confirm the findings was not uncommon in those days. The first X-ray image that Roentgen took was that of his wife's hand showing very clearly the shadows of the bones and the ring she was wearing. Roentgen submitted a second paper on X-rays to the Wurzburg physical-medical society in March 1896. This paper dealt mostly with the ionizing properties of X-rays and his third paper with further experiments and measurements. Though Roentgen described most of the properties of X-rays, the actual nature of X-rays itself was not known. In fact Roentgen himself erroneously surmised that they are the longitudinal vibrations in the so-called ether. This of course, in no way undermines his greatness, but only highlights the bewildering nature of the discovery. The genius of Roentgen consists in the fact that he immediately recognised an entirely new phenomenon and new kind of rays, which had eluded previous workers with cathode ray tubes. For example, Lenard while working with cathode rays found that they penetrate through the hand but failed to recognise the new kind of rays. Even Sir William Crookes found photographic plates being fogged by X-rays but attributed the phenomenon to inferior quality plates he was using at that time.

Soon after his discovery, honours and awards followed from several scientific bodies and public institutions. He was honoured with the first Nobel Prize for Physics in 1901 when he was a professor of physics at the University of Munich. Roentgen was characteristically modest and did not relish the public adulation showered upon him. He disliked the idea of naming the new rays after him and preferred the anonymity of 'X' as a prefix to the rays he discovered! In fact, it is said that he declined to deliver the Nobel lecture and preferred to be away from the limelight. He also donated the Nobel



Prize money to his University. He did not patent his discovery and wanted the world to benefit freely from it. It is no surprise that he also rejected the German title of nobility (i.e. von Roentgen) which was sought to be conferred upon him.

He loved working by himself and even felt embarrassed to have an assistant, preferring to build the instruments whenever possible all by himself with great ingenuity and skill! He loved mountaineering and entertaining people at his summer home at Weilheim at the foot of the Bavarian Alps. He was, of course, not a recluse though he turned to nature frequently and was happy to be left alone. In fact there are not many quotes of Roentgen other than a rather ubiquitous one "I didn't think; I experimented". That perhaps best sums up his personality.

Four years after his wife Anne passed away, Roentgen died at Munich on February 10, 1923 at the age of 78 from cancer of the rectum. Anne and Roentgen are buried together at a cemetery at Giessen. In spite of the huge wealth he inherited earlier from his parents, Roentgen was nearly bankrupt at the time of his death from the hyperinflation that followed World War I.

Roentgen's legendary humility can be discerned from the statement during the address delivered on assuming the Rectorship of the University of Wurzburg in 1894, a year before the discovery of X-rays: "The scientist must consider the possibility, which usually amounts to a certainty, that his work will be superseded by others within a relatively short time, that his methods will be improved upon and that the new results will be more accurate and the memory of his life and work will gradually disappear." This may be indeed true of most of the present day scientific discoveries, though it is difficult to reconcile it with that of Roentgen's own achievements which remain green in the memory till this day.

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