Wilhelm Conrad Roentgen

The First *NOBEL PRIZE in Physics, 1901*

“"in recognition of the extraordinary services he has rendered by the discovery of the remarkable rays subsequently named after him"

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Sprawls Educational Foundation, www.srawls.org

I. INTRODUCTION

Wilhelm Conrad Roentgen was a German physicist recognized and honored for his discovery of a “new kind of radiation”. His contribution was not just the discovery, but the extensive research determining and documenting the characteristics of the radiation and demonstrating its value for medical applications.

A comprehensive biography describing his education and academic activities has been published and can be read here.
wilhelm conrad röntgen – biographical - nobelprize.org.

Our interest here is his research following the discovery and his publications and presentations.

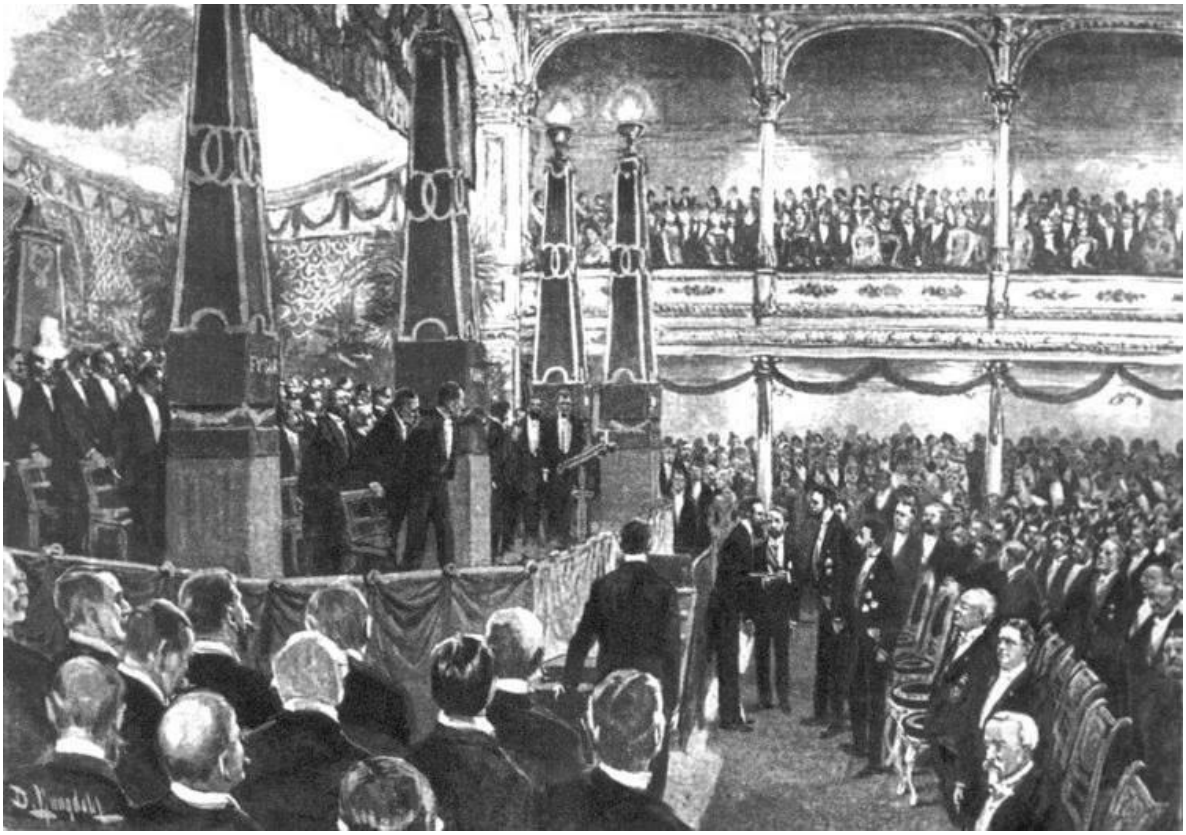
II. THE NOBEL AWARD CEREMONY

The Nobel Award ceremony on 1901 was the first for physics and is especially significant for the field of medical physics. It was for the discovery of radiation that was to become a major medical procedure and establish the profession of medical physics as we know it now.

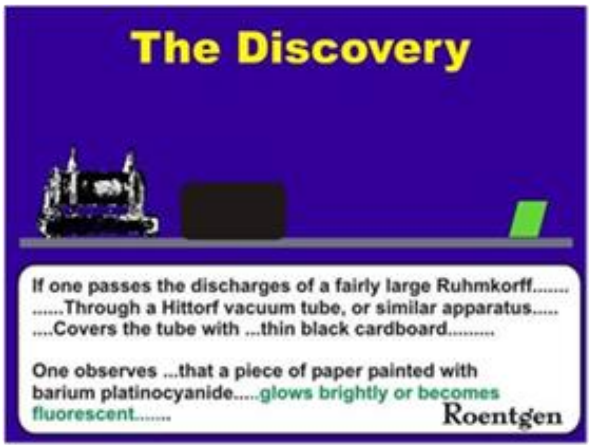
Roentgen did not provide a lecture, and the presentation was by the-former Rector of the National Archives C. T. Odhncr, President of the Royal Swedish Academy of Sciences:

Your Royal Highnesses, Ladies and Gentlemen. The Royal Swedish Academy of Sciences received from Alfred Nobel the privilege of awarding two of the great Prizes which he founded in his will- the Prizes in those branches of Science which lay nearest his heart - those in Physics and Chemistry. Now that the Royal Academy of Sciences has received from its Committees their expert opinion on the suggestions sent in, as well as their own suggestions, it has made its decision, and as current President I am here to make it known. The Academy awarded the Nobel Prize in Physics to Wilhelm Conrad Röntgen, Professor in the University of Munich, for the discovery with which his name is linked for all time : the discovery of the so-called Röntgen rays or, as he himself called them, X-rays. These are, as we know, a new form of energy and have received the name <<rays>> on account of their property of propagating themselves in straight lines as light does. The actual constitution of this radiation of energy is still unknown. Several of its characteristic properties have, however, been discovered first by Röntgen himself and then by other physicists who have directed their researches into this field. And there is no doubt that much success will be gained in physical science when this strange energy form is sufficiently investigated and its wide field thoroughly explored. Let us remind ourselves of but one of the properties which have been found in Röntgen rays; that which is the basis of the extensive use of X-rays in medical practice. Many bodies, just as they allow light to pass through them in varying degrees, behave likewise with X-rays, but with the difference that some which are totally impenetrable to light can easily be penetrated by X-rays, while other bodies stop them completely. Thus, for example, metals are impenetrable to them; wood, leather, cardboard and other materials are penetrable and this is also the case with the

muscular tissues of animal organisms. Now, when a foreign body impenetrable to X-rays, e.g. a bullet or a needle, has entered these tissues its location can be determined by illuminating the appropriate part of the body with X-rays and taking a shadowgraph of it on a photographic plate, whereupon the impenetrable body is immediately detected. The importance of this for practical surgery, and how many operations have been made possible and facilitated by it is well known to all. If we add that in many cases severe skin diseases, e.g. lupus, have been successfully treated with Röntgen rays, we can say at once that Röntgen's discovery has already brought so much benefit to mankind that to reward it with the Nobel Prize fulfils the intention of the testator to a very high degree.



III. THE DICOVERY



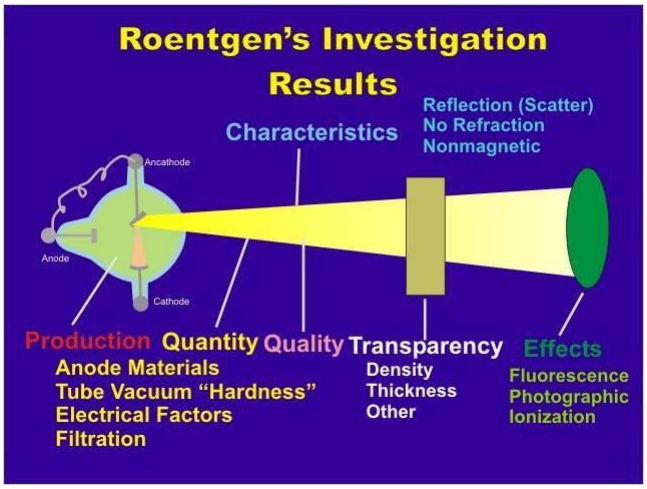
Before the time of the discovery physicists in various institutions were experimenting with partially evacuated glass tubes connected to high-voltage sources of electricity. It had been determined that streams of accelerated electrons, or cathode rays, were produced within the tubes. If a tube had a sufficiently thin window, some of the cathode rays penetrated the surrounding air. Roentgen was experimenting with cathode rays coming from a tube when he made the discovery. Typically, the tubes would glow because of the ionization of the air that remained in the tube. This light interfered with Dr. Roentgen's experiment of observing fluorescence produced by the cathode rays close to the tube. To produce a dark environment, he enclosed his glowing tube with an opaque cover. It was in this darkness that he noticed light being emitted from a fluorescent material at some distance from the tube-a distance much greater than the range of cathode rays in air.

IV. THE INVESTIGATIONS

Following the discovery, Roentgen realized he had a new kind of radiation and began an intense investigation to determine Their characteristics and especially compare it to other known radiations, visible light and cathode rays.

The series of experiments described by Roentgen and illustrated by Sprawls are published here:

ROENTGEN'S INVESTIGATION DETERMINING THE CHARACTERISTICS OF X-RADIATION
P. Sprawls. MEDICAL PHYSICS INTERNATIONAL Journal, vol.2, No.2, 2014
http://www.mpijournal.org/pdf/2014-02/MPI-2014-02-p435.pdf .



The experiments are summarized in this illustration.

His investigations included experiments with tubes designed for X-ray production with different anode materials operated at different electrical voltages and the effects of filtration on the characteristics of the radiation. It is significant that he discovered the effects of the radiation, fluoresence and photographic, because this was to become the basics of the two X-ray imaging modalities, radiography and fluoroscopy.

Roentgen published the results of the investigations in a scientific journal as a series of three (3) articles:
1.W. C. Roentgen: On a New Kind of Rays, December 28, 1895. (Preliminary Communication)

2.W.C. Roentgen: On a New Kind of Rays. March 9, 1896 (Continued)

3.W. C. Roentgen: Further Observations on the Properties of X-rays. March 10, 1897.

It appears that these did not attract attension beyond the physics community that did not recognize the significants for imaging the human body.

V. THE PRESENTATION

In 1896 he gave a presentation at the University of Wurzburg in which he described the physics of the new radiation and demonstrated its medical potential by producing an image of the anatomy professor's hand on a photographic plate. When it was developed and shown to the audience it was greeted with excitement and with cheers for Dr. Roentgen.

VI. THE NEWS SPREADS TO OTHER COUNTRIES

The story of the new kind of radiation and its medical applications was picked up by the news media and published in other countries. This is when physicists and engineers in various institutions realized that the partially evacuated tubes and high-voltage electrical sources they were experimenting with and used in demonstrations were actually X-ray machines and began to use it make images of the human body in collaboration with medical doctors.

VII. THE FOUNDATION OF MEDICAL IMAGING AND THE MEDICAL PHYSICS PROFESSION

Now that the principle and process of medical imaging has been demonstrated by Dr. Roentgen, physicists and engineers began the development of more appropriate x-ray tubes, high-voltage and controllable electrical sources, fluorescent screens and photographic film receptors. This area of research and development continues with the general objective of increasing visibility of anatomical structures and signs of pathological conditions…especially in the breast and brain, both challenging anatomical regions to image. With improvements in X-ray projection imaging and the development of X-ray computed tomography (CT), other modalities using radionuclides, ultrasound, and radio frequency (RF) signals were developed.

The role of physicists expanded beyond research and development to include direct involvement in clinical imaging procedures, with special attention to image quality and the radiation exposure to patients. These became recognized as radiological or medical physicists, often with certificating boards examining and providing recognition of their qualifications to practice the profession.

With the development of radiation oncology or therapy, physicists were required for calibrations of equipment and creating treatment plans for maximum effectiveness. This became the largest specialization within the field of medical physics.

With the expanding scope of medical physics, graduate level academic courses have generally become recognized as a requirement for entering the profession.

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