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WILHELM CONRAD RÖNTGEN

1845-1923

Wilhelm Conrad Röntgen, the discoverer of X-rays, was born in 1845, in the town of Lennep, in Germany. He received his Ph.D. in 1869 from the University of Zurich. During the next nineteen years, Röntgen worked at a number of different universities, gradually acquiring a reputation as an excellent scientist. In 1888, he was appointed professor of physics and director of the Physical Institute at the University of Würzburg. It was there, in 1895, that Röntgen made the discovery which made him famous.

On November 8, 1895, Röntgen was doing some experiments with cathode rays. Cathode rays consist of a stream of electrons. The stream is produced by applying a high voltage between electrodes placed at each end of a closed glass tube from which almost all of the air has been removed. Cathode rays themselves are not particularly penetrating, and are readily stopped by a few centimeters of air. On this occasion, Röntgen had completely covered his cathode-ray tube with heavy black paper, so that even when the electric current was turned on, no light

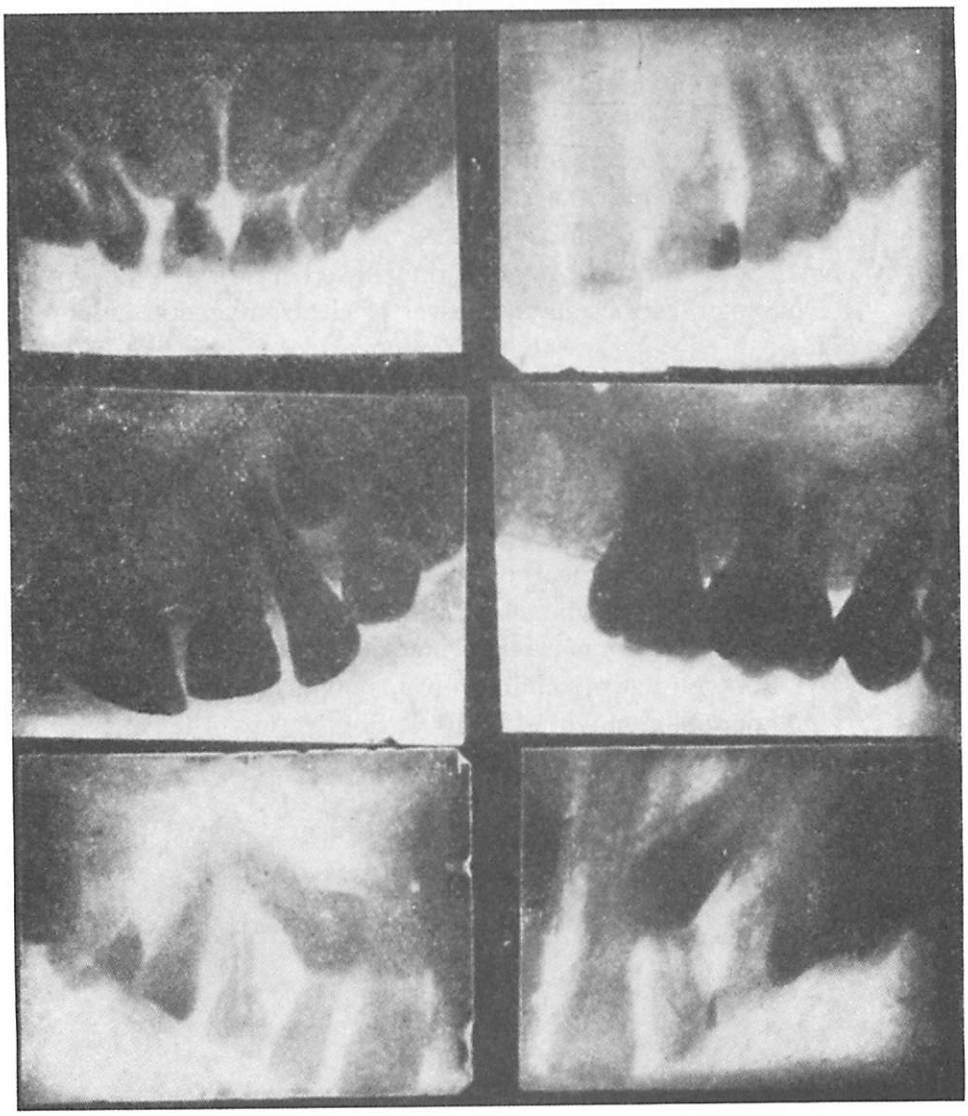
could be seen coming from the tube. However, when Röntgen turned on the current in the cathode-ray tube, he was surprised to see that a fluorescent screen lying on a bench nearby started glowing, just as though a light had stimulated it. He turned off the tube, and the screen (which was coated with barium platinocyanide, a fluorescent substance) stopped glowing. Since the cathode-ray tube was completely covered, Röntgen soon realized that some invisible form of radiation must be coming from the tube when the electric current was on. Because of its mysterious nature, he called this invisible radiation "X-rays"—"X" being the usual mathematical symbol for an unknown.

Excited by his chance discovery, Röntgen dropped his other research and concentrated on investigating the properties of the X-rays. In a few weeks of intense work, he discovered the following facts: (1) X-rays can cause various other chemicals besides barium platinocyanide to fluoresce. (2) X-rays can pass through many materials which are opaque to ordinary light. In particular, Röntgen noticed that X-rays could pass right through his flesh, but were stopped by his bones. By placing his hand between the cathode-ray tube and the fluorescent screen, Röntgen could see on the screen the shadow of the bones in his hand. (3) X-rays travel in straight lines; unlike electrically charged particles, X-rays are not deflected by magnetic fields.

In December 1895, Röntgen wrote his first paper on X-rays. His report promptly aroused great interest and excitement. Within a few months, hundreds of scientists were investigating X-rays, and within a year roughly a thousand papers had been published on the topic! One of the scientists whose research was directly motivated by Röntgen's discovery was Antoine Henri Becquerel. Becquerel, although intending to investigate X-rays, instead chanced upon the even more important phenomenon of radioactivity.

In general, X-rays are generated whenever high-energy electrons strike an object. The X-rays themselves do not consist of electrons, but rather of electromagnetic waves. They are therefore basically similar to visible radiation (that is, light waves), except that the wavelengths of X-rays are very much shorter.

The best known application of X-rays, of course, is their use in medical and dental diagnosis. Another application is radiotherapy, in which X-rays are used to destroy malignant tumors or



X-rays have facilitated great advances in dentistry.

to arrest their growth. X-rays also have many industrial applications. For example, they can be used to measure the thickness of certain materials or to detect hidden flaws. X- rays are also useful in many fields of scientific research, from biology to astronomy. In particular, X-rays have provided scientists with a great deal of information concerning atomic and molecular structure.

Röntgen deserves full credit for the discovery of X-rays. He worked alone, his discovery was unanticipated, and he followed it up superbly. Furthermore, his discovery provided an important stimulus to Becquerel and to other researchers.

Nevertheless, one should not overestimate Röntgen's importance. The applications of X-rays are certainly very useful; however, one cannot say that they have transformed our whole technology, as Faraday's discover of electromagnetic induction did. Nor can one say that the discovery of X-rays was of truly fundamental importance in scientific theory. Ultraviolet rays (whose wavelengths are shorter than those of visible light) had been known for almost a century. The existence of X-rays—which are similar to ultraviolet waves, except that their wavelengths are shorter still—therefore fits quite smoothly into the framework of classical physics. All in all, I think it quite reasonable to rank Röntgen significantly below Rutherford, whose discoveries were of more fundamental importance.

Röntgen had no children of his own; however, he and his wife adopted a daughter. In 1901, Röntgen was the recipient of the Nobel Prize in physics, the first one ever awarded. He died in 1923, in Munich, Germany.