Two Foundation Stones of Radiation Medicine*

N.K. VERMA
Institute of Nuclear
Medicine and
Allied Sciences

MODERN PHYSICS may be said to date from 1895 when Roentgen discovered X-rays. Two other major discoveries followed in quick succession, namely, the discovery of radioactivity by Becquerel in 1896 and the discovery of radium by Madam Curie in 1898. These epoch making discoveries not only revolutionised physics but have proved to be of immense application in the medical field.

Madam Curie's birth centenary was recently celebrated in November 1967. This article gives an account of the discovery and applications of the two foundation stones of radiation medicine, namely X-rays and radium.

The first Nobel Prize for physics was awarded to Wilhelm Conrad Roentgen, Professor of Physics and Director of the Physical Institute of Wurzburg in Bavaria, for his epoch-making discovery of X-rays on 8 November 1895. He saw the bones of his living hand projected on a barium cyanide screen when he interposed it between the invisible beam of electromagneticz radiation, originating from the Hittorf Crookes tube, excited under the influence of high voltage from an induction coil, and the detector plate. And this was the beginning of Radiation Medicine.

He made two important communications in this connection. The first was on 23 January 1896 in the auditorium of the Physical Institute. The title of his lecture was: "A New Kind of Ray (Ueber eine neue Art Von Strahlen)" in which he explained about his discovery of the penetrating rays. His lecture was accompanied by demonstrations. He took the X-ray photograph of the hand of Von Kolliker, the famous anatomist of the Wurzburg University and he showed it to the audience. In his second communication

WILHELM CONRAD ROENTGEN
Winner of first Nobel Prize for Physics, 1901,
(Courtesy: Dr. Lewis E. Etter *and the Science of Ionizing Radiation)*

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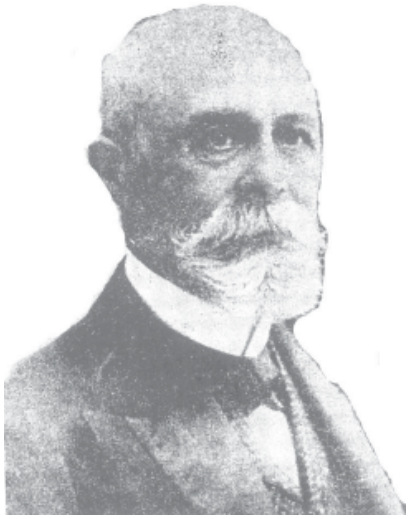
on 10 March 1896, he explained the various properties of this new kind of ray. This was entitled "Further observations on the properties of X-rays".

These two communications of far reaching importance were sufficient to stimulate, originate and develop a number of new ideas and researches. This physical discovery, in its further developments, led to an integral discipline of physics, general science, engineering, biology, medicine, chemistry, mathematics and so on; and it entered the field of almost any and every subject. It also helped to explain many phenomena hitherto regarded as an unsolved mysteries of nature.

Roentgen died of cancer of the intestine on 10 February 1923 at his Munich residence. He however impregnated his dynamic image over his time, which, like engravings on stone, can be seen in hospitals, research laboratories, biological laboratories and analytical institutions all over the world.



A.H. BECQUEREL
Winner of Nobel Prize for Physics 1903,
(Courtesy: Prof. A. Gandy, Foundation Curie, Paris)

Within a matter of months, this discovery caught the imagination of scientists all over the world. Medical and commercial applications of X-rays followed with great rapidity. Speaking exactly, it was after one month and three days only of the discovery of X-ray that it was brought into use in Belgium hospitals. Roentgen Societies and Committees came into existence. Scientists and engineers put their heads together for the development of X-ray apparatus. Film manufacturers and dark room technicians made themselves busy after X-ray applications for the purposes of diagnosis. The subject of X-rays formed a strong nucleus round which many other branches of science began to revolve.

Before this discovery, hospitals were acquainted with the application of electromagnetic energy in the form of high frequency current, diathermy, etc. but it was for the first time that this energy (electromagnetic) entered the arena for the hospital in the form of penetrating radiation. Both civil and military uses of X-rays were quickly realised.

But not even six months had passed before reports of dermatitis on the hands of X-ray workers were received. These were similar to those which appeared before 1895, on the hands of discharge tube and vaccuum tube workers, resembling sun-burn. This proved that X-rays could induce biological changes. And so, it was the starting point of radiation plus biology, that is radio-biology.

And now, with the help of X-rays, supported by special radiographic procedures, about two dozens of radiographies, covering from head to foot, are possible. Medical examinations of, say, neck section, chest, breast, cardio-vascular system, genitourinary tract, skeleton, lymphatic system etc. can routinely be carried by means of X-radiation.

X-rays also began to be used for the treatment of tumours. In the field of kilovoltage and supervoltage therapy, 250 kv, 400 kv, million volt and two million volt X-ray machines are quite popular. Even in a linear accelerator or in a van de Graaf generator or in a betatron, high energy electron beams sometimes hurled against a target to produce highly penetrating X-rays, which in turn, are made useful, in the treatment of deep-seated tumours.

Thus, roentgenography and radiobiology have become established as recognised specialities in clinical medicine. This was the first foundation stone of radiation medicine.

The second important phase followed in quick succession. It happened thus. Aroused by this sensational discovery of X-ray, Antoine Henri Bacquerel, the son of a professor of physics in Paris, began to look for a similar sort of penetrating ray from some other source. He thought about the phenomena of fluorescence which was seen to occur inside the Hittorf tube at the point where cathode rays struck the wall of the tube to originate X-radiation. The suggestion, therefore, was that there must be some sort of correlation between the fluorescence and the emission of X-ray. It could be possible that the substance, capable of giving rise to fluorescence or phosphorescence could also be the emitter of this X-radiation. Driven by this belief he began to examine a number of such substances. In that pursuit he undertook the investigations of double sulphate of uranium and potassium. He also used photographic film as the detector of radiation. He found that the film, wrapped up with black paper, over which the crystal of uranium salt was kept in the drawer of his table, because of cloudy weather, for several days, showed the image of the substance on its developing. This photograph was similar to the one which he had obtained when the same arrangement of crystal and the photographic plate was kept in the sunshine. Rays, similar to X-ray, had

Prof. PIERRE CURIE *and his wife*
MARIE SKLODOWSKA CURIE.
(Courtesy: Prof. A. Gandy, Foundation Curie, Paris)

thus been discovered by Becquerel. He found that, this emission was inherent in all the uranium compounds. Fluorescence had nothing to do with it. Becquerel communicated the result of his investigations to the Academy of Science, Paris, in the month of January 1896, that is only after three months of the discovery of X-rays. This was the beginning of natural radioactivity.

At this stage, Marie Sklodowska, a Polish girl, the daughter of physicist parents, holder of masters' degrees in physics and mathematics, a research scholar and the wife of a celebrated scientist Pierre Curie of Paris, was attracted by Becquerel's radiation. She began to investigate all the available substances for their emission of any penetrating radiation. In her case the detector was not a photographic film but a device based on the principle of ionisation. The ionisation chamber coupled with an electrometer, working on the principle of piezoelectric effect of quartz crystals, discovered by her husband, measured the intensity of radiation coming from the sample. Every time she found that the intensity was proportional to the amount of sample under investigation. A preparation of thorium salt also gave the same sort of result. But chalkolite, a uranium mineral, showed higher intensity than what was expected. She concluded that there must be a substance other than uranium, present in the sample, responsible for the higher emission. It really came out to be so when she started her historical work in collaboration with her husband, in the hutment of a school. The hard work of days and nights consisted of pulverisation, precipitation and fractional crystalisation of pitchblende ore from the JOACHIMSTHAL uranium mine in Bohemia. The processing of each twenty-five pounds of ore gave an yield of a milligram of a white shining metal which was announced in December 1898 as radium. This new substance was two million times more active than uranium. The name radioactivity, that is, action at a distance, was given by Mme Curie to all those substances which emitted radiation. Thus, came into existence an element which is playing a vital role in clinics and in laboratories, even today.

MARIE CURIE
Nobel Prize Winner for Physics 1903,
for Chemistry 1911
(Courtesy: Prof A. Gandy, Foundation Curie, Paris)

In the year 1903, Mme Curie submitted her thesis for her degree of doctorate in which she described the various properties of radium.

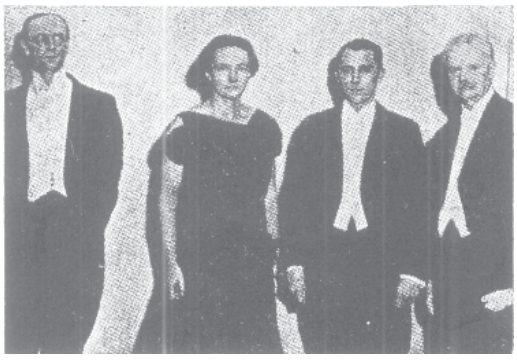
She was the recipient of the Nobel Prize for physics jointly with A.H. Becquerel in 1903. She received the Nobel Prize for the second time in the year 1911, this time for chemistry.

Biological and medical implications of radium came accidentally when in 1901. Becquerel loaned some radium from the Curies for a demonstration to his students. A glass vial containing 200 milligram of radium remained in the pocket of his vest coat for six hours. This produced erythema that is reddening of his skin just beneath the vest coat pocket. Then appeared crackings of the skin at that site finally forming into an ulcer which was painful. Conventional treatment was able to bring a cure.

On receiving this report, Pierre Curie voluntarily exposed his arm to the rays from radium to verify the findings and he went through the same experience as substances like radium were also capable of producing biological changes just as X-ray did. The Curies and Becquerel started a lot of animal experimentation to study the physiological effects of radium rays. During years 1901-1906 radium was tried for its therapeutic effects on a number of ailments such as blindness, dermatological conditions, sciatic pain, female hemorrhages, cancer, etc.

Then in the year 1906, the Biological Laboratory of Radium (which later on became Foundation Curie) came into existence in Paris and it started clinical works with radium. This was followed by radium institutes and radium departments in other countries also. Similar to X-rays, this discovery too spread far and wide and secured its position in the clinics.

Mme Curie, a lady of great eminence, the symbol of scientific faith and missionary zeal, a deep devotee at the temple of learning, did phenomenal work during her life time. Perhaps nature itself became jealous of her achievements, honours and awards. She became a widow when her illustrious husband Pierre Curie was run over by a truck on 19 April 1906. Soon after this tragic event however, she was again deeply engrossed in her work. As a result of prolonged exposure to anaemia she died of it on 4 July 1934. Radium which had bestowed such incalculable gifts in the alleviation of disease, took its toll from its discoverer. Mme Curie left behind her, an ideal and a strong scientific legacy in the persons of her daughter, Irene Curie



Prof. FREDERIC JOLIOT CURIE *and his wife* Mme IRENE CURIE *(daughter of Mme Curie) Centre of the photograph. Winners of Nobel Prize for Chemistry,* 1935, *(Courtesy: Prof A. Gandy, Foundation Curie, Paris)*

and her son-in law, Prof. Frederic Joliot Curie, again both of them Nobel laureates.

Rapid research and development followed and radium was found to be best suited for cancer treatment. Interstitial, intracavitary and surface applicators of radium in the form of moulds, plaques, etc came into use for the treatment of cancer of the various regions of the body such as skin, hand, nose, ear, eye, tongue, oral cavity, vocal cord, breast, uterus, rectum, etc. Permanent implants of radon seeds (bits of thin gold tubing containing radon gas) at certain delicate sites like tongue, tonsil intestine, etc. proved to be very effective. Combined therapy of surgery and radium, backed up by roentgenography gave excellent results. Radium packings on curie level, gave high intensity beams of gamma radiation suitable for the treatment of deep-seated tumours. Solid radium salt filled in platinum containers in the shape of needles and shells began to pour into hospitals. In our country, this costly substance (about Rs. one lakh for a gram) came for the first time in Ranchi, Bihar, around the year 1920.

Thus, the two great discoveries of X-ray and radium plus the pioneering work of Roentgen, Becquerel and Mme Curie laid the foundation stones of Radiation Medicine.

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