The N-Ray Affair

Early in this century an eminent physicist discovered a new kind of radiation, and others confirmed his work. The radiation turned out to be totally imaginary, proving that believing can be seeing

by Irving M. Klotz

Science, like any other area of human endeavor, has had its grand illusions: compelling concepts that have excited a substantial segment of the scientific community and yet have turned out to be totally wrong. Since history tends to record the successes in science rather than the failures, even the most striking of these concepts are likely to disappear. An exception to the rule is a completely imaginary form of electromagnetic radiation known as N rays. For a brief time the extraordinary reported properties of this radiation captured the imagination of scientists all over the world. Today N rays are remembered only for the insights they provide into the psychosociology of science.

To understand the significance of N rays one must consider the climate in which they were "discovered." The beginning of the 20th century was one of the most exciting periods in modern science. In 1895 W. K. Röntgen had generated X rays. Then radioactive emissions had been identified: alpha rays, beta rays and gamma rays. By 1900 it seemed inevitable that other types of rays would be found. Then in 1903 René Blondlot, a distinguished French physicist at the University of Nancy, announced that he had discovered the new type of radiation he called N rays.

Blondlot, a member of the French Academy of Sciences, was not a crackpot. His discovery of N rays was a mistake, not a hoax. Indeed, if the rays had been discovered in the 1880's, a decade before X rays and radioactivity, they would have been without precedent, and Blondlot would almost certainly have subjected his findings to a much more rigorous analysis. In the 1900's, however, a good physicist was psychologically prepared to encounter a new type of ray, just as other scientists were psychologically prepared to receive word of one. As a result Blondlot's findings touched off a hysterical reaction in parts of the scientific community, a wave of self-deception that took years to subside. The story, then, is a complex one that begins with Blondlot.

Blondlot was an accomplished experimenter in the physics of electromagnetic radiation. He had studied electric discharges through gases, the same type of phenomenon that had led Röntgen to the discovery of X rays. Therefore it was not surprising that after 1895 Blondlot became deeply involved in research on X rays. In particular he addressed himself to a question that was troubling many physicists around the turn of the century: Were X rays particles or were they electromagnetic waves?

It is now known that any form of matter or energy can exhibit the characteristics of both a particle and a wave, but in Blondlot's time physics had standard criteria for determining the nature of rays from a particular source. On the one hand it was known that particles coming from an electrified source normally carried an electric charge, so that if they were made to pass in a straight line between two metal plates, one charged negatively and the other positively, they would be bent out of their original trajectory. On the other hand it was known that although electromagnetic waves could not be deflected by charged plates, they could be polarized: they could be made to oscillate in a single two-dimensional plane. Blondlot planned to apply this last property of electromagnetic waves to determine the true nature of X rays.

If X rays were waves, Blondlot reasoned, they might be polarized as they emerged from the electric-discharge tube in which they were generated. To detect such polarization he proposed placing in various orientations in the path of the X rays a detector consisting of a pair of sharply pointed wires with a short electric spark jumping in a straight line between them. If the line along which the spark was jumping could be oriented so that it lay in the plane of the polarized X rays, the electric component of the electromagnetic wave should reinforce the energy of the spark and increase its brightness. When Blondlot carried out the experiment, he found to his delight that if the spark-gap detector was placed at a certain angle with respect to the electric-discharge tube, the brightness of the spark did indeed visibly increase.

Blondlot's excitement was quickly dampened, however, by his next discovery. Further testing with the detector revealed that the radiation acting on the spark was bent when it was passed through a quartz prism. Previous experiments had shown unequivocally that X rays are not bent when they traverse such a prism. It was at this point that Blondlot made what turned out to be a disastrous conceptual leap. He reasoned that the visible increase in the brightness of the spark showed that some wave was impinging on the spark-gap detector, and so if the waves were not X rays, they had to be some new form of electromagnetic radiation. He named the new radiation n rays, and later N rays, for the University of Nancy.

As an experienced physicist Blondlot knew that he also had to rule out the possibility that traces of ordinary light waves from the electric-discharge tube were responsible for the increase in spark brightness that signaled the presence of the N rays. Therefore he developed a photographic apparatus for recording spark intensities in which the spark-gap detector was covered by a cardboard box. Visible light rays could not penetrate the cardboard box but the N rays could. Comparing photographs made when an N-ray source was aimed directly at the box with those made when a special screen that blocked N rays was placed between the source and the box clearly demonstrated that the effect of N rays on the spark was not diminished by the exclusion of light. Encouraged by this success, Blondlot went on to develop more sensitive devices for detecting N rays, the most successful of which relied on phosphors: substances that emit light when more energetic radiation impinges on them.

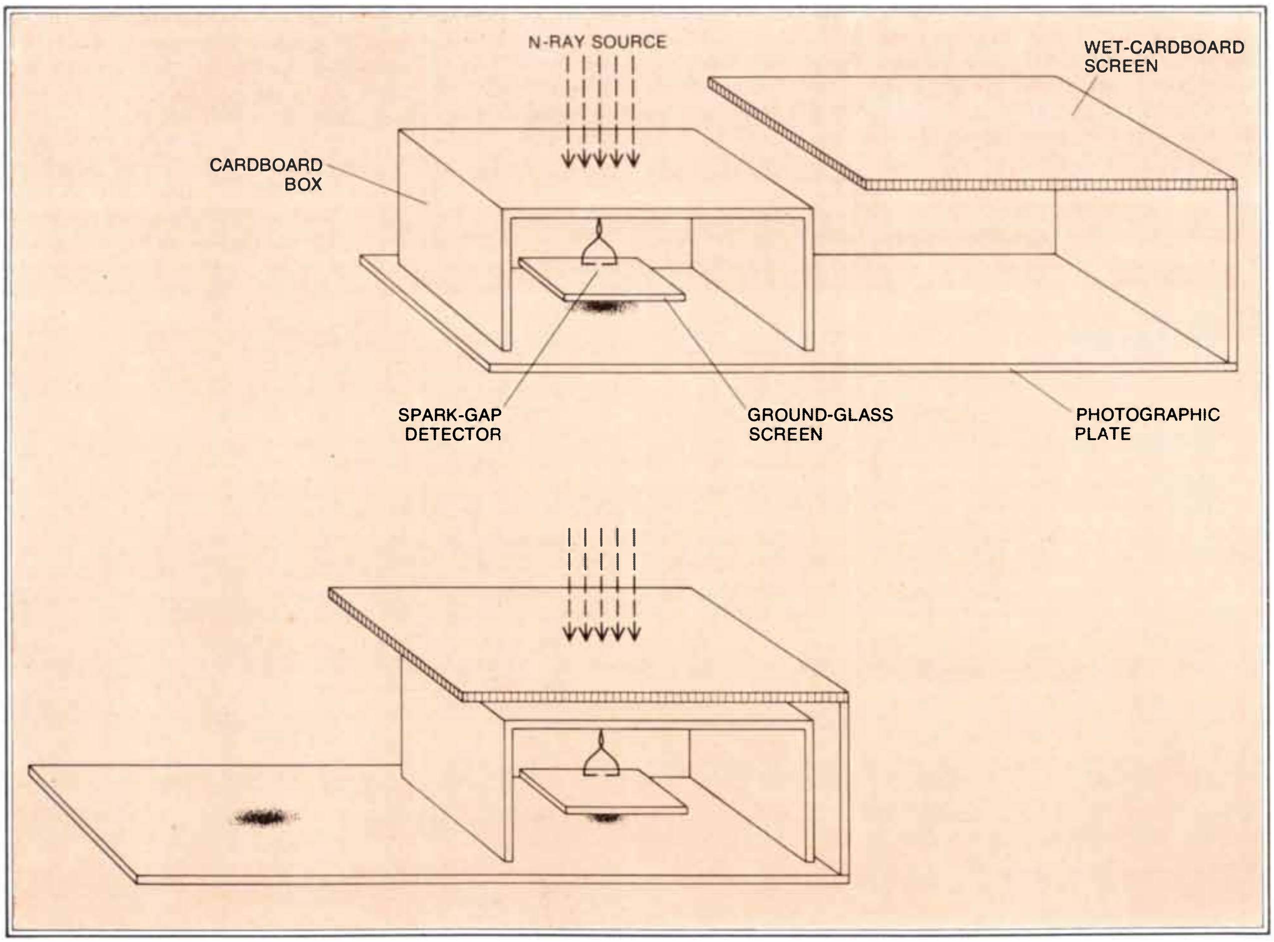
With these improved detection methods Blondlot was able to carry out a wide-ranging study of the properties and sources of N rays, and early in 1903 he began publishing his findings in *Comptes rendus,* the annals of the Academy of Sciences. Soon Blondlot was joined in his efforts by scientists of every description. Physicists, physiologists and psychologists all leaped to meet the challenge of investigating and exploiting the new form of radiation.

This massive research effort soon uncovered properties of N rays that were quite remarkable. Almost all the materials that proved to be transparent to the rays were opaque to visible light. Wood, paper and thin sheets of iron, tin, silver and gold were found to efficiently transmit N rays. In fact, Blondlot made aluminum lenses and prisms for focusing and bending the rays. Mica, quartz and paraffin were also shown to be transparent to the rays; water and rock salt blocked them and therefore could be employed to screen them out.

It was quickly discovered that there were many sources of N rays in addition to the electric-discharge tube. The Welsbach mantle, a type of gas burner widely used for home lighting around the turn of the century, proved to be a rich source of N rays. So did the Nernst glower, a lamp in which a thin rod of rare-earth oxides was heated to incandescence by an electric current. Heated pieces of silver and sheet iron emitted the rays, but surprisingly the Bunsen burner did not. More interesting, however, was the discovery of N-ray sources in nature.

Blondlot himself found that the sun emitted N rays. Late in 1903 another member of the Nancy faculty, a respected professor of medical physics named Augustin Charpentier, submitted to the Academy of Sciences a report on N-ray emissions from the human body. In the report, which was sponsored by the distinguished French physicist and academy member Arsène d'Arsonval, Charpentier described the discovery of particularly strong N-ray emissions from nerves and muscles. He later announced that he was able to detect N-ray emissions from bodies after death, and a Monsieur Lambert reported that even enzymes isolated from body tissues gave off the rays. (Charpentier put these discoveries to practical use. Early in 1904 he announced that the increase in N-ray emissions accompanying motor activity could serve as the basis for improved methods of exploring the body for clinical purposes, for example to detect the outline of the heart.)

As often happens with major advances in science, the pioneers of N-ray research—Blondlot, Charpentier and their colleagues—were challenged by other workers who maintained they had been the first to discover and investigate the new form of radiation. In the spring of 1903 Gustave le Bon, a dabbler in many



TANGIBLE PHOTOGRAPHIC EVIDENCE for the existence of N rays was obtained in the experiment schematically re-created in this cutaway diagram. The presumed detector of the rays was the spark gap; the spark was said to get brighter when N rays fell on it. The detector was enclosed in a cardboard box. At the bottom of the box was the photographic plate. Between the spark-gap detector and the photographic plate was a ground-glass screen, which diffused the light from the spark so that it made a fuzzy spot on the plate. It was believed cardboard was transparent to N rays, so that when the rays (*arrows*) fell on it (*top*), they would pass through it, make the spark brighter and make the spot on the photographic plate darker. Water, however, was believed to be opaque to N rays, so that when a screen of wet cardboard was pushed into place over the box (*bottom*), the water in the screen would block the rays, making the spark dimmer and the spot on the photographic plate lighter. Many other factors affected the degree of darkness and lightness of the spot, however, and in the end it appeared that the experimenters' willingness to believe in the validity of the experiment led them to overinterpret their results.

different areas of physics, sent Blondlot a letter (which Blondlot subsequently published) asserting that seven years earlier he had discovered a form of radiation that could penetrate metals. In December of the same year one P. Audollet submitted a petition to the Academy of Sciences, stating that he and not Charpentier had been the first to discover the emission of N rays from living organisms. A month later a spiritualist named Carl Huter entered a similar claim, but in the spring of 1904 the academy declared in a solemn report by d'Arsonval that Charpentier's findings had preceded all the others.

In 1904 the academy also bestowed on Blondlot the prestigious Prix Leconte, which included a cash award of 50,000 francs. According to the citation accompanying the prize, it was given to Blondlot for (to translate from the French) "the whole of his works"; his "new ray" is mentioned only at the end of a three-page listing of his achievements. The citation does conclude, however, by expressing support for Blondlot and offering him encouragement in his investigations of N rays. Rumors circulated through the French scientific community at the time to the effect that the first draft of the citation had dealt exclusively with the discovery of N rays but that caution had finally prevailed. (When Albert Einstein was awarded the Nobel prize in physics in 1922, it was for his "discovery of the law of the photoelectric effect." Relativity was mentioned only obliquely, by a reference to "services to theoretical physics.")

With this kind of encouragement research in N rays flourished. In the year and a half following Blondlot's announcement of his discovery the number of publications on the subject grew almost explosively. In the first half of 1903 four papers on the subject appeared in *Comptes rendus;* in the first half of 1904 the number had risen to 54. (It is interesting to note that in the latter period *Comptes rendus* carried only three papers on X rays.) Thereafter the explosion came to an abrupt halt; in 1905 *Comptes rendus* published no papers on the subject at all. A catastrophe had befallen N rays. It was a visit to the University of Nancy by the American physicist R. W. Wood.

Wood, professor of physics at Johns Hopkins University, was an internationally known expert in optics and in spectroscopy, the branch of physics that specializes in the analysis of electromagnetic radiation. He was naturally excited by the report that Blondlot had identified a new type of radiation and, as is customary when a new phenomenon is discovered, had promptly set about trying to reproduce Blondlot's striking results. As he told his biographer William Seabrook, he failed completely "after wasting an entire morning."

Wood's experience was not unique. Other physicists, including Lord Kelvin and Sir William Crookes in Britain and Otto Lummer and Heinrich Rubens in Germany, had been equally unsuccessful. In fact, other workers began urging Wood to go to Nancy and observe Blondlot's experimental procedures for himself. Wood decided to visit Blondlot's laboratory, where as he put it "the apparently peculiar conditions necessary for the manifestation of this most elusive form of radiation [appeared] to exist."

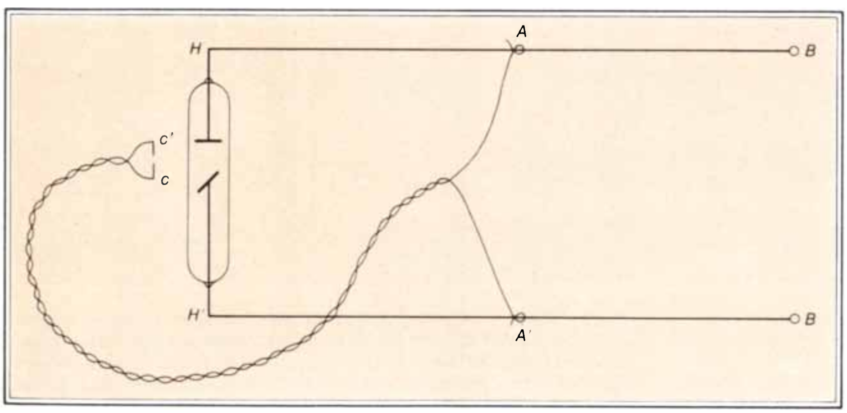
Wood's qualifications for the assignment were not only scientific. Ebullient and perceptive, he was a man of many interests outside physics. Among his numerous publications is *How to Tell the Birds from the Flowers,* a small parody of a nature manual in which Wood's humorous verses are accompanied by his own drawings of birds and plants. Wood was in all things a showman, and long after adolescence he was an inveterate perpetrator of pranks and hoaxes. As an example, he once used his redoubtable talents in optics to fabricate what must have been one of the first photographs of an unidentified flying object. He was also a relentless pursuer of frauds such as spiritualistic mediums. One medium maintained he was in touch with the deceased British theoretical physicist Lord Rayleigh. Wood framed some abstruse questions about electromagnetism for the medium to ask the ghost, and there was no response.

The extent to which these predilections came into play in Wood's confrontation with Blondlot can be judged from Wood's report of his visit to Blondlot's laboratory, published in the September 29, 1904, issue of *Nature.* (Wood does not identify Blondlot in the article, but in his biography of Wood, Seabrook reports that all the events Wood describes in the article took place in Nancy.) According to Wood, Blondlot and his colleagues received him cordially and for his benefit did a series of experiments intended to demonstrate the diverse properties of N rays.

The first experiment Wood witnessed was an improved version of the one that originally revealed the existence of the N rays to Blondlot. N rays emitted by a Nernst lamp were directed through an aluminum lens, which served to concentrate them on the spark of a spark-gap detector. Blondlot and his colleagues said that if an observer held his hand in the path of the rays at any point between the source and the spark, the blockage of the rays would be visible as a decrease in the brightness of the spark. A small plate of ground glass on the side of the detector opposite the source served to diffuse the light of the spark so that changes in its brightness could be more easily observed.

Wood described the outcome of the experiment as follows. "It was claimed that [the fluctuation in the brightness of the spark] was most distinctly noticeable, yet I was unable to detect the slightest change. This was explained as due to a lack of sensitiveness of my eyes, and to test the matter I suggested that the attempt be made to announce the exact moments at which I introduced my hand into the path of the rays, by observing the screen. In no case was a correct answer given, the screen being announced as bright and dark in alternation when my hand was held motionless in the path of the rays, while the fluctuations observed when I moved my hand bore no relation whatever to its movements."

Visual judgments of light intensity are notoriously unreliable, but the next demonstration Wood observed was one of those Blondlot had devised to give photographic evidence for the existence of N rays. The apparatus for this experiment included a horizontal photographic plate with a screen of ground glass above it. Above the ground glass was a spark-gap detector, and above that was a screen of cardboard (actually the top of a lighttight box covering the appara-



ONE SOURCE OF N RAYS was a gas-discharge tube (*H–H'*). In this diagram based on one published in France in 1903 the spark-gap detector (*c–c'*) is wired into the discharge-tube circuit. Most observations of the effects of the rays on the spark in the gap were made visually.

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"Nature's logic—that's how I see aerodynamics. The dolphin, the swallow, the cheetah, each moves with speed, attuned to its environment, yet each minimizes the expenditure of energy. What better lesson for a designer?"

Robert Opron
Director of Styling/Régie Renault


Portrait by Marie Cosindas

Robert Opron's name has been associated with the successful use of aerodynamic principles in automotive styling for 20 years. (His credits include a U.S. "Car of the Year" award, an Italian styling award and the prestigious Prix Européen.) Today, his aerodynamic enthusiasm is a designer's contribution to solving the energy enigma. "The CX (a scientific measurement of aerodynamics) is a scientifically credible and demonstrable principle. The energy crisis has restored a goal that never should have been forgotten. Styling that significantly reduces the amount of drag, promotes more efficient use of energy."

"Practicality for the user" is another guiding principle for Opron. Trained to be an architect, his first job was designing kitchen appliances. This early training and work apprenticeship helped instill user-practicality in his design philosophy. "After all, when you design a building. . . or are involved with *la cuisine,* you deal with real life, real people, real problems."

For five years now, Opron has been responsible for the design and styling of all Renault cars; and all products bearing the Renault name, a range that includes trucks, industrial and agricultural machines, marine equipment and such everyday tools as lawnmowers. Whatever the project, however, he stresses the human imperatives: "How can this product be better designed to answer human needs. . . to make life a little pleasanter or easier?"

A typical week's work schedule has Opron in Milan for two days (Renault maintains a design atelier there as well as in Paris); and then he might be off to the U.S. or, possibly, South America for another two days. Back in Paris to review current design projects, he seems to thrive on the accelerated pace.

Trucks, one of Opron's current design enthusiasms, are also subject to his aerodynamic basics. "Trucks must become more economical, *ergo*, you must have more sophisticated aerodynamics in the styling." Opron sees the growth of electronics in the auto industry as adding to his *nouvel humanisme*. Vital data for the driver—upcoming road conditions or weather—could be standard dashboard information thanks to electronics.

Opron's home, which he and an architect friend designed and built, is brimful with his practical humanism. The house, an unassuming *petite villa de la campagne* is sited in an abandoned orchard a short ride from Paris. As Opron's wife Geneviève and the two Opron children (Philippe, a 26-year-old medical student and Valérie, a *lycée* teenager) all testify, it seems a perfect machine for living in. Its quintessential modernity can be seen in the details. The ingenious open floor plan is studded with pockets of privacy; there's easy garden access from all rooms; a socially-magnetic central hearth; and throughout, an underlying practicality of materials. "The design," says Opron, "is 'internal', not a facade."

In addition to the "energy imperative"—there's also the "internationalization imperative": Renault products must meet human needs in "the mosaic of different cultures" in which they will be used. Then, too, the aesthetics of a given design are another imperative—"after all, these are Renault products." In facing these not necessarily confluent requirements, Opron reiterates the importance of the human factor. "Even as I respond to the urgent needs of the present, I dream of automobiles whose very being—in the pertinent words of the Roman architect Vitruvius—'would make living easier for all mankind.' That perhaps, is my true designing logic."

We welcome your comments, questions or thoughts about any of the above. Write to: Renault, U.S.A., Inc., Corporate Group, Englewood Cliffs, N.J. 07632.

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tus and the photographic plate). Above the entire array was the N-ray source.

The photographic plate extended to one side of the cardboard box and could be slid from side to side under it. Mounted with the plate was a wet-cardboard screen that could be slid over the box. Thus when the photographic plate was in one position, it could record the brightness of the spark without the wet cardboard between the spark and the N-ray source, and when it was in the other position, it could record the brightness of the spark with the wet cardboard between the spark and the source. Since N rays were blocked by water, the spark would presumably be dimmer when the wet cardboard was between it and the source.

Wood was shown a number of plates that had been made in this way, and one plate was exposed in his presence. All of them had a distinctly more exposed image on the side that was not screened by the wet cardboard. In other words, the plates appeared to show the existence of the new radiation. Wood pointed out, however, that the photographs had all been made "under conditions which admit of many sources of error." The fact that the brightness of the spark fluctuated naturally (by an amount Wood estimated to be as much as 25 percent) was alone enough to make "accurate work impossible."

Furthermore, in this experiment every pair of photographic images was made by exposing both sides of the photographic plate not once but several times, so that whatever disparity there was between the two experimental states—with and without N rays—would be intensified. Each exposure was supposed to last for five seconds, and so the experimenter had to slide the plate from one side to the other at five-second intervals. Wood pointed out that this procedure introduced the possibility of experimental bias: "It appears to me that it is quite possible that the difference in the brilliancy of the images is due to a cumulative favouring of the exposure of one of the images, which may be quite unconscious, but may be governed by the previous knowledge of the disposition of the apparatus."

So far neither the Nancy experimenters nor the skeptical Wood had proved their point. The photographic plates did support Blondlot's interpretation, but Wood was "unwilling... to believe that a change of intensity which the average eye cannot detect when the n-rays are flashed 'on' and 'off' will be brought out as distinctly in photographs as is the case on the plates exhibited." Wood pointed out that "experiments could be easily devised which would settle the matter beyond all doubt." His own suggestion was to employ two screens in conjunction with Blondlot's photographic apparatus, one "composed of two sheets of thin aluminium with a few sheets of wet paper between, the whole hermetically sealed with wax along the edges," and the other "exactly similar [but containing] dry paper." On Blondlot's hypothesis the screen incorporating wet paper would block the N rays and the screen containing dry paper would transmit them. Wood thought that if "the person exposing the plates [was] ignorant of which screen was used in each case... the resulting photographs would tell the story." Indeed, he felt "very sure that a day spent on some such experiment as this would show that the variations in the density on the photographic plate had no connection with the screen used."

The next experiment Wood observed, however, was quite different from the one he had in mind: he was shown how N rays were bent when they traversed an aluminum prism. In the apparatus used to demonstrate this behavior N rays from a Nernst lamp were first passed through screens of aluminum foil, black paper and wood (so that all types of electromagnetic radiation other than N rays would be blocked out) and then through a screen of wet cardboard in which had been cut a vertical slit about three millimeters wide. The stream of N rays that came through the slit fell on the prism, which, according to Blondlot, served not only to bend the rays but also to spread them out in a spectrum. In other words, there appeared to be N rays of different wavelengths!

To locate the position of the deviated rays Blondlot employed a small piece of dry cardboard mounted on a curved steel support. A narrow strip of phosphorescent paint was applied down the middle of this detector, which could be moved along the support with the screw of a ruling engine: a machine originally designed for making precisely spaced grooves. The calibrations of the ruling engine made it possible to measure exactly where the strip painted on the detector underwent changes in brightness, that is, where the deviated rays fell on the support. Blondlot and his colleagues

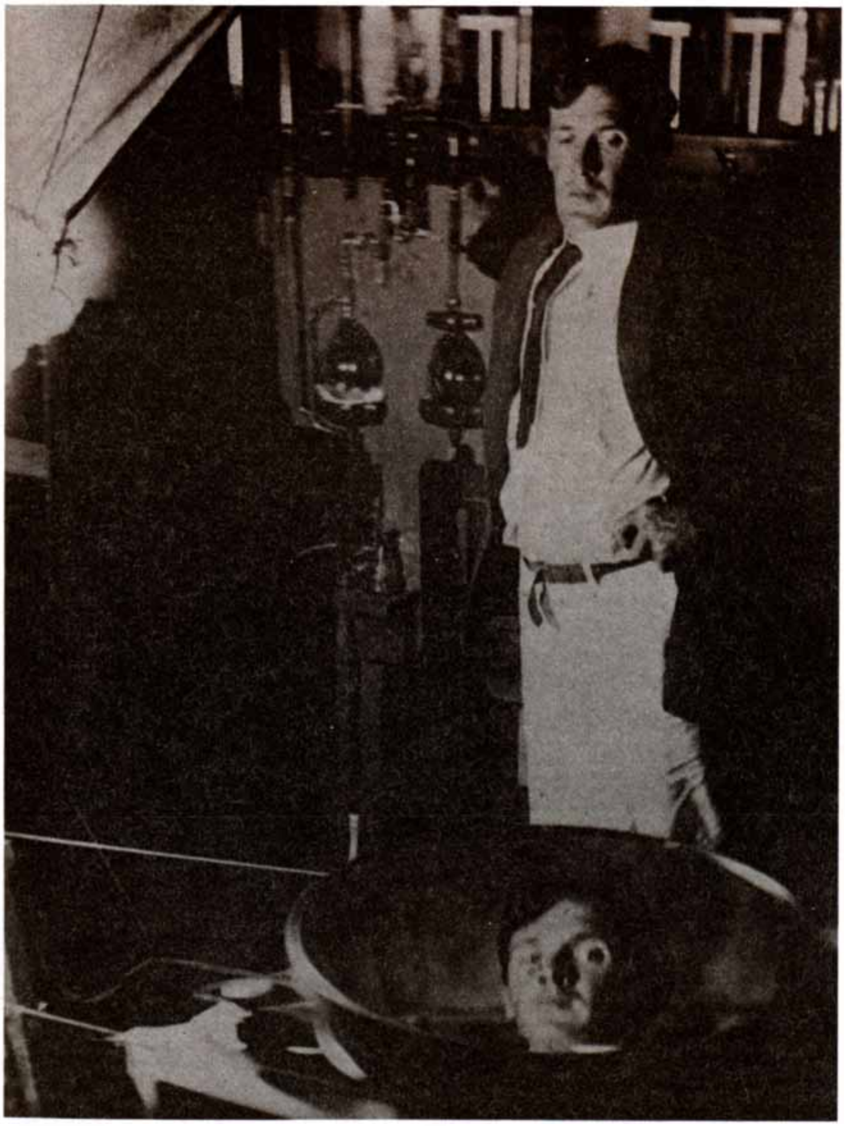
RENÉ BLONDLOT (1849–1930) was the physicist who thought he had discovered N rays. A respected professor at the University of Nancy, Blondlot was much honored for his work on this subject and others. He appears wearing the robes of the French Academy of Sciences.

maintained that at least four such locations, or at least four different N-ray wavelengths, could be identified by this procedure, and that at each location a movement of the detector of no more than .1 millimeter was sufficient to cause the phosphorescent strip to go from dim to bright and back again. Wood expressed surprise that a beam coming from such a broad opening (three millimeters wide) could be resolved into such thin components (.1 millimeter wide); his hosts assured him that this was one of the inexplicable and astounding properties of N rays.

When Wood moved the detecting device up and down the N-ray spectrum, he was unable to perceive any change in the brightness of the phosphorescent strip. At this point he was moved to play a prank of a serious kind. In order for changes in phosphorescence to be visible the experiment had to be done in a darkened room, and so Wood was able to surreptitiously remove the most important element of the experimental apparatus: the aluminum prism. In his *Nature* article he wrote: "The removal of the prism... did not seem to interfere in any way with the location of the maxima and minima in the deviated (!) ray bundle."

Wood went on to discuss some of the even more fantastic properties attributed to N rays. For example, in investigating the effects of N rays on various physiological activities Charpentier had determined that the rays acted to sharpen the senses. By the end of 1904 Blondlot and his colleagues had, possibly independently, reached the same conclusion. They presented to Wood a series of experiments designed to show that exposure to N rays increased visual acuity.

In a dimly lighted room a large steel file—an N-ray source—was held near an observer's eyes. On the wall of the room was a clock. The subject of the experiment assured Wood that the hands of the clock, which were normally not clearly visible to him, became brighter and much more distinct when the file was nearby, a phenomenon credited to the peculiar effect of N rays on the retina. Again Wood was "unable to see the slightest change." Since the room was not completely dark, Wood could not perform quite the same kind of control experiment he had performed by removing the aluminum prism. He was nonetheless equal to the challenge. As he wrote, "the substitution of a piece of wood of the same size and shape as the file in no way interfered with the experiment." The substitution was of course made without the knowledge of the observer.



R. W. WOOD (1868–1955) was the physicist who discredited N rays. An expert in optics and spectroscopy, Wood spent his career at Johns Hopkins University. Here he is seen reflected in a mirror made by rotating mercury in a bowl, an apparatus that had nothing to do with N rays.

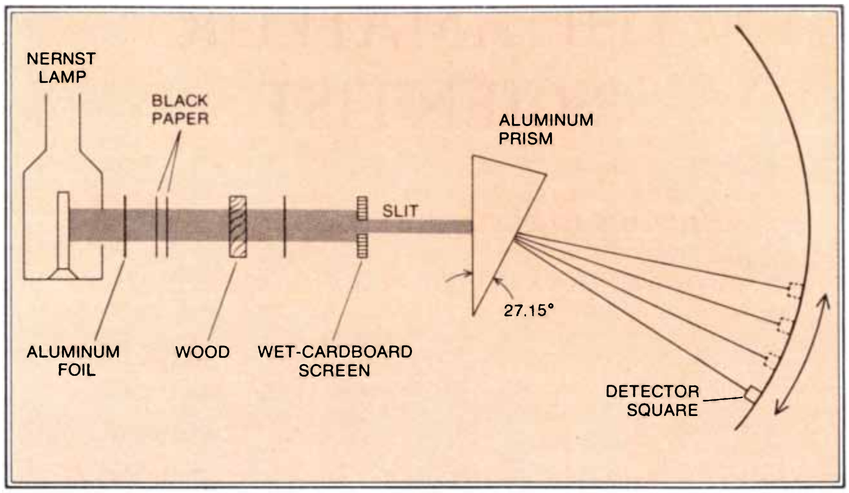
Wood spent some three hours observing various N-ray experiments at Blondlot's laboratory. At the end he found himself "unable to report a single observation which appeared to indicate the existence of the rays." Indeed, he "left with a very firm conviction that the few experimenters who have obtained positive results have been in some way deluded." Many leading scientists had already failed to reproduce Blondlot's results, and the publication of Wood's account of his experience at a center of N-ray research effectively put an end to support for N rays outside France.

The French proponents of N rays continued, however, to defend them vigorously. After all, the existence of the rays had been confirmed by 20 French scientists, including such well-known figures as Charpentier and Jean Becquerel, son of the discoverer of radioactivity, Henri Becquerel. Furthermore, many others had personally witnessed the various manifestations of N rays at demonstrations given by Blondlot and his followers at the University of Nancy or in Paris. After Wood's visit Blondlot wrote defiantly: "Several eminent physicists, who have been good enough to visit my laboratory, have witnessed [the photographic detection experiments]. Of... forty experiments, one was unsuccessful.... I believe this failure, unique, be it noted, to be due to insufficient regulation of the spark, which undoubtedly was not sensitive."

Blondlot nonetheless went to great lengths to respond to Wood's criticism of his experimental procedures. Wood had suggested that the photographic evidence supporting the existence of N rays could be discounted as natural fluctuations in the brightness of the detector spark and irregularities in the exposure times. In 1905 Blondlot described new procedures for regulating exposure times automatically and for monitoring the stability of the spark by means of a telephone receiver inserted in the power source. Moreover, for the images made in the absence of N rays he began allotting time bonuses: increases in the exposure times of between .5 second and 1.5 seconds. Soon after introducing numerous checks and precautions such as these Blondlot presented a large number of new photographs demonstrating once again that N rays brought about a striking increase in the intensity of the spark.

In 1905 Blondlot also published an elaborate set of instructions on how to best observe the manifestations of N rays: It was essential in these experiments to avoid all straining of vision, whether deliberate or the result of accommodation to low levels of illumination, and to avoid any conscious fixing on the luminous source whose variations in brightness it was sought to ascertain. One had to, so to speak, see the source without looking at it, and even to glance in a slightly different direction. The observer was required to play an absolutely passive part, on pain of perceiving nothing useful. Silence had to be kept as much as possible. Any smoke, particularly tobacco smoke, had to be avoided, as it was likely to perturb or even entirely mask the effect of the N rays. The observer had to accustom himself to looking at a luminous detector in the way a painter, particularly an impressionist painter, would look at a landscape. To gain such abilities would require practice and would surely not be easy. Some people, in fact, might never be able to gain them.

According to Blondlot and his disciples, then, it was the sensitivity of the observer rather than the validity of the phenomena that was called into question by criticisms such as Wood's, a point of view that will not be unfamiliar to those who have followed more recent controversies concerning extrasensory perception. By 1905, when only French scientists remained in the N-ray camp, the argument began to acquire a somewhat chauvinistic aspect. Some proponents of N rays maintained that only the Latin races possessed the sensitivities (intellectual as well as sensory) necessary to detect manifestations of the rays. It was alleged that Anglo-Saxon powers of perception were dulled by continual exposure to fog and Teutonic ones blunted by constant ingestion of beer.



REFRACTION OF N RAYS was demonstrated by Blondlot with this apparatus. Radiation from a Nernst lamp (an incandescent lamp believed to emit N rays) was first filtered through screens of aluminum foil, black paper and wood so that all forms of radiation other than N rays would be blocked. A screen of wet cardboard with a vertical slit about three millimeters wide was employed to direct a beam of the rays onto an aluminum prism with an angle of 27.15 degrees. According to Blondlot, the prism served not only to bend the N rays but also to spread them out into a spectrum, demonstrating that there were N rays of different wavelengths. To detect the deviated rays Blondlot used a square of cardboard with a phosphorescent strip painted down the middle. The square could be moved along the curved steel support on which it was mounted by means of the calibrated screw of a ruling engine. Changes in the luminosity of the painted strip signaled the location of a refracted ray. Blondlot and his colleagues detected such changes at several points on the steel support, and their results were confirmed with remarkable precision by other workers. When Wood observed the experiment, he was unable to perceive any change in the luminosity of the painted strip. Since the experiment had to be done in a darkened room, he was able to surreptitiously remove the prism from the apparatus, an adjustment he found did not change the experimenters' perception of refracted rays.

Actually French scientists deserve a great deal of the credit for the debunking of the N rays. No country, of course, greeted Blondlot's discovery with more enthusiasm than France, but as soon as experiments done with precautions similar to those suggested by Wood failed to produce any sign of the rays, French scientists began to take a more critical look at the published accounts of successful experiments. One funny thing soon became evident: there was a curious localization of positive results in the vicinity of Nancy. (The findings coming from Jean Becquerel's laboratory in Paris were an exception to this effect, but they too became suspect when Becquerel reported that he could stop pieces of metal from emitting N rays by "anesthetizing" them with chloroform.)

Eventually the French journal *Revue scientifique,* whose staff was particularly sensitive to the possible embarrassment to French science represented by N rays, launched an effort to resolve the question once and for all. In addition to providing a forum for a discussion of N-ray research the journal made a valiant effort to push Blondlot into making a definitive test of the existence of the rays. Following the suggestion of several physicists the journal proposed that two small wood boxes be submitted to Blondlot, one containing a piece of tempered steel (an alleged source of N rays) and the other a piece of lead. The weights of the boxes would be identical, so that once the boxes were sealed they would be indistinguishable except for an identification number. In other words, it would be impossible for anyone except the person who made and numbered the boxes to tell which held the N-ray source. Blondlot, using either a spark-gap detector or a phosphorescent detecting device, would be required to determine which box was emitting N rays, that is, which one contained the tempered steel.

Blondlot did not respond to the proposal for a long time, but finally in 1906 he wrote: "Permit me to decline totally your proposition to cooperate in this simplistic experiment; the phenomena are much too delicate for that. Let each one form his personal opinion about N-rays, either from his own experiments or from those of others in whom he has confidence."

In effect that is exactly what happened. Science has no vicar on the earth to reveal doctrine and no central committee to proclaim dogma. In general, however, the evolution of scientific theories does appear to follow a pattern that is perhaps best described in an aphorism attributed to James Clerk Maxwell, the founder of the mathematical theory of electromagnetism. Maxwell is said to have observed in an introductory lecture on light: "There are two theories of the nature of light, the corpuscle theory and the wave theory; we used to believe in the corpuscle theory; now we believe in the wave theory because all those who believed in the corpuscle theory have died."

Blondlot died in Nancy in 1930.