# The Wood's Way: Brilliant Experimental Physics and Practical Jokes

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***ABSTRACT - Robert Williams Wood was the American who exposed Blondlot's error in believing that he had discovered N-rays. This has to be amongst the most often repeated story in modern physics. However usually in the telling of this story, Robert Williams Wood's own history and important discoveries are omitted. This paper is intended to restore the balance and tell the story of a man with a long and distinguished career as an experimental physicist.***

## *WOOD'S EARLY LIFE*

Wood was born at Concord, Massachusetts on 2nd May 1868 (1). Wood's father, Robert Williams Wood, Senior, was born in 1803, became a physician and eventually traveled to Hawaii where he practised medicine (2). Robert was loaned a five inch refracting telescope (3) which was the start of his lifelong interest in astronomy and optics.

The family then moved to Boston and his interest in science was encouraged by a neighbour who operated a factory and allowed Robert the use of chemicals and equipment. As a teenager, Robert played practical jokes, such as putting a dunce's cap on a local statue and setting off explosives to frighten people and animals. His pranks got him newspaper headlines when he constructed the fossil of a giant insect at an abandoned quarry frequented by anthropology students. Or again when he claimed that a piece of metal had hit the ground as a fireball and produced a chemist's report claiming that it was made of an unknown element (4). Prior to his first year at university he wrote to *Science* about his astronomical observations (5) showing that there was a serious side to his nature:

Wood's senior secondary education was in classical studies at Roxbury Latin School where he failed the course twice (6) before being admitted to University at Harvard in 1887. In 1891 he received a BA with a major in Chemistry but his academic record was undistinguished (7). His first scientific paper written as an undergraduate critiqued a theory of his geology professor. He also experimented with hallucinogenic drugs (8), and was probably fortunate to get any degree at all.

## *EARLY CAREER*

On 19 April 1892, he married Gertrude Ames in San Francisco (9). They took their honeymoon as a camping trip mainly on horseback visiting Yellowstone. He threw a bottle of fluorescein into the pool at Emerald Springs with the result that the water actually looked green, which amazed the guide and other tourists (9a). Chemistry was his initial choice of subject for his doctoral studies. He started his PhD at Johns Hopkins University in 1892. He found physics more interesting and decided to move to the new university at Chicago University (1892-1894) but still studied chemistry. He eventually completed the thesis for his Ph.D. degree in chemistry, but the regulations changed; he thus missed out on his doctorate (8). He moved to Berlin University (1894-1896) where he restarted his studies but he continued his pranks. He decided to change to physics; again did not complete his doctorate (9a).

In 1897 he was hired as an Instructor at the University of Wisconsin. He thought that the salary was miserly but only lectured twice each week in physical optics. Wood was productive as a researcher; in 1900 and 1901 Wood authored fourteen of the eighteen papers published by Wisconsin physicists (10). He presented some of his papers to the Royal Society in Britain and his areas of strength include those that he continued researching for the remainder of his career such as light, photography and acoustics (11).

His life style was as wild as ever. He also managed to make influential friends by using electricity (then a recent commercial innovation) to melt the ice blocking the frozen water pipes leading to the house of the President of the University Board of Regents (a former US senator), indicating the practical use of physics (10).

In 1901, Robert Williams Wood was appointed Professor of Experimental Physics (12); at this time Wood had written some thirty papers covering an extensive range of topics in both physics and chemistry (7). He again had light teaching duties and was able to concentrate on research, mainly in physical optics. His career path was now set and he stayed connected with Johns Hopkins University until his death in 1955. During the first World War, Wood undertook scientific

work in France as a major in the Signal Officers' Reserve Corps (12). One of his suggestions was that seals be trained to hunt German submarines with a red balloon attached to the seal as a surface marker. A destroyer would follow the balloon and eventually sink the submarine. This idea was tried out in the Channel but given up when it was found that seals tended to abandon the submarine hunt to chase schools of herring (13). However he did have some success. At this time he developed his earlier discovery of a filter for ultraviolet transmission (14), which combined with a mercury lamp, suppressed the visible light, while transmitting freely the ultra-violet; this filter was called Wood's filter (Wood's glass). This invisible light was then used for signalling without the knowledge of the enemy.

There is a pattern of events that does not change with his advancing years. In fact his only biographer, Seabrook (1941) entitles his biography *Doctor Wood, modern wizard of the laboratory: the story of an American small boy who became the most daring and original experimental physicist of our day-but never grew up* (9a). The book appears to consist of Wood's own memories so the material for secondary sources in general relies on this partially autobiographical source. Thus the main source of all information about events in Wood's life is Wood himself. Where these events are not disputed, this is unproblematic, but sometimes there are other interpretations of events.

## *SOME OF WOOD'S DISCOVERIES*

In February 1903, Wood, after a number of trials, described the invention of a filter for ultraviolet transmission, which excluded all visible light (14: 15). Wood continued his research into invisible radiation photography with considerable success making him the founder of all invisible radiation photography. The fluorescence caused by Wood's light is still used in the medical treatment of fungi in skin disease (16). Many of his discoveries were important in that others developed yet more uses for his many inventions.

Wood (17) used ultraviolet and infrared photography to photograph the moon and also planets such as Jupiter, Saturn and Mars. In 1909, Wood constructed the first liquid mirror astronomical telescope (18). It was formed by spinning mercury so that it forms a paraboloidal shape though problems with the technology made the instrument impracticable (19); new materials have now allowed such instruments to be constructed (20).

Another of Wood's strengths was his interest in spectroscopy, sodium vapour and the manufacture of diffraction gratings. The area of spectroscopy (21), which he pioneered, eventually expanded into what is now called Raman spectroscopy. His spectrographic discoveries were remarkable, so much so that his experimental data was used by Niels Bohr in putting forward his model of the atom (22). Wood (23) investigated extension of the Balmer Series of hydrogen and spectroscopic phenomena of very long vacuum tubes. For the experimental work, Wood used a much modified vacuum tube, viewed end on, so that the light emitted came from the central portion of the tube. He obviously enjoyed his experimental work and by the end of the paper is considering further modifications to the apparatus to obtain yet more data. He never seemed to run out of ideas, but missed out on developing research on the scattering of visible light which eventually yielded information about molecular structure; this research was pursued by Raman and it was for this work that Raman received the 1930 Nobel Prize for physics. Wood's name was put forward jointly with Raman for the Nobel Prize for physics but in the end he did not achieve this honour which he very much desired.

An important feature of Wood's research was his co-operation with other scientists. In this regard his friendship with Alfred Loomis, who was a successful financier, was particularly productive. Wood helped Loomis with understanding basic physics and with planning and equipping the laboratory at Tuxedo Park which became a first class research facility (6). Loomis helped Wood with the purchase of equipment and provided him with better research facilities than the university could provide. The major field of their joint research was ultrasonics and they are jointly known as fathers of this area of science.

## *BLONDLOT AND N-RAYS*

This story is one of the most frequently told stories in physics and the storyline is often of a French physicist who fraudulently claimed that he had discovered a new ray, the N-ray, named after his home town of Nancy. This is unjust, but it is difficult to describe events both briefly and fairly because N-rays do not exist. Blondlot (65) was wrong but he also genuinely believed in the existence of N-rays; it is generally agreed that Blondlot was absolutely honest but that his observations, at the limit at what could be observed, were faulty. Robert Williams Wood, who showed that N-rays did not exist, was not entirely truthful and may not have acted ethically. A wide variety of sources, for example (24: 25: 26: 27: 28: 29: 30: 31: 32: 33: 34: 35) describe these events. The stories are notable because only one witness to the events of 1904 has left a written record. That witness was Robert Williams Wood who wrote two different accounts, one of which was to *Nature* (36) written immediately after his visit to Blondlot's laboratory which resulted in his conclusion that N-rays did not exist and the other written for his biographer nearly forty years later (9a). Ashmore (29) compared Wood's two accounts (36: 9a) and found discrepancies between the two versions. This is not entirely surprising after an interlude of forty years, but Ashmore uses the differences between the two

accounts by Wood to cast doubt about his version of the N-ray story. X-rays had been discovered by Röntgen in Germany in 1895; French scientists were looking for a discovery of similar significance. The discovery of N-rays by Blondlot and confirmed by other mainly French laboratories restored 'honour' to French science. American, British and German scientists were generally unable to duplicate the phenomenon. Blondlot claimed (32) that N-rays were produced by many things, for example, 'iron, most metals, even human bodies'.

Wood was asked by a friend from the University of Berlin, Heinrich Rubens (Dewdney, 1997, p. 21) to investigate. Wood too was sceptical so he was not neutral, but partisan in his investigations. For example, after the normal formalities were exchanged, Wood claimed to speak no French (9a), whereas, in fact, he spoke French well; this allowed him to hear the conversations going on, without Blondlot and his assistant knowing that he understood them. After Wood observed a number of different experiments, where he was unable to see the changes in the intensity of illumination which Bonndlot claimed to see, he removed the prism from the spectroscope, leaving Blondlot still reading out his observations just as before.

This was the 'coup de grâce' which showed that N-rays did not really exist. On consideration, Blondlot followed experimental procedures more scientifically than Wood who conducted his experiment of removing the prism, dependent on subterfuge, only once with no independent observers; this is not really science, but Wood's method instinctively appeals as a story. 'The tragic exposure eventually led to Blondlot's madness and death' (9a). This statement is incorrect; Blondlot carried on with N-ray experiments and publications continued to mid 1906. Blondlot retired in 1910 (30) and died in 1930 (37). Blondlot was honoured in Nancy with streets and a park named after him (35).

## *WOOD'S PERSONALITY AND WRITING*

Wood was well liked by some but very much disliked by others and in some cases there is conflicting evidence. For example, He is said 'not to get along' with Professor Ames at Johns Hopkins University, Baltimore was Head of the Physics Department (38). On the other hand, in his preface to *Physical optics* (39) said: "I am under very great obligation to my friend, Professor J. S. Ames, …". Perhaps this is just politeness, but it may well be sincere.

Franck who was a friend and collaborator of Wood said that Wood and the physicist R. A. Millikan disliked each other.

"… I believe Millikan couldn't stand him at all. But that was vice versa also. And he was always pleased when he could tell a nasty joke about Millikan." (40)

Wood was a skilled boomerang thrower and there are stories of him entertaining the crowd at a Johns Hopkins football team match with a boomerang during the interval (9a).

Wood could be generous in his praise for others and was very generous in his praise of Raman.

It appears to me that this very beautiful discovery which resulted from Raman's long and patient study of the phenomenon of light scattering is one of the most convincing proofs of the quantum theory of light (41).

He was similarly generous in books that he reviewed. For example, Wood (42) reviewed a book on light, which appears to fit his model of a good book: '…the subject is treated in a very readable manner, free from mathematics and requiring little or no previous knowledge of the subject on the part of the reader'.

Wood's publications were prolific. The World Catalog credits him with more than ninety books , for example (39: 43: 44: 45: 47) , but this may be an overestimate. Evidence of Wood publishing the same material in different languages (48) is given by Franck (40). Wood's research output was in excess of two hundred papers on a multiplicity of topics, mainly in physics (49), but with a number including chemical or astronomical (17) concepts.

His writing falls into two different types, pure physics research and his fiction writing. He wrote fiction (nonsense verse) to entertain young children, for example, *How to tell the birds from the flower: a manual of flornithology for beginners* (50 or 51) or in the newly established genre of science fiction for young adults, for example, *The man who rocked the earth* (52 or 53) with Arthur Train. However he was equally proud of his fiction and his physics, which dismayed his scientific colleagues.

## *EXTRA-CURRICULAR*

The number of anecdotes about Wood seems endless. Firstly there were his practical jokes, which were sometimes amusing and harmless enough to be enjoyed by all but on other occasions many would interpret his conduct as being rude and boorish. As a youth there is the story of him spitting into puddles of water and dropping sodium into the puddle surreptitiously at the same time. The resulting flame evidently alarmed the good citizens of Baltimore (34). In Paris he played a joke on his landlady who kept a pet tortoise. He bought several tortoises of different sizes and exchanged them every few days making it appear that the tortoise was growing at a tremendous

rate. The landlady told Wood about this and he suggested she should tell the press. Later he shrank the tortoise by reversing the process.

Wood travelled a great deal and when in Egypt wondered about the purple colour which covered the gold on ornaments from the tomb of Tutankhamen. His paper (54) shows how Wood carefully analyzed the purple coating, concluding that it was caused by traces of iron ore, arsenic and heat treatment (54: 55). Wood was certainly multitalented across a range of disciplines and believed in the importance of keeping the public interested in science. The Baltimore radio show, known as *Quiz the Scientist*, had the 'inveterate ad libber' and 'impish' Dr Wood on its panel of scientists answering questions from the general public. He liked to preface these intellectual discussions with his verses such as: "'Roses are red, violets are blue, sugar is sweet and skunks are - phew!" (56).

Wood was interested in exposing many well-known mediums as psychical frauds. He was one of three members of a commission to investigate a medium (Margery) for the American Society for Psychical Research (ASPR). At one sitting the investigators were permitted to control Margery's hands and feet while she was supposedly sprouting "ectoplasmic rods" from her thighs (57). The Crandons terminated the proceedings after the fourth sitting with the committee when the following episode took place: 'Wood very cautiously touched and finally pinched the end of the "ectoplasm"'. Wood claimed that it felt like 'a steel knitting needle covered with one or two layers of soft leather' (9a). He concluded that was the medium was fraudulent. Wood said that neither Margery nor Dr Crandon noticed this at the time, but at the end of the sitting when Wood described what had occurred, Margery gave a shriek and pretended to faint. Later 'they pretended that she was dangerously ill for weeks as a result of my "brutality"' (9a). The ASPR (58) in a lengthy statement said that Wood in touching 'the ectoplasm' had broken his 'covenanted word'. The ASPR (58) did not consider that there was evidence of fraud whilst the members of a commission were convinced that Margery was fraudulent. This demonstrates that it is very difficult to change ingrained beliefs in such instances.

Wood assisted the police in giving scientific advice in a number of well known cases. For example, on September 16, 1920 a bomb exploded along Wall Street opposite the J. P. Morgan Bank, killing 38 people and injuring hundreds more (6). Wood managed to reconstruct the actual bomb (9a) and evidence from this eventually led to the arrest of the culprits. In books that relate the story of the bombing of Wall Street (59: 60) there seems to be no reference to Wood playing any part in helping to identify the criminals responsible for the outrage. Similarly in a well-reviewed book on the history of forensic science (61) there is no mention of Wood. One may therefore wonder if Wood does not exaggerate the importance of his own role in the solution of this and other mysteries.

Wood was later called in to help solve the Briscoe case where a young woman was found dead in a locked room (9a: 62). She had evidently been shot in the chest and had bled to death. There appeared to be no weapon, no indication of an intruder, and no motive. The body lay in front of the open door of a coal furnace. The solution to the mystery became yet another of his academic papers (63). Wood after many experiments concluded that the very small projectile embedded in her chest was part of a detonator left in the coal in error.

In the case of the Candy Box bomb (or Brady Bomb Case), a bomb exploded in December 1929 in the kitchen of the Hall residence in Seat Pleasant, Maryland. Through Wood's reconstruction of the bomb, police traced the explosion back to a young garage mechanic in Washington, D.C (9a).

As well as helping to solve such crimes, Wood also advised about inventions where an investor might want to know if an invention genuinely worked or if it was some sort of scam. Giving advice provided a significant source of his income (3). Wood is probably at his best when solving such problems, as Conant (6) states. 'He had no patience for scientific quackery and set ingenious "bear traps" for those who claimed to have made some secret invention that they were actually using to con investors.'

### *RETIREMENT AND CONCLUSION*

In 1938, Wood at the age of seventy should have retired according to the rules, but he persuaded the university not to retire him and he was allowed to continue his work as 'Research Professor of Physics' rather than the less active sounding title of 'Professor Emeritus'. He continued active research at Johns Hopkins University until just before his death. The University of Berlin awarded him an honorary doctor's degree in 1934 as he had never obtained his Ph.D. Sir William Bragg presented Wood with the Rumford Medal (in absentia) on 17$^{th}$ November 1938 for his studies of physical optics over the previous forty years (64).

Johns Hopkins University honoured him with an honorary doctorate when in 1951 he had finished his fiftieth year as Professor at that Institution (2). He died on 11 August 1955 peacefully; he passed away during his sleep without any severe illness.

For those interested in education, his life is a reminder that 'physics is fun' or at least it can be enjoyed and that some students can develop exceptional practical skills without necessarily shining at theoretical physics.

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