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EMANATION

Around the turn of the 20th Century, events occurred that would impinge on our lives in many new ways. In popular culture, basketball was born in Springfield, Mass. in 1891. Conan Doyle authored the first of the Sherlock Holmes stories in 1892. Coca-cola was first sold in bottles in 1894 and the first gasoline powered cars by the Duryea Bros.appeared in 1897.

On a more material and scientific level, mysterious discoveries were made in labs and research facilities mainly in Europe, Great Britain and Canada. These discoveries would completely alter our understanding of the nature of matter altogether. New elements were found and named, new energies explored and released. Physics and chemistry would be altered drastically.

One of the new elements would be applied later as a luminescent paint be young women working in New Jersey and Illinois. Their lives would come to be affected in new very harmful ways. If not handled carefully, the new substances and energies could cause direct tissue deterioration in the body.

Uranium was originally discovered by Martin Klaproth in 1789. It was named after the planet Uranus and was initially found in mines in Central Europe. Its main industrial use was to color glass and ceramics. Fiesta Ware, a type of pottery, was popular having a bright orange color. There was a green fluorescent glass with yellow tones called Vaseline Glass.

No other special properties were indicated until Antoine Henri Becquerel examined the material especially for its phosphorescence. In 1896 he found a persistent photographic effect from uranium, with glass plates becoming exposed when in the vicinity of the material. This happened even in a dark room and at some distance from the material. There seemed to be a sort of light energy emitted by the ‘Becquerel rays’. Or could this be interpreted as similar to the ‘X- rays’ just discovered the year before by Wilhelm Roentgen?

Several major discoveries in glass making, mercury pump design and the production of high voltages had led Roentgen to produce X-rays. Electrodes were embedded in glass tubes as early as 1850 by Johann

Geissler, leading to 'cathode-ray' discharges. With the development of mercury pumps that could create virtual vacuums in these electrode embedded tubes, the way was clear for the work by Roentgen. The scientific community became enamored by this work and other discoveries, such as the 'Becquerel-rays' or 'Uranium-rays', received much less attention. Becquerel soon abandoned this area of his focus, returning at a later time.

When a young woman from Warsaw needed a suitable topic for her doctoral thesis, she decided to pick up where Becquerel had left off. Marie Sklodowska had arrived in Paris from Poland in 1891 at the age of 23. France offered the intellectual freedom so lacking in the Poland of her birth as ruled by the Russian Czar. She was very gifted academically and intellectually, but had a fairly poor preparation in math and the sciences and her technical French was only rudimentary. Nonetheless she worked tirelessly and by 1893 had earned a Masters in Physics, 1st in the class. The next year, she completed her Masters in Mathematics, graduating in 2nd place. That same year, Marie S. started work on a Doctorate in Physics at the Sorbonne. She was the first woman to do so.

Needing a place to conduct her research, Marie S. located space in a school where Pierre Curie taught. They were immediately attracted to each other. She was given an old, damp storeroom at the School for Physics and Chemistry and cast off equipment. Pierre's field was magnetism, for which he received a Doctorate in 1895, the year of their marriage.

It is noteworthy that Pierre and his brother Jacques had discovered the 'piezo-electric' effect in 1880. They found that with certain crystal structures, a voltage could be generated under pressure. Alternatively, an electric field would cause these same crystals to expand. This principle led the brothers to design the Piezoelectric Quartz Electrometer. The electrometer was a balance scale which could be used to measure faint electric fields. The Curies determined that such an electrical field was created by uranium compounds.

Pierre soon joined Marie Curie in her experiments. Working in the storeroom, later in a hallway and finally in a pottery shed, The Curies performed repeated experiments on the rays from uranium. They found that they were unaffected by light or heat, dampness or dryness, whether in solid or liquid or powdered form, pure or when combined with other elements. The only conclusion could be that they were a direct property of the metal, an atomic property independent of chemical or physical state,

with the intensity of the energy related only to the amount of the material. They coined this property “Radioactivity” in 1898.

In this period of time, the source of the uranium was uranium oxide, called ‘pitch-blende’. This was found by the Curies to be even more active than the uranium itself. But since this material contained 20-30 different elements, separation of the active from inactive material became necessary. The method used was called Fractional Crystallization. Mixed with various solutions, heated to boiling, as cooling took place, the inactive elements would crystalize first and thus were removed. Working in the worst conditions of extremes of cold and heat, with exposure to toxic fumes, handling huge metal vats and with poor laboratory equipment, The Curies crystallized out 0.1 gram of pure radium chloride by 1902. It was estimated that over seven tones of pitch-blende from Poland yielded that small amount. Poland had already removed the uranium!

With repeated fractionalization and using the Curie electrometer to test for radioactivity, the Curies isolated the most highly active elemental compounds from bismuth and from barium. These they named Polonium and Radium. With the increased concentrations, they took special delight in seeing their test tubes emitting “faint,fairy lights” in the lab at night. (Passachoff, p.45) Heat and light were being generated. By 1900 the possibility of atomic processes generating energy became very exciting to scientists.

In 1903, the Curies along with Antoine Becquerel were awarded the Nobel Prize in Physics for the “discovery of spontaneously radioactive elements”. (Passachoff, p.55) That same year Madame Curie was awarded a Doctorate in Physics by the Sorbonne. During all the years of her work, she faced the challenges of poor, ill-equipped lab spaces. She was challenged by persistent health issues, damage to her fingers, loss of weight and fatigue. She gave birth to and raised two daughters. Madame Curie also lost her husband Pierre in a wagon accident.

Many other scientists in physics and chemistry also worked diligently on the ‘uranium rays’. The Curies had thought that a gas was being emitted from radium as early as 1899. Ernest Rutherford and Robert Owen, working at McGill University in Canada, identified this gas and called it “Emanation”. They labeled this the fifth radioactive element after uranium, thorium, radium and polonium. The name ‘Radon’ was accepted in 1920 but even into the 1960’s, the element was often referred to as Emanation.

Industrial scientists became involved with materials from pitch-blende, mainly with radium, to develop materials for industrial applications. Friedrich Giesel had witnessed the spontaneous glow working for a chemical factory in Germany. He became a major supplier of radium to scientists in Europe, beginning in 1902. In 1906, Giesel began selling a luminescent paint made from radium and zinc sulfide. Later, the company produced fluorescent zinc sulfide screens for detecting and counting alpha particles.

In 1904, the French Industrialist Arnet de Lisle went into commercial production of radium for medical uses. The Curies took up his offer of funding and lab space for their work. Even after the untimely death of Pierre in 1906, Madame C. continued her work as well as the training of technicians in production processes. There was a growing demand from physicians for the element. Radium had been found to kill cancerous cells. In the early 20th Century, fear of cancer was of great concern to the general public. Cancer was the invisible monster that destroyed lives. The promise of a cure fueled a craze over radium.

Radium went from medical remedy to an all-purpose cure-all for just about anything, from blindness to hysteria. There were radium spas and radium suppositories, even a radioactive jock strap. One ad raved there was no longer need of medicines or drugs, just strap a pad onto the back in the day and on the stomach at night to alleviate asthma and nine other things. (Orci) The inventor who called this the Radiendocrinator later died of bladder cancer.

The French company Tho-Radia marketed a lipstick and dentifrice, along with other cosmetics. The Revigator stored a gallon of water inside a radium-laced bucket. This was meant to cure ailments such as arthritis, impotence, even wrinkles. A German company sold radium chocolate, radium butter, bread and milk. When the U.S. Food and Agriculture agency began to investigate these products, they found many did not even contain any radium at all. Apparently the use of the name alone helped to sell the products.

In Harm's Way - Grace Fryer

After medical uses, the next most important application came from the making of luminescent paints. Combined with certain phosphores, a continuous luminescence could be achieved. There was immediate usage on clocks and dials, on anything needing to be seen in the dark. The U.S. paint industry grew around the time of WW1 in response to demand by military forces around the conflict in Europe. U.S.Radium marketed their product which they called Undark. According to one of their ads, the paint was promoted for watch/clock dials, electric push buttons, buckles on slippers, house address numbers, flashlights and gauges. "…for anything you need to see in the dark. The power of radium is at your disposal. Radium serves you safely and surely." (Orci)

At the age of 18, Grace Fryer went to work as a dial-painter in the Orange, N.J. plant of U.S.Radium. The U.S. had just entered the war and demand for Undark was high, leading to an expansion to a new plant there. The pay rate was very attractive as well as the lure of radium. Grace was civic-minded and wanted to support the war effort. Many other young women were also hired at the plant.

Grace was shown into the new studio, with large windows, skylights and sun streaming in. The new employees sat at long tables and learned how to mix the materials, the radium with zinc sulfate, water and an adhesive. Fine camel-hair brushes were used and the routine taught was 'lip…dip…paint'. As the hairs on the brushes became splayed, Grace was instructed to use her lips to repoint the brushes. And this the young women did all day long as they made the letters and numbers on the dials and clock faces. Especially as the material hardened, moisture from the mouth was essential to soften the brushes.

The company's founder, Sabin von Sochocky, a 34 year old doctor, invented the paint mixture used in Undark. He was an expert, had read extensively and knew the dangers of Radium. He had learned first-hand with the loss of a finger. But as the company grew, he became increasingly removed from the production side of things. Besides, there was a huge demand for the work and to the layman, the effects of radium could only be positive.

Lab workers at the plant were provided with protective equipment such as lead-lined aprons and ivory tongs for moving the tubes of Radium. In the sunny studio where the women worked, there were no warnings of nor concerns about the work or any health hazards involved. It was a wonder drug. They twirled their brushes over and over as taught: 'lip… dip…paint'. In the darkroom for inspection, Grace noted the sparkle of radium dust all over her hair and clothing. Some women used the paint on their faces, especially if going out dancing at the end of the week. They were called the 'shining women', as they left the plant in the dark and sparkled all the way home.

Many didn't like the gritty taste of the paint or the feeling of sickness with the work. After only a short time, some women noted sores in the mouth. Grace herself was admonished by von Sochocky not to lip-point. Walking through the studio one day, he noticed her at work and stopped. "Do not do that!" he said suddenly. "You will get sick." (Moore, p.25). For a brief time, the company provided crucibles with water for forming the brushes. But it was quickly seen how much the very expensive radium was being wasted. Many women went back to lip-pointing because it was easier. And the production staff told her there was no harm in the work. She was encouraged to continue as before.

By early in 1923, Grace had left U.S.Radium for a bank job. In January, she had two teeth removed and was left with an abscessed hole that exuded an odorous discharge and took weeks to heal. In the summer of that year, she learned that two former colleagues had died from necrosis of the jaw and from progressive infections in the mouth and throat. By 1924, Grace was seeing doctors with pains in her lower back and feet. She was having increased difficulty walking and her medical bills were piling up. Along with others from the plant, she began a long process of finding the right lawyer to represent them and to take the company to trial.

The trial against U.S.Radium began in 1928. All along, from the very first complaints of medical problems, the company maintained there were no health issues from the use of radium, at one point trying to claim the women had syphilis! At the trial, Grace testified as follows:

> "I have had my jaw curetted seventeen times, with pieces of the jawbone removed. Most of my teeth have been removed. [My]spine [is] decaying and one bone in [my] foot [is] totally destroyed." (Moore, p.202)

Indeed, in 1927 doctors had found she had crushed vertebrae and a collapsed spine from bone sarcomas. Grace Fryer died in Oct.1933, cause of death listed as “Radium sarcoma”. By then, many of her friends from the dial-painting days had passed on, or continued to suffer as she had from the radium in their bone structures.

Harmed As Well - Margaret “Peg” Looney

The Radium Dial company of Chicago also operated a dial-painting business in a plant in Ottawa, Illinois. By 1925 it had become one of the largest in the country. Peg Looney started work there in 1923. At 17,she was the eldest of eight children. Her family was desperately poor. Peg was thrilled to land such a good, high paying job. Her wages helped the family with food and clothes. Peg painted clock dials on the Big Boy clocks made by Westclox. She and the other women sat and carefully traced out the numbers with the greenish-white paint, lipping and dipping as taught. They used the camel-hair brushes the same as in New Jersey.

Several year later, Peg had to have a tooth extracted at the dentist’s. The wound would not heal and even after a year she was still visiting for the problem. The response of Radium Dial was very different from that of U.S. Radium. Due to the notoriety of news reports from New Jersey and pictures of the young women affected by their work, the company began testing some of the women for adverse medical issues. Company doctors examined many of the workers and kept records of the results. However, the women were never informed of these results and the records kept confidential. When the Department of Labor became involved in the health hazards at the plants, their radium poisoning investigator Swen Kjaer was able to see some of the records and reported as follows:

> “One dial-painter, ML, a twenty-four-year-old female, employed in a studio in Illinois, had been found radioactive in 1925 by electroscopic test. In 1928, another test was made, and she was found still radioactive… Complete information was not obtainable, and the firm protests against calling the diseased condition radium poisoning, but it seems well indicated by the test.”
> (Moore,p.244)

ML, Margaret Looney, had been told by the firm that she had “a high standard of health.” She had been told that there was nothing to worry about. However, Peg had a pain in her hip and could barely walk. Her blood tested for anemia and her mouth would not heal properly. Her fiancee could be seen pulling her around town in a little red wagon. She was checked into the company hospital in 1929 where she died in August. The company insisted on performing an autopsy and arranging for burial. When researchers exhumed her body in 1978, she was highly radioactive with 1000 times safe levels. They also discovered that in 1929, her jawbone had been removed.

There is real tragedy in the telling of this story. Radium had been known to be harmful as early as 1901. Hundreds of young women were employed in dial-painting in New Jersey and Illinois. In 1956, growing public unease over the health risks with atomic bomb testing led the Atomic Energy Commission to establish the Center for Human Radiobiology. This was located near Ottawa at the Argonne National Lab. The medical studies and tissues taken in relation to the court battles in New Jersey and Illinois were amalgamated at this center. Special lead-lined faults were constructed, buried under three feet of concrete and ten feet of earth. The radioactive burdens of many of the dial-painters were placed here after study to determine the long-term effects of radium. Many bodies were exhumed to be studied here. A hunt began to find all the living dial-painters, with the goal of following them for the rest of their lives.

As for the companies, the law eventually caught up with them under the Environmental Protection Agency. The Orange, N.J. site and locations for the dumping of waste from the plant were declared unsafe. This was over 200 acres with almost 750 houses built on the debris. Courts in 1991 finally forced the successor company to help pay for clean-up and decontamination costs. Even so, the government ended up with an over $200 million cost.

In Ottowa, a meat-locker company took over the Radium Dial site in 1943. Many workers later died of cancer and even meat sold to customers was found to cause colon cancer after only six months. (Moore,p.385) Eventually, the EPA took on this area as well as the one in New Jersey. Debris from the plant site and waste which had been dumped around town caused a dangerous legacy left from dial-painting days. Radioactivity in

New Jersey and Illinois went many feet into the ground. As of 2015, cleanup in Illinois was still ongoing.

With a half-life of over 1600 years, the radium extracted over 100 years ago is still emanating radon wherever it has ended up. From the graves of the dial-painters, in the chambers at the Argonne National Labs, from the EPA clean-up sites where radium was extracted and used, the atomic energy activity of the material has diminished very little. One can only wonder how this contributes to the radon in air we measure.

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