Marie Curie and Spooky Rays: Crash Course History of Science #31

Crash Course: History of Science
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The late 1800s and early 1900s saw a revolution in the very basics of what-is-stuff.

This story features killer rays and a family of geniuses: it's the discovery of radioactivity, the birth of particle physics, and the life and enduring legacy of Marie SkÅ‚odowska Curie. Now, Nobel Prizes—which started being given out in Marie's time—aren't everything.

But she was the first woman to win one, the first person to win two of them, the only woman and one of only four people to win in two different fields… And she remains the only person, ever, to win Nobels in multiple natural sciences. [INTRO MUSIC PLAYS] Before we get to Marie, let's review physics so far. Scientists around the world had worked out the physics of Newton's universe—in which large, visible stuff collides due to the invisible but law-like action of gravity—as well as the strange world of thermodynamics and electromagnetism. Heat is energy!

Radio waves can carry signals around the world! All weird—and about to get weirder. In 1895, German engineer Wilhelm Röntgen was experimenting with making cathode rays, or rays of electrons.

His device was blacked out. But he noticed that a piece of cardboard painted with barium platinocyanide fluoresced, or glowed, when it was placed near the cathode ray tube. This made no sense.

No light meant no glowing… and yet, my dude's cardboard glowed. So Röntgen set up another experiment. He blacked out the machine, turned the lab's lights out… And saw that the painted board was already glowing in the dark.

Faintly, sure, but glowing. The machine wasn't on. No known source of energy could have been producing that spooky light.

So Röntgen threw himself into investigating what he called "spooky rays" after his friend, Count Fritz von Spooky. I'm kidding, he called them X-rays, after the letter mathematicians use to symbolize unknown variables. And this phenomenon got spookier when, testing the rays on different materials and arriving at lead, Röntgen saw a projection of his own skeleton!

So he experimented with creating images of what he was seeing, and at this point made the now-typical scientist move: he asked his wife for help. Because the couple that sciences together, stays together! So Anna Bertha Röntgen let her husband make an image of the bones in her hand using X-rays.

And then Röntgen wrote up his experiments in a paper called, wait for it, "On a New Kind of Rays." This paper earned him an honorary medical doctorate, the very first Nobel Prize in Physics, in 1901, and a place in the hall of fame of radiology—or using radiation to see the inside of the body. In fact, in his day, X-rays were sometimes called "Röntgen rays." In early 1896, at the Academie des sciences, French physicist Antoine Henri Becquerel heard about the discovery of X-rays. Becquerel had been experimenting on phosphorescence, or hitting materials with light to make them glow new colors.

He reasoned that maybe some phosphorescence was related to Röntgen's X-rays. So he busted out his inherited supply of his father's uranium—yes! seriously, this was a thing. Thanks, Dad!

Becquerel soon realized using photography that some materials naturally gave off spooky rays. Like, uranium left an impression in a photographic plate just by being near it. Some sort of energy was hitting the plate.

This was radiation: energy that comes out of matter as it decays, or breaks down into other, smaller forms of matter. Curie would later name this process of decay "radioactivity." Becquerel dove into research on radioactivity. He figured out that uranium emits rays that can be deflected, or pushed around, by electromagnetism, so they're a different form of radiation from X-rays, which are not affected by electromagnetism at all.

Becquerel also researched what happens when you mix radiation and magnetic fields, showing that radiation can have electrically negative, positive, or neutral charge. And he did important work on electrons, which we'll get to next time. Becquerel's contributions to radiation studies were wide ranging, from basics to potential applications.

When he accidentally burned himself by carrying around a piece of radium, he and other researchers concluded that radioactive substances might be able to burn bad stuff like tumors, so they might have a medical use in fighting cancer. This continued the tradition of using radiation as a medical technique that Röntgen had started and the Curies would build on. Becquerel died in 1908, likely due to his work with radioactive substances.

He was only 55. He left behind a clear research question: what happens when matter radiates spooky energy? Enter Maria Curie, born Marie SkÅ‚odowska in Warsaw, at the time part of the Russian Empire.

Born—to science. But the Russians outlawed lab science in schools, and the University of Warsaw didn't admit women. So she went to a secret school called the Flying University which is totally real and you should Google.

Then in 1891, she joined her older sister, BronisÅ‚awa, in Paris. They made a pact to help each other finish degrees. Marie smashed this goal.

Despite not being great at French, and with no formal training in the sciences, she enrolled at the University of Paris, one of the best schools on earth… And earned a degree with distinction in physics—basically a master's—in 1893 and a second, in mathematics, in 1894. At first, she was super broke and hungry. She tutored all night after her own classes, and she was barely keeping up.

But then after her first degree, she was hired to study the relationship between magnetism and steel for the Society for the Encouragement of National Industry. She needed a place to work, and in her search for a lab, she met Pierre Curie, who taught at the School of Physics and Chemistry. And they fell in love over SCIENCE!!!

Pierre proposed, but Marie was like, yeaaah, I'm from Poland… The place Germany and Russia have been fighting over for a thousand years? Cold!? I'm moving back.

And you don't want to do that, right? But—plot twist—Pierre was like, anything for you! Even leaving La Belle Epoque Paris right as modern art is being born.

Marie said I'll think about it. On summer break, she returned to Poland and went up for a job at the prestigious Jagiellonian University of Kraków. But the Jagiellonians were clear: they would never grant a professorship to a woman, no matter how brilliant.

So Marie returned to Paris and started a Ph. D. She also made Pierre finally finish his own Ph.

D., and he was promoted. He admitted that Marie was "his biggest

discovery." Which is pretty sweet. Well, in 1895, they got hitched.

It was a secular affair. Marie wore the same clothes she wore to the lab. Marie found out about Röntgen's and Becquerel's discoveries and, being trained in the study of electromagnetism, formulated an experiment.

She used a sensitive electro-meter, which measured electric charge and was developed by Pierre years earlier, to test how ray-producing uranium affected electromagnetic fields. She found that uranium gave off rays that made the very air conduct electricity. Her work also showed that the only thing that mattered in terms of this effect was how much uranium was present.

That's it. The uranium didn't have to interact with anything in order to give off energy and change electromagnetic fields. What happened next, Thought Bubble?

Marie created, for the first time, a theory of radioactivity: in some substances, atoms themselves must be breaking down slowly, releasing energy. This theory became foundational for modern physics. From the Presocratic Atomists to the the creator of the periodic table, Dmitri Mendeleev, a long tradition of people studying stuff had built upon an imaginary indivisible unit of matter—the atom—that a woman from Warsaw had just divided.

Radioactive decay clearly violated the immutability of atoms, so atoms could be split. Intense foreshadowing! Oh, and a lot of this work happened between her marriage in 1895 and the birth of her first daughter in 1897.

And it happened in a shed. She scienced in an unventilated room, unaware of the dangers of handling radioactive substances. And when I say "she," I mean it.

She recorded her experiments and her ideas separate from her belovèd husband's. But they increasingly worked together as Pierre realized that, smart as he was, she wore the brain pants. (Err, you know what I mean.) Here are some highlights: In 1898, she showed that thorium is radioactive, around the same time as another scientist, Carl Schmidt. Also in 1898, Marie and Pierre discovered the element polonium, naming it after her oppressed homeland.

Also in 1898—most famously—she isolated the radioactive element radium out of uranium ore. In fact, she developed techniques for isolating radioactive isotopes, or forms of the same element with different properties, which we now know are due to different amounts of neutrons. The Curies shared a Nobel Prize with Becquerel in 1903.

Basically, for discovering that, while most matter doesn't decay quickly, some relatively rare elements do. And Marie applied her theory. She used radioactive materials to treat cancer.

Pierre had the idea of implanting small seeds of radioactive material into tumors to shrink them. And when the Great War broke out in 1914, she set up mobile radiography units, meaning X-ray systems, to help field doctors treat soldiers. Thanks Thought Bubble.

Tragically, Marie died in 1934 of cancer. She literally gave her life to help others. And belatedly, in 1995, Marie SkÅ‚odowska Curie—the first female professor at the Sorbonne—became the first woman to be entombed in Paris's Panthéon, AKA Science Valhalla, for her own achievements.

But Marie was not the only professional woman scientist to succeed in the early 1900s. Other notables include American chemist Alice Ball, one of the first female chemistry professors and one of the first professional African-American women of science. She developed the best treatment for Hansen's disease, or leprosy, until World War II.

Czech–American biochemist Gerty Cori worked out the important cycle of how glycogen, a form of sugar, breaks down in muscles into lactic acid, and then is reformed as a source of energy. This became known as the Cori cycle, and she won the Nobel Prize for discovering it in 1947. Finally, the Curies' daughter, Irène Joliot-Curie, was an outstanding chemist who also won a Nobel!

While Nobels aren't the only or best way to tell the story of the history of science, the fact that we could do whole episodes on three different members of the Curie family is just. Dang. Impressive.

Next time—we follow the development of modern physics into the office of a humble patent clerk with a big secret: the key to the relationship between matter and energy. It's Einstein o'clock! Crash Course History of Science is filmed in the Dr. Cheryl C. Kinney studio in Missoula, Montana and it's made with the help of all this nice people and our animation team is Thought Cafe. Crash Course is a Complexly production.

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