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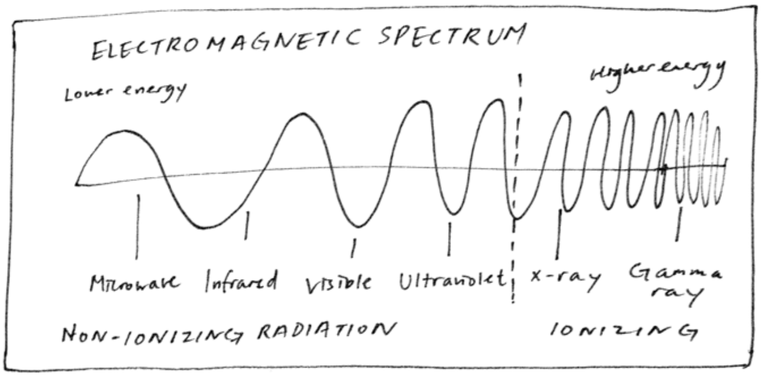
Does radiation make superheroes? By Fai Chan

Radiation was still a very novel and unknown science by the late 50s and early 60s. The mystery and intrigue surrounding atomic energy sparked public interest in radiation. Everyone was curious about the phenomenon which led to overactive imaginations by comic artists, who came up with wildly creative applications for radiation. At that time, the untapped potential of radiation in medicine, health and sciences meant that radiation was a fascinating field waiting to be explored.

Radiation certainly can cause mutations, but can it give you superpowers? We've seen superheroes like the Amazing Spider-Man, the Hulk or the Fantastic Four, who gain powers after being exposed to radiation. What are the effects of different kinds of radiation on the human body? How does radiation change the structure of the body?

To answer that question, we need to first understand what radiation is. Radiation is all around us, both natural and man-made, but different types of radiation exist which can affect us in different ways (US NRC, 2018). Simply put, radiation is the emission of energy in the form of waves (Weisstein, 2014). That could refer to waves emitted within a microwave, waves from a cell phone, or even UV rays from the sun. As they say, everything in moderation – any radiation can be useful in appropriate amounts, but in excess, it can seriously damage the human body. For example, UV light, which is non-ionising, helps the synthesise of Vitamin D, but if you go out to the beach without putting on sunscreen and protective clothing, surely, you're going to get burnt. That's because the ultraviolet light from the sun can cause the DNA in your skin cells to undergo chemical change, putting you at risk of skin cancer (Department of Physics at Union University, 2004).

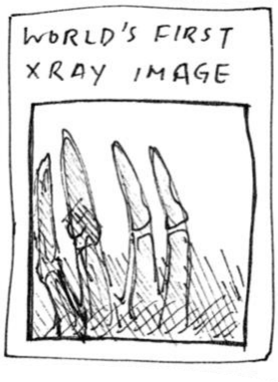
Depending on the energy of the radiated particles, radiation can be categorized as either ionizing or non-ionizing. And what actually causes changes in our atoms is ionizing radiation. Ionising radiation has the unique ability to remove electrons from our atoms, which changes the way the atoms interact and lead to cell mutation (Lea, 2018). The radioactivity we often hear as "dangerous" refers to ionising radiation, because only ionising radiation has the energy to affect the atoms in living cells and damage the genetic material (US EPA, 2014), which means that potential superpowers can only come from ionising radiation.



You may have heard another term being thrown about: radioactivity. What radioactivity refers to is the act of emitting radiation spontaneously by an atomic nucleus (DOE, n.d.). Radioactive decay almost always produces ionising radiation, which means radioactive materials or events could perhaps give superpowers. This is in line with comic book superheroes – for example, Peter Parker was bitten by a radioactive spider and became Spiderman. Radioactivity is when the forces in the nucleus are unbalanced and the atom becomes unstable. The atom breaks down, or decays, and will attempt to shift to a more stable configuration by ejecting protons or neutrons, other particles, or by releasing energy in other forms (ARPANSA, 2017). Because radioactivity is a physical and not a biological phenomenon, it is measured by the number of atoms that are spontaneously decaying each second (DOE, n.d.). Scientists often measure things like radioactive elements in half-life, which refers to "the length of time it takes for one half of the atoms you're looking at to decay" because the probability of an atom decaying is constant (Soniak, 2012).

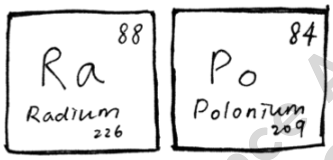
Combing through the history of x-rays and radiation, the thrill and mystique of a new phenomenon coupled with a lack of understanding led to interest in radiation as a well of bottomless potential. Medical industries saw radiation as a way to help patients, and comic artists saw radiation as an all-powerful force.

Before radiation, x-ray was already discovered in 1895, by a man named Wilhelm Roentgen, who observed that invisible rays from the cathode rays he was studying could penetrate through black paper. These x-rays could pass through the body's soft tissue but not bone, which gave rise to radiation imaging (APS News, 2008). His first experiment in 1895 was to make an x-ray photograph of his wife Bertha's hand, which became the world's first x-ray photograph (Reed, 2010)! Though the phenomenon of x-rays is different from radioactivity, Roentgen opened the door for radioactive discovery.

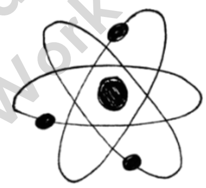


We owe the discovery of radioactivity to French physicist Henri Becquerel in 1896. His discovery was the epitome of a surprise discovery - the story goes that Becquerel was trying to prove that uranium absorbs the energy from the sun and emits it as x-rays. He wrapped photographic plates with black paper and florescent salts, unfortunately, on the day of the experiment, the weather in Paris was overcast, meaning his experiment couldn't go ahead (Radvanyi and Villain, 2017).

Forced to delay the project, Becquerel shelved away the wrapped plates in a dark drawer, expecting only the lightest imprint from the salts. To his surprise, when he checked and developed the plates a few days later, the image was as clear as ever (LibreTexts, 2020), meaning uranium salts could emit radiation without the need for sunlight (APS News, 2008). This discovery led to a greater understanding of radioactivity and documented the difference between x-rays and radioactivity. Following Becquerel's discovery, husband and wife Marie and Pierre Curie decided to investigate more. Marie and Pierre Curie are famous for having coined the term radioactivity and were awarded the Noble Prize in Physics in 1903 for their work on radioactivity (LibreTexts, 2020).They believed that there were other sources of radioactivity in a uranium ore, and significant experimentation led them to the discoveries of elements polonium and radium.



Then came Ernest Rutherford, known for his pioneering work of radioactivity and atoms. He ran many experiments and discovered different types of radiation coming from uranium, namely alpha and beta particles, and classified them by their ability to penetrate different matter (Matis, 2000). He also successfully transmutated an element (oxygen) into another element (nitrogen), which was known as "splitting" an atom (LibreTexts, 2020).

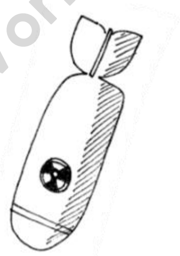


The discoveries by Roentgen, Becquerel, the Pierres and Rutherford led to the widespread utilisation of radioactive elements, at great personal expense. It was believed Marie Curie died from aplastic anemia as a result of prolonged radiation exposure (LibreTexts, 2020). In modern times, when handled correctly, radiation has a wide variety of applications spanning across the fields of medicine, academics, industrial and energy generation. Examples include cancer diagnosis and treatment, food sterilisation and nuclear energy (US NRC, 2017). But at the peak of radiation discoveries in the late 19th century and early 20th century, there was little concern for any unintended consequences of radiation exposure. Understandably, the long-term harmful effects of radiation were unknown at the time with many even touting the benefits of radiation, giving rise to radiation quackery and misuse in the early 20th century.

Hoaxes sprung up across the country, the most famous being Radithor, a popular but expensive potion of radiation-laced water. It was advertised as an all-powerful treatment that could cure "over 150 'endocrinologic' diseases", with popular slogans like "A Cure for the Living Dead" and "Perpetual Sunshine" that emphasised the supposed benefits of radiation (Macklis, 1990). Eben Byers, a Pittsburgh tycoon and an avid drinker of Radithor, died after the ingested radium bore holes in his skull and skeleton. Byers' gruesome death in 1932 prompted the regulation of radiation-based treatments (Jorgensen, 2016).

Since radioactivity's discovery in 1896, we have learnt more about its limits and dangers. History has shown us the immense power and potential of radiation, but at the same time, it has proven the damaging consequences of radiation exposure. The question remains: can radiation help you gain superpowers? The answer is no. The simple answer is that radiation in comics never works the same way as real life. The radioactivity exposure would kill any human that came in contact, let alone give them superpowers. Exposure to high levels of radiation can cause acute health sicknesses such as "skin burns and acute radiation syndrome ("radiation sickness")", and long-term effects such as "cancer and cardiovascular disease" (US EPA, 2014) and can even kill you by inflicting so much damage onto your bodily systems that you can no longer function (US NRC, 2017).

Comic seemingly present an overly positive view on radioactivity, but in reality, they have never shied away from the dangers of atomic power. A character which embodies the terrifying aspects of nuclear radiation is the Incredible Hulk. Dr Banner was the victim of a gamma-ray explosion, causing him to mutate into a sprawling green monster. Though he was blessed with incredible power, he was deprived of any control. In a way, the Hulk's unbridled strength is a cautionary tale of the unbelievable devastation that could be harnessed from these elements, and a grim reminder of the events of Nagasaki and Hiroshima.



As readers become more sophisticated in our understanding of radiation, comic artists have moved away from improbable sci-fi theories to more plausible explanations. But radiation-based superheroes were always a defining aspect of Marvel comics. Sure, maybe Stan Lee added cosmic rays and radioactive spiders and gamma-ray explosions in his comics just because they "sounded good". Maybe radiation could never bestow powers onto you or make you a superhero. But as Stan Lee says, "everybody loves things that are bigger than life" – superheroes are a thrilling celebration of something fanciful but fantastical.

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