THIS IS THE TWELFTH IN A SERIES OF ARTICLES THAT INVESTIGATES THE HISTORY OF SCIENCE AND ENGINEERING.

One way in which this history has been preserved is in the names of the scientific units that we commonly use. Those units will serve as starting points for these articles as we explore "Why do we call it a...?"

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WHY DO WE CALL IT A...

HERTZ

One of the pleasures — and sometimes annoyances — of living in a retirement community is occasionally hearing the phrase, "Well, I remember when I was a child ..." followed by a tale of some interest, albeit occasionally of doubtful veracity. I'm going to exercise that privilege of old age today by saying that when I was a student, frequency was measured in cycles per second (cps). Indeed, it was common to simply drop the last two words and say, "I tuned the radio to 1.1 megacycles." About 1960, however, the establishment decided to catch up with the International Electrotechnical Commission and start using the hertz as a measure of frequency instead of cycles per second. Much to the relief of the linguistic purists, we then started saying, "I tuned the radio to 1.1 megahertz." A hertz is defined as one cycle per second and is the unit of frequency for alternating electrical signals, mechanical vibrations, sound, and any other oscillatory phenomenon. It is named for Heinrich Hertz (1857–94), a German physicist of some renown. He led a short but productive life.

Heinrich Rudolf Hertz was born on February 22, 1857, in Hamburg. The city was then a city-state in the German Confederation, a rather loose association of small German-speaking monarchies that existed before the modern German state was formed. Like many — but not all — men and women who excelled in science in the early years, Hertz was born into a family that had the wherewithal to provide opportunities for education. His father was an attorney and legislator, and his paternal grandfather was a wealthy Jewish businessman who had converted to Christianity when he married into a Lutheran family. More about that anon.

In 1863, at the age of six, Hertz was enrolled in a private school for boys in Hamburg where he studied until he was fifteen. I presume the curriculum was mostly devoted to the three Rs, but there must have been an introduction to science as well.

In the mid-nineteenth century, a student had to pass examinations in Greek and Latin to gain entry to university. Hertz had neglected those subjects, so when he decided that he would like to go to university, Hertz spent two years learning the languages while studying at home. He then enrolled in the Johanneum

Gymnasium, a private high school founded in 1529 and still operating today.

After a year at the Johanneum and a brief flirtation with architecture, Hertz decided that he wanted to be an engineer and started on an educational odyssey that took him to several universities around Germany. He worked with various scholars of note including Helmholz and Kirchhoff and served for some years as an assistant to Helmholz. His education was interrupted when he was about 20 years old, and was "volunteered" to spend a year in the army.

Hertz was a brilliant scientist/engineer and was especially recognized as an experimentalist. He would study theory during the day and then work on physical experiments in the evening. His most noted achievements were associated with his laboratory techniques.

About 1880, the Philosophy Department of the University of Berlin offered a prize for anyone who could determine whether an electric current possessed mass and hence kinetic energy. The arrangement was not unlike the Xprizes that we have today. Hertz was working for Helmholz at the time and Helmholz assigned to him the task of answering the question. Hertz devised and conducted some very sensitive experiments and determined that if current did have mass, it was exceedingly small. Some 20 years later, J.J. Thomson discovered the electron, which is, of course, the carrier of electric current. It has a mass of about 10^{-30} kilograms which is, indeed, exceedingly small and presumably beyond the range of Hertz's experiments.

Hertz made a number of contributions to scientific knowledge, but the one for which he is most famous — and for which he is honored through the naming of a physical unit — is the first systematic observation of electromagnetic radiation. In 1865, British physicist, James Clerk Maxwell (1831–71) published a paper showing that alternating electric and magnetic fields are coupled and that they propagate through space at the speed of light. He also proposed that light was actually an electromagnetic wave. It is all well and good to make such predictions but, as with many good theories, they had to wait a few years for laboratory experiments to demonstrate their validity.

In 1885, Hertz was appointed Full Professor of Experimental Physics at the University of Karlsruhe and intensified his attention to the problem of electromagnetic radiation. While experimenting with electric discharges into a spiral coil, he observed that sparks were created in the corresponding gap in another similar coil. Suspecting that this might be due to the electromagnetic radiation predicted by Maxwell, he embarked on a series of experiments to better understand the phenomenon.

I have long been intrigued by the fact that we usually report only our successes and rarely trouble the community with tales of the things that did not work. It would be interesting to know how many different experimental arrangements Hertz tried before he designed and built the apparatus that finally succeeded. There must have been many. An electric spark is a noisy, messy event, consisting of a broad spectrum of currents flowing back and forth. To generate a coherent signal, Hertz needed to construct a resonant circuit that would select a narrow range of oscillations and suppress all the others. He ended up building a capacitance-loaded dipole antenna at a time when those words had no meaning to anyone. But he did it and it worked. He then used a coil with a spark gap to detect the wave he generated. Q.E.D.

Hertz went on to explore electromagnetic radiation at length, demonstrating polarization of the waves and showing that they propagated at the speed of light. Even though he couldn't explain it, he also demonstrated the photoelectric effect by observing that a capacitor discharged faster when it was exposed to ultraviolet light.

Hertz was married in 1886 and he and his wife, Elizabeth, had two daughters. Eight years later, in 1894, he developed an infection and died as a complication of surgery. He has no living descendants.

There is an interesting sequel to the Hertz story. You will recall that Heinrich's grandfather was a Jew who had converted to Christianity when he married. That conversion wasn't good enough for Hitler's Nazis. They tried — unsuccessfully — to eliminate the hertz as a unit and substitute the helmholz, still abbreviated Hz. They also harassed Heinrich's wife and daughters until they left Germany and migrated to Great Britain.

So, long after his death, Heinrich Hertz still excited both admirers and detractors. In his short life, he made many contributions to science, but he is best known for his work proving that high frequency electromagnetic waves propagate through space. That frequency needs to be measured and that measurement needs a unit and that's why we call a hertz a hertz.

Diagram of the Hertz transmitter and receiver.