

DO PHYSICS ONLINE

HERTZ'S EXPERIMENTS

PRODUCTION & RECEPTION OF RADIO WAVES

HEINRICH HERTZ (15 - 1894): RADIO WAVES – PHOTOELECTRIC EFFECT – SPEED OF RADIO WAVES

In the 1880s many were seeking experimental evidence to establish the equivalence of light and electromagnetic propagation. James Clerk Maxwell's mathematical theory of 1873 had predicted that electromagnetic disturbances should propagate through space at the speed of light and should exhibit the wave-like characteristics of light propagation. In 1887 Hertz designed a brilliant set of experiments tested Maxwell's hypothesis.

He used an oscillator made of polished brass knobs, each connected to an induction coil and separated by a tiny gap over which sparks could leap.

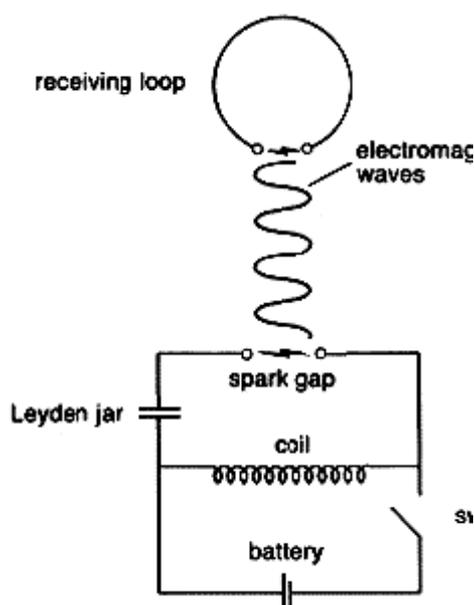


Fig. (1) Sketch of the apparatus used by Hertz for producing and detecting radio waves.

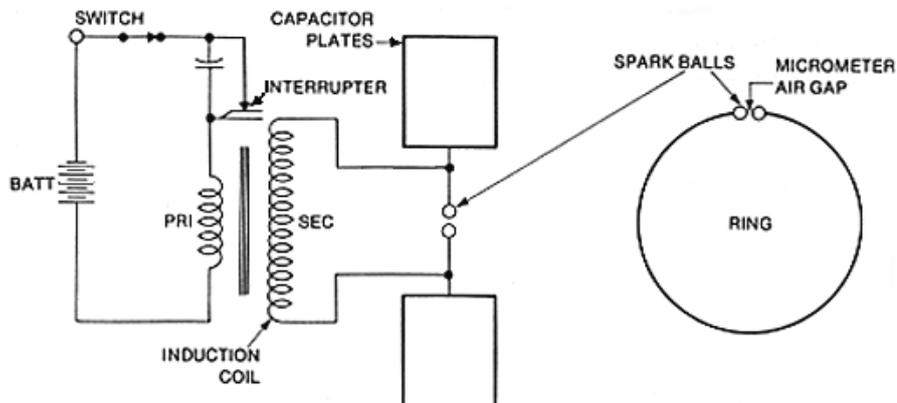


Fig. (2) Diagram of apparatus used by Hertz in his experiments on radio waves.

Hertz reasoned that, if Maxwell's predictions were correct, electromagnetic waves would be transmitted during each series of sparks. To confirm this, Hertz made a simple receiver of looped wire. At the ends of the loop were small knobs separated by a tiny gap. The receiver was placed several yards from the oscillator. According to theory, if electromagnetic waves were spreading from the oscillator sparks, they would induce a current in the loop that would send sparks across the gap. This occurred when Hertz turned on the oscillator, producing the first transmission and reception of electromagnetic waves. Hertz also noted that electrical conductors reflect the waves and that they can be focused by concave reflectors. He found that non-conductors allow most of the waves to pass through.

In one of his experiments Hertz aimed the irradiation at a wide metal sheet. The direct and reflected waves combined to form a standing wave. Moving the vibrator, Hertz found nodes and loops of the standing wave, he measured the distance between the nodes and determined the wave length. Then, calculating natural frequency of the vibrator, he determined the spreading speed of the electromagnetic wave: . Magnitude equal to the velocity of light was yielded. This proved the electromagnetic nature of light.

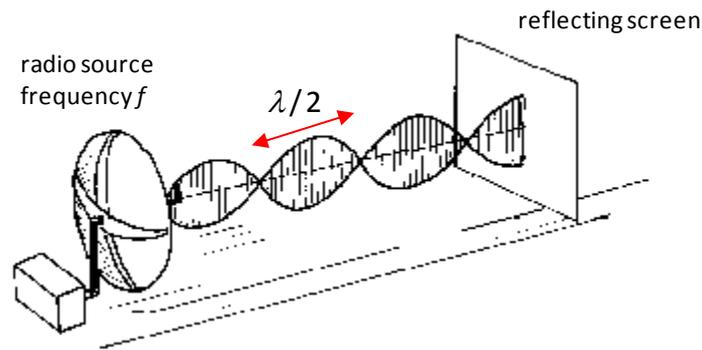


Fig. (3) Standing wave created between source and screen. From the measurements of f and λ , the speed of light c can be calculated from $c = f\lambda$.

In other experiments he found that the small receiver spark was more vigorous if it was exposed to ultraviolet light from the transmitter spark. It took a long time to figure this out- he first checked for some kind of electromagnetic effect, but found a sheet of glass effectively shielded the spark. He then found a slab of quartz did not shield the spark, whereupon he used a quartz prism to break up the light from the big spark into its components, and discovered that the wavelength which made the little spark more powerful was beyond the visible, in the ultraviolet. In 1887, Hertz concluded what must have been months of investigation: "... I confine myself at present to communicating the results obtained, without attempting any theory respecting the manner in which the observed phenomena are brought about." Hertz had discovered the photoelectric effect.

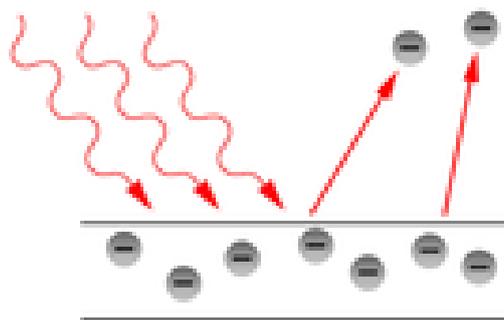


Fig. (3) The photoelectric Effect – when light above a critical frequency hits a metal surface, electrons are released.

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