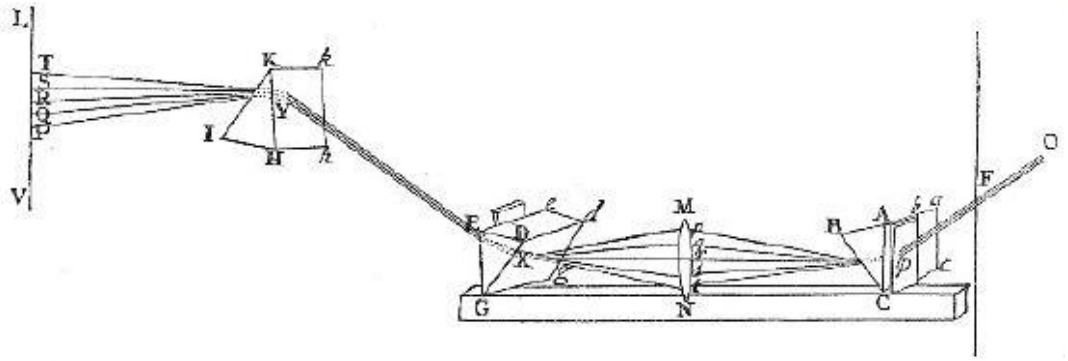
A Short Introduction to the Birth of Electromagnetic Waves

Visible light is so common that we take it for granted. Ever since humans have walked on the Earth, and even long before, the Sun has risen in the morning and shone light across the surface of the planet. Without light, the Earth would be in darkness and humans would effectively be blind.

When we think about light in more detail, we might first consider how it is made and what it actually is. In particular, we could look at a rainbow in the sky and wonder where those colours come from and why they are confined to a narrow (and curved) area of the sky. We might also watch in amazement as lightning flashes across the sky or ask why and how light is "released" when objects burn.

Sir Isaac Newton is generally credited with putting our early knowledge about light into order in his book *Opticks*, which was published in 1704 and led to his knighthood in 1705. (He was the first scientist to be knighted.) One of his most famous experiments was to split sunlight into colours using a prism then to use a second prism to combine these colours back into white light.

The arrangement for this experiment is probably the most common incorrect science diagram/image that you will encounter online: if you do a search for Newton's double prism experiment (or any other similar term) then almost every single result you get will be wrong. They may be pretty, but they are definitely wrong! The correct diagram is shown below. Note that sunlight comes in from the right (O) and is projected onto a screen on the far left (L-V).



Source: http://www.relativitycalculator.com/pdfs/Opticks_by_Sir_Isaac_Newton.pdf (p73 of the PDF)

Continuing to think about sunlight, we might also recall that the Sun also gives heat to the Earth: is that heat carried by the colours within sunlight? One way to test this would be to take sunlight that has been split (dispersed) into its colours and to place a thermometer in each of the different coloured areas. And that is exactly what William Hershel did in 1800. To his surprise, he found that the hottest area was outside the visible colours and he concluded that there must be invisible "heat light", which he named infra-red because it was beyond the red end of the visible spectrum.

A year later, Johan Ritter used a chemical reaction (the effect of light on silver chloride) to show that there was also invisible light beyond the violet end of the spectrum. He called this light Chemical Rays but we now know it as ultra-violet.

Throughout the rest of the 1800s, various scientists worked on the theory (James Clerk Maxwell) and creation (Heinrich Hertz) of another type of electromagnetic waves, radio waves. By the end of that century, Jagdish Bose had demonstrated that ultra-short radio waves, now known as microwaves, could be used as a remote control system to fire gunpowder and Guglielmo Marconi had succeeded in sending radio signals between machines that were hidden from sight of each other.

All of these examples are members of the family of electromagnetic waves.