

Zeeman Effect Encyclopedia Article

Zeeman Effect

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Zeeman Effect

The Zeeman effect is named after Pieter Zeeman, a Dutch physicist, who studied under Hendrik Lorentz at the University of Leiden. During a lecture on optics, Lorentz suggested that a beam of light would be broadened as it passed through a magnetic field. Zeeman soon discovered that a similar experiment had been attempted by Michael Faraday in 1862, but had proved unsuccessful. Inspired by these two scientists, Zeeman decided to conduct the experiment himself. The Zeeman effect was the final proof that light and magnetism were integrally connected. By showing that electrons were affected by a strong magnetic field, it helped scientists to determine the structure of the atom.

Zeeman used the light from a bright sodium flare, which he placed between the poles of a giant electromagnet. As the light was passed through a diffraction grating it was dispersed into its spectrum, throughout which the dark spectral lines could be seen. As he examined the dark lines, Zeeman found that they were, indeed, broadened slightly. He made certain revisions to his procedure, and in 1897 he repeated the experiment. When he examined the dark spectral lines he found three where there should have been just one--the magnetic field had split the lines into triplets.

This was an important discovery, for it proved Lorentz's much earlier hypothesis that the atom is comprised of charged particles. Since electrons (which emit light) are charged, they are easily affected by a strong magnetic field. It was later found that the tripling of the spectral lines was caused by the altering of an electron's spin.

Unfortunately, the importance of Zeeman's work was not immediately recognized, and went almost unrecognized until it was publicized by William Thomson (Lord Kelvin). By that time Zeeman had moved to the University of Amsterdam, whose laboratory facilities were inadequate compared to those at Leiden. Thus, Zeeman fell behind in his own work, and the bulk of the research into the Zeeman effect was conducted by other scientists at other laboratories. They later found that the light observed in Zeeman's experiments was similar to that emitted by sunspots. This seemed to indicate that sunspots were areas of intense magnetic activity.

For the prediction and discovery of the Zeeman effect, Lorentz and Zeeman shared the 1902 Nobel Prize for physics.