

Biography

Katherine Clerk Maxwell and Color Mixing of Light

Katherine Clerk Maxwell is most known as the wife of James Clerk Maxwell, who is famous for his many notable discoveries such as his work with electromagnetic radiation, color vision, Saturn's rings, and the kinetic theory of gasses. Katherine is known to have served as an assistant and as the subject of James' experiments, working to help run some of his more tedious or laborious work. Although records of her role have been largely lost, it seems as though she had a large involvement in running experiments on color vision and gasses.

Katherine is a prime example of a spouse to a prominent physicist, who is known to have helped in many experiments, but whose involvement is not well documented and not often credited.

Katherine Clerk Maxwell was born as Katherine Mary Dewar in Glasgow, Scotland in 1824.¹ As a woman in the early to mid-1800s, much of Katherine's life is known only in the context of her father and husband. Because of this, not much is known about her early life. She was the daughter of Susan Place and Daniel Dewar. Her father was a prominent figure: a Presbyterian reverend with a Doctorate of Divinity, working as the principal of Marechal College Aberdeen.² Likely because of her parents, Katherine was raised in a very religious setting, and remained pious throughout her life.

In terms of education, Katherine likely received an early education to learn women's obligations and religion. She was able to get much of her schooling because of her father's social class,² likely learning more of literacy and numeracy than typical women of her time.³ It was not until 1889 that Scottish universities allowed female students in higher education.⁴ However, the universities of Edinburgh, Aberdeen, Glasgow, and St. Andrews were involved in the 18th century Scottish enlightenment in education, which particularly impacted the upper-classes (which Katherine's father was part of).

Katherine met James Clerk Maxwell through her father when James was working as a professor of Natural Philosophy at her father's institution, Mariscal College at the University of Aberdeen. (The University of Aberdeen where both her husband and father worked did not allow women until 1892.⁵) Katherine and James married on June 2, 1858,⁶ and they remained married until James's premature

¹ "Katherine Mary Dewar," FamilySearch, Intellectual Reserve Inc, 2022, <https://www.familysearch.org/tree/person/details/KCDV-DTR>.

² Slater's Royal National Commercial Directory and Topography of Scotland, (London: Isaac Slater, 1861), 276. <https://digital.nls.uk/directories/browse/archive/90204588?mode=transcription>.

³ Glocer, Katharine. *Elite Women and Polite Society in Eighteenth-Century Scotland* (Boydell & Brewer, 2011) <https://www.cambridge.org/core/books/elite-women-and-polite-society-in-eighteenthcentury-scotland/FDC18AFC1E87CC654CFCF1D1C3E96E81>.

⁴ "Celebrating trailblazers of the past," National Library of Scotland, National Library of Scotland, 2022. <https://www.nls.uk/exhibitions/treasures/women-of-science/>.

⁵ "History," The University of Aberdeen, University of Aberdeen, accessed 16 June 2022, <https://www.abdn.ac.uk/about/history/our-history.php#:~:text=A%20separate%20science%20faculty%20%2D%20also,a%20quarter%20of%20the%20faculty>.

⁶ "James Clerk Maxwell (1831-1879)," National Records of Scotland, Crown, accessed 14 June 2022, <https://www.nrscotland.gov.uk/research/learning/hall-of-fame/hall-of-fame-a-z/maxwell-james-clerk>.

death.⁵ Katherine did not remarry. Katherine and James never had children, enjoyed riding horses,⁷ and were extremely devout in their shared Presbyterian religion and dedication to each other. James's friends described their bond as "unexampled devotion."⁸ James Maxwell enjoyed writing poetry as a hobby, with the subject of many of his poems being devoted to his wife: "I, drinking deep of thy rich love, / Thou feeling all the strength of mine, / Our souls will rise in faith above / The cares which make us pine."⁹ Letters from their friends remarked that James's "one and only care was for his wife,"⁷ with James writing to his Aunt that "we are quite necessary to one another, and understand each other better than most couples I have seen."¹⁰ Both Katherine and James had their fair share of illnesses, seemingly trading off taking care of each other. For example: "... Maxwell suffered from two severe illnesses... in both of them he was nursed by Mrs. Maxwell... his wife was left quite alone with him—the servants only coming to the door of the sick-room. He has been heard to say that by her assiduous nursing on this occasion she saved his life."⁸ James lost his battle with stomach cancer on November 4, 1879.

In a letter to his aunt announcing their soon-to-be marriage, James mentioned Katherine's support of his physics endeavors, writing that "she certainly won't stop the mathematics."¹¹ This proved to be true later, when it has been confirmed that Katherine served as a research assistant to his work.

Katherine's main involvement with her husband's work was on his color vision and gas studies. Many of these experiments were done in their shared home. Maxwell's biography (written by two of his friends, Lewis Campbell and William Garnett) states:

"Maxwell resided at 8 Palace Gardens Terrace, Kensington, where he carried on many of his experiments in a large garret... which ran the whole length of the house. When experimenting at the window with the colour-box (which was painted black, and nearly eight feet long), he excited the wonder of his neighbours, who thought him mad to spend so many hours in staring into a coffin. This was also the scene of his well-known experiments on the viscosity of gases at different pressures and temperatures."¹²

As these experiments were performed in the privacy of their home, much of the extent of Katherine's involvement in the work was unrecorded in history. Much of the evidence revealing her involvement has only been found in correspondence or notes from James' friends, rather than in published scientific papers.

In the color vision experiments, Katherine acted as a research subject, as we know from the record of measurements of her responses to color mixing and color blindness tests. In his 1860 paper "On the theory of compound colours, and the relations of the colours of the spectrum" James Maxwell wrote down the observations of "observer J. (myself)" to represent himself on page 70. However, on the same page, there is a second observer listed as "another observer (K.)"¹³ Though there is no name tied directly

⁷ Campbell, Lewis, and Garnett, William, *The Life of James Clerk Maxwell* (London: Macmillon and Co, 1882), 159.

<https://www.sonnetsoftware.com/bio/maxbio.pdf>.

⁸ Campbell and Garnett 139.

⁹ Campbell and Garnett 304.

¹⁰ Campbell and Garnett, 151.

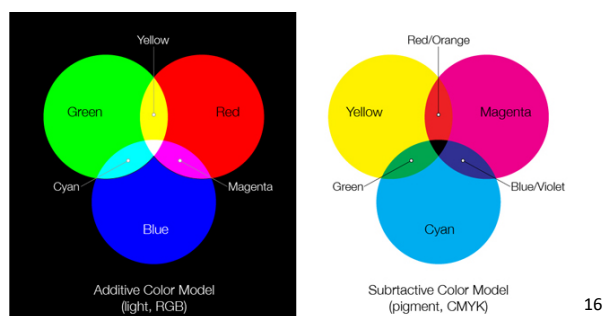
¹¹ Campbell and Garnett, 151.

¹² Campbell and Garnett, 158.

¹³ Clerk Maxwell, James. "On the Theory of Compound Colours, and the Relations of the Colours of the Spectrum," *The Royal Society Publishing*, 150, (1860): 57-86. <https://doi.org/10.1098/rstl.1860.0005>.

to observer K, correspondence between James and his close friend Lewis Campbell reveal that it is Katherine.¹⁴

In this experiment, they built a box which used mirrors, prisms and diffraction of light in order to allow adjustable amounts of the three primary colors of light to be shown onto a white wall inside the box. Volunteers such as Katherine and James were then employed to look into the box, adjusting different amounts of each color and recording their visual observations. This color box experiment was performed in their home, looking at the additive and subtractive aspects of light. Working with Young's theory of light (revolving around using three primary colors that mix to form any other color), they mathematically showed how much of each primary color of light (red, green, blue) needed to be mixed to make virtually any color.¹⁵ As an observer, Katherine determined when certain amounts of the red, green, and blue mixed to form very specific variations of color. Below is a diagram containing the additive and subtractive color models, where the additive model pertains to light and the subtractive model relates to pigment. When mixing the three primary colors of light, Katherine and James would have seen the additive color model in action.



The three primary colors of light (red, blue, and green) differ from the three primary colors of pigment (red, yellow, and blue), because of additive and reflective properties of light. In the case of light, white light is formed when all colors are mixed together, but in a physical medium like pigmented paint, dark colors are created when all colors are mixed together. The Maxwells also applied theories of color to investigate the cause of color-blindness, theorizing that it may be because an individual could lack certain color receptors, as the eye has red, green, and blue receptors.

Katherine also acted as a lab assistant or technician in James' experiments on gasses, as revealed through two sources of correspondence with James' friends: in an 1877 postcard to Peter Guthrie Tait and in a biography on James written by two of his friends (Lewis Campbell and William Garnett) published in 1882. James was studying the viscosity of gasses, eventually producing "On the viscosity or internal friction of air and other gases" in 1886.⁹ These experiments required a considerable amount of manual effort to produce steam and maintain different required temperatures. A fire had to be kept going for many days in some experiments, with ice employed to keep it cool in others, and "Mrs. Maxwell acted as stoker, which was very exhausting work when maintained for several consecutive hours."¹⁷ James also wrote to Peter Guthrie Tait "my better 1/2, who did all the real work of the kinetic

¹⁴ Bruce J Hunt, email message to Emma Goulet, June 14, 2022.

¹⁵ Longair, Malcolm S. "Maxwell and the science of colour." *Philosophical Transactions: of the Royal Society*, 366, no. 1871, (2008): 1685-1696. <https://www.jstor.org/stable/25190777>.

¹⁶ Cotnoir, Leigh, "Primary Colors of Light and Pigment," learn, accessed July 10, 2022, <https://learn.leighcotnoir.com/artspk/elements-color/primary-colors/>.

¹⁷ Campbell and Garnett, 158.

theory is at present engaged in other researches. When she is done I will let you know her answer to your enquiry.”¹⁸ James thus reveals the physical work that Katherine put into the experiment, although Tait’s original enquiry, as well as following correspondence, has been lost.

Unfortunately, records of any other involvement that Katherine had in her husbands’ work have not yet been found, if they exist. It is suspected that she had a hand in far more of his work than was recorded, as the couple were life partners in many ways and much of James’s work was done at their home.

After James passed away, Katherine served as an executor to her husband, managing his personal papers. She sorted through his records and correspondence, donating most of his records to the Cavendish Laboratory Archives at Cambridge University, and to two of his friends (Lewis Campbell and William Garnett) who published a biography about James in 1882. However, Katherine decidedly did not donate personal letters or those pertaining to herself. These records relating to Katherine are presumably lost, as with much of the paper trail of her life.

There are no apparent records of Katherine’s life after her husband’s passing. Katherine passed away on December 12, 1886 and is buried with her husband and his parents.¹⁹

¹⁸ *The Scientific Letters and Papers of James Clerk Maxwell Volume III 1874-1879*, ed. P. M. Harman (Cambridge: Cambridge University Press, 2002), 559.

¹⁹ “Parton,” James Clerk Maxwell Foundation, Clerk Maxwell Foundation, accessed 16 June 2022, <http://www.clerkmaxwellfoundation.org/html/parton.html>.