SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Encouragement Award

Science Writing

Year 7-8

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Electromagnetic radiation outlines the fluctuations of electric and magnetic fields, transporting energy at the speed of light - approximately 300,000 kilometres per second (Baraniuk, 2016). That being said, the term 'light' refers to electromagnetic radiation the human eye is capable of detecting, typically defined as wavelengths in the range of 380-700 nanometres (nm) ("Visible Light", n.d.).

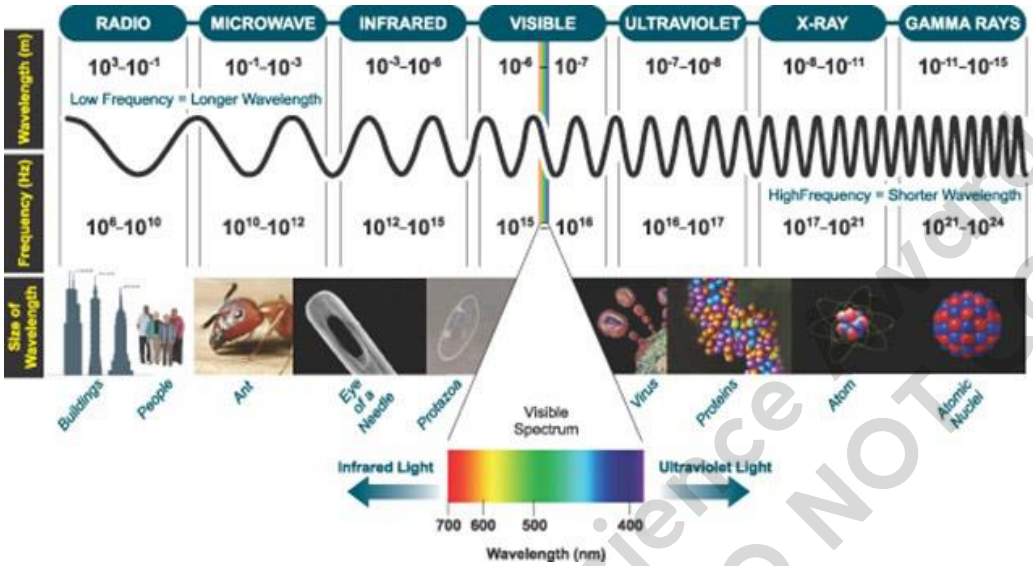

Figure 1.0

The Electromagnetic Spectrum, emphasising the narrow window of Visible Light that is detectable by the human eye.

Electromagnetic Spectrum n.d., Diagram, Oxford Instruments, viewed 28 June 2021, <https://www.oxinst.com/learning/uploads/inline-images/what-is-light-lc-20191125104755.jpg>.

Light is a primary means of perception regarding the surrounding environment; and in a scientific context, investigating the universe. Matter may be altered as a result of interaction with light – it can emit, absorb, transmit, refract, diffract, and reflect light (Clark, 2011). Through studying light that has originated or interacted with matter, many properties are able to be determined; for instance, microscopic physiological processes that occur within living cells, such as photosynthesis, can be viewed simultaneously.

As technology has advanced, effective methods of manipulating light have increased; and of these, photography is prevalent.

The term photography itself was derived from Greek origins; 'photos', meaning light or clarity, and 'graphein', meaning to write or draw. Thus, it is directly translated as 'writing of light'. Fittingly, photography is the process in which light is captured on an object or landscape and creates an image.

The earliest surviving photograph, as depicted below, is said to have been taken in 1826 by French inventor Joseph Nicéphore Niépce (Archambault, 2015). It took numerous hours to form the image; and even then, it was monochrome and blurry.

Figure 2.0

Simply titled, 'View from the Window at Le Gras' and taken by Joseph Nicéphore Niépce, this image is said to be the world's earliest surviving photograph.

Phillips, I Ian Phillips n.d., View from the Window at Le Gras, Photograph, Insider, viewed 3 July 2021, <https://i.insider.com/57b74fac04732f18008b500c?width=700&format=jpeg&auto=webp>.

Clearly, before the invention of the photographic camera, transferring an image to another surface was not an easy feat. It was done so throughout use of the concept camera obscura – mentioned as early as in the 5th century BC, by Chinese philosopher Mozi (Ensch, n.d.). Camera obscura, meaning 'dark room' in Latin, can be defined as a box-like apparatus fully closed off to light that allows light to enter through a small transparent opening on one side, then projects an inverted image on the other. It operates analogously to the human eye – "both possess an opening, a biconvex lens for refracting light, and a surface where the image is formed" (Taggart, 2020).

Figure 2.0 depicts the world's first rudimentary photograph, which was taken using a camera obscura; additionally including application of a bitumen-coated metal plate that allowed the actual acquirement of the image projected by the camera obscura (Keener, 2020).

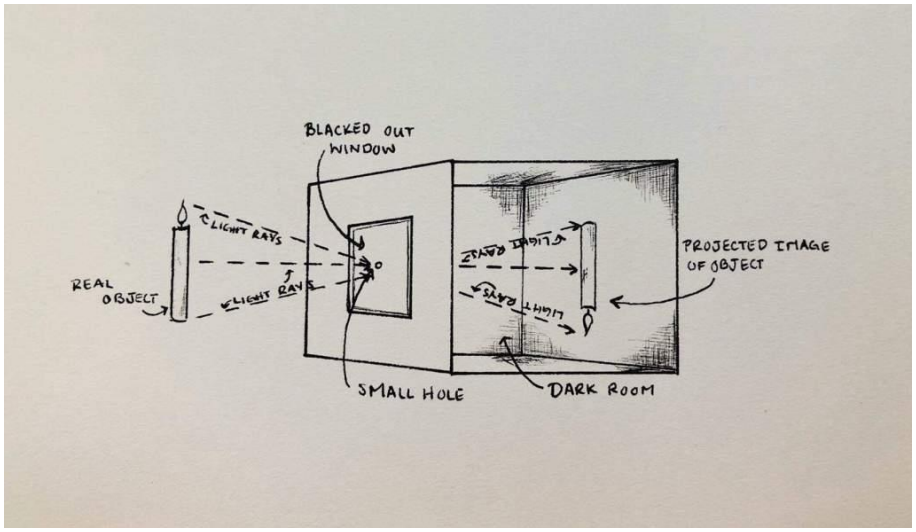

Figure 3.0

An illustration of how a camera obscura works.

Keener, K 2020, Camera Obscura, Illustration, Art Critique, viewed 19 July 2021, < https://i0.wp.com/www.art-critique.com/wp-content/uploads/2020/03/WhatsApp-Image-2020-03-02-at-16.50.23.jpeg?resize=1024%2C591&ssl=1>.

Nowadays, modern cameras allow photographs to be taken and stored digitally at the simple push of a button – the lens plays a significant role in allowing this. Light commonly reflects off of objects; however, it can also pass through selective items, and when it does, the light alters direction. A lens' functions similarly to that of the human eye – first, it controls the amount of light that enters the camera, and second, bends it to refract into a single sharp focal point using a series of convex and concave optical elements.

An imperfection that occurs while a lens focuses the light it captures can be indicated by the term 'aberration'. There are two most prevalent types – chromatic and monochromatic – both affecting colour, sharpness, focus, magnification, and distortion, in black and white and colour images alike (Hull, n.d.). Each have multiple subtypes that photographers contend with.

Firstly, chromatic aberrations are the outcome of a lens's inability to focus various wavelengths of colour at the same point. The dispersion of different colours of light is comparable to the method by which a prism separates white light into a rainbow. This category of aberrations falls into two subtypes – longitudinal, that occurs when different wavelengths of color do not converge at the same point after passing through a lens, and lateral, which ensues when, due to the angle of light entering the lens, different wavelengths of color focus on the same plane, but at different positions (Mansurov, 2019).

Secondly, flaws in a lens's optical system result in a negative impact on its capacity to focus a single colour of light; thus, monochromatic aberrations are entailed. German mathematician Philipp Ludwig von Seidel identified and described five subtypes by 1857 – and in the subsequent 164 years, designers have been unable to entirely rectify the following Seidel Aberrations.

Spherical aberrations affect rays from a point on the optical axis: if the lens has a spherical surface, they do not all meet at the same image point. Conversely, coma aberrations affect rays from a point off the optical axis, as when various parts of the lens are considered, it is likely that the location of where the image of an off-axis point is formed may change. Likewise, astigmatism aberrations also affect rays from a point off the optical axis. As these rays travel through the lens to the point in the image where they will be focused, they pass through a lens that is, from their perspective, tilted. If the rays of light in the plane of the tilt are considered, and the rays of light that are in the plane perpendicular to that, these rays pass through a part of the lens with a different profile; consequently, they may not be focused at the same distance from the lens, even if they do come to a focus in each case. Distortion entails a situation in which the light from points in the object are brought together on the image plane at the incorrect distance from the optical axis, instead of being linearly proportional to the distance from the optical axis in the object (Savard, 2004). Finally, field curvature is a simple lens aberration where the sharpest focus of the lens is on a curved surface in the image space rather than a plane

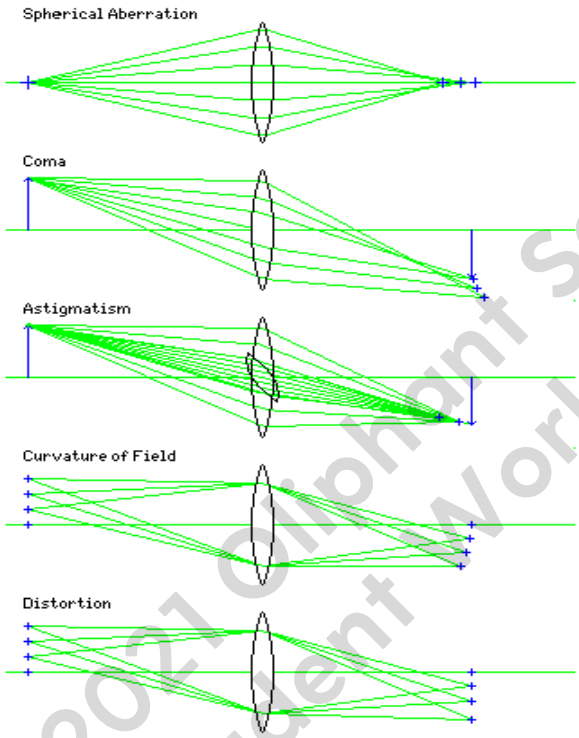

Figure 4.0

A diagram attempting to illustrate the forms of the different Seidel aberrations.

Savard, J 2004, The Five Seidel Aberrations, Diagram, Quadibloc, viewed 7 July 2021, <http://www.quadibloc.com/science/images/abill.gif>.

The amount of light that enters a camera is controlled through manipulation of two primary elements: firstly, the aperture, and secondly, the shutter speed. The aperture refers to the "diameter of the lens opening controlled by an iris" (Trigwell, n.d.), and shutter speed indicates the length of time the shutter remains open to permit light to enter the camera (Ambrose, 2019).

The relationship between these two components is termed as the law of reciprocity: being inversely proportional, if one value increases, the other decreases in response (Ambrose, 2019).

The overall development of photography is intriguing – envisioned by philosophers, constructed by artists, adopted by journalists, and advanced by scientists. In the present day, we walk around with smartphones tucked away in pockets and grasped in hands: we can document any moment with a short click. A photograph is, after all, a play of light – nothing more, nothing less.

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