Melanie King

Ancient Light: Rematerialising The Astronomical Image

Declaration

Figure 0:1: Melanie King, Ancient Light, Kilpisjarvi, Finland, 2019.

This thesis represents submission for the degree of Doctor of Philosophy at the Royal College of Art. I confirm that the work presented here is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

During the period of registered study in which this thesis was prepared the author has not been registered for any other academic award or qualification. The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.

Signed: Melanie King.

Date: 15 April 2024

Volume 1

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Abstract

How can the field of astronomical photography, viewed through the lens of new materialism, alter our collective perception of ecology? How does the coalescence of astronomy and materiality alter our perception of analogue photographic processes?

In this time of ecological catastrophe, it is important to readdress our tangible, material connection with the universe and our planet. By analysing this interaction between astronomy, new materialism, and photography, new insights are provided on how this convergence of theories alters our understanding of the natural world. The thesis demonstrates the interconnectedness between the universe, humans and photographic materiality. It discusses the importance of investigating the materials that we use daily, with a specific focus on waste produced by the photographic industry.

Analogue astronomical photography uniquely allows us to understand the intimate connection between the cosmos and the earthbound. Silver is found in distant stars, yet it can be mined from the depths of our Earth and used to create photographic images. Calcium is also found within stars such as our Sun, yet it is also a building block of bones and teeth, which can then be processed to make gelatin. In this text, I draw upon my own reflective practice; I have taken long exposure photographs of the stars in international dark sky locations and observatories. The methodology of this practice-based research is informed by Donna Haraway and Melody Jue, who advocate for an embodied experience of landscape. This research builds on Donald Schön's concept of *reflective knowledge*. I discuss photographic artists working in and with the landscape, including Garry Fabian Miller and Susan Derges.

I go on to consider *more-than-representational*, non-human photography, as introduced by Rebecca Najdowski and Joanna Zylinska. My thesis is situated in the context of new materialism, which seeks to understand the intrinsic material connections between human and non-human phenomena. I draw on theorists such as Jane Bennett, Karen Barad, Donna Haraway and Timothy Morton, as well as from Robin Wall Kimmerer, who analyses the complex network of material exchanges from a perspective informed both by contemporary science and ancient indigenous thinking.

Understanding more about the interconnected nature of photographic and astronomical materiality, it becomes imperative to innovate new methods of sustainable photographic practice. This research demonstrates analogue photographic processes which are less damaging to the environment, including plant-based developers and silver reclamation from photographic fixer. Distinct from contemporary astronomical photographic images, which are often digital composites with interpreted colour, *Ancient Light* demonstrates our intimate connection with the cosmos, by examining the tangible, entangled connections between the stars, human existence, and the ecology of planet Earth. The thesis advances knowledge in this area by weaving these connections together, providing new insights into the materiality of photography through theoretical lenses of varying magnitude, from subatomic to cosmic.

Key Words: Photography, Astronomy, Materiality, Sustainability, New Materialism, Non-Human, Analogue

Acknowledgements

Ancient Light: Rematerialising The Astronomical Image is the result of nine years of research. The research has profoundly altered my understanding of the universe, an experience which has pushed me to look beyond my preconceptions, whilst adopting a new way of seeing.

I would like to thank my supervisory team Dr Tim O'Riley and Annie Cattrell who have both challenged and supported my research for several years. I would also like to thank Dr Nicky Coutts, Dr Clair Le Couteur, Kira O'Reilly, Emma Falconer, and Sian Bonnell for their attention to detail and guidance.

This research was prompted by the *Envisioning The Universe* seminar (National Maritime Museum, 2013), a series of lectures which made me curious about the parallel histories of photography and astronomy. My study is inspired by the transdisciplinary research carried out by fellow members of The Committee for the Cultural Utilisation of Space (ITACCUS), a group organised within the International Astronautical Federation. It is also inspired by an informative internship taken with the Arts Catalyst between 2013 and 2015.

I would like to thank my former colleagues at the Photography and Archive Research Centre, London College of Communication, University of the Arts London College of Communication who have highlighted the potential of photographic research at doctorate level. In addition to this, I would also like to thank my current colleagues at Canterbury Christ Church University, for the support and opportunities

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This study has been enhanced with opportunities to exhibit my PhD work as part of solo and group exhibitions. I would like to thank the Blyth Gallery at Imperial College London, Leeds Art University (alma mater), Bloomsbury Festival, Big Day Film Collective, USA and Photofusion, London . I would also like to thank Dr Melanie Vandenbrouck for the opportunity to exhibit at the Hasselblad Foundation in Gothenburg, Sweden, and to Hannah Redler Hawes for curating ‘To The Edge of Time ' at KU Leuven Library in Brussels.

Finally, I thank my husband Sam Bartle, as well as my parents Angela and Richard King, for their ongoing support whilst undertaking this research degree.

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Introduction

Genesis of Research

This project began with my long-standing interest in astronomy and the origin of the universe. This enquiry is inspired by an enduring overall concern, pondering the existence of humanity and its connection to the cosmos. My research enables me to understand my own connection to the cosmos from a western atheistic perspective. It is concerned with the connections between astronomy and photographic practice, where light is a conduit to connect with stars existing beyond Earth's atmosphere. I discuss how both observing and photographing a starlit night sky can inspire a *cosmic perspective*. I explore how analogue astronomical photography can bring about a feeling of interconnectivity with the ecology of Earth, and by extension, the cosmos. Focusing on sustainable photographic processes, I propose that hopeful actions and activist measures can enhance our connection with our surrounding environment.

The motivation for this research was to find out more about the parallel histories of photography and astronomy. Following a presentation by Elizabeth Kessler during the Envisioning The Universe seminar (National Maritime Museum, 2013), I was made aware of how Hubble Telescope photographs can be mediated with image crops and colour. An example of a mediated astronomical image is *Pillars of Creation* — a well-known astronomical image created by NASA. Following this, I became keen to find out how it might be possible to create astronomical photographs with low fidelity, analogue cameras using minimal mediation processes. The seminar allowed me to understand restrictive tropes used in

astronomical imaging (such as highly saturated colours and selective framing), and prompted me to find a different approach to making astronomical photographs. Ultimately, I chose not to pursue a historical approach to my research; instead, this body of work has transformed into an expansive dialogue, which engages with embodied practice, photographic materiality and new materialism. My practice-based research expands outside of existing structures in astronomical photography, considering the materiality of photographic substances which have been touched by starlight. It is concerned with capturing light from distant stars using photosensitive materials, such as silver gelatin film. Underneath a dark sky full of stars, often in a remote landscape, an embodied position allows me to analyse the connections between astronomy, new materialism, analogue photography and ecology. Analogue photography allows for a direct material link. Light is emitted from or reflected from a subject. This subject is then tied to the photographic surface through the conduit of light, in contrast to digital photographic processes where light information is transformed to electrical signals and stored as data. In Chapter Two, I discuss how the direct material link in analogue astronomical photography has engendered a stronger sense of interconnectivity within my work.

Viewing and taking photographs of celestial objects can alter our understanding of time. Arcturus is the fourth brightest star in the night sky; it is relatively close to Earth at 36 light years away. However, even at this close distance, it has taken 36 years for its light to reach this photographic film. Thinking about this amount of time is tangible: it corresponds to a human life span. In contrast, the light emitted from the Andromeda Galaxy takes 2.5 million years to reach us, which is an amount of time which predates the existence of proto-human life forms on Earth. Thinking about relative distances can help us to conceive of the magnitude of the universe. This allows us to consider the unlikely set of circumstances that have enabled life on

Earth to exist. Thinking in expanded magnitudes of time is a way to step outside of a terrestrial bias (a term coined by Melody Jue, discussed in Chapter One). To consider the timeline of the universe, we must step outside of our own human experience, confined to one lifetime. The Double Cluster in Perseus is 7500 light years away. In the time that it has taken for the light to reach my photographic film, entire civilisations have emerged and disappeared. This fact prompts me to consider the precarity of our contemporary globalised civilisation, which is teetering on the edge of ecological ruin on a planetary scale.

Chapter Summary

Chapter One — 'Encountering Ancient Light' — deals with the experience of taking photographs in an isolated area, underneath a dark sky full of stars. This chapter inquires into the experience of physically viewing stars and constellations, considering how this experience can lead to new perspectives. I map out the terrain of my research, considering artists working with astronomical images. These artists include Thomas Ruff, Katie Paterson, Simon Starling, and Semiconductor, whose work primarily deals with archival or sourced imagery relating to astronomy. I distinguish my own photographs from these chosen artists: my photographs require my embodied presence in a starlit landscape. I then consider the importance of embodied knowledge and subjective experience in the context of astronomy, in opposition to a distanced, allegedly-objective study. I draw on Donna Haraway's *situated knowledges*, Melody Jue's *milieu-specific analysis*, and Donald Schön's *reflection in action*.

In *The Overview Effect* (1987), Frank White discusses astronauts viewing the Earth from space. They experienced a perceptual shift, where they saw the Earth as if it were a single fragile organism. This cognitive shift altered the astronauts' collective perception; they saw Earth's ecosystems as a valuable resource to protect. I consider that it is possible to obtain a perspective similar to the overview effect from a terrestrial standpoint by looking up to the stars. By extension, taking time to photograph the night sky using analogue cameras and film can enhance our feeling of connection to the cosmos, as photography encourages us to look more closely at our subjects. Analogue astronomical photography necessitates a slower, more considered approach than digital photography, both out in the field, and inside the darkroom.

Chapter Two — 'The Delayed Rays Of A Star' — demonstrates the unique nature of astronomical images, which are formed by light that has travelled for large magnitudes of time, across vast distances. The field of astronomy consistently alters our perspective of the dimensions of the universe, with instruments such as the James Webb Space Telescope allowing us to see farther back in time and space than we have ever seen before. This chapter sets out different scenarios in astronomical photography, considering the highly mediated photographs produced for public engagement purposes. I explain in detail how contemporary astronomical images from Hubble are mediated by institutions such as NASA and the European Space Agency. These images are contrasted with low fidelity analogue images, which require limited mediation. This chapter subverts restrictive tropes in astronomical imaging, proposing methods which highlight the interconnected nature of photographic materials, the ecology of Earth, and the stars. I discuss the significant environmental and political impacts of photographic materialities.

I introduce my *Ancient Light* series: photographs made with limited mediations and subjective interventions. I discuss how the concept of the *indexical image* and the direct material link in photography has influenced my practice based research. I then consider how my *Ancient Light* series of photographs could be described as *more-than-representational*, as home-made plant-based developers influence the outcome of my final photographic prints. I demonstrate that photographs produced under certain conditions can be affected by non-human interventions, beyond my own control. To conclude, I affirm the importance of small, hopeful actions and showcase the work of artists such as Martha Gray, Hannah Fletcher and Alice Cazenave. These artists use sustainable photographic processes that address problems with gelatin usage, plastic and the toxicity of photographic chemicals.

Chapter Three— 'Cosmic New Materialisms' — extends current new materialist theory to the cosmos. The aim of this chapter is to demonstrate how astronomy can change our perspective on materiality, as we learn that all matter on Earth originates from the dawn of the universe. Our bones and teeth contain calcium which can be found within the stars. The atoms that make up our bodies were created during The Big Bang, along with the stars and galaxies that we can see through our telescopes. Earth remains the only planet that we currently know of which harbours complex life forms. Life, therefore, is incredibly rare in time and space. In this chapter, I look at new materialist theory through lenses which peer in at a range of scales: subatomic, microscopic, anthropic, and cosmic. I discuss theoretical perspectives from Karen Barad, Timothy Morton, Jane Bennett and Astrida Neimanis. To conclude, I consider how these theories can be extended out into the universe, exploring our intimate connections to the cosmos. I show how new materialist thinking on a cosmic scale alters our understanding of materiality, as we humans view ourselves as part of a large web of connections, entangled with non-humans, the environment of

Earth, and the outer reaches of the universe itself. I propose that the study of materialism encourages us to treat the materials that we use in a manner which preserves the life of human and non-human beings, and the ecosystems on Earth.

Finally, Chapter Four demonstrates how my practice has altered during the seven years of this research project. I propose that the act of embodied astronomy, of physically viewing the stars, can allow us to feel intimately connected to the cosmos. This chapter is split into three separate sections, which mirror the flow of the *Ancient Light* portfolio and include First Light, a project influenced by the history of astronomical photography and contemporary mediations in astronomical images. I discuss the production of my *Ancient Light* photographs in residencies in rural Iceland and Italy. I also consider a residency which took place at the UCL Observatory in London.

The second section considers the specific decisions that I have made, and the data that I have collected while producing photographs in isolated, starlit environments. I discuss the choices made when exhibiting photographs and moving image works from the *Ancient Light* series.

The third section explores how I have improved the sustainability of my practice, thus reducing the environmental impact of my work. I discuss how I have landed upon certain recipes for organic developers and have altered them to suit my own practice.

Methods

During my time spent under the night sky, considering the intimate connection between human, non-human beings and the cosmos, I have become compelled to work with sustainable photographic processes to reduce the impact of my practice on the natural environment. In this practice-based research, I have used multiple methods that result in two interconnected strands: embodied photographic practice in a dark-sky environment; and sustainable photographic practices. These research strands are discussed in detail in Chapter Four.

Embodied Photographic Practice Within A Dark Sky Environment

I have collected data whilst producing images of the night sky. This data includes camera settings, exposure times, and written vignettes as I documented my experience of making the images. I have consistently written out this data into notebooks, which I am able to refer to when producing new works. Drawing on the written vignettes, I have detailed the methodological choices for display to produce an immersive exhibition environment. Reflecting on my findings, I then propose movement within the landscape is an important method for knowledge production, which allows new ideas to form. Exercise within a natural environment can induce physiological effects that are conducive to a shift in perspective. I propose that movement in the landscape, such as running or walking, can enable the production of knowledge.

Sustainable Photographic Practice:

I have collected data in the process of developing new recipes and techniques for sustainable photographic practice. For example, while producing a new plant-based

developer, I have tried and tested multiple recipes, timings and temperatures. I have also determined which processes work best for certain images — for example, caffenol-c works best with high contrast images.

Key Terms

This section introduces key terms which have been used in this thesis:

Situated Knowledges

My use of the term *situated knowledge* stems from Donna Haraway's 'Situated Knowledges: The Science Question In Feminism and the Privilege of Partial Perspective' (1988). In this text, Haraway suggests that knowledge is influenced by the situation in which it is produced. Haraway wrote this text in the 1980s, in response to scientific and technological perspectives of the time, which Haraway argues were predominantly male, white, and heterosexual. These perspectives were generally acknowledged as universal, meaning that views from different perspectives were ignored. In addition to this, scientific theory at the time claimed to be objective. Haraway argued that these perspectives fail to be objective, as their viewpoints are inherently biased. In response to this, Haraway advocated for knowledge produced in a range of conditions, by people from a range of backgrounds. In addition to this, Haraway advocated for methods of producing knowledge in science which could be layered, sensory and embodied.

Embodiment

In 'Situated Knowledges', Haraway writes:

> I want a feminist writing of the body that metaphorically emphasizes vision again, because we need to reclaim that sense to find our way through all the visualizing tricks and powers of modern sciences and technologies that have transformed the objectivity debates. We need to learn in our bodies, endowed with primate colour and stereoscopic vision, how to attach the objective to our theoretical and political scanners in order to name where we are and are not, in dimensions of mental and physical space we hardly know how to name. (Haraway, 1988, 575-599)

Haraway advocates for a way of knowing that utilises the senses of the body. These senses can be layered alongside other forms of knowledge production to provide a multi-dimensional perspective. I have adopted *embodiment* from Melody Jue, (Jue, 2020), who uses an embodied method to explore the ocean, physically immersing herself in the sea. Jue claims that immersion in the water can temporarily remove terrestrial bias, allowing her to experience her environment in a manner which mirrors how aquatic creatures might experience it. These embodied experiences can be layered alongside other forms of knowledge-making. Mari Heleen-Coetzee considers the limitations of a dualistic perspective, which views the mind and body as separate entities:

> Without the bodily, we would not be able to organise ourselves in our environment: we will not know where/what we are, what/how we are learning or how we can communicate about our feelings, experiences, and modes of being. (Heleen-Coetzee, 2018)

In this thesis, I use *situated knowledge* and *embodiment* as methods to explore starlit landscapes. I immerse myself within the environment using my senses to interpret phenomena that I may encounter.

Entanglement and Intra-action

In *Meeting The Universe Halfway* (2017), Karen Barad re-evaluates our understanding of matter through the lens of quantum physics. Distinct from intertwinement — where two things are joined — an entangled state lacks 'an independent, self-contained existence ' (Barad, 2007, pIX).

The term *intra-action* stems from Barad's theory of entanglement, where two or more things are inseparable, lacking boundaries from one another. Intra-action describes dynamic forces and exchanges that occur in an entangled entity. Barad uses the terms *entanglement* and *intra-action* together to describe a dynamic exchange of forces. For Barad, intra-action 'signifies the mutual constitution of entangled agencies. That is, in contrast to the usual "interaction", which assumes that there are separate individual agencies that precede their interaction, the notion of intra-action recognizes that distinct agencies do not precede, but rather emerge through, their intra-action.' (Barad, 2007, 33).

In this text, the terms *entanglement* and *intra-action* are used to describe an interchange between cosmic phenomena, photosensitive materials, humans and non-humans.

Chapter One: Encountering Ancient Light

Figure 1:0: Melanie King, Ancient Light, Atina, Italy, *2017.*

Astronomical images have a remarkable impact on our understanding of the scope of our cosmos, enabling us to see our planet as a rare life-supporting organism in a cold and hostile void.[1] However, astronomical images are primarily produced by astronomers, and often edited to appeal to scientific communication outlets and the public. Therefore, I argue, astronomical photography has been shaped by the social and cultural conventions in which it was conceived. In 'Observing By Hand' (2014),

[1] James Lovelock describes the Earth as an organism in his text on the *Gaia Hypothesis*.

Lovelock, James. (1979) Gaia: A New Look At Life On Earth. Oxford: Oxford University Press.

Omar Nasim discusses drawings of nebulae from several astronomers, considering the cultural and social conventions preceding astronomical photography. Nasim explores the history of scientific observation through the lens of hand drawing, which requires a different set of skills and focus to an ocularcentric perspective (Nasim, 2014, 242). This thesis builds on Nasim's discussion of scientific observation through drawing, focusing solely on astronomical photography. In this thesis, I offer an alternative perspective to contemporary astronomical imaging, concerned with the interconnected nature of photographic and astronomical materiality. I demonstrate the intimate relation that humans share with the stars, examining the tangible, entangled connections between the stars, human existence and the ecology of planet Earth.

Inventions such as NASA's Hubble Space Telescope have continuously revised our conception of the depths of outer space. The first Ultra Deep Field image created by the Hubble Telescope in 2004 combined many exposures, made during September 2003 and January 2004. *NASA,* Ultra-Deep Field (*Figure 1:1)* was made in response to the Hubble Deep Field image, which was produced in 1995. NASA chose an area in the sky which seemed empty so that the telescope could look out beyond the stars of our own Milky Way. This seemingly blank section of the sky contains a view of over 10,000 galaxies, showing not only the vastness of our universe, but its complexity.

Figure 1:1: NASA, Ultra-Deep Field*, 2004.*

The James Webb Telescope, launched on 25 December 2021, is even more sensitive than the Hubble Telescope. It allows for observations of the most distant events in the universe. The James Webb Telescope is unique, as one of its purposes is to look back towards the first light of the universe. [2] The telescope is built to observe far back in time: the formation of distant stars and galaxies beyond our current reach. By the time this thesis has been published, photographs will be produced showing objects at distances that have never been seen before. These discoveries will enable us to conceive of Earth's place in the universe with increasing accuracy and help to understand more about the universe that we live in.

[2] In astronomy, the term *first light* refers to the first use of a telescope after its construction to create an astronomical image. In cosmology, however, *first light* refers to the light emitted from the first stars and galaxies.

Consistently, astronomical photography has made us more aware of the fragility of life on Earth. One of the most important astronomical images is *Earthrise*, a view of the Earth from the lunar orbit taken by William Anders on board Apollo 8 in 1968. Standing on the Moon during the Apollo 11 mission, astronauts were able to see our planet at a distance, rising and setting upon the lunar landscape. Philosopher Frank White (2014) has interviewed astronauts to find out how their perception had altered since viewing the Earth from space. Many have experienced a cognitive shift, in which they felt a strong desire to protect the Earth. Having seen the Earth from the Moon, Apollo 9 astronaut Rusty Schweickart said:

> The Earth is so small and so fragile and such a precious little spot in that universe that you can block it out with your thumb, and you realise on that small spot, that little blue and white thing, is everything that means anything to you — all of history and music and poetry and art and death and birth and love, tears, joy, games, all of it on that little spot out there that you can cover with your thumb. (Frank White, 2014, 36)

Schweickart describes the Earth as fragile, a vulnerable yet dynamic living planet, suspended in the hostile environment of space. *Earthrise* was distributed globally, and as a result the astronauts' view was able to be accessed worldwide.

While it is currently not possible for most humans to view the Earth from space, I propose astronomical photography created from a terrestrial standpoint can engender a similar feeling of a cosmic perspective. In Chapter Four, I will describe my personal experience of viewing the night sky in a dark, remote area. In the portfolio, I also include first person excerpts from my notebook which detail

immediate reactions to gazing at the stars. I have included these sections to give a sense of my own embodied feelings within the landscape.

Astronomical Imaging and Mediation

This thesis borrows its title from David Malin's *Ancient Light* (2009), a collection of analogue astronomical photographs taken from the Anglo-Australian Schmidt telescope in New South Wales. The images are derived from large format silver gelatin glass negatives, which Malin claims were some of the last to be used on a telescope. These photographs were taken with a specific scientific approach, to discover new star clusters, galaxies and nebulae. Contemporary astronomical images, such as those from the Hubble telescope, enable us to view the cosmos in ever-increasing detail. The astronomical images produced by NASA have afforded us a window through which to see the depths of our universe. However, conventions such as the Hubble Palette — a colouring system used by NASA to represent chemical constituents within stars, galaxies, and nebulae — represent celestial objects in a colour code, corresponding to gases which are detected.[3] For example, hydrogen can be assigned to the colour green and oxygen to blue (Makuse, 2018). These methods are continually replicated, as similar imaging techniques are adopted by amateur astro-photographers.

Reading Elizabeth Kessler's *Picturing The Cosmos* (2012), I first became aware of the composite nature of astronomical photographs. I was curious to see an

[3] More can be found out about the Hubble Palette at https://astrobackyard.com/narrowband-imaging/ [Accessed 04 March 2022].

astronomical image with minimal editing, to learn how an analogue photograph of the stars might appear. I was interested to find out how an artist might go about creating an astronomical image using low fidelity equipment in accessible locations. Since the turn of the millennium, digital cameras have been the standard for astrophotography, mainly due to the cost, convenience and speed of transmission when creating an image in comparison to analogue photography. Analogue astronomical photographs would involve lengthy exposures. For example, The H335H plate produced by Edwin Hubble, took 45 minutes to expose. (Whitten, Carnegie Observatory Archives, 2023) Such images were generally produced by astronomers, apart from a few exceptions mentioned below. They were created by astronomical institutions primarily for a scientific purpose; for example, to study a galaxy to understand its formation. Artists approach the creation of analogue astronomical images in myriad ways, and this text will uncover why and how individual artists might use light from distant stars with analogue material.

Artists Working With Archival Astronomical Images

Several contemporary artists have engaged with astronomical photography and image making, and the *Ancient Light* series should be seen in relation to these works. These artists have created a conversation between astronomy, materiality, and photography, which has led me to build on their current research. In this section, I will review artists who have worked with archival astronomical images. Distinct from my own work, these artists were not present during the creation of the photographs; in consequence, they did not benefit from the embodied experience of viewing the night sky for themselves.

Thomas Ruff created *Sterne*, a series of prints at 260 x 186 cm (Schulze, 2019), using thousands of negatives purchased from the European Southern Observatory (ESO), originally produced by the Schmidt Telescope and the 1m ESO telescope at La Cilla, Chile (Allen, 2008). Ruff scanned, enlarged, and digitally enhanced the images to emphasise the incredible detail in the negatives. In addition to the prints, Ruff produced a book with 164 plates (Ruff, 2014).

Ruffs' intention was not to capture light from the stars, but instead to bring attention to the unseen details in archival material. His reframing of the ESO negatives in a large format in an exhibition context allows us a closer look at individual stars.

Figure 1:2: Thomas Ruff, Stellar Landscapes, *2019, David Zwirner Gallery. © DACS.* All rights reserved.

Figure 1:3: Thomas Ruff, Ma.r.s 04 III, *Gagosian, 2012.* © Ruff. All rights reserved.

> This artistic approach has resulted in large-format photographs showing a sky full of stars, which neither the human eye nor a quick look through a telescope could normally see in this format. Although the images are unaltered scientific photographs, the objects — distant stars, galaxies and gas nebulae, which stand

> out before the black background — are sometimes extremely dim and cannot be made out by the naked eye. (Bono, 2011, 50)

Inspired by his tutor Bernd Becher, Ruff became interested in the concept of authorship and how culture can influence our reading of an image (Bono, 2011, 51). Ruff did not press the shutter button on the camera which produced the '*Stellar Landscapes* ' images, but this is not of concern to him. According to Bono, Ruff is interested in how we can work with scientific instruments to produce images that we would not be able to create otherwise.

In his exhibition 'Ma.r.s' at the Gagosian Gallery , Ruff has worked with images from the NASA website, using his computer to add colours and details. In the video *Meeting The Photographer* by the Victoria and Albert Museum (Ruff, 2018), Ruff uses editing techniques to frame or illuminate certain areas of the image to accentuate certain details and minimise others. Ruff uses digital editing to guide the viewer and mediate their experience of the image. In the Ma.r.s images, Ruff alters the perspective by rotating and cropping the image to make the viewer feel as if they are viewing the planet from orbit. In addition, Ruff alters the colours to create the impression the viewer is looking at a landscape on Earth (Ruff, 2018). Though related to *Ancient Light* through subject matter, Ruff is happy to relinquish direct authorship of his image, using material produced by remote telescopes and spacecraft (Bono, 2011, 51).

For *Ancient Light*, my emphasis is focused upon intercepting light from distant stars, allowing a tangible chain of connection between the stars, the photographic materials, and myself. This research aims to relocate subjectivity, from looking at an image to initiating the image itself. The connection between photographic

materiality, ecology, and starlight has brought about new artworks, which have, in turn, altered my perspective and have inspired new research trajectories.

Simon Starling produced the film *Black Drop (Starling, 2012)*, splicing together archival footage and his own recording of the transit of Venus. The film discusses the parallel histories of astronomy and moving image, claiming that Jules Janssen influenced the history of cinema with his use of chronophotography.

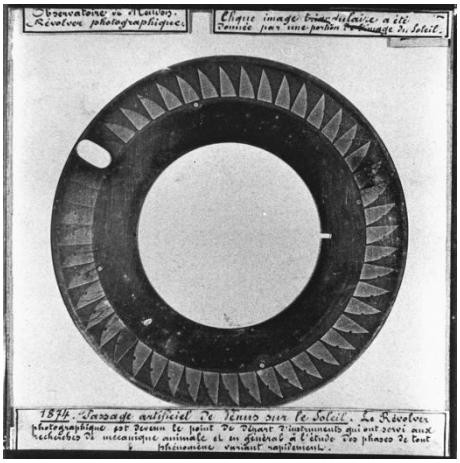


Figure 1:4 Passage artificiel de Vénus sur le Soleil en 1874 pris avec le revolver photographique. *Artificial passage of Venus across the Sun in 1874 taken with the photographic revolver. Daguerreotype, Paris Observatory. (Janssen, 1874).*

Janssen recorded the transit of Venus in 1874 using the daguerreotype process (Canales, 2002). With the chronophotographic camera, Janssen was able to capture carefully timed observations. The camera exposed photographs on a revolving wheel. This allowed Jannsen to record 48 photographs during a period of 72 seconds, each with their own controlled exposure.

Figure 1:6: Venus mirrors (05/06/2012, Hawaii & Tahiti inverted) *2012, Simon Starling*
Courtesy the artist and Casey Kaplan, New York. Photo: BLANK.

Starling's film *Black Drop, 2012* [4] *and accompanying book (Starling, 2013),* is a detailed history of cinema and astronomy, which touches upon how the apparatus we use to document objects can have an impact on the resultant image. The title refers to an optical anomaly that is only evident when Venus passes the sun: the disc appears to elongate, transforming into a droplet shape (Canales, 2002). The film is accompanied by the *Venus Mirrors,* which show the transit of Venus in 2012. Both the title and the use of mirrors in this installation hint at the levels of mediation that light must pass through to reach our eyes or camera. In the film Starling suggests that mirrors and lenses sometimes distort what we perceive as reality. The film also suggests that all capturing devices and viewing apparatuses, such as cameras and

[4] Simon Starling's film *Black Drop* can be viewed on The Modern Institute website, alongside a transcript of the film. https://www.themoderninstitute.com/viewing-room/film-screening

telescopes, have an impact on what we see, and on our experience of viewing (Dean, Starling, 2013).

For example, a large format camera forces the photographer to slow down their photographic working processes. In addition, a viewfinder screen in different camera formats can alter our experience of viewing. With a large format camera, one must cover themselves with a dark cloth to focus their image. The viewing screen is often significantly larger than a medium format or 35mm camera, thus allowing for fine detail to be seen and captured. In contrast to a 35mm camera or medium format camera, a large format camera requires each frame to be inserted into the camera in a dark slide. The camera needs to be manually focused, and exposures need to be checked with a light meter, whereas digital cameras allow us to be spontaneous and to create large amounts of photographs in a short amount of time.

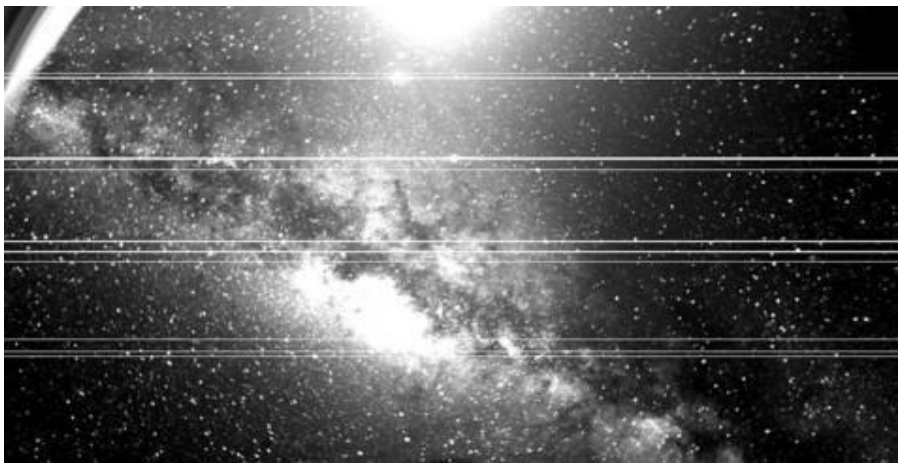


Figure 1:7: Still from Black Rain, 2009, *by Semiconductor: Ruth Jarman and Joe Gerhardt.*

Semiconductor are an artist duo whose work considers the interconnections between art and science. They produced two films *Brilliant Noise* (2006) and *Black Rain* (2009), during a residency at NASA. In harmony with Simon Starling, Semiconductor explore how the detecting instruments onboard the Solar and Heliospheric Observatory (SoHO), influence our reading of the images that NASA produce. As the Solar and Heliospheric Observatory is a satellite beyond the Earth's atmosphere, cosmic rays can cause interference in the images (Semiconductor, 2006). The scientists working on the images see the noise artefacts as discrepant data and remove the specks from the image. In these works, Semiconductor preserve the interferences in the raw data images.[5]

Semiconductor explore how scientific images are presented to the public and aim to raise awareness of how these images can alter our understanding of certain phenomena, in this case, the cosmos. Responding to the works *Brilliant Noise (2006),* Lilly Husbands comments that Semiconductor

> Received personal instruction by some of the foremost scientists in their fields and were given privileged access to specialised research tools and scientific data. Semiconductor often use these technologies and techniques in ways that emphasise the dramatic difference between the world that science reveals to us and the world as we experience it. (Husbands, 2013, 13-14)

[5] The technical information for incidental image artefacts, seen in the Semiconductor's artworks *Brilliant Noise (2006)* and *Black Rain (2009)* can be viewed on Semiconductor's website, alongside artist statements. https://semiconductorfilms.com/art/black-rain/ https://semiconductorfilms.com/art/brilliant-noise/

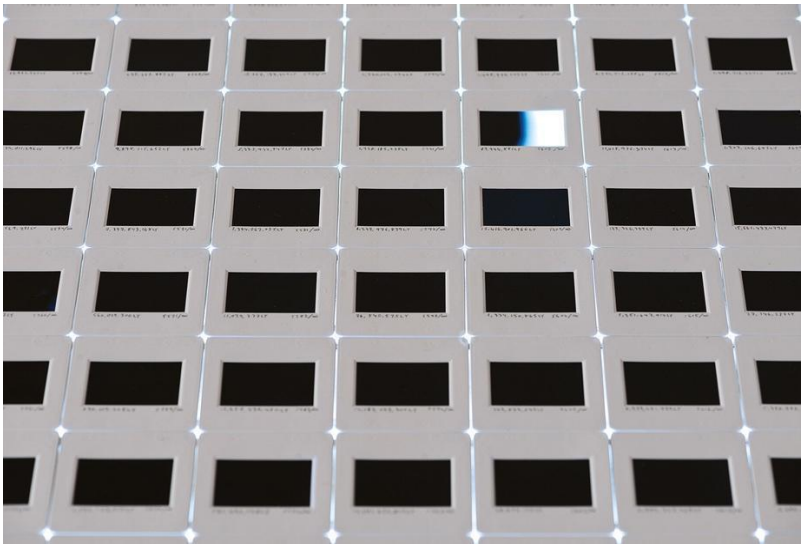


*Figure 1:8 Katie Paterson ,*History of Darkness*, 2010. Silver Gelatin slides.*

In *History of Darkness (2010)* Katie Paterson presents thousands of slides containing images of darkness. The slides are arranged and titled in accordance with the time and places that are recorded in the history of the universe. I have alighted on this work, as they are collected by Katie Paterson from telescopes around the globe and document dark areas of the universe. Paterson does not produce the images herself, but puts to use existing, archival images. Paterson says of the work:

> Each image (all entirely black or almost black) [is] handwritten with its unique distance from earth in light years. It will be an open-ended and life-long project, added to and extended over time. There is never a way to represent, see or know all the darkness in the universe, so it's a kind of infinite journey, and a futile one, to try to capture it on a human scale, and make it an entity. The

> images are uprooted — they refer to places/times/spaces that could be anything and anywhere, with no definite beginning or end. (Paterson, 2010) [6]

Ruff, Starling and Semiconductor engage with the reading of astronomical images, admitting that astronomical images can be subjectively modified. They share an understanding that these mediations can alter our reading of the resultant image. Paterson's work also reflects this train of thought, but in contrast *(*2010*)* embraces aspects of the universe that currently remain dark and unknown.

The above works by Paterson, Thomas Ruff, Simon Starling and Semiconductor are unified by a shared utilisation of archival photographs and images to comment upon how astronomical images are perceived by the public. Though the understanding of scientific mediation in astronomical imaging is a concern of this research, *Ancient Light* interrogates the interaction of analogue, light sensitive materials with the astronomical, when produced by an artist themselves. In the section 'Situated Knowledges' below, I explain the importance of an embodied experience when taking astronomical photographs in a dark sky location. Before turning to this, I highlight another example from Trevor Paglen.

[6] Photographs of the *History of Darkness* (2010) installation can be viewed on Katie Paterson's website, along with her artist statement: https://katiepaterson.org/artwork/history-of-darkness/

Figure 1:9: Trevor Paglen, *PAN (Unknown; USA-207)*, 2010, C-printm 60 x 48 in, 152.4 x 121.92 cm Courtesy of the Artist, Altman Siegel, San Francisco, and Pace Gallery. © Trevor Paglen. All Rights Reserved. *All Rights Reserved.*

In contrast to Paterson, Ruff, Starling and Semiconductor, Trevor Paglen has produced a series of analogue and digital photographs which depict the night sky. Paglen is a photographer who aims to document hidden systems, such as surveillance satellites and undersea cables which provide the infrastructure for the internet. *The Other Night Sky (2008-Ongoing)* aims to track confidential satellites sent into Earth's orbit by the USA. Paglen used observational data and worked with computer scientists to discern movements of these classified satellites. This research allowed Paglen to predict when satellites would pass over his location. Paglen used this information to create several long exposure photographs of the satellites using

telescopes, large format cameras and equatorial mounts. In this project, Paglen documents the night sky using analogue film. However, Paglen's intention with *The Other Night Sky* is to document satellites, rather than stars.[7]

[7] *The Other Night Sky* (2008 - Ongoing) by Trevor Paglen can be viewed on the Trevor Paglen Studio website, along with an artist statement. https://paglen.studio/2020/05/22/the-other-night-sky/

Figure 1:10: Melanie King, Ancient Light, Kilpisjarvi, Finland, *2019.*

Situated Knowledges

As I have worked in darkened environments to produce the Ancient Light photographs (Figure 1:10), both in the field and in the darkroom, I have adapted to working without light. I have gained motor skills enabling me to complete a range of complex tasks using muscle memory, such as loading a 120mm film into a camera, or a film developing tank. Over time, these techniques have become embodied, and I am able to complete these tasks without conscious effort. Returning to daylight, I have become aware of how much humans are reliant on sight. When city or town dwellers such as myself are thrown into darkness, we can

become disorientated and find it hard to navigate. The experience of being in a novel environment can offer us the opportunity to shift our perspective. This concept is explored by Melody Jue in her text, "Wild Blue Media" (Jue, 2020).

In this text, Jue analyses her own diving practice, which she titles *milieu-specific analysis*: a way of thinking that 'acknowledges that thought forms emerge in relation to different environments and that these environments are significant for how we form questions about the world and how we imagine communication with it' (Jue, 2020, 3). Jue is concerned with how diving can help us to shift our *terrestrial bias*. She imagines terrestrial bias 'as a necessary partial perspective—one that, once recognized, erodes the dream of a master language that would be totally objective, distant, and adequate to articulating and describing the world in its entirety' (Jue, 2020, 10).

Swimming underneath the surface of the ocean challenges the human body, as we move and breathe differently immersed within the water. The familiar pull of gravity on land is replaced with buoyancy, and light behaves differently as it travels through water. As Jue explores deeper below the surface of the waves, she can see ocean creatures that are not visible on land. Milieu-specific analysis is key to her methodology, as unexpected encounters beneath the waves can lead to new thought forms.

> Instead of seeing the ocean as a decodable structure that determines thought, we can think of it as a dynamic milieu whose characteristics manifest as actively moving within it (human, octopus, plant or other) and through mediated forms of contact. (Jue, 2020, 3)

Jue aims to escape her terrestrial bias by submerging herself in the ocean. I believe that observing the stars inside a dark sky area also allows us to shift our *terrestrial bias*, as the experience places us into an environment which is unfamiliar and disorientating. Jue is critical of a view which is solely scientific and objective, which does not consider other forms of knowledge production. Historically, the night sky has predominantly been studied with such an objective and scientific lens.

Melody Jue considers that objectivity is a myth, and believes that 'it aspires to a form of disembodied, disinterested, critical distance — a point of view (Jue, 2020, 9). Her criticism of the myth of objectivity parallels Donna Haraway's concept of *situated knowledge*, which refers to the objective standpoint as a 'gaze from nowhere' (1988, 581). In this project, I aim to uncover a specific perspective for astronomy using a method that requires immersion in the landscape. I aim to extend Jue and Haraway's concepts of situated knowledge to experiencing a starlit sky. In her text, Jue demonstrates the importance of challenging existing outlooks, which have historically been informed by people coming from a narrow range of backgrounds.

> To 'situate knowledge' is to address the radical historical specificity and thus contestability of every layer of the onion of scientific and technical constructions. (Jue, 2020, 9)

Haraway's text considers the danger of institutionalised knowledge for science and technology, which suggests that matter is passive and inert. Instead, Haraway suggests that our objects of study have an active agency:

> Situated knowledges require that the object of knowledge be pictured as an actor and agent, not as a screen or a ground or a resource, never finally as slave

> to the master that closes off the dialectic in his unique agency and his authorship of objective knowledge. [...] Ecofeminists have perhaps been most insistent on some version of the world as active subject, not as a resource to be mapped and appropriated in bourgeois, Marxist or masculinist projects. Acknowledging the agency of the world in knowledge makes room for some unsettling possibilities, including a sense of the world's independent sense of humour… Feminist objectivity makes room for surprises and ironies at the heart of all knowledge production; we are not in charge of the world. (Haraway, 1988, 592-4)

In Haraway's recent book *Staying With The Trouble* (2016), she discusses the importance of thinking practices by referencing Navajo string figures. These string games intend to tell stories of how constellations came to be, through the winding and connecting of string. Haraway pinpoints these techniques as 'thinking as well as making practices' (Haraway, 2016, 14).

The concept of situated knowledges encourages an approach to research which is less impersonal. Haraway claims that it is important to think about our method of research, as these ultimately influence our object of study.[8]

> It matters what we use to think other matters with; it matters what knots knot knots, what thoughts think thoughts, what descriptions describe descriptions, what ties tie ties. (Haraway, 2016. 12)

[8] Sandra Harding has analysed Haraway's concept of situated knowledges and has put forward *standpoint theory*. This theory proposes that one's social situation can set limits on what a person can know (Harding, 1992).

Jue and Haraway both describe a more sensory, intuitive reading of natural phenomena allowing us to access new perspectives. Jue and Haraway's thinking, rooted in sensory, embodied ways of knowing, can be applied to the field of astronomy. This immersive approach offers a way for me to experience a starlit sky from a perspective which is embedded in, and connected to, the landscape. Looking at the stars through the lens of Jue and Haraway's methodologies has enabled me to obtain a broader perspective on humanity's fragile position in the Earth and the cosmos. As I discovered the rarity of complex life forms, I became more aware of the precious organisms, plants and creatures on Earth. In turn, this has prompted me to produce artwork using sustainable photographic processes, which are less damaging to Earths' environmental systems.

Objectivity — Lorraine Daston and Peter Galison

Lorraine Daston and Peter Galison's text 'Objectivity' (Daston, Galison, 2007) discusses how ideas surrounding objectivity have altered significantly within the twentieth century. Overall, Daston and Galison's text discusses how scientists use various methods of judgement to determine their results.

As recording equipment and processes became more complex, scientists required new methods:

> In the twentieth century, as the limits of procedure-governed mechanical objectivity became more apparent, one atlas maker after another insisted that objectivity was not sufficient — complex families of visible phenomena needed trained-judgement to smooth, refine or classify

> images to the point where they could actually serve any purpose at all. (Daston, Galison, 2007, 316)

An example used by Daston and Galison discusses how the World Meteorological Council produced a new cloud atlas to direct the reader's attention to essential features of cloud formations in the 1930s. The World Meteorological Council used line drawings to highlight certain features of clouds that were not easily visible from photographs alone. In the example given by Daston and Galison, threadlike forms were drawn to accentuate a *Cirrostratus Filosus* cloud. (Daston, Galison, 2007, 371). Another example in the text draws attention to Gerhart S. Schwarz and Charles R. Golthamer's Radiographic Atlas (Daston, Galison, 2007, 356) which utilised composites of photographs, hand painted prints and transparent sections to build up a detailed map of a skull. The results relied upon the combined trained judgement of several members of staff at the College of Physicians and Surgeons, who had differing skills in line drawings and half-tone drawings.[9]

In addition to their observations, scientists use trained judgement to interpret their data. In their text, Galison and Daston give the example of *Sun Rotation 1417, Aug – Sept 1959,* by Robert Howard, Václav Bumba and Sara F. Smith in *Atlas of Solar Magnetic Fields*, (1959) to illustrate how the astronomers removed artefacts and smoothed image outputs from solar observation equipment (Daston, Galison, 2007, 21). The scientists used their skills gained from multiple years of research and

[9] Jan Baetens summarises trained judgement as a;

> scientific attitude of the expert, who is able to interpret the raw data of mechanical objectivity in a way that identifies meaningful patterns and family resemblances in what can be observed, but not understood, by the eye of the observer or the machine. (Baetens, 2008)

practice to ascertain the importance of different data streams. In *Picturing The Cosmos: The Hubble Telescope and the Astronomical Sublime* (highlighted in Chapter Two), Kessler also discusses how astronomers make judgements on how to present astronomical image data to the general public – for example, altering colours, crops and contrasts to highlight features of a galaxy or nebula.

Later in the text, Galison and Daston describe multifaceted approaches to research, which enable scientists to hone their trained judgement:

> Instead of listening passively to lectures, students were actively inducted into the craft and standards of their specialities — in the laboratory, the botanical garden, the observatory, and the field, as well as in the seminar room. (Daston, Galison, 2007, 316)

This practical aspect to knowledge production can be compared to practice-based research, where practical and theoretical approaches are combined in one methodology. Artistic research can therefore offer another perspective, that is complementary to existing research in astronomy. This study offers an approach which takes a *bigger picture* into account.

The act of stargazing is a way to obtain a cosmic perspective, aiming to shift our partial view informed by terrestrial bias. Many cultures and civilisations have been intimately engaged with the Sun, Moon and stars in human history. While a complete history of such civilisations cannot be known, examples include the complex calculations of astronomical movements by ancient Mayan and Egyptian astronomers many millennia ago. What we know of such civilisations and cultures suggests they viewed the cosmos and the Earth as intertwined: they recognised the

movements of the Sun and the Moon and considered their impact on earthbound phenomena. In the *Ancient Light* series, I have framed the photographs to include elements of the landscape, in order to demonstrate the intimate connectedness between the ecology of the Earth and cosmic bodies.[10]

[10] There are several texts which have discussed ancient knowledge and astronomy, I present a small selection in this footnote.

Archaeoastronomy: Introduction to the Science of Stars and Stones by Giulio Magli (2015) is a broad account of the history of archaeoastronomy. It considers how previous civilisations have made connections between astronomy, the landscape, architectural features and people. The book discusses tools and methods for measurement, related to how celestial objects such as the stars, sun, moon and planets seem to appear in the sky. It then moves on to discuss specific architectural structures including the Pyramids of Giza and Stonehenge.

Celestial Stone Circles of West Cornwall: Reflections of the Sky in an Ancient Landscape by Carolyn Kennett (2018) specifically discusses four stone circles in Penwith, West Cornwall, exploring how these structures could be connected to astronomical events.

Calculating Brilliance An Intellectual History of Mayan Astronomy at Chich'en Itza by Gerardo Aldana y Villalobos (2022) focuses on the work of one Mayan female astronomer K'uk'ul Ek' Tuyilaj. In this text Gerardo Aldana y Villalobos brings to light pre-Colombian astronomy in mesoamerica, exploring indigenous cosmologies in the time of K'uk'ul Ek' Tuyilaj. Gerardo Aldana y Villalobos then charts how the fields of astronomy and astroarchaeology have evolved globally up to the twenty first century.

The Cosmos in Ancient Greek Religious Experience by Dr Efrosyni Boutsikas (2020) explores astronomy in ancient Greece. Boutsikas looks into the relationship between spirituality, religious structures and their connections to the cosmos.

Stargazing often requires very specific environments in dark and isolated locations. Without light pollution, I can see the Milky Way. Similarly, without noise pollution from a road or building, I can tune into birdsong. It is easier to focus on one specific element in the countryside, away from a bustling city space. Telescopes tend to be placed in isolated locations to provide optimal readings. The Hubble Telescope is in orbit around the Earth just outside of the atmosphere, so that it can gaze through the night sky without atmospheric interference. Similarly, artists can situate themselves in locations that allow for time and space without distractions.

> The sense of a natural order, always in some way correcting the pretensions of the Self, gave mode and measure to pre-modern art. If this sense has now become dimmed, it is partly because for most people Nature has been replaced by the culture of congestion: of cities and mass media. We are crammed like battery hens with stimuli, and what seems significant is not the quality of meaning or the messages, but their excess. (Hughes, 1980, 324)

Robert Hughes originally wrote *The Shock Of The New* in 1980, before the proliferation of the internet and social media. Hughes' analogy of the battery hen crammed with stimuli has only intensified. Looking out to a night sky full of stars or an 'empty' horizon, I can project my thoughts without much distraction. Residencies in isolated environments without light pollution allow a clearer view into the cosmos. They also allow for a kind of focus that is harder to obtain in a city filled with signs. I feel I can absorb the starlight as if I am photosensitive, as if I myself am a sensor.

Reflexivity

Jue and Haraway's fluid and sensory approaches to environments can be compared to theories surrounding reflection and reflexivity. For Mika Hannula, a practice can have a defined direction 'but with an open ended undetermined procedural trajectory... [that is] particular, content-driven, self-critical, self-reflective and contextualised' (Hannula, 2009, 1). Donald Schön's notion of a reflective practitioner introduced the term *reflection-in-action*, considering how a person may improvise in their working environment. Katrine Hjelde cautions that due to the popularity of Schön's book *The Reflective Practitioner* (1983) in a wide range of practice-based disciplines, *reflection* 'is in some danger of meaning all things to all people' (2012, 3). However, Schön makes a useful distinction between types of knowledge production. Certain forms of technical knowledge, such as medicine, can follow tried and tested methods to reach conclusions. Other types of professional knowledge require a more fluid approach to thinking, such as the role of a social worker or an artist.

> For Glazer, the critical distinction is between kinds of professions. To professions like medicine and law Glazer attributes fixed and unambiguous ends, stable institutional contexts and fixed contents of professional knowledge sufficient for rigorous practice. To professions such as divinity and social work he attributes ambiguous ends, shifting contexts of practice and no fixed content of professional knowledge. (Schön, 1983, 46)

Schön describes the nineteenth-century trend of positivism as a dominant form of knowledge. Positivism is a philosophical system which only recognises theories that can be verified scientifically or mathematically (Schön, 1983, 32). He makes the

point that a positivist approach cannot always promise certainty, using the example of a physician who is faced with a situation that they have not faced before — perhaps two physical impairments that combine to create a new problem.

> A unique case falls outside the categories of applied theory; an unstable situation slips out from under them. A physician cannot apply standard techniques to a case that is not in the books. And a nutritionist attempting a planned nutritional intervention in a Central American community may discover that the intervention fails because the situation has become something other than one planned for… A conflict of ends cannot be resolved by the use of techniques derived from applied research. It is rather through the non-technical process of framing the problematic situation that we may organise and clarify both the ends to be achieved and the possible means of achieving them. (Schön, 1983, 41)

The field of astronomy contains a wealth of questions that have not yet been answered — for example, the search for dark matter. Scientists have measured the density of the universe and have discovered that observable matter only accounts for 5% of the universe. Scientists now consider that the universe is approximately made up of 68% dark energy and 27% dark matter, though we are not quite sure what dark matter and dark energy are (NASA, 2020). Schön suggests that scientists can choose to ignore troubling elements of their research. For example, they might use 'junk categories to explain away discrepant data' or they may 'try to force the situation into a mould which lends itself to the use of available techniques' (Schön, 1983, 44). A leading theme in my thesis is to point out that scientists do grapple with uncertainty in their work, thus abandoning the positivist approach. Instead of

following a rigorous scientific approach, Schön suggests that we 'search instead, for an epistemology of practice implicit in the artistic, intuitive processes which some practitioners do bring to situations of uncertainty, instability, uniqueness and value conflict.' (Schön, 1983, 49)

Schön's text aligns with Karen Barad's *Meeting The Universe Halfway* (2007), which begins by discussing Michael Frayn's play *Copenhagen*. This describes a fictional meeting between the physicists Niels Bohr and Werner Heisenberg to discuss the uncertainty principle. This principle considers the limits to our knowledge of atoms and electrons. Ending the chapter by describing the issues concerning the *Copenhagen* play, Barad outlines their diffractive methodology. They hope to 'provide a transdisciplinary approach that remains rigorously attentive to important details of specialised arguments in a given field, to foster constructive engagements across disciplinary boundaries' (Barad, 2007, 25). Barad is critical of positivism and neo-positivism in science and quantum physics, which is reliant upon objectivity and empiricism. For Barad, a positivist approach does not consider nuance, uncertainty, or subjective readings.

> I part company with my physics colleagues with neopositivist leanings who believe that philosophical concerns are superfluous to the real subject matter of physics. Rather, I am sympathetic to Bohr's view that philosophy is integral to physics. [...] Physics without philosophy is a meaningless exercise in the manipulation of symbols and things that have no basis in the world. This is why Einstein and Bohr engaged with all their passions about the meaning of quantum theory. (Barad, 2007, 69)

I propose that a situated, reflective and intuitive methodology is appropriate for combined research into creative practice-based research that deals with astronomy.

In *Figuring* (2019), Maria Popova talks about the intuitive nature of astronomical research as she discusses the history of astronomy, which has consistently revised our understanding of the universe. She uses the example of Lord Kelvin, who said at the British Association of Science in 1900, 'There is nothing more to be discovered in physics now. All that remains is more and more precise measurement' (Kelvin as quoted in Popova, 2019, 8). Popova makes the point that during the same year, Albert Einstein was considering ideas about relativity and spacetime, which went on to revolutionise our ideas about physics.

> Bit by bit, discoveries reconfigure our understanding of reality. This reality is revealed to us only in fragments. The more fragments we perceive and parse, the more lifelike the mosaic we make of them. But it is still a mosaic, a representation — imperfect and incomplete, however beautiful it may be, and subject to unending transfiguration. [...] Even the farthest seers can't bend their gaze beyond their era's horizon of possibility, but the horizon shifts with each incremental revolution as the human mind peers outward to take in nature, then turns inward to question its own givens. We sieve the world through the mesh of these certitudes, tautened by nature and culture, but every once in a while — whether by accident or conscious effort — the wire loosens and a kernel of a revolution slips through. (Popova, 2019, 8)

*Reflection in actio*n is a term used by Schön to describe intuitive and spontaneous decisions that we make without too much thought (Schön, 1983, 49). Throughout this research, I have obtained several skills that have become second nature. When I

began to work with a telescope, I found it difficult to use at first, yet over time the telescope became an extension of my own body. Similarly, working for long periods in darkness (whether using a camera at night, or spooling a film with my sense of sight removed) was difficult at first, but became easier as my technique improved. Already, this research has developed my embodied knowledge.

> Both ordinary people and professional practitioners often think about what they are doing, sometimes even while doing it. Stimulated by surprise, they turn thought back on action and on the knowing which is implicit in action. (Schön, 1983, 50)

Schön uses the example of a tight-rope walker reflecting-in-action as he walks along the wire, making decisions to move which are informed by many different factors. In my practice, I work in a similarly reflective way, responding to situations as they arise; for example, choosing to use a particular kind of film or camera depending on the weather and environment. If it is a still night, I may use a lightweight camera and tripod, such as Canon EOS 300 Film Camera. The portability of this equipment enables me to walk further than I could with a heavier camera. Likewise, if the moon or light pollution is semi visible, I may opt for a film with a lower ISO (a standardisation that attributes sensitivity to light in numerical terms)

Schön's concept of reflection in action is important for creative practitioners because it encourages unexpected reactions, explorations and new discoveries. This is an approach that is in opposition to a linear enquiry, which follows tried and tested routes from A to B.

The reflective methodology can also require a generative approach, where the researcher puts into practice a series of experiments in an open-ended enquiry. Donald Schön and Estelle Barrett mention issues with certain scientific research, where data is contorted to fit pre-determined aims. For this reason, Barrett is supportive of the generative, unpredictable approach in practice-based research:

> A sharper articulation of a number of aspects of research in the creative arts may help to establish studio-based enquiry more firmly within the broader field of research and scholarly activity. These include: the relevance that practice-based research has for extending and articulating our capacity to discover new ways of modelling consciousness and designing alternative methods of research capable of generating economic, cultural and social capital; the implication that creative arts research has for extending our understandings of the role of experiential, problem-based learning and multiple intelligences in the production of knowledge; the potential of studio-based research to demonstrate how knowledge is revealed and how we come to acquire knowledge; the ways in which creative arts research outcomes may be applied to develop more generative research pedagogies and methodologies beyond the discipline itself. (Barrett, 2007, 2)

Katrine Hjelde distinguishes between the terms *reflective* and *reflexive* (Hjelde, 2012, 8), suggesting that reflexivity involves reflection on many different levels, considering many different themes at the same time. Hjelde uses an approach, which enables the researcher to make interpretations and gain an in-depth understanding of the researched phenomena. Hjelde's approach is qualitative and involves subjective interpretations in the research of meanings of texts, art and

culture. This kind of research is liberating rather than constricting. However, this does not mean that the research does not have structure.

Reflective and reflexive approaches have proved to be important in my research. Residencies in remote locations and regular immersion within a starlit landscape allow for new thoughts and ideas to form. In the text *On The Value of Not Knowing* (2013, 16) Rachel Jones suggests that 'to work without knowing is a necessary condition of creation, of the generation of difference rather than reproduction of the same'. As I participate in residencies with unspecified trajectories in unfamiliar locations, I allow myself to encounter what to me is strange and unusual. As I visit these landscapes at night, lit by the stars, I am more likely to experience a sense of awe, which can inform the work. For example, as I have taken photographs in dark sky locations, I observed how the stars seemed to move through the sky, due to the spin of Earth on its axis. This reflection led me to produce a 16mm time lapse of the night sky in Margate (Figure 1:12, p61).

The act of analogue photography can itself be reflective, as a photographer is prompted to remember specific scenes, as they develop their negatives and resultant prints. The act of photography can also be expanded to other aspects of the process, which may also facilitate reflective thought. Reflection could occur during the journey which the photographer may take to create the photograph, or within the landscape as time elapses during the photographs' exposure. During the residencies that I present in Chapter Four, I have been prompted into reflective thought by multiple unexpected circumstances, for example the experience of being alone in the dark in an unfamiliar landscape or encountering geological phenomena such as the landscape of Thingvellir National Park in Iceland, where a

section of the Mid-Atlantic Rift is visible above sea level.

Darkroom Milieu

Analogue photographs require certain environmental conditions to come into being, due to the use of dynamic light-reactive substances. Many photographic processes require complete darkness, red or subdued light. An artist using analogue photographic processes must facilitate the production of these objects, therefore entering a darkened room. The darkroom has its own milieu which can alter our perspective. As a person enters, vision becomes reduced. As a result, our senses of touch, smell and hearing become stronger. The darkroom can often be a quiet, solitary space, where we are immersed by a calming red light. The act of working in the darkroom can be a meditative experience, where time is experienced differently. In the darkroom there is no sunlight to indicate the time of day. Similarly, it is not possible to look at a mobile phone or laptop screen to pass the time. To create optimal prints from my Ancient Light series, I found that lengthy enlarger exposures (between thirty seconds and one minute) and enlarger filters four and five, produced the clearest results.

The prints have been created using fibre-based silver gelatin paper, which requires a longer washing stage. Fibre based papers can take up to an hour to wash, depending on the paper, whilst resin coated papers can be washed in twenty minutes. These factors meant staying in the darkness for extended periods of time, gently agitating the development trays to ensure an even coverage. Whilst producing the *Ancient Light* prints, the darkroom gave me an opportunity to reflect upon the experience of creating each individual photograph, considering what it was like to be in each environment. It allowed me to focus on the process of

physically making the prints. The prints titled *Ancient Light, Brow Head, Ireland (2019)* were produced using fibre-based paper (Portfolio Pages 26-27).

Working in the darkroom is an embodied experience, as the human body physically adapts to being in a space with reduced light. Darkroom chemistry can have a negative effect on the human body due to its varying levels of toxicity, which can lead to ill health, and even death. The chemicals are often unpleasant to work with due to their smell. Some people can become sensitive to photographic chemistry, affected by dermatitis and breathing problems. This prompted me to explore sustainable photographic processes using plant-based developers. These developers are safer and more pleasurable to work with; they smell nicer and do not have a negative effect on the body. In comparison to standard photographic developers, the plant-based counterparts can mean longer developing times, leading to a much longer presence in the darkroom overall. [11]

Analogue photography has enabled me to make discoveries that I would have not made otherwise. When taking photographs in specific locations, I am not able to review the image immediately. The choices I make when taking a photograph must be carefully considered, due to the limited amount of film inside my camera. The act of reviewing the image must happen after I have developed and printed the image, by which time I am surprised by details that I had forgotten. The time elapsed between the taking of a photograph and the printing of a photograph can

[11] There are several theorists who have considered the effects of the darkroom environment on the body. These include Dr Sara Dominici: 'Darkroom Networks, Mundane Subversiveness for Photographic Autonomy 1880's – 1900's' *(2021)* , Professor Michelle Henning; 'The Worlding of Light and Air: Dufaycolor and Selochrome in the 1930s' (2020) and Dr Rowan Lear 'A Photographing Body' (2021).

be up to six months. In an extreme case, a 16mm film of the night sky I made took nine months to film, due to cloudy weather. The film consists of 4000 frames, each taking 30 seconds to expose. These frames could only be exposed when there were no clouds in the sky.

Movement in the Landscape

It is not only environmental factors which have enhanced my creative production; movement in the landscape has also generated new thoughts and ideas. In Thanet, I purposefully take time to walk, run or swim in the landscape. I can regularly observe the landscape around me and meditate on my thoughts. I can enter a reflective mindset that I am not able to access otherwise. Walking through the landscape is a form of embodied practice, as the brain focuses on individual movements, sensations and surrounding environmental features. It is a way to momentarily relieve the brain of jumbled thoughts, accessing a state of mind which is meditative and mindful. This calm and focused state of mind can allow creative thoughts to form, which often leads to new insights about the surrounding landscapes and can provide inspiration for new works.[12]

For this reason, I propose that movement in and through the landscape is a method for knowledge production. Running and walking are sensory activities that necessitate distance from a screen. Participating in these activities has led to a shift

[12] There are several writers who have discussed the relationship between walking and thinking. These include: *The Old Ways: A Journey On Foot* (2017) by Robert Macfarlane; *Wanderlust: A History of Walking* (2014) by Rebecca Solnit; *The Living Mountain (Canons): A Celebration of the Cairngorm Mountains of Scotland.* (2011) by Nan Shepherd.

in my perception. When we run or walk, the brain's attention is naturally diverted to different body parts. To run requires the brain to make several different complex calculations, allowing us to navigate the terrain we are running on, to avert danger and to notice the environment around us. Our senses are heightened when we run for this reason. In his book *Footnotes: Why Running Makes Us Human* (2016), Vybarr Cregan-Reid makes the point that running is part of our evolutionary past. He suggests that we are becoming used to our sedentary lifestyle, which is a relatively recent development in the timeline of humanity's existence. Cregan-Reid points out that the human body has evolved to move in the landscape over thousands of years, and to consciously run outdoors has many benefits. One of these advantages is the endorphins that are released during exercise, another is the opportunity to engage with thoughts over a longer duration.

> Running is analogue. It is hunter-gatherer. It is paleo. It is linear. It is long-form thought. It is an uninterrupted conversation with yourself. It is a journey back through modernity. It is a way out of technology, it is a way to be free. (Cregan-Reid, 2016, 96)

Running conditions the mind to escape from every-day distractions, and to focus on movement in relation to the landscape as you travel through it. Breathing changes as you run, which can have a calming effect. Exercises such as pranayama in yoga promote breathing practices to calm the body and mind, as well as directing attention to specific body parts. In all these activities, thoughts are controlled and focused by exercise. Movement is a way to think and see differently, and Cregan-Reid often refers to the body as if it is a camera. He claims that movement affects how our senses determine our perception of the world.

> In short, we don't receive the world as atomistic sense data like the sensor panel in a camera, but directly in relation to our ability to interact with it in various ways. Senses are lenses, change them and change the world they perceive. (Cregan-Reid, 2016, 78)

To further Cregan-Reid's analogy of the human body as a camera, he imagines a camera based on the human body:

> Imagine a dynamic lens that could learn from the way that you used the camera, that could focus tighter, let in more light or sink down into itself when it wasn't being used. (Cregan-Reid, 2016, 78)

Cregan-Reid asserts that our eyes are not cold, unfeeling machines; they are changeable and can alter depending on how we use them. These changes within the body and mind are gradual, requiring repetitive actions over time.

The artist Garry Fabian Miller discusses the body as if it is a light-sensitive substance. Miller is compelled to take daily walks around sunrise and sunset, as he believes that light can accumulate throughout a lifetime (Appendix Two). By not walking and taking time to explore the landscape, light exposure is missed.

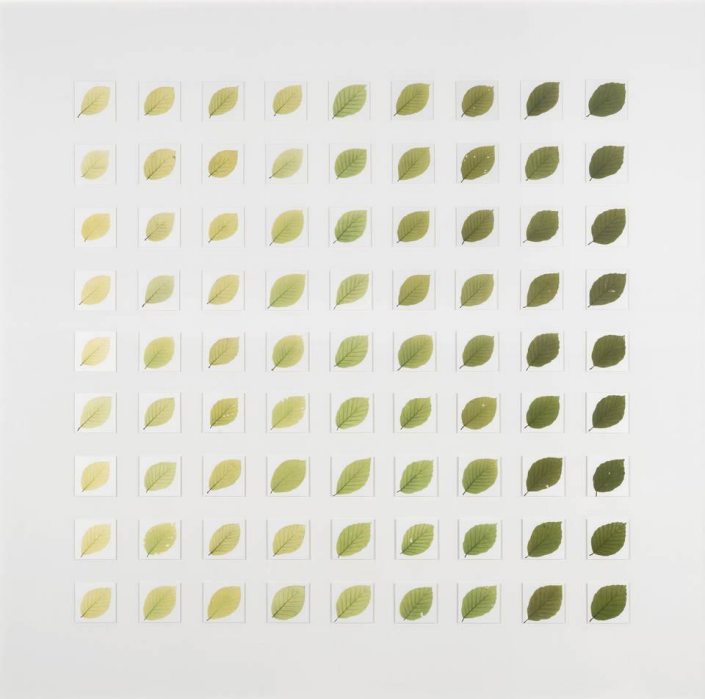


Figure 1:11. Breathing in the Beech Wood, Homeland, Dartmoor, Twenty Four Days of Sunlight, *dye destruction print. Garry Fabian Miller, 2004.*

Breathing In The Beech Wood is a product of Millers' walks in the landscape. To create this work Miller walked daily, picking up leaves as they changed from a light yellow to a dark green. The change of the colour of the leaves represents a shift in seasons. Miller appreciates the landscape around him, noticing small changing details as months pass. In 2020, I had the opportunity to interview Garry Fabian Miller, which gave me an in-depth insight into his practice:

> I remember beginning with the Poplar tree, which has this remarkable flesh pink leaf when it came from the bud, followed by this remarkable new pink, followed by a deep pink. It would then turn from light pink, into the palest of greens before ending up dark. 20-30 days later, depending on the kind of Spring we were having, I gathered those leaves. I then set up a system where everything stayed the same in the darkroom; the exposure was the same and the filtration

> was the same. Each day I would come into the darkroom with the next group of leaves from that days' exposure and place the leaf into the enlarger head. I would then print the next picture which would be different because the Sun had made it different. I felt like a collaborative act between the Sun, the tree, myself, and the photographic materials. (Fabian Miller, 2020)

As Miller used the enlarger with the same set of parameters, the variable of the process are the leaves changing colour due to the advancement of spring. As the environment changed gradually, the artwork evolved simultaneously.

Miller constantly talks about accumulating light on the photographic surface, as well as his own exposure to light.

> I began to develop this idea that we make our brains through our accumulated exposures to the things that we look at. For example, when the light falls upon us, we have both light on our body surface, light entering our eyes and the images it brings into our mind. I began to think of the brain being like a dark rock which was then filled with light through the accumulated exposure of being alive. It is important for me to spend a lot of time in those places, to build your exposure and create your perception. (Fabian Miller, 2020)

In the interview, Miller specifically discusses the light he receives from the Sun and Moon, and how it alters his thinking processes. The eye is an aperture, the retina is light sensitive, and the brain is a repository. In addition to this, Miller is influenced by the experience of viewing starlight in the landscape.

> I relate to the sky as I see it standing on the earth with my eyes– without needing to use telescopes and computer-generated reading systems. It is a kind of sense of wonder at the night sky, at the Moon's existence and its reflection of the light of the Sun, as well as the light of stars. I feel deep time on Dartmoor intensely at night, more so than the daytime. I really feel I am with people from long ago and also with people way into the future. The night space is this wonderful other space where something really deep and profound exists. (Fabian Miller, 2020)

For Miller, the night sky resonates with the ancient landscape of Dartmoor and recalls inhabitants of the distant past. According to Miller, there is evidence of humans living on Dartmoor in Neolithic times, around 6000 years ago (Fabian Miller, 2020). [13]

6000 years is a magnitude of time which is familiar in the context of astronomy. One of the oldest stars in the universe — SMSS J031300.362670839.3 — is 6000 light years away from Earth. The light from this star has been travelling for the same amount of time that human life has existed on Dartmoor, and Miller says that he 'feels' this magnitude of time as he explores the landscape.

Whilst producing the *Ancient Light* series of photographs and moving image works (See Figure 1:12 and 1:13), I have become increasingly aware of the ecological pressures in the landscapes I spend time in. As discussed in Chapter Four, during a residency in Iceland, the volatile volcanic, glacial panorama continually reminded

[13] More information on human activity on Dartmoor can be found on the Dartmoor National Park official website. https://www.dartmoor.gov.uk/wildlife-and-heritage/dartmoor-story/dartmoor-story-pages/shaped

me of the Earth as a dynamic planet. Similarly, in Italy, landslides and water shortages made me aware of the presence of climate change. For this reason, it has become important for me to represent each individual environment in the image alongside the night sky. From my perspective, the features of each landscape (plants, mountains, weather) are intimately entangled with the stars and galaxies that can be seen in the night sky. I aim to remind the viewer of the material connection between our Earth and celestial bodies existing in distant reaches of the cosmos. The fields of astronomy and geology allow us to consider our lives within a vast magnitude of time, which far outreaches our own lifespan. In astronomy, both light and time can be distorted and bent. In geological records, the past is rarely laid out in the neat diagrams of rock strata that we are used to in textbooks.

Figure 1:12: Melanie King, Ancient Light, 16mm Film*, Margate, 2019.*

Inherent in this study is a resistance to the relentless productivity of technological innovation. Hannah Arendt warned in *The Human Condition* (1958) of planetary alienation, considering that innovations such as space exploration may come at a cost to our own Earth.

> The earth is the very quintessence of the human condition, and earthly nature, for all we know, may be unique in the universe in providing human beings with a habitat in which they can move and breathe without artifice. The human artifice of the world separates human existence from all mere animal environments, but life itself is outside this artificial world, and through life man remains related to all other living organisms. For some time now, a great many scientific endeavours have been directed toward making life also 'artificial', toward cutting the last tie through which even man belongs among the children of nature. (Arendt, 1958, 2)

To counter Arendt's argument, technology could be seen to be directed toward becoming better acquainted with the Earth and cosmos, as new sensors and understandings of materials are developed. For example, it is possible to use historical processes (such as plant-based phytochemistry) with a contemporary understanding of how they work, and subsequently use this knowledge to innovate new practices. Using a traditional technique with a contemporary perspective can help us to foster an ecological approach.

In her blog *Making A Slow Revolution* (2008), Helen Carnac describes how her *slow revolution* for craft takes its inspiration from the Slow Food movement. She describes how these movements have developed as a critique of the consequences

of our unsustainable consumerist culture and its increasingly fast lifestyle. She suggests that there are two types of slowness and differentiates between the two. The first type of slowness refers to the speed of making in craft production. The second type of slowness refers to notions of time and process, economy and material, nature of production and consumption, community and society (Carnac, 2008). Returning to the etymology of the word *indigenous*, which comes from the verb *to produce*, she claims that 'the slow revolution is situated in a sense of locality, through its treatment and use of local resources, response to environment and local markets, and the social and community status of craft practitioner'. This method of slowness and sensitivity towards the environment is distinct from the current globalised practices where environmental concerns are low priority in the lifecycle of mass production.

Figure 1:13: Melanie King, Ancient Light, Iceland*, 2018.*

To stargaze is to accumulate starlight in our eyes and our minds. Being in an environment where I can view a dark night sky gives me a consistent feeling of

cosmic perspective. Similarly, as I walk beneath the chalk cliffs of Thanet, I think about the time it has taken for dead sea creatures to deposit themselves on the ocean floor, before being compressed over many thousands of years. The residencies and walks in remote, dark-sky areas have altered my perception of the connections between the cosmos and landscapes on Earth. In the context of astronomy, my existence is a momentary flicker in the grand timeline of the universe. As I look up to the night sky, I consider how long it has taken for the light to reach me. In the timeline of the universe, conscious, complex life has existed for a short fraction of time. Currently, with ecological collapse on the horizon, it is increasingly important to think about how rare complex life is in this vast universe, which presently is hostile to living organisms.

Chapter Two: The Delayed Rays of a Star

Figure 2:1: Melanie King, Ancient Light, Atina, Italy*, 2018.*

Stars are composed of plasma, often made from hydrogen and helium. The matter inside a star is held together by gravity. As a star burns through its fuel, light is emitted out into space and travels in all directions. From our distant perspective, we see a star as a point of light in the night sky. The photons travel in a straight path in most cases. However, if light encounters an object with a large amount of mass, the light may be distorted by gravitational lensing, a phenomenon where the fabric of space itself is bent and warped. When the stellar light reaches Earth, the light travels through the atmosphere, and is sometimes obscured by clouds or sunlight.

When I stand on Earth, pointing a camera up to a clear and dark night sky, light can enter through the transparent glass of my lens. When I open the aperture of my camera to f2.8, the light can continue its journey to my photographic film, which is highly sensitive to light. As the camera shutter is open, light filters through the lens and accumulates over periods of minutes and seconds. If there are mountains and trees blocking the celestial light, they will appear in my resultant image.

When I close my shutter, the light remains latent on my photographic film until it meets photographic developer, which enhances the film's receptivity to light. The areas of the film which received light turn black, as the silver in the film begins to darken. This interaction forms a direct connection between stellar light and the resultant print. This is because the light directly touches the film, which forms a dark area once developed. In the enlarger, these dark areas block light, whilst unexposed areas allow light to pass through. In turn, the photographic paper turns dark once touched by light.

In *Ancient Light,* my mediation in the photographic process is limited to framing, exposure time and use of photographic chemistry. This process emphasises that analogue astronomical photographs maintain a tangible and material connection to distant stars, existing thousands, if not millions, of light years away. In addition, it demonstrates that analogue astronomical images are dynamic, three-dimensional objects that maintain direct links to their subjects.

Astronomy Archaeology

Analogue astronomical images held in photographic archives can alter our understanding of the dimensions of the universe. The images mentioned below prompted a re-evaluation of the universe's scale.

In 2018, I visited the Mount Wilson Observatory and the Carnegie Archive in California.[14] In the Mount Wilson observatory there are two telescopes, with apertures measuring 60 and 100 inches. During the period from 1917 to 1949, the 100-inch telescope had the largest aperture of any telescope in the world. As a result, Mount Wilson Observatory is the site of many discoveries in the field of astronomy. Edwin Hubble began working at Mount Wilson Observatory in 1919, and the Carnegie Observatory Archive contains many of his original glass plates. Hubble was prolific during his time at the observatory, making meticulous notes on the plates that the Carnegie Observatory Archive has sought to preserve. As Corey Powell says, in his article on the discovery of Hubble's variable star, '[a] single variable star, spotted by Edwin Hubble in the Andromeda nebula, completely changed our understanding of the scale of the cosmos' (Powell, 2002). At Mount Wilson, Hubble created an extremely detailed long exposure of the Andromeda Nebula, which previously had only resembled a smear of light and gas, rather than many individual stars in a galaxy formation. After measuring the luminosity of the stars, Hubble had a hunch that the Andromeda Nebula was much further away than first thought. Following his intuition, Hubble eventually found a variable star within

[14] The Carnegie Observatory archive holds astronomical glass plates from Mount Wilson Observatory that can be viewed online. https://obs.carnegiescience.edu/plate-archives [Last accessed: 04/08/2023]

Andromeda, suggesting that this spiral nebula was a galaxy, existing far beyond the Milky Way. (Powell, 2002) This photograph dramatically altered our conception of the size of the universe and prompted speculation about its creation and expansion.

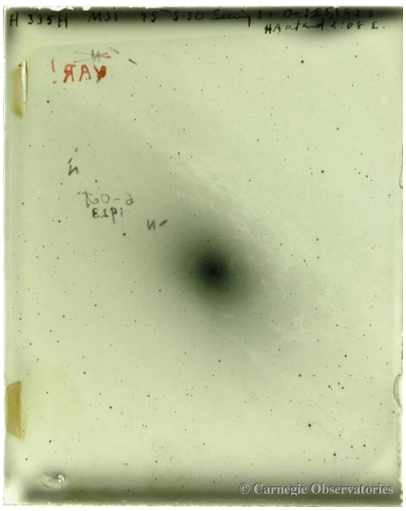


Figure 2:2: Edwin Hubble, Variable Plate: Archive Number H335H*, 1923.*

The Big Bang Theory is a term coined by Fred Hoyle to describe Georges Lemaître's hypothesis. Lemaître built on Albert Einstein's General Theory Of Relativity to describe how the universe originated from a single atom, and has been expanding since the universe began (Soter, deGrasse Tyson, 2000). This discovery was made less than a century ago; before then, the overriding theory was that the universe was confined to the Milky Way Galaxy. Viewing the vast 100-inch telescope situated inside the church-like dome at Mount Wilson, one can imagine Hubble sat gazing into the eyepiece at the Andromeda Galaxy. We now understand that light from the Andromeda Galaxy has been travelling for 56 million years, much longer than the existence of complex life forms on Earth. The Carnegie Observatory holds Hubble's astronomical photographic plates, including this glass plate with the

variable star. These plates were made using silver gelatin emulsions, which were designed specifically for astronomical purposes and sensitised to respond to red light.[15]

The photographic plates that Hubble created have recently been used by astronomers to extract data from the past: it is important that these plates are analysed to find out if anything has changed (Farihi, 2016). [16]

Holger Pedersen discovered 150 astronomical glass plate photographs in the basement of the Niels Bohr Institute in Copenhagen (Meier, 2016). These photographs originated from the Østervold Observatory, and the plates were moved to the Niels Bohr Institute after the observatory closed down. Pedersen took the plates to his office and examined them in detail. He describes the collection as 'astronomy archaeology' (Pedersen, 2015) as these photographs were created around 1895; they can give us important information that can be compared with

[15] George Ellery Hale produced the first H-alpha spectroheliograph photograph using a film emulsion designed to be red-sensitive. More information on George Ellery Hale's photograph can be found on the following link. https://www.mtwilson.edu/discovering-mount-wilson-chapter-16-hale-nicholson-law/

The Eastman Kodak Company were in conversation with the Yerkes Observatory to produce specailised emulsions. https://www.lib.uchicago.edu/collex/exhibits/capturing-the-stars-the-untold-history-of-women-at-yerkes-observatory/science-at-yerkes/photography/

[16] In 2014, Professor Ben Zuckerman and Dr Cynthia Hunt observed a glass plate spectrograph, which provided evidence for the existence of a white dwarf star. More information can be found in the following link: https://exoplanets.nasa.gov/news/1467/overlooked-treasure-the-first-evidence-of-exoplanets/

contemporary astronomical discoveries. The most important glass plate for Pederson is from the total solar eclipse in Sobral, Brazil in 1919, created by Arthur Eddington. Due to the bending of the Sun's light in the corona of the eclipse, the plate provided evidence for Albert Einstein's theory of general relativity.

Figure 2:3: Holger Pedersen Observes Silver Gelatin Glass Plate*, Niels Bohr Institute, 2015.*

Hubble's photograph of the variable star and Eddington's glass plate of the solar eclipse have both revolutionised our understanding of the cosmos. In contrast to terrestrial photography focusing on ground-based phenomena, astronomical photography allows us to obtain a wider view of our place in the universe. This cosmic perspective reveals how rare, if not unique, the conditions on Earth are in their ability to support living organisms. The planets that astronomers have discovered so far are extremely unlikely to be habitable for complex living organisms. At the time of writing, organisations such as Space X and Blue Moon intend for humans to travel to the planet Mars. However, the conditions on Mars are more hostile than the most extreme environments on Earth. Earth's formation tells a story of a distinct set of circumstances which allowed life to form. The Moon, oceans, tides, and proximity to the Sun are values that are unique to Earth. Amongst other attributes, these values allowed life on Earth to flourish over millions

of years. Today, humanity sits on a precipice of ecological devastation, which threatens the existence of humanity itself. It is vital to readdress our intimate connection with the stars, the cosmos, and the ecology of life on Earth.

In the following sections, I discuss how and why contemporary digital astronomical images are mediated. I then consider how the direct material link in analogue processes can formulate a more intimate approach with starlight and photographic materiality.

Mediations In Digital Astronomical Images

Contemporary astronomical photographs produced by institutions such as NASA are often altered for a non-specialist audience. In these images there are many levels of mediation that the viewer is not made aware of. In *Picturing The Cosmos: The Hubble Telescope and the Astronomical Sublime*, Elizabeth Kessler discusses how colours, crops and contrasts are added to make a photograph more appealing to a general audience (Kessler, 2012, Introduction). She goes on to suggest that these alterations are influenced by conventions of the sublime landscape seen in painters of the American West, such as Thomas Moran. The images are altered to such an extent that they are sometimes unrecognisable from what you might see through a telescope.

In 2015, astronomer Zolt Levay at the Space Science Telescope Institute described the process of creating a contemporary astronomical image of the Pillars of Creation, columns of gas and dust which form part of the Eagle Nebula (Levay, 2016). The name *Pillars Of Creation* is inspired by an 1857 sermon by Charles Haddon Spurgeon titled *The Condescension of Christ,* which describes the birth of

Christ (Devorkin and Smith, 2015, 67). To create an image of the Pillars of Creation for public consumption, Zolt Levay selected three black and white raw digital images from the Hubble Telescope, using different exposure times. Without the protection of the atmosphere of Earth, Hubble's digital photographs return noise from cosmic rays, which appear as glitches in the images (Kedmey, 2015).

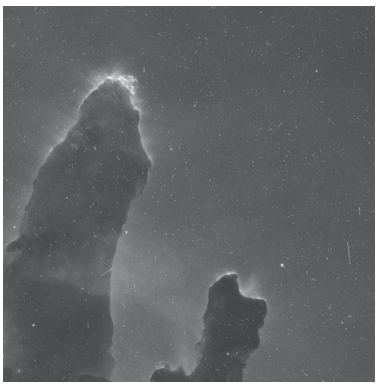


Figure 2:4: Zolt Levay, Pillars of Creation: Raw Data Image (Cosmic Ray Trails), *2017.*

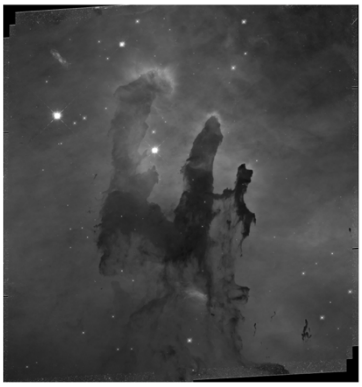


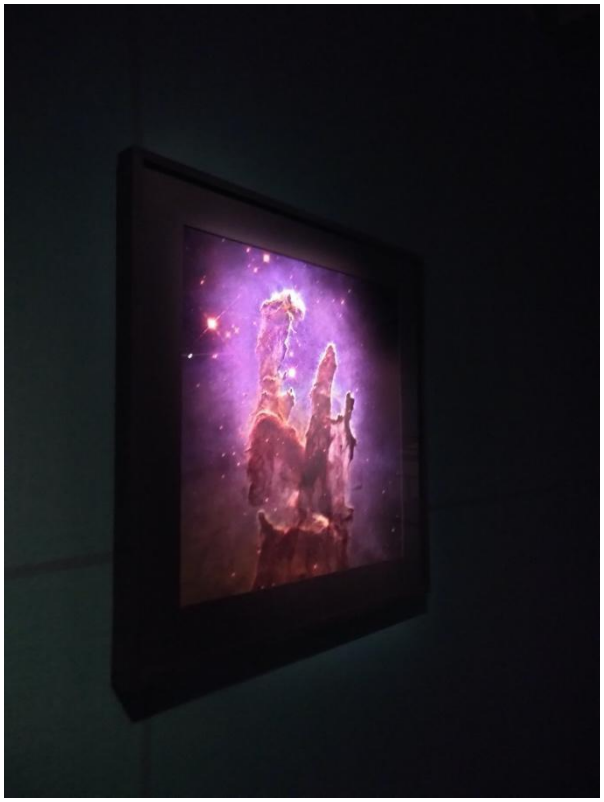
Figure 2:5: Zolt Levay, Pillars of Creation: Raw Data Image (Cosmic Ray Trails), *2017.*

Figure 2:6: Zolt Levay, Pillars of Creation: Red, Green, Blue*, 2017.*

When the three photographic exposures are combined, Levay can remove the evidence of cosmic ray trails. Individual exposures showing different parts of the nebula are then stitched together to produce one composite image, which does not show joined corners and artefacts from cosmic ray interactions with the sensor. Levay then adjusts brightness and contrast to accentuate parts of the nebula. In the context of *Pillars Of Creation*, the nebula is artificially brightened to have the same luminosity as surrounding stars. Hubble images often have artefacts which produce green and magenta tinges when grayscale channels are put together as an RGB composite. Levay counteracts these effects by colour correcting the image. Levay uses red, green and blue layers which correspond to chemical constituents that are found within the nebula, such as hydrogen and oxygen. These colours correspond to the Hubble Colour Palette (see Chapter One), which is used by astronomers to colour map stars and galaxies. The colours and contrasts are subtly changed to accentuate details inside the nebula that Levay wants to draw attention to. Levay then combines the red, green and blue images to create one full-colour image.

In 2017, I worked with Claudia Mignone at the European Space Agency and Levay

at the Space Science Telescope Institute to produce a lenticular print of this image. The lenticular print highlights the levels of mediation that an astronomical image goes through when produced for public consumption. On the left-hand side of the lenticular print, it is possible to see the black and white image produced by the sensor on the Hubble Telescope. On the right-hand side of the lenticular print, the full colour, high contrast image can be viewed. [17]



[17] Myself, Claudia Mignone and Zolt Levay produced a lenticular print of "Pillars of Creation" for "Altered Realities", an exhibition at the Lethaby Gallery, Central Saint Martins. https://www.arts.ac.uk/colleges/central-saint-martins/stories/altered-realities [Last accessed 04/08/2023]

Figure 2:7: Melanie King, Pillars Of Creation, *Lenticular Print, 2017. Exhibited at 'To The Edge Of Time', KU Leuven Gallery, Belgium, 2021.*

Figure 2:8: Melanie King, Pillars Of Creation, *Lenticular Print, 2017. Exhibited at 'To The Edge Of Time' KU Leuven Gallery, Belgium, 2021.*

Figure 2:9: Zolt Levay, Pillars of Creation: RGB Layers, *2017.* © Zolt Levay. All rights reserved.

Figure 2:10: Zolt Levay, Pillars of Creation: Full Colour Image, *2017.* © Zolt Levay. All rights reserved.

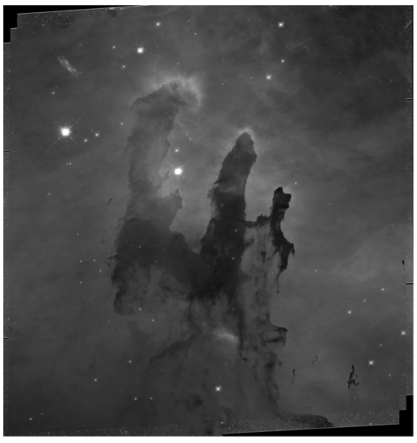


Figure 2:11: Zolt Levay, Pillars of Creation: Raw Data Image, *2017.* © Zolt Levay. All rights reserved.

This example of an astronomical image altered by Levay demonstrates that there are many levels of interventions that the viewer is not made aware of. In digital photography, light travels into the camera lens and is intercepted by a digital sensor which converts the light to electrical signals. This information is automatically coded and stored electronically. For those without a background in engineering, the idea of digital photography is difficult to grasp on a material level. When sophisticated photographic editing techniques are introduced, the quantity of mediations become much greater and therefore more complicated. These interfaces can include electrical components, hardware, and multiple operations using computer software. In contrast, analogue images (a print from the film) maintain a causal link with the cosmic phenomenon. As a result, analogue astronomical photography makes it easier for me to imagine the journey that light from a star must take to reach a reciprocate material.

The Direct Material Link

Whilst producing analogue photographs of the stars from dark sky locations (*for example, Figure 2:12)* I have been inspired by the concept of the direct material link and indexicality. These ideas have emerged from the process of working underneath starlit skies and working in the darkroom. All photographs capture light from the past, but astronomical photographs work on a much grander magnitude of time scale than photographs captured here on Earth. In terrestrial photographs, time separates the viewer from the missing being by months or years, rather than millennia. The act of capturing light from a distant star using photographic means is notable because it demonstrates the far-reaching possibilities of photography. The

photograph can maintain a link between subject and image across vast distances and time spans. The photographic surface is akin to the skin of a body which receives light from the past; the photographic surface is a lively, reciprocating medium.[18]

In the context of *Ancient Light*, the delayed rays of the starlight tangibly connect us to the star itself. Astronomy can prompt us to consider the very small fraction of time and space that humanity inhabits in the overall timeline of the universe. The stars I am photographing can be millions of light years away, yet their light is absorbed into the photographic film, something that I can handle and touch. For me, the *Ancient Light* negatives are analogous to other natural phenomena, such as meteorites or fossils, which are the material trace of processes that take extremely long periods of time. Like a meteorite or fossil, photographs are three dimensional objects comprising multiple layers: in this case the plastic base of the film, paper, gelatin and silver. Silver is formed in high energy supernova explosions, meaning that the silver present on Earth today was created before the planet formed. All the silver that is used in photography is cosmic in origin. It can be processed within the Earth, but new silver cannot be made; that silver is finite and therefore precious.[19]

[18] The relationship between skin and the photographic surface has been explored in a publication 'The Skin of The Image' edited by Beverley Carruthers.
https://ualresearchonline.arts.ac.uk/id/eprint/9080/ [Accessed 20 March 2024]

[19] In Chapter Three, I discuss how it is possible to reclaim silver from photographic fixer for reuse.

Figure 2:12: Melanie King, Ancient Light, Andalucia, Spain, *2019.*

Photographic materials and processes are dynamic, something which was made clear to me as I took part in a residency in the School of Metallurgy and Materials at the University of Birmingham with Dr Leah-Nani Alconcel in 2021. Here, we viewed silver nitrate, ascorbic acid, and light reacting with one another. We observed the crystallisation of silver in real time as it responded to light. Figure 2:13 and 2:14 show the silver nitrate crystallising under a microscope. The black and white image was produced using an optical microscope, whereas the colour image was created using a conformal laser scanning microscope with a polarised filter. The conformal microscope can produce scans which probes different layers in the observed medium, allowing the microscope to build up a topographic image. In addition, the polarising filter allows one to closely observe light refraction from the object. In the case of the silver nitrate images, the conformal microscope afforded an opportunity to view several dimensions of the silver nitrate crystals. Figure 2:13 shows the silver crystals using the optical microscope. The image is black and white and appears flat. Figure 2:14 shows the crystals at a higher magnification, using the conformal

microscope and a polarising filter. This zoomed in view highlights detail of the crystal structure, that cannot be seen with an optical microscope.

As I probed the material, I watched it morph and change, in a manner I had never observed before. This experience further cemented my understanding that the photograph is dynamic and multi-dimensional.

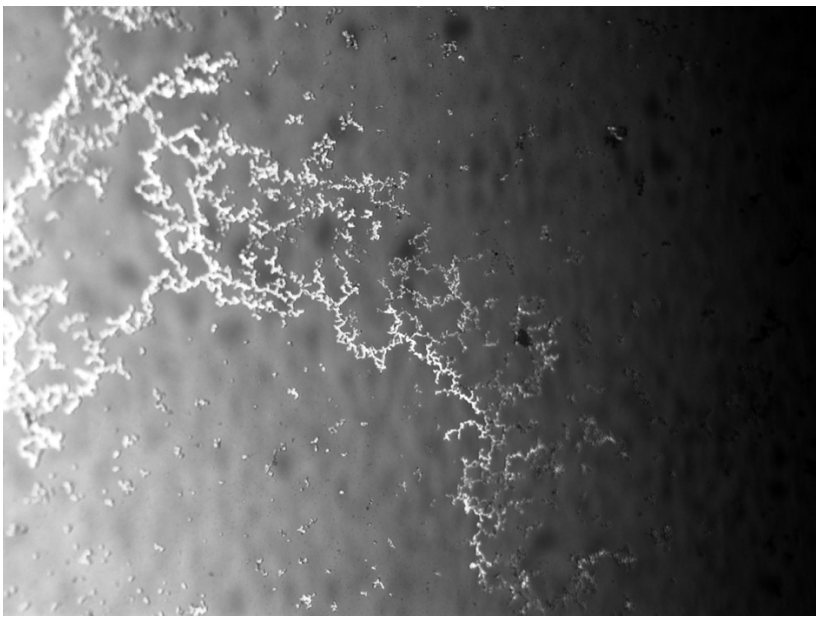


Figure 2:13: Melanie King and Dr Leah-Nani Alconcel, Silver Nitrate Crystallising*, Optical Microscope Photograph, University of Birmingham, 2021.*

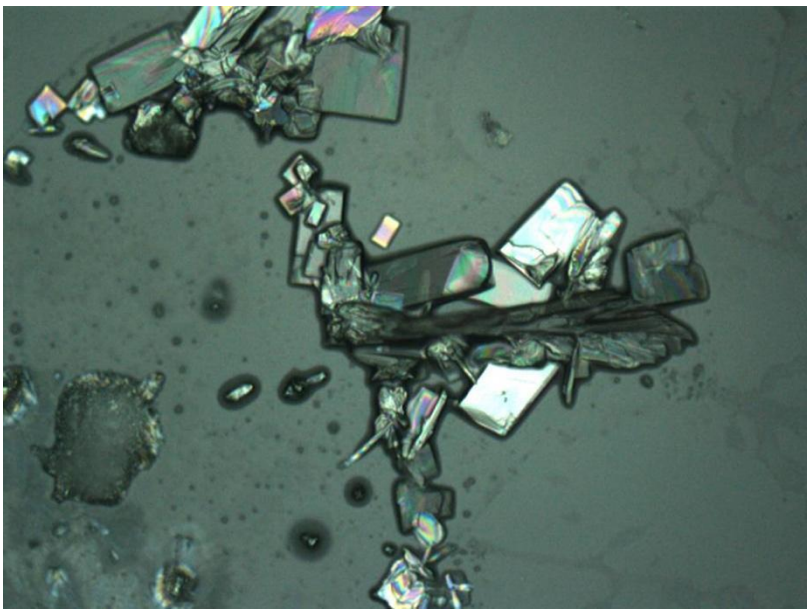


Fig 2:14: Melanie King and Dr Leah-Nani Alconcel, Silver Nitrate Crystallising*, Conformal Microscope Photograph, University of Birmingham, 2021.*

Elizabeth Edwards describes the photograph as a 'three-dimensional thing' in her text 'Photographs As Objects' (Edwards, Hart, 2004, 9). These materials transform over time, can be altered by environmental circumstances, and are subject to degradation. Edwards text is a reminder that photographs are both images and physical objects that exist in time and space, and thus in social and cultural experience.

In her preface to *Things: A Spectrum of Photography* (Haworth Booth, 2005), Marina Warner discusses photography in the context of the Victorian era, where photographs were kept with locks of hair to conjure memories of a loved one. Warner considers the photograph as a three-dimensional object, which can stand in place of another missing object. In this way, she suggests that photographs can be compared to relics 'through their celebrated relation with the dead and with

stillness, and they circulate among the group of viewers and set up bonds of knowledge held in common' (Warner, 2005, Introduction).

For me, it is possible to imagine the physical process of the photographic practitioner digging for something unexpected, or covering a body with preservatives. Garry Fabian Miller describes his practice as 'like excavating into the dark to bring an image into the world, just like archaeology.' (Miller, 2020). As Miller works in his studio, unexpected forms emerge from the darkness. Miller uses obsolete Cibachrome photographic paper, which cannot be reproduced. He is working through his supply of this precious material and considers that his project will be finished once the paper has been used up. To Miller, photographic materials are finite and precious, to be used with respect and care. Miller's use of the term *archaeology* refers to the process of discovery, working with materials that may provide unexpected results. Miller's practice has influenced me to work with organic materials in processes such as botanical cyanotype toning. Due to seasons or environmental conditions, cyanotype toning using foraged plants may vary in tone or contrast.

In connection to this, Jane Bennett's *Vibrant Matter: A Political Ecology of Things* (2010), discusses how materials can have agency. A good example of this is how materials can be used as evidence. Bennett tells a story of materiality with meaningful, lawful implications, based on her own experience of being on a jury panel. She describes how a Gunpowder Residue Sampler was used to convict a murderer as it provided microscopic evidence that the accused had been within three feet of a gun that had been fired. The actant can be used to make a legal decision, in Bennett's case, for the prosecution of a murderer.

> This composite of glass, skin cells, glue, words, laws, metals and human emotions had become an actant. Actant, recall, is Bruno Latour's term for a source of action: an actant can be human or not, or most likely, a combination of both. (Bennett, 2010, 9)

In *Assemblage Theory* (2011), drawing on the work of Deleuze and Guattari, Manuel De Landa suggests that an assemblage can only function if there are multiple parts that work together to create a whole. A mere collection of objects together is not what De Landa would describe as an *assemblage,* as an assemblage cannot be reducible. In other words, something new and specific happens when each of the parts come together.

> What is an assemblage? It is a multiplicity which is made up of many heterogeneous terms and which establishes liaisons, relations between them, across ages, sexes and reigns — different natures. Thus, the assemblage's only unity is that of a co-functioning: it is a symbiosis, a 'sympathy'. It is never filiations which are important, but alliances, alloys; these are not successions, lines of descent, but contagions, epidemics, the wind. (Deleuze and Guattari, 1972, 147)

In the example that Jane Bennett offers, it is the 'glass, skin cells, glue, words, laws, metals and human emotions' coming together to form evidence in the murder trial. In the context of assemblage theory, the *Ancient Light* works are an assemblage of parts (a star, a camera, a telescope, silver gelatin film, my body) that can only be formed when the correct components come together in the correct way.

The Photographic Index

Ancient Light has been influenced by the concept of the photographic index. Philosopher of language C. S. Pierce (1839–1914) coined the term *index* to mean a sign which is connected to the object it represents through causality, rather than through resemblance or convention — for example, the footprint of an animal, or smoke from a fire. This *indexical sign* is 'not the mere resemblance of its Object, but it is the actual modification of it by the Object' (Pierce, quoted in Buchler, 2011, 2). The term 'indexicality' has been borrowed by photographic theorists such as Liz Wells, arguing the *indexical materiality* of the photograph provides direct evidence of existence. Wells suggests that a key characteristic of photography is its dependence on a physical presence of the source of an image.

> The image stands as an index of the once physical presence. It is this indexical status which is the source of the authority of the image. (Wells, 34, 96)

In 2007, Mary Ann Doane recontextualised the index to account for digital technologies. Doane makes the point that digital means of recording 'face a certain crisis of legitimation' as 'the digital offers an ease of manipulation and distance from any referential grounding that seem to threaten the immediacy and certainty of referentiality we have come to associate with photography' (Doane, 2007, 1).

In the context of the *Ancient Light* series, starlight directly affects the photographic surface. In contrast to a terrestrial photograph, light has travelled for thousands, if not millions, of years through space. The implication of this photographic interaction is that we are viewing stars as they were a significantly long time ago. In addition to this, the stars occupy a space which is extremely distant from Earth. To

summarise, the analogue astronomical photograph maintains an indexical link, where light from a star interacts with photographic materiality, providing direct evidence of its immense journey throughout time and space.

Inspired by my reading on the direct material link and indexicality, I chose to exhibit negatives from the Ancient Light series in an exhibition at Blyth Gallery, Imperial College London (Fig 2:15. 2017). (This image is also visible in the adjacent portfolio, on page six).

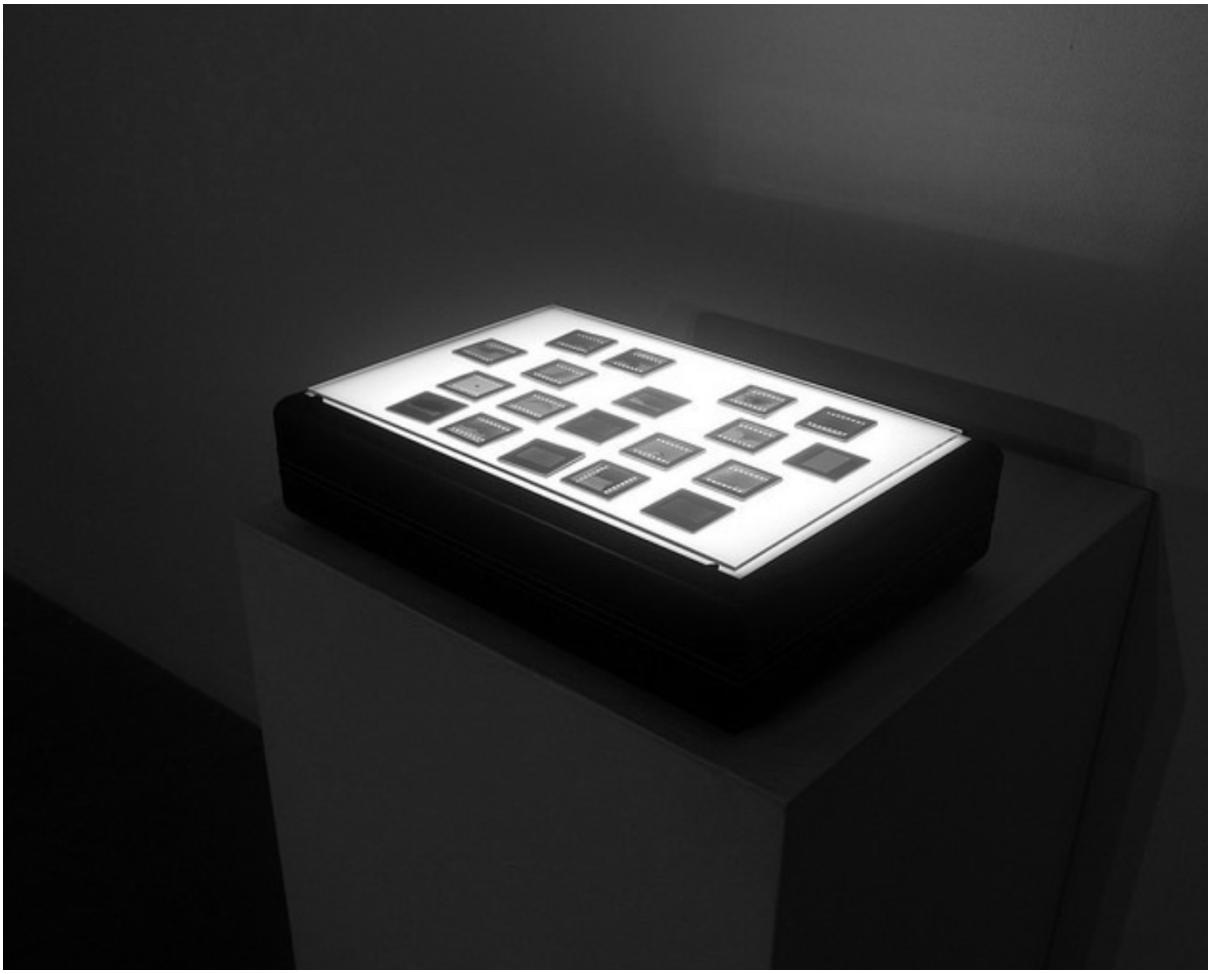


Fig 2:15 :Melanie King, Ancient Light, 35mm Silver Gelatin Negatives, Installation shot at Ancient Light, Blyth Gallery, Imperial College London, 2017.

Visitors to the Ancient Light exhibition at Blyth Gallery were able to directly view negatives that had been touched by starlight. I chose to exhibit the negatives in addition to prints that were made from the negatives themselves. In this exhibition, it was important for me to allow the viewer to experience photosensitive material that had been affected by distant stars.

In a film screening in June 2022 at the studio of artist Cathy Rogers in Ramsgate, I presented my 16mm film "Searching For The Moon" in negative (Fig 2:16), using a 16mm projector. The audience were able to view the 16mm physically travelling through the projector. Viewers were able to see film touched by moonlight and could experience small incidental scratches and marks produced by the projector itself. A small amount of marks from the films' journey through the projector can build up each time the film is played, and be joined by hairs and dust that are attracted from the environment where the film is played. In my experience of seeing my films projected through a 16mm projector, I have noticed that my film seems to be more scratched each time. Both exhibition opportunities exemplified the tangibility of analogue film touched by light emitted beyond our atmosphere. I further discuss these exhibition experiences in the section entitled 'Exhibiting Ancient Light' in Chapter Four.

Fig 2:16 Searching For The Moon, London, UK, 16mm Film, 2017. Projected in negative, Ramsgate, 2022. Approx. 1x1.5m projection

More Than Representation

Artist Rebecca Najdowski describes her photographs as ‘more-than representational'; she considers the ‘non-human agencies of photographic processes and materials, as well as environmental forces and conditions to produce artwork' (Najdowski, 2020, 3). An example of Najdowski’s work that exemplifies this is a series of cameraless photograms on silver gelatin paper produced by the artist, which were exposed to the emissions of a geyser on a field trip to Iceland. In Najdowski’s work, the silver gelatin paper interacts with a geyser, whose chemistry irreversibly alters the paper’s surface. Najdowski allows steam, water and minerals to fall onto the photographic paper, thus creating a mark. The geyser is now

indexically linked to the photographic paper, leaving a trace behind. This kind of interaction between natural phenomena, photographic materiality and humans has influenced the direction of my practice. I intend to further enhance this concept using sustainable photographic processes, as opposed to traditional developer and fixative, to produce artworks.

In her book *Nonhuman Photography* (2017), Joanna Zylinska also discusses the photograph as a phenomenon that is more-than-representational. In harmony with Marina Warner, Zylinska compares photography to the material process of fossilisation. However, in this context, she discusses fossilisation in relation to the Anthropocene, the proposed geological epoch relating to human impact on the Earth:

> Thinking photography under the horizon of extinction will allow me to draw two temporal lines in the history of this particular medium: one extended toward the past, the other — toward the future. If we consider the history of photography as part of the broader natural-cultural history of our planet, as I propose to do here, we will be able to trace parallels between photographs and fossils, and read photography as a light-induced process of fossilisation occurring across different media. Seen from this perspective, photography will be presented as containing an actual material record of life rather than just its memory trace. (Zylinska, 2017, 104)

Zylinska suggests that it is important to re-engage with the materiality of our environment, as it enables us to bring the prospect of extinction into our field of view. Referring to Haraway's criticism of an objective 'gaze from nowhere', Zylinska advocates for writing, theory, philosophy and photography as 'vehicles for enabling

a radically different set of arrangements for the world, after thinking of extinction' (Zylinska, 2017, 105). In addition to photography as a vehicle for thinking through extinction, Zylinska considers the materials of photography as entangled with the geology of the Earth. She describes how the materiality of photographs are formed using materials that have been extracted from the Earth and can therefore be compared to fossils as both are impressions of soft organisms impressed onto harder forms. In this way, Zylinska suggests that photography is not a new process, but instead a 'modern mediated extension of the ancient-long impressioning activity enabled by light, soil and various minerals' (Zylinska, 2017, 111).

Ephemeral impressions with light have existed long before the invention of photographic fixer. A pinhole was used to safely observe the solar eclipse by Aristotle in 4th century B.C. and was documented in Leonardo da Vinci in Codex Atlanticus (Taggart, E. 2020). In addition to this, photosensitive plant materials have interacted with light before the invention of photography. As Fabbri notes, the use of vegetable juices and their reactions with light were observed by Henrich August von Vogel in 1816 (Fabbri, 2016, 12).

Non-Human Influences and Impressions

There are several photographic artists whose practice is influenced by non-human impressing. In her *River Taw* series (1997-2019), Susan Derges steps into a local river to create camera-less photographic prints. Derges' photographs were influenced by a walk, where she saw a still pond with frogspawn. The sun illuminated the pond and allowed shadows of the frogspawn to be temporarily printed onto the bottom of the pond. Derges then returned to these bodies of

water at night, placing pieces of photographic paper underneath the surface of the water, before flashing her torch to create an imprint of the small waves.

> The River Taw flows from its source in the high ground of north Dartmoor to the north Devon coast near Barnstaple. Its journey is one of change, growth, maturation and disposal. It's a long transparency embodying an infinite number of liquid states. I think of it as a living entity reflecting a human microcosm. A brief moment in the constant movement of the river is exposed onto the paper with flash light, making visible the information and flow from contained within particular states that are never repeatable and always surprising. (Derges, 1997, 3)

Derges is intrigued by nature's emergent patterns, which Martin Kemp describes as 'underlying visual music of physical phenomena':

> Systems that are constantly changing are found to be extremely sensitive to their initial state and as the system evolves in time, small fluctuations can be amplified to produce enormous change differences resulting in totally new 'self-organised' structures. It is nature seen as process and as creative evolution, transformation and emergent order, where the creation of form exists at the edge of chaos (Kemp and Derges, 1999, 1).

These chaotic instances allowed Derges to repeat the process of immersing a piece of photosensitive paper into the river and exposing it to light, without ever capturing the same result. As Derges says, the River Taw never flows in the same state, which leads her to think of her own experience of nature and the concept of time itself. In his essay 'Music of Waves', Kemp compares Derges' practice and exploration of fluid thought to the poem 'Water' by Kathleen Raine, which he

describes as a 'flow of fluid allusion to water-forms, simple organisms, time and individual human existence'. (Kemp and Derges, 1999, 3)

Similarly, Garry Fabian Miller's practice is influenced by walking in Dartmoor. He walks repetitively in a very small area, allowing for an intimate understanding of the landscape.[20]

> Something happens which is incommunicable, and it can happen in a work of art, or it can happen in a moment in the landscape when you're walking, and something occurs, a certain kind of light touches the landscape or in your home — light comes into a room, and something else seems to be in the room with you and you feel it. (Barnes and Miller, 2020)

In his walks, Miller allows for unexpected events to occur, encountering phenomena which may be influenced by seasonal changes or a change in light. These experiences are a catalyst of inspiration, which prompt him to make new works. Miller is also concerned with the preciousness of materials, as he works with his limited supply of Cibachrome paper, as mentioned above. Miller considers that photography as we know it will one day change.

> We're in the kind of in between times where both chemical and digital photography exist. I think that eventually chemical photography will fall away.

[20] In addition to Gary Fabian Miller and Susan Derges, many other artists are working in a responsive way with natural phenomena. Artist Adam Fuss has produced photographic prints using spores that are left behind by mushrooms. (Fuss, 1996). Similarly, In the *Last Analog Photograph,* Hans Danuser works with the materials embedded within photographic paper, processing them in particular ways to allow different elements to surface. (Danuser, 2017).

(Fabian Miller, 2020)

While I concede that silver is finite and cannot be created on Earth, I do believe that chemical photography can continue with renewable, plant-based materials. As the most prevalent materials in analogue photography are silver gelatin and iron-based materials, the photographic industry has left scars on the surface of the Earth. The impressioning of photography is not confined to the printed image but is extended to the deep chasms in the landscape left when precious metals are extracted. Zylinska believes that the consideration of materiality in photography and the acknowledgement of non-human photography helps us to consider the photograph as what Najdowski would describe as *more-than-representational*. The photographic subject and its materiality are implicitly entangled and cannot easily be separated from one another. From my perspective, it is then problematic to continue producing photographic work documenting the connection between humans, Earth and the cosmos whilst contributing to its destruction using unsustainable photographic processes. In Chapter Four, I discuss how I have used several sustainable photographic processes to reduce the environmental impact of my practice.

The photographic indexical sign has long been discussed in relation to light reflecting or emitted from an object, a trace upon a reciprocating material. However, in this instance, it becomes clear that the developer itself leaves its own indexical trace. These prints are distinct from contemporary astronomical images as there are two visible layers of non-human interactions during their production. The first takes place as starlight interacts with the silver halides present in the film. The second takes place as the photographic paper interacts with an organic developer.

As Katve-Kaisa Konturri describes, the final print is informed by the artist, who allows the materials to have an active role in the process.

> The emphasis is on artistic actions that are more than human, meaning the materialities have their own active role in the process, they are not mastered by the artist alone… the expressive and agential potentialities of matter are taken seriously because of the emphasis. The concept of collaboration is extended to include co-working with vital materialities of art, of paint, light, canvas and bodily movement for example. (Konturri, 2018, 18)

The *Ancient Light* prints produced with organic developers allow materials to have their own dynamic role in the process. As an artist, I set up the circumstances to allow the print to be made, but do not have full control over the result. Considering the photograph as a three-dimensional object prompts a more sustainable approach to using photographic processes. It is easier to conceive of an analogue photograph as a material object which can tangibly affect the ecological systems of our planet.

Environmental Impact of Photography

In this section, I will briefly discuss several analogue and digital photographic processes that have a negative impact on the environment. The materiality of the photographic industry is highly problematic, damaging the environment and surrounding communities. In 2019, I attended a series of workshops entitled The Stuff of Photography at The Photographers' Gallery, led by Dr Michelle Henning and Dr Rowan Lear. In these workshops I was made aware of the environmental

impact of both analogue and digital photography and began my own inquiry into this subject. [21]

The environmental concerns surrounding nitrate recently came under observation by Ignacio Acosta, Xavier Ribas and Louisa Purbrick in a study entitled 'Trafficking the Earth' (2019). The project focuses on depletion of mineral wealth in Chilean landscapes. Nitrate and copper are pulled from the earth and the waste deposits are left to fester in the Atacama Desert. 'Trafficking the Earth' highlights the use of nitrate in the photographic industries and discusses the violence of mining on an industrial scale.

> Twentieth century Chilean political history is revealed in that of nineteenth century nitrate mining. The thwarted attempts by Jose Manuel Balmaceda to restrict foreign control of natural resources in the 1880s foretell and echo that of Salvador Allende in the 1970s. But there is no need to rely upon literary devices such as allegory: following the USA instigated military coup, General Augusto Pinochet used the ruins of the nitrate industry as prisons for the workers and students of the Chilean left. (Acosta, Purbrick & Ribas, 2020, 17)

As Acosta, Purbrik and Ribas have illustrated, analogue and digital photographic processes are inextricably bound up with global geo-political issues surrounding mining and extraction.

[21] For further reading related to the environmental impact of photography, refer to Professor Michelle Henning; 'The Worlding of Light and Air: Dufaycolor and Selochrome in the 1930s' (2020) and Dr Rowan Lear: 'A Photographing Body' (2021).

It is not only nitrate which raises questions about the sustainability of photography. In *Animal Capital: Rendering Life in Biopolitical Times* (2009), Nicole Shukin explores the use of gelatin in photographic processes. Gelatin is a protein taken from farm animals such as cows and sheep; it is a by-product of the meat industry. The environmental impact of gelatin is inextricably tied to the meat industry, which has a significant impact on the emission of greenhouse gases (Milman, 2021). Shukin argues that the use of gelatin is especially problematic as its presence in photographic processes is often obscured. Shukin makes the claim that gelatin usage in photography and film is obfuscated: the term 'silver-gelatin print' is rarely connected to its material origin. She highlights the fact that gelatin is barely registered as a material, despite having been widely used in photographic processes since 1873.

> The actual material consists of the leavings of tanneries and slaughter-houses i.e. trimmings, so-called skips, ears, cheek pieces, pates, fleshings etc. The suturing tissue of animal bodies is exchanged for what Sheppard calls the 'physiological and biochemical unity' of image life in the duplicit, material symbolic rendering of animals that helped to leverage cinema into historical existence. In the material convolutions of photographic and film stocks, in the viscosity of their 'negative gelatin emulsions', resides an opaque politics of rendering. (Shukin, 2009, 104)

Shukin's text is written in the context of moving image and cinema. However, the materiality of film in moving image and still photography is almost identical. Traditional analogue black and white photography has its part to play in the

casualties of the meat industry. In addition to Shukin, Michelle Henning discusses gelatin usage in photography in *Photography: The Unfettered Image*:

> By the start of the twentieth century, the manufacture of gelatin-based photographic emulsions was already a massive business dependent on the industrialised slaughterhouses. By the 1890s, one of the biggest manufacturers of photographic materials was the Lumière company in Lyon… The Lumières' competitors included the American photographic company Eastman Kodak, and the German chemical giant Agfa… By 1999, the Wall Street Journal could report that Kodak was still processing 80 million pounds (in weight) of cow skeletons at this plant every year. (Henning, 2018, 97–98)

Digital technology is no more absolved from environmental guilt. In *Liquid Crystals: The Science and Art of a Fluid Form* (2018), Esther Leslie describes the pollution which is created by the production of Liquid Crystal Displays. LCD screens are made of rare earth minerals and metals, mined in a similarly destructive process to that used for nitrate. Leslie describes a toxic lake in Baotou in Inner Mongolia, contaminated by industrial waste from these factories. She is critical of the extractive method of production for LCD screens:

> The landscape's minerals are splintered into tiny parts and distributed on the surfaces and inside the box that is supposed never to be opened, at least not until its life's end and even then not. From under the ground, from immense cavernous holes in the earth, from brown rock and mud, smashed and grabbed from the crust, elements take up residence inside the glossy pebbles, the black boxes, the smooth white slabs, the rose-gold gewgaws. (Leslie, 2018, 29)

Similarly, in the paper 'Coltan, The Congo and Your Cell Phone' (2011), Ewan Sutherland describes mineral extraction in the Democratic Republic of the Congo, with specific connections to mobile phone usage.

> The connection between your mobile phone and the war crimes and human rights violations committed for more than a decade in the eastern part of the Democratic Republic of the Congo (DRC) lies in the metallic ores found there. The ores contain metals valued for their use in a range of high technology products. By controlling the mining, in order to impose a 'tax' or simply to expropriate the ores, a variety of armies and militia, regular and makeshift, domestic and foreign, have found the means to continue their conflicts, including the purchase of arms. A strong correlation has been shown between valuable resources and civil wars. (Sutherland, 2011)

The unsustainability of digital media has also been explored by theorist Jussi Parikka. He is keen to communicate the magnitude of geological time involved in producing minerals and metals that we use in computers and digital cameras.

> It is the lens of media art practices and theoretical discourse that offers us a specific way to look at the recent years of climate change, the Anthropocene, and geophysics-embedded work: the ideas about deep time of the media, psychogeophysics, e-waste, the Anthropocene, chemistry, and the earthly as a media history that works in nonlinear ways. This idea of media (art) histories as one of nonlinear strata pushes even the media archaeological agenda of media history to its extreme. Human history is infused in geological time. (Parikka, 2015, 4)

Heavy metals such as silver and platinum were created during high energy supernovae, embedded inside the Earth as it formed at the beginning of our solar system. Over millions of years, the metals transformed as the Earth's tectonic plates migrated and altered. In the past two hundred years, these metals have been dug from the Earth and used in a myriad of technological devices.

> We have shifted from being a society that until the mid-twentieth century was based on a very restricted list of materials (wood, brick, iron, copper, gold, silver and a few plastics) to the fact that even a computer chip is composed of 60 different elements [...] Media history is conflated with earth history, the geological materials of metals and chemicals gets deterritorialized from their strata and re-territorialized in machines that define our technical media culture. (Parikka, 2015, 35)

Zylinska and Parikka demonstrate that the environmental impact of digital photography is considerable, though the reality of its negative effects on the ecology of Earth are often hidden from our view. Corporations such as Apple build planned obsolescence into the devices that they produce, so that consumers are forced into purchasing a new phone every year. The electronics in contemporary phones are often made using extremely small components. This means that the average consumer is not able to fix their device themselves, as they may have been able to in the past. Consumers then become reliant on ongoing expensive repair schemes, and corporations can maintain income.

As a response to this research into the environmental impact of current photographic practice, I have produced several artworks using photographic

processes which are kinder to the Earth. These projects will be set out in Chapter Four and the accompanying portfolio. While these contributions are small, they are a direct action of an individual in response to the serious environmental impacts of climate change.

Hope

In a time of ecological crises and ongoing warfare, it can be difficult to find motivation. However, it is important to acknowledge hopeful actions, considering how activism and hope can inspire constructive movement. Solnit's book *Hope In The Dark* (2005) addresses climate change and war with a call to action:

> Political awareness without activism means looking at the devastation, your face towards the centre of things. Activism itself can generate hope because it already constitutes an alternative and turns away from the corruption at the centre, to face the wild possibilities and the heroes at the edges or at the side. (Solnit, 2005, 24)

Solnit's call for activism in the face of darkness chimes with Haraway's notion of *staying with the trouble*. In response to the gravity of the Anthropocene, Haraway warns against two possible reactions. The first is a dangerous amount of faith in the possibility that technology could save us from catastrophe. The second is nihilism:

> a position that the game is over, it's too late, there's no sense trying to make anything any better, or at least no sense having an active trust in each other working and playing for a resurgent world. (Haraway, 2016, 3)

The term *Anthropocene* is used to describe a geological era defined by human impact on Earth's ecological systems. The term was popularised by chemist Paul J. Crutzen but has been criticised for a number of reasons. One critique of the term is that it infers the action of *all* humans.

> The rhetorical 'we' of Anthropocene discourse smooths over severe inequalities and universalities the site-specific consequences of environmental damage. The designation of this epoch as the 'age of man' also seems like our crowning act of self-mythologization and as such only to embed the technocratic narcissism that has produced the current crisis. (Macfarlane, 2019, 77)

Nevertheless, the Anthropocene is a useful term to describe humanity's effect on the planet. Humanity has existed for only a small section in the timeline of Earth's history, yet humans have altered the planet significantly since the industrial revolution. As Robert Macfarlane says,

> [i]t exposes both the limits of our control over the long term processes of the planet and the magnitude of the consequences of our activities. [...] Perhaps above all the Anthropocene compels us to think forwards in deep time and to weigh what we will leave behind, as the landscapes we are making now will sink into strata, becoming underlands. What is the history of things to come? What will be our future fossils? As we have amplified our ability to shape the world, so we become more responsible for the long afterlives of that shaping. The Anthropocene asks of us the question memorably being posited by the immunologist Jonas Salk 'Are we being good ancestors?' (Macfarlane, 2019, 78)

Thinking on astronomical and planetary timescales allows us to consider a wider perspective, a future which is not limited to our human lifespan. Organisations such as the Long Now Foundation urge us to consider the future ten thousand years from now. On their website, the Long Now Foundation describe themselves as an organisation which 'hopes to provide a counterpoint to today's accelerating culture and help make long-term thinking more common. [They] hope to foster responsibility in the framework of the next 10,000 years' (Chabon, 2006).

It strikes me that the crises we are facing today have long been predicted. At the same time, many innovations have arisen, meaning that we are ever closer to our goals of transferring to sustainable alternatives — for example, renewable energy sources and biodegradable packaging. Solnit, Haraway, and Macfarlane encourage us to face up to the terrible catastrophes that we see on the news every day without sinking into despair. These thinkers encourage us to act in whatever ways we can. This practice-based research contributes to this call for action, suggesting several methods which reduce the environmental impact of photographic practice.

> Our task is to make trouble, to stir up potent response to devastating events as well as settle troubled waters and rebuild quiet places. (Haraway, 2016, 1)

Throughout this research, I have had the privilege of working with many scientific institutions. This unique access to cutting-edge scientific research has instilled hope in me on many occasions.

Robin Wall Kimmerer discusses her experience of being a Native American woman alongside her practice as a botanist. She compares the different strands of her experience to the ancient practice of braiding sweetgrass, where different strands

become one whole. As a scientist, Kimmerer does not accept that science holds all the answers, pointing out that indigenous stories have often preceded discoveries made by science. Kimmerer hopes that ancient, indigenous elders may one day be consulted as scientists are:

> I dream of a world guided by a lens of stories rooted in their revelations of science and framed with an indigenous world view — stories in which matter and spirit are given voice. (Kimmerer, 2013, 346)

Both as a botanist and as a Native American, Kimmerer is extremely concerned about the ecological issues that the Earth is facing. However, Kimmerer is hopeful for a reparation between humans and the land.

Anna Lowenhaupt Tsing's *Mushroom at the End of the World: On The Possibility of Life In Capitalist Ruins* (2015) considers what it is to live in a world that is already suffering from the effects of climate change brought on by capitalism. Tsing's book points out that we are living in extremely precarious times, as many species are under the threat of extinction and tides are rising faster than we thought possible. The unknown can be daunting, but it can also give rise to new innovations and ideas. The future is not yet determined, and there is still time for change to happen. In the next section, I discuss how several artists are working individually and collectively to solve issues with sustainability in the photographic industry.

Innovations

In this chapter, I have discussed the negative impact of analogue and digital photography processes on the environment. I acknowledge that my own writing and

practice is facilitated by these problematic materials used in digital and analogue processes. This research aims to highlight environmental issues related to technology, whilst providing possible solutions to specific material and environmental problems. Greater understanding of our current ecological crisis through worldwide investigation and reporting has led to innovations in many different areas. This chapter has also discussed the silver gelatin used in photographic processes that has strong connections to the meat industry. Analogue photographic processes have recently come under scrutiny - artists have responded accordingly. In this section, I discuss several artists who have reduced the negative impacts of their practices on the environment.

This chapter has also discussed the silver gelatin used in photographic processes has strong connections to the meat industry. For example, Josephine Ahnelt has recently produced a vegan film using polyvinyl alcohol or PVA, which has been used for 16mm film production and Martha Gray has produced cyanotypes that are mixed into a gelatinous bioplastic formed from agar. Similarly, artists Hannah Fletcher and Alice Cazenave have produced a cyanotype on a type of bioplastic using a kombucha SCOBY (Symbiotic Culture of Bacteria and Yeast).

Figure 2:17: Josephine Ahnelt, Vegan 16mm Film Still.

Figure 2:18: Martha Gray, Cyanotype, Bioplastic*, 2021.*

Figure 2:19: Hannah Fletcher and Alice Cazenave, Cyanotype, Kombucha SCOBY*, 2020.*

Shop bought film developers contain hydroquinone, which can be harmful for aquatic organisms. Film makers Julia Emily Parks and Dagie Brundert have produced black and white 16mm film developers using seaweed, bicarbonate of soda and vitamin-c. [22] In Chapter Four, I will discuss how I have modified their recipes to produce a developer for 35mm and medium format film.

[22] One can view the work of Dagie Brundert and Julia Emily Parks here:
https://juliaparks.co.uk/seaweed-stories/
https://www.dagiebrundert.de/ECaffenol.html

Fig 2:20: Julia Emily Parks, Still from Salty Yarns BBC Bladderwack 16mm Film*, Seaweed Film Developer from Roa Island, Cumbria, 2018.*

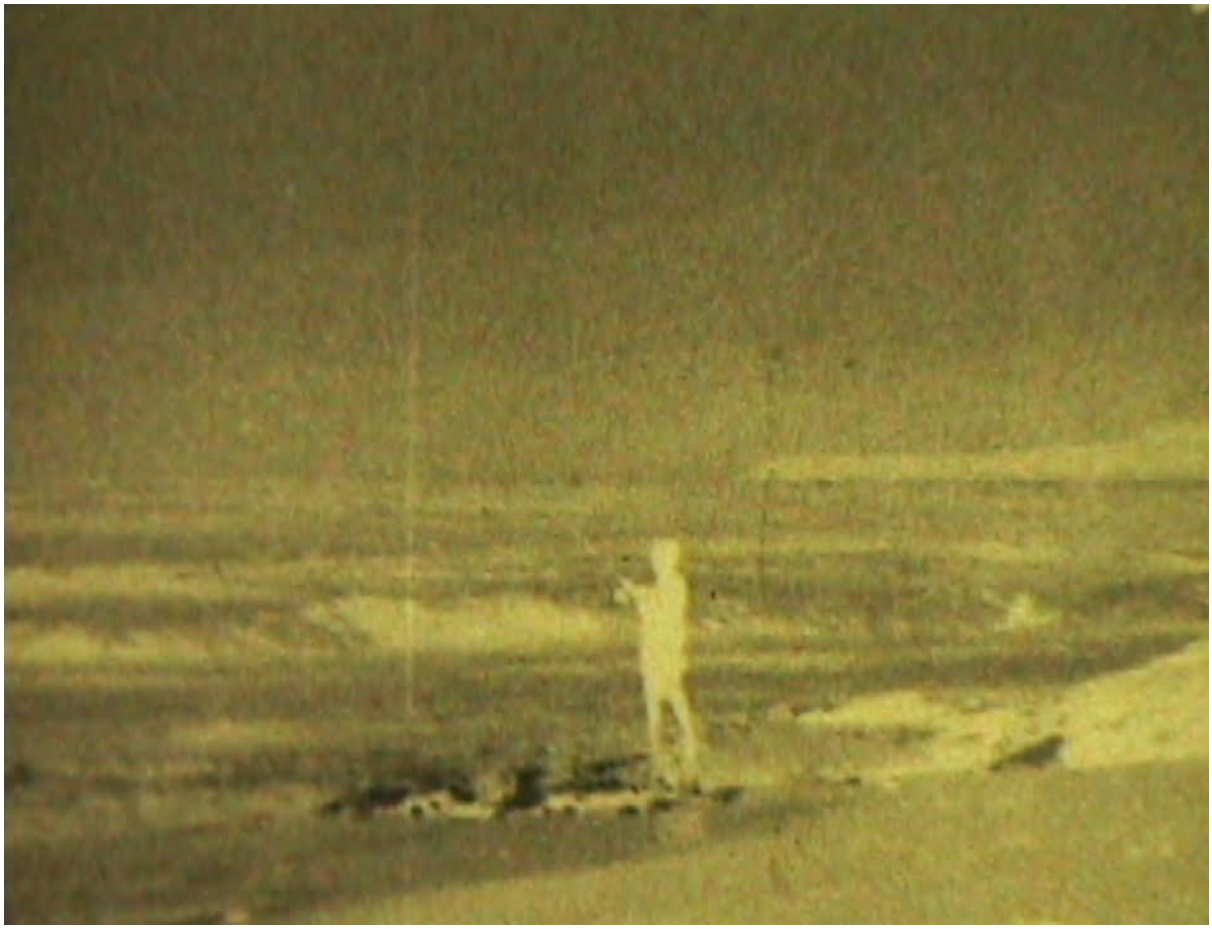


Figure 2:21: Seeschmodder, *Dagie Brundert, 2014. Seaweed Film Developer For Super 8 Plus.*

In February 2024, I became a trustee of the Sustainable Darkroom CIC, after informally collaborating with the group since its inception in 2020. As part of The Sustainable Darkroom project, Hannah Fletcher has produced a publication with the title *This Is Not A Solution* (Fletcher, 2019). I have contributed to the publication, by sharing a seaweed developer recipe. [23]

The book is a provocation, which breaks down the current state of analogue photography into its constituent parts. The book urges the reader to consider their own use of resources such as silver, plastic and water, and offers a few sustainable alternatives. However, the text concedes that it cannot yet offer a complete solution to issues of sustainability in photography. *This Is Not A Solution (Fletcher, 2019)* views the sustainability of photography as an entity which is constantly being revised — it is fluid and open to alteration. The sustainability of photography is not a fixed and complete set of rules; it must change and adapt as new technologies arise. The innovations mentioned below show small-scale alternatives to plastic and gelatin, produced by artists with limited means.

None of these examples currently represent an ideal alternative to silver gelatin film or plastic, as they are very much in their first stages of development. However, they do offer a glimpse into a potential future where analogue photographic processes can exist in symbiosis with the environment. If adopted by larger scale organisations, these innovations could have a huge impact on the sustainability of the photographic industry.

[23] *This Is Not A Solution* is a self-published book, which can be viewed online:http://www.londonaltphoto.com/shop/this-is-not-a-solution/ [Accessed 08/07/2023].

In the field of digital photography, there are several artists who are working to reduce electronic waste. Artist Levin Haegele repurposes obsolete *point and shoot* digital cameras to produce low-cost infrared cameras. Similarly. Michael Golembewski has recycled an old desktop scanner, housing the scanner into a camera obscura made from a cardboard box, which ultimately produces glitched images. Artist Brendan Barry recycled an obsolete television to create an 8x20 large format camera. Barry then used the camera to produce detailed photographs of the electronic circuits from the television itself. The act of documenting the circuit highlights the labour and craft needed to create analogue electronics.

Figure 2:22: Levin Haegele, Dedham*, Infrared Photograph, 2017.*

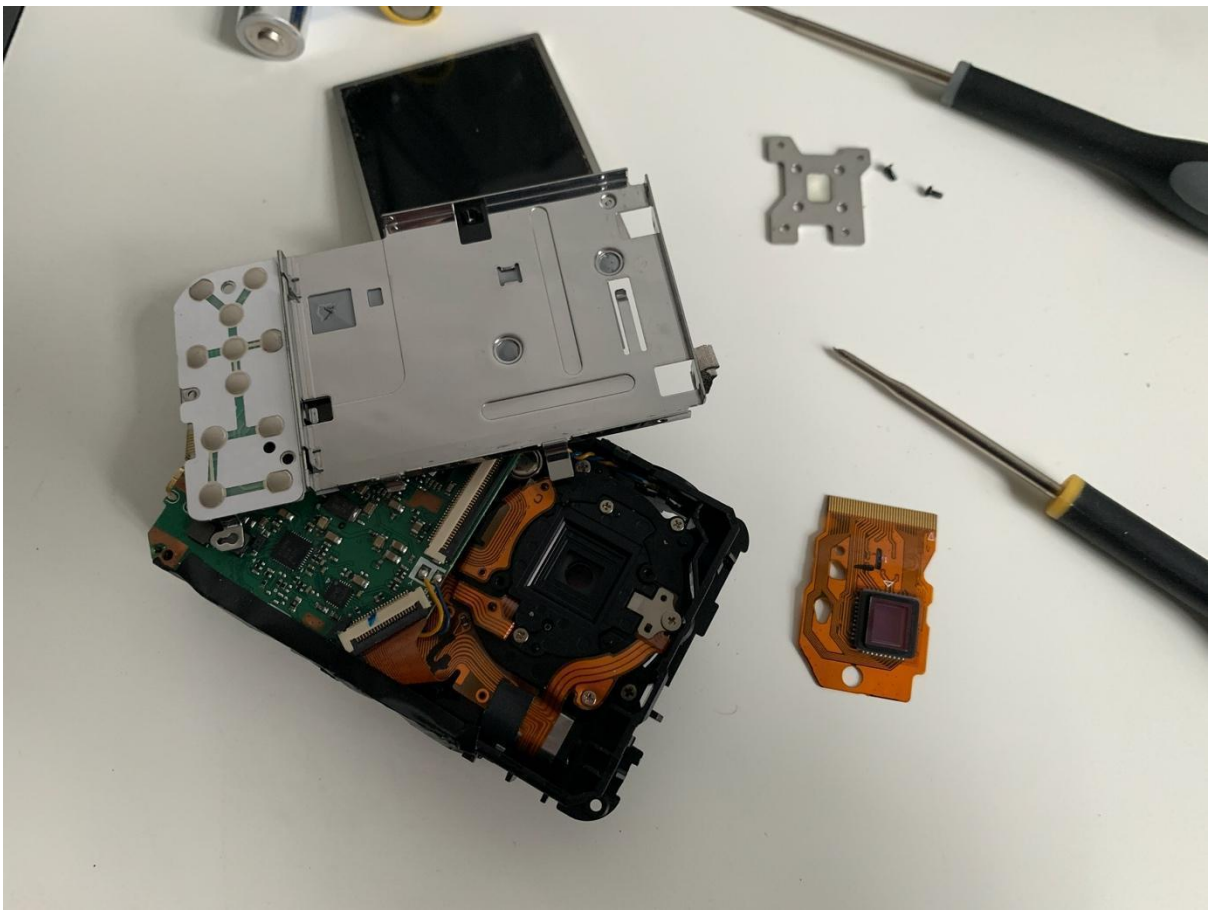


Figure 2:23: Levin Haegele, Infrared Sensor Removal, *2022.*

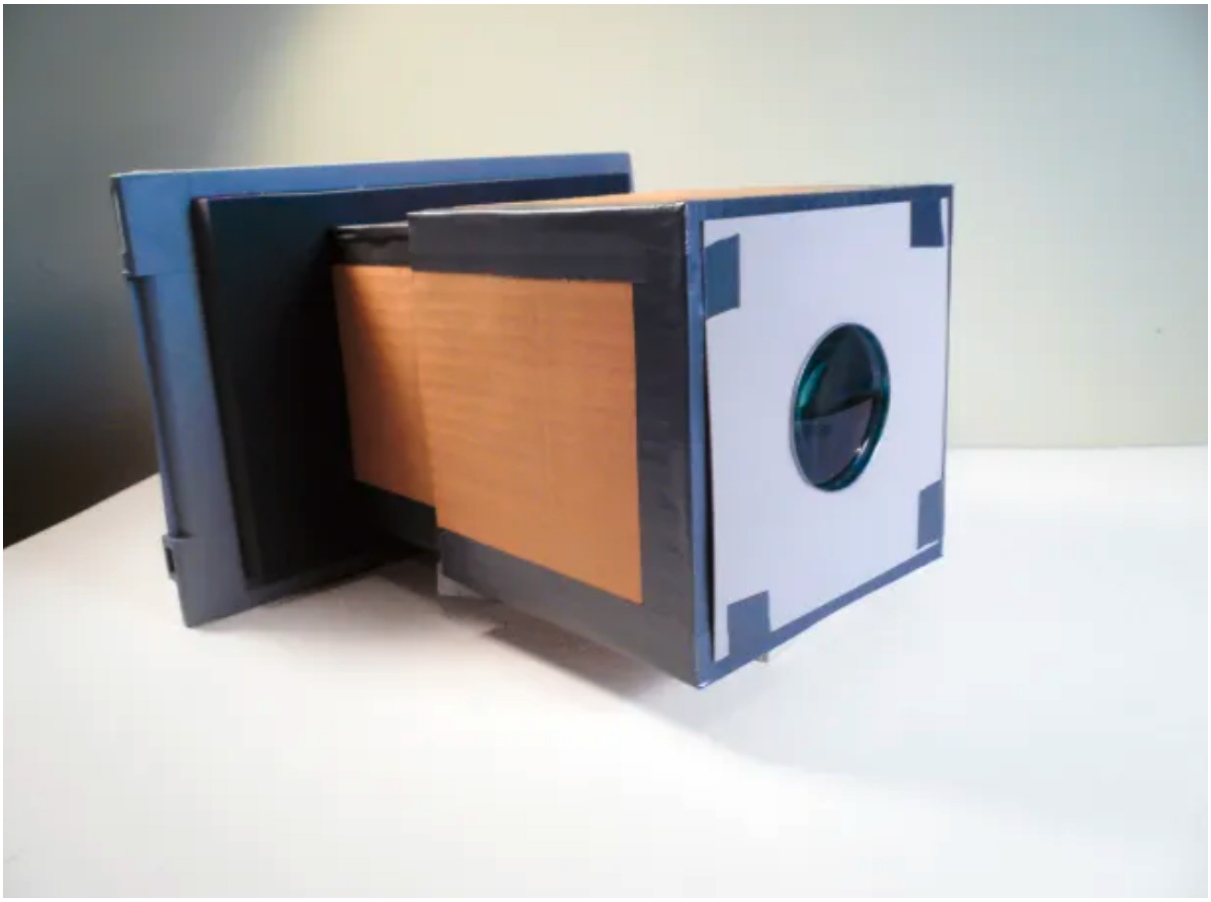


Figure 2:24: Michael Golembewski, Scanner Camera*, 2012.*

Figure: 2:25: Michael Golembewski, Scanner Camera Photograph, *2008.*

Figure 2:26: Brendan Barry, 8x10 TV Camera*, 2019.* .

To summarise this section, I have presented several artists who have provided innovative solutions to environmental concerns caused by analogue photographic processes. These contributions may appear tiny in the face of ongoing ecological catastrophe. Sometimes it can be difficult to understand the purpose of making such a small offering. However, the actions made by these artists can generate wider impacts as they work towards common sustainability goals.

In the following chapter, I will discuss new materialism and its connection to sustainability and cosmic materiality. I will consider how theorists such as Jane Bennett and Karen Barad alter our perspective on the intimate material connections between human and non-human beings. I will then extend Barad and Bennett's concepts of vibrant materiality and entanglement out into the cosmos, to further highlight humanity's intimate material connection with phenomena existing in deep space. In Chapter Four, I will then discuss my own innovations within sustainable photographic practice.

Chapter Three: Cosmic New Materialisms

In this chapter I will consider how looking at materiality from a planetary perspective can alter our perceptions of ecology. I will consider new materialist theories from Jane Bennett, Karen Barad and Timothy Morton, whose work considers the intimate connections between humans and non-humans. I will then consider the materiality of phenomena originating in outer space through the lens of new materialism, and the implications of these ideas when extended out to the universe at large.

Materialism

The universe is constantly in a process of material transformation. We currently inhabit a unique period in time and space when life on Earth can exist, due to the specific cosmic environment that we find ourselves in. Earth is positioned close enough to the Sun to benefit from life-giving processes such as photosynthesis, but far enough away from the Sun so that it does not receive too much radiation and heat. Humans have existed for a brief moment in the Earth's overall timeline, as it took 3.5 billion years before single cell organisms developed into complex life forms (Stetka, 2017.) Of these 3.5 billion years, modern humans have existed for 200,000. Humans have lived in and with the environment, responding to seasons and environmental changes in order to survive. In the past two hundred years since the industrial revolution, human activity has released large amounts of carbon dioxide into the atmosphere, which has irreparably altered the Earth's climate. Levels of carbon dioxide have increased and decreased throughout Earth's history (Mulhern, 2020). However, we now stand at a point in history where high levels of carbon

dioxide in the atmosphere are present due to human activity.

We are living in a time of ecological catastrophe. The oceans are slowly rising due to high carbon emissions (Solomon, 2009). The sea is polluted by plastic (Parker, 2019), and wildfires have begun to encroach on places that were previously untouched (Gutiérrez, Kirk, Watts, Hulley-Jones, 2019). Many people in developed, technologically rich environments are currently living out of balance with the natural world; in these environments, it is difficult to think of the materials we use or where they come from. It is therefore vitally important to examine our material connection with the universe and our planet. Artists have their own relationships with materiality — witnessing and putting into action material transformations. The painter, for example, can have a kinship with a certain process such as egg tempera. The ceramicist becomes aware of the idiosyncrasies of certain clays and glazes, considering the organic origin of their production. The printer, too, can have a deep understanding of the composition of papers and inks that they use daily.

The study of materiality can also allow us to imagine different magnitudes of time. During a time span of thousands, if not millions, of years, mountains develop and land masses move together and apart. Indeed, rock could be described as fluid, if considered outside of the human lifespan. In geological science, the principle of *original horizontality* enables us to conceive of time through segments of layered rock. Sediment is deposited horizontally and compressed through the action of gravity. Geologists use this principle to study the dynamic forces working inside our planet over vast magnitudes of time, as tectonic plates separate and collide. Though we cannot ourselves witness the long processes of tectonic plates colliding, we can see traces that are left behind. As a result, these layers of rock can then be used by scientists as a dating technique to analyse folding and tilting patterns. My

photograph *The Principle of Original Horizontality* was created on a visit to Chamonix in 2013 in the Alps, an area where mountains formed due to the collision of tectonic plates. Over the course of more than 23 million years, the Alps have been forming where the European and African plates converge. In the Alps, we can touch this ancient rock and observe the strata. Geological time describes one magnitude of time, which relates to the formation of Planet Earth.

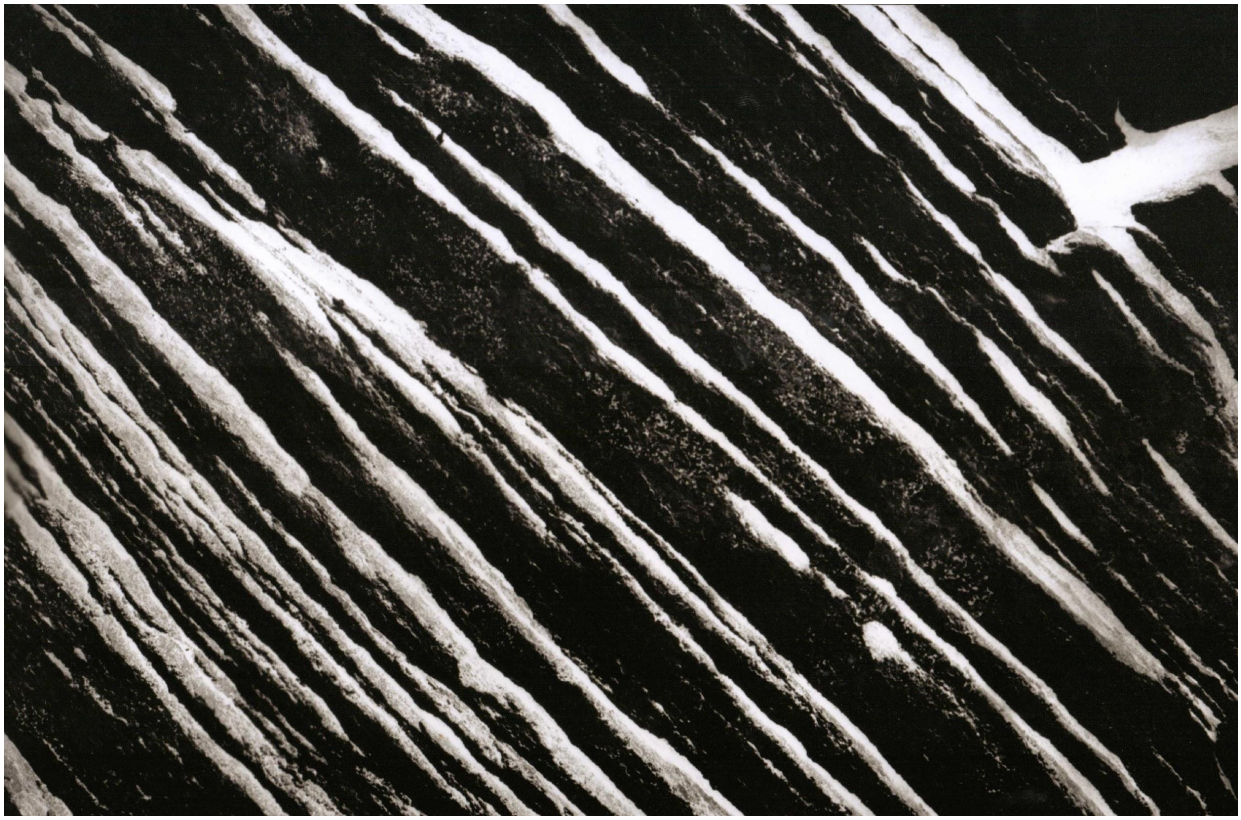


Figure 3:1: Melanie King, The Principle of Original Horizontality*, Chamonix, 2013.*

This practice-based research is specifically concerned with astronomical time, a magnitude which far outstretches geological time. An astronomical photographic glass plate could be described as a material object which has been inscribed by light that may have travelled for millions of years. Rather than a representation of

time built up through layers of sediment, this plate bears an indexical trace of a distant star or nebulae.

New Materialism

New materialism is an area of philosophy which aims to alter our perspectives about the relationship between humans and non-humans. Thomas Nail suggests that there are different strands of new materialist theories, but all 'share at least one common theoretical commitment: to problematize the anthropocentric and constructivist orientations of most twentieth-century theory in a way that encourages closer attention to the sciences by the humanities' (Nail, 2019). This area of research is concerned with the agency of matter. New materialism is inspired by understandings of materiality informed by contemporary scientific fields such as quantum physics, an area of research which is continually altering our perspective of the universe. As research expands in disparate scientific fields, we are beginning to understand how humans are deeply interconnected with non-human beings.[24]

In the next section of this chapter, I will explore how new materialist theorists such as Karen Barad, Jane Bennett, and Timothy Morton demonstrate the interconnectivity between humans, living beings, and the environment surrounding

[24] For a detailed summary of new materialism and key texts, visit New Materialism.en https://newmaterialism.eu/about/about-the-almanac.html and Oxford Bibliographies. https://www.oxfordbibliographies.com/view/document/obo-9780190221911/obo-9780190221911-0016.xml [Accessed 10/07/2023].

us. The text will start at a subatomic level, gradually increasing in scale from microscopic to cosmic.

Subatomic

In *Meeting The Universe Halfway: Entanglements of Materiality and Meaning* (2007), Karen Barad interrogates the ways in which the language of quantum physics is used in philosophical discourse. Barad, a former physicist, asserts that historically, philosophers have mainly referred to atoms. In contemporary quantum physics, many physicists are now researching sub-atomic phenomena such as protons, neutrons, muons, quarks and photons amongst others. Barad suggests that philosophical theory should be updated to consider these new discoveries. From a quantum perspective, the division between one entity and another is less clear. As physicists have observed atoms, they have found that they do not have defined edges, their boundaries are fuzzy and unstable. Atoms are made up of neutrons and protons — forming the atom's nucleus — and electrons; these are held together by electromagnetic forces, which encourage specific elements and materials to form. These forces allow us to experience the world with seemingly hard and defined edges. We stand on the surface of the Earth without passing through the ground because of the electrical charge inside atoms. *Meeting The Universe Halfway* takes inspiration from the field of particle physics, drawing a picture of a world where phenomena are entangled, existing without hard edges and defined boundaries. Barad defines the term *entanglement* as a way of being which is 'not simply to be intertwined with another, as in the joining of separate entities, but to lack an independent, self-contained existence. Existence is not an individual affair' (Barad, 2007, Preface).

A central idea in Barad's text is that of *agential realism*, which proposes a new approach to understanding technology, nature, science and culture, taking into account both the dynamic nature of matter and our understanding of quantum physics. Subatomic science challenges our idea of what a boundary is, where one thing begins and another thing ends. Barad urges us to look past these constructed boundaries in relation to matter and allow this to alter our perception of imagined borders. Barad suggests 'separateness as mere illusion, an artefact of human consciousness led astray' (Barad, 2007, 136). Going further, Barad suggests not only that matter has agency, but that it is not a fixed phenomenon:

> Matter is neither fixed and given, nor the mere end result of different processes. Matter is produced and productive, generated and generative. Matter is agentive, not a fixed essence or property of things. [...] This dynamism is agency. Agency is not an attribute but the ongoing reconfigurings of the world. The universe is agential intra-activity in its becoming.' (Barad, 2007, 137, 141)

Crucially, Barad points out that we should not only scrutinise the agency of materials, but the outdated mechanisms with which we conceive of the world. Barad moves on to a section focused on the apparatus, which redefines our understanding of what apparatus is or can be. Barad extends the term apparatus to include humans and non-humans within its' configuring.

> Apparatuses are not merely about us, and they are not merely assemblages that include non-humans as well as humans. Rather, apparatuses are specifically material reconfigurings of the world that do not merely emerge in

> time but iteratively reconfigure space-time-matter as part of the ongoing dynamism of becoming. (Barad, 2007, 142)

In Katie Warfield's essay 'Making the Cut: An Agential Realist Examination of Selfies and Touch' (2016), she describes agential realism as an ontological inseparability of phenomena that are normally perceived to be pre-existing and separate. Where usually a body, camera, self, space and image would be considered as separate entities, Barad would instead describe these as an entangled whole. Using the example of a selfie, Warfield explains Barad's *agential cut* as a repeated boundary-drawing practice 'demarcating, like a sculptor with a knife, what makes the cut' (Warfield, 2016).

With the theory of Agential Realism, Barad is proposing a way of thinking which allows us to conceive of the subject, the human, the apparatus and the environment as an entangled group of phenomena *intra-acting* with one-another. *Intra-action* is a term coined by Barad, which can be used as an alternative to 'interaction.'[25] In contrast to interaction, intra-action is influenced by the field of quantum physics, where phenomena are entangled. Barad considers that a person using apparatus, such as a camera, is not fully in control of the process. Barad would not view photography as a linear activity where a human directs all events — pressing a button on a camera, developing the film, and producing a print. Instead, Barad believes that there is a constant interchange, where elements such as the subject, environment and equipment all influence one another. In the previous chapter, I discussed how working with plant-based developers can allow non-human forces to

[25] 'Intra-action' and 'entanglement' are both introduced in my Key Terms section.

influence the final print; this interchange could therefore be described as intra-action.

Microscopic

Moving upwards through the scale of measurement, in *Humankind: Solidarity With Non-Human People* (2017), Timothy Morton discusses how humans and their microbiome are entangled.

> The symbiotic real is a weird 'implosive whole' in which entities are related in a non-total, ragged way. In symbiosis, it's unclear which is the top symbiont, and the relationship between the beings is jagged, incomplete. Am I simply a vehicle for the numerous bacteria that inhabit my microbiome? Or are they hosting me? Who is the host and who is the parasite? (Morton, 2017, 1)

Following on from this, Morton gives the example of how bacteria present in human milk can coat a baby's stomach with a film that aids the immune system. The bacteria become part of the baby's microbiome, allowing the baby to fight off potential illnesses. For Morton, the human and non-human are entangled, materially bound together. It is not possible to draw a line where they separate.

> Human means 'me' plus my nonhuman prostheses and symbionts, such as my bacterial and my technological gadgets, an entity that cannot be determined in advance within a thin, rigid outline or rigidly demarcated from the symbiotic real. The human is what I call a 'hyperobject': a bundle of entities massively distributed in time and space that forms an entity in its own right. (Morton, 2017, 41)

The artist Helen Chadwick regularly discussed the slippages between the atom, microscopic organisms, humans, and the environment. Chadwick's artistic practice predates new materialism, but her work aligns with contemporary new materialist thinking. Chadwick's series *Viral Landscapes* (1988–1990) explored the interconnections between human and non-human beings. In this piece, Chadwick introduced paint to the ocean waves and allowed the tide to create marks on the surface of a canvas. These paintings were interspersed with digital microbial images, and colour photographs of the Pembrokeshire landscape.

> The living integrates with other in an infinite continuity of matter, and welcomes difference not as damage but potential… Spliced together by data processing, these are not ruined catastrophic surfaces but territories of prolific encounter, the exchange of living informational systems at the shoreline of culture. (Chadwick, Bashford & Hooker, 2001, 225)

Of *Viral Landscapes*, Chadwick said 'like physics… [i]t seems I cannot distinguish anything as separate from myself, so perhaps after all, I am the anything I observe' (Schlieker, 1994, 11–15).

Figure 3:2: Helen Chadwick, Viral Landscapes No. 3, *1988–89. Copyright The Estate of Helen Chadwick. Courtesy Richard Saltoun Gallery London and Rome.* © Helen Chadwick. All Rights Reserved.

In 1995, Chadwick worked on *Body Visual*, a photographic installation with Arts Catalyst, for which Chadwick worked with discarded embryos at Kings College London. In the accompanying publication, Louisa Buck explored how Chadwick has 'drawn on an extensive range of materials and methods in order to capture and freeze physical effect. (Buck, 1996, 7–10)' In addition, Buck emphasised that Chadwick chose to collect an embryo herself, 'to become fully engaged with the procedures of IVF in order to experience the fragile negotiations that revolve around human fertility and to reflect them in her work (Buck, 1996, 7–10).

Figure 3:3: Helen Chadwick in residence at King's College Hospital Assisted Conception Unit, *London, 1995. Courtesy: Edward Woodman, DACS/Artimage 2018; photograph: Edward Woodman.*

From this residency, Chadwick produced *Nebula* (1996), a large photographic installation featuring a cataracted eye, embryos, and dandelion clocks. Chadwick often worked with her body to create her artworks. To create *Nebula*, Chadwick sucked on a tube connected to the microscope to move around embryonic matter. In this installation, the images are presented in an ambiguous way, so that we are not quite sure what we are looking at. Chadwick had designed this installation so that the work can take on a multiplicity of meanings. The cataracted eye at the centre of *Nebula* could be a moon, an opal or a dying star. The etymology of the word *nebula* is also at play here, originating from Latin as a word approximating to *mist*. A gaseous dying star could be described as a nebula due to its vaporous appearance, whilst at the same time describing the clouding over of the eye,

creating a visual impairment. Chadwick's practice enacted the entanglement with human and the non-human. In addition to this, Chadwick worked with an embodied methodology, always choosing to interact with the phenomena she observed. Chadwick's practice is sympathetic with new materialist thinking, where the human is on equal footing with the non-human.

Figure 3:4: Helen Chadwick, Nebula, *1996.*

Returning to *Meeting The Universe Halfway*, Barad is reluctant to distinguish between the human and non-human. Barad does this to avoid creating an unnecessary distinction between nature and culture, from the outset her explanation of agential realism.

> Any such hardwiring precludes a genealogical investigation into the practices through which 'humans' and 'non-humans' are delineated and differentially constituted. A posthumanist performative account worth its salt must also avoid

> cementing the nature-culture dichotomy into its foundations, thereby enabling a genealogical analysis of how these crucial distinctions are materially and discursively produced. (Barad, 2007, 32)

Barad would caution separating the human and non-human, or privileging one above the other.

Anthropic

As we move further up the scale of measurement, we arrive at the anthropic perspective. Earth is described as a 'blue planet' due to its large bodies of water. Water exists on other planets, but it is a rare feature; astronomers search for signs of water on other planets as this could indicate the existence of life forms. Astrida Neimanis gives insights into how water can be a conduit between human and non-human beings. In *Bodies of Water: Posthuman Feminist Phenomenology* (2012), Neimanis considers how water connects the human to the geographical. Neimanis explains how when we drink water, we are connected to reservoirs, rivers, and oceans.

> In this act of ingestion, we come into contact with all of our companion species that inhabit the watershed from which that water was drawn—book lice, swamp cabbage, freshwater mussel. But we connect with the sedimentation tanks, and rapid-mix flocculators that make that water drinkable, and the reservoir, and the rainclouds, too. [...] Water connects the human scale to other scales of life, both unfathomable and imperceptible. We are all bodies of water, in the constitutional, the genealogical, and the geographical sense. (Neimanis, 2012, 98-99)

In the UK, water is generally an abundant resource, readily available when we need it. For this reason, we rarely consider its source. Neimanis' text encourages us to pay attention to where our water originates from. In Thanet and London, it is common for kettles and bathrooms to become congested with limescale, due to the chalky composition of the surrounding environment. Neimanis also highlights that we are connected to local bodies of water due to our excretion of water, which can be affected by the hormones or medications that we ingest. Neimanis' description of water flowing through taps demonstrates how we are inextricably connected to the environment that we live in.

Neimanis describes how water connects us with the origin of life on Earth, considering how humans have evolved from ocean creatures, making the point that humans are incubated in watery, amniotic environments.

> We have all arisen out of the same primordial soup, gestated by species upon watery species that have gifted their morphology to new iterations and articulations. (Neimanis, 2012, 99)

Jane Bennett's book *Vibrant Matter* (2009) also describes the fluidity between humans and non-human beings. Bennett highlights the importance of *thing-power* and demonstrates the agency of objects. Throughout the book, Bennett gives several scenarios in which seemingly inert objects have meaningful effects on the surrounding world. For Bennett, this thing-power is *vital materiality*, a world populated by active bodies rather than passive objects. The plastic pollution crisis has been well documented. After many decades of consuming and discarding plastic waste, it is turning up unwelcomed, filling the bellies of dead birds and

invisibly infiltrating our tap water (Powers, 2021). Bennett believes that our habit of referring to matter as inert or dead fuels human consumption and has led to the ecological catastrophe that we are currently experiencing. *Vibrant Matter* was published in 2009, before we found giant rafts of plastic floating in the Pacific Ocean (Labreton, 2018); before we knew the extent to which climate change is melting the Polar ice sheets. Bennett argues that by closely studying materiality — considering how materials are made, how they are used, and where they go afterwards — we may be led towards more sustainable practices. Humans are physically dependent on living systems (plants, animals, minerals) found on Earth. For this reason, Bennett believes that this type of thinking can lead to an ecological sensibility, where humans are respectful of the environment and beings surrounding them.

Bennett describes her reaction on seeing a collection of objects, including a dead rat, a glove and a plastic bottle cap:

> it hit me then in a visceral way how American materialism, which requires buying ever-increasing numbers of products purchased in ever shorter cycles, is antimateriality. The sheer volume of commodities and the hyper-consumptive necessity of junking them to make room for new ones conceals the vitality of matter (Bennett, 2010, 4).

Bennett notes how she is emotionally affected by this encounter. She believes that her stories 'highlight the extent to which human being and thinghood overlap, the extent to which the us and the it slip-slide into each other.' (Bennett, 2010, 4) Through telling stories such as these, Bennett encourages others to consider their personal relationships with materials and objects they come across in everyday life.

> The hope is that the story will enhance receptivity to the impersonal life that surrounds us and infuses us, will generate a more subtle awareness of the complicated web of dissonant connections between bodies, and will enable wiser interventions into that ecology. (Bennett, 2010, 4)

Vibrant Matter is thought-provoking and timely; her writing urges us to consider the materials that we use daily. Throughout the text, Bennett argues that contemporary culture has become disassociated from the materiality of objects, and this has led to the current situation where materials are consumed and discarded with little thought to where the materials come from and where they may end up. Bennett includes an important passage by Robert Sullivan, who describes the vitality that persists even in trash:

> The garbage hills are alive, there are billions of microscopic organisms thriving underground in dark, oxygen-free communities. One afternoon I walked along the edge of a garbage hill, a forty-foot drumlin of compacted trash that owed its topography to the waste of Newark. There had been rain the night before, so it wasn't long before I found a little leachate seep, a black ooze trickling down the slope of the hill, an espresso of refuse. In a few hours, this stream would find its way down into the groundwater of the Meadowlands; it would mingle with toxic streams. But in this moment, here at its birth… this little seep was pure pollution, a pristine stew of oil and grease, of cyanide and arsenic, of cadmium, chromium, copper, lead, nickel, silver, mercury and zinc. (Sullivan, quoted in Bennett, 2010, 6)

Sullivan reminds us that materials can never really be thrown away; though out of sight, things continue to have agency. Sullivan's garbage ooze will pollute the water system, in turn polluting the bodies of those who have polluted it.

Later, Bennett explores the ethical implications of thinking of humanity as composed of vital materiality, suggesting that a new approach to matter can lead to a feeling of interconnectedness:

> Such a newfound attentiveness to matter and its powers will not solve the problem of human exploitation or oppression, but it can inspire a greater sense of the extent to which all bodies are kin, in the sense of inextricably enmeshed into a dense network of relations. And in a knotted world of vibrant matter, to harm one section of the web may very well be to harm oneself. (Bennett, 2010, 13)

Returning to the example of plastic seeping into the oceans, and thus vital water sources for humanity, contemporary humans have created a global ecological problem which has begun to affect other humans (Ragusa, 2021). The floating plastic islands in the pacific are part of this knotted world of vibrant matter. Ten years after Bennett published *Vibrant Matter*, we are only just realising the extent to which we are harming our web. Inspired by Bennett's conception of vital materiality, in Chapter Four, I will demonstrate how it may be possible to create analogue photographic artworks with a significantly reduced environmental impact.

Cosmic

In new materialist texts, discourse has mainly been confined to a terrestrial or oceanic environment. In this section, I will discuss how new materialist theory can be considered in relation to the cosmos. The field of astronomy is unique, as materials and matter transform in a manner which is hard to imagine. In consequence, astronomy can alter our perspective of materiality, as we begin to understand how all matter originates in the cosmos. Additionally, astronomy allows us to understand how forces such as gravity can influence how materials are formed, altered, experienced, and destroyed. In *Cosmic Connection: An Extraterrestrial Perspective* (1973), Carl Sagan describes how humans are intimately connected with the cosmos:

> Our Sun is a second or third-generation star. All of the rocky and metallic material we stand on, the iron in our blood, the calcium in our teeth, the carbon in our genes were produced billions of years ago in the interior of a red giant star. We are made of star-stuff. (Sagan, 1973, 190)

The idea of being made of *star-stuff* is a romantic thought, but firmly based on scientific evidence. Humans are part of a universe-wide ecology, they are materially composed of chemical constituents found in outer space. Cosmology tells us that all the matter in the observable universe was created from a single event known as the Big Bang, which occurred 13.7 / 13.8 billion years ago. Astronomers believe that all matter in the universe was confined inside a very small speck — a point of massive density and gravity — which suddenly expanded, creating time, space and all known matter. The atoms that make up our bodies were created in the Big Bang, along with all the other materials and beings that make up the universe. Previous

new materialist texts have demonstrated the interconnections between humans and non-human beings, but these descriptions are often limited to the confines of the Earth. Astronomical research allows us to understand how humans, non-human beings, and the cosmos are intimately connected.

Astronomy demonstrates how matter behaves differently outside of our planet. Deep inside the Milky Way Galaxy, there is a black hole in Messier 87, which is capable of distorting time and space itself. Materials are dramatically transformed as they approach the *event horizon* of a black hole - the point at which nothing, not even light, can escape its gravitational pull. Here, objects such as planets and stars collide, becoming incredibly hot. They are violently pulled apart and eventually sucked into the black hole itself. Astronomy also demonstrates that dark matter and dark energy exist, unseen forces which comprises approximately 96% of our universe (Panek, 2010). Dark matter and dark energy also have the capability to distort space and time, and are responsible for the expansion of the universe. As we look to astronomical research, our understanding of materiality is dramatically expanded. This research demonstrates how it is possible to utilise materials originating from outside of the Earth.

Ancient Light, Entanglement & Intra-Action

In summary, viewed through the lens of new materialism as defined by Karen Barad and Jane Bennett, analogue astronomical photography could be described as an intrinsically material practice, in which we can intra-act with the universe. Returning to Barad's theory of agential realism, it could be said that the camera, the landscape, the photographic materials and I myself become entangled. This is certainly true if we understand that all visible materials emerged from the Big Bang,

from which perspective all the entire cosmos is entangled. In addition to the Big Bang, quantum physics and the development of new telescopes have provided new sets of questions about where the boundaries between the human, the apparatus, and the subject lie. Both Barad and Bennett are interested in this idea of a slippage between beings and things, using thorough contemporary scientific and philosophical research to set out their reasoning. The tools that are used to explore the universe — for example, The Hubble Telescope — could be said to intra-act with stars and nebulae. The Hubble telescope is made of physical materials, which define its own peculiarities, thereby having agency to affect the measurements that it produces.

In this chapter, we have established that photographic materials, the landscape, apparatuses, humans, and non-humans are entangled in a web of connections. As Jane Bennett discusses earlier in the chapter, if we negatively affect a section of the web, we end up damaging ourselves, non-humans, and the ecology of the Earth. In the following chapter, I will discuss how I have tried out several sustainable photographic processes, to reduce the environmental impact of my practice.

Chapter Four: The Practice Of Ancient Light

Introduction

This chapter is accompanied by a portfolio, which is referred to using the acronym PP (for Portfolio Page), followed by a page number. It charts the trajectory of my practice throughout my research degree, demonstrating how my practice has changed and shifted during residencies in dark sky areas, where I have had the opportunity to observe starlit landscapes. As my practice has a participatory element, I also share how it has altered through activities within collectives and workshops.

The entangled strands of my developing practice have affected the methodological decisions that were made to produce the work. For example, the works that I have produced with sustainable processes have been influenced by spending time underneath a night sky full of stars. The embodied experience of viewing the stars from the perspective of several landscapes has allowed me to sense the intimate connections between human, non-human beings, and the cosmos. As I began to understand how photographic processes could damage the natural environment, I became compelled to work with processes that are kinder to the ecology of the Earth.

As a result, this chapter is split into four separate sections, which mirror the flow of the accompanying portfolio:

First Light: This section describes the genesis of my research, which was focused

upon mediations in astronomical images. This area of practice-based research aimed to understand how our reading of contemporary astronomical images is altered when they are printed using alternative photographic processes. For example, I consider how the mirrored surface of a daguerreotype can disrupt our experience of viewing an image of Mercury. (PP71-72)

Embodied Photographic Practice: This section discusses how I have collected data as I produced images within a dark sky environment. It goes into detail about how I settled upon specific exposure times and camera settings. It includes notebook scans, which record my immediate responses to being in areas away from light pollution.

Exhibiting Ancient Light: This section discusses how I exhibited the work to produce an immersive environment for the viewer, using projection, installation and framing techniques.

Sustainable Photographic Practice: This section details aspects of my practice that have been adapted to become more sustainable. For example, I have produced plant-based developers that do not contain hydroquinone, which is toxic to aquatic organisms (Appendix 3 and Appendix 4). Similarly, I have developed a method of reclaiming silver from photographic fixer (Appendix 5). I describe my recipes, how I determined the success of each technique, and how I chose images to complement the chosen processes.

First Light

This research was influenced by a lecture given by Elizabeth Kessler at the Envisioning The Universe conference at the National Maritime Museum in 2013. In Kessler's related text, *Picturing The Cosmos* (Kessler, 2012, Introduction) she considers how Hubble's images are composites of a range of different photographs. Several cameras and sensors are used to capture ultraviolet and infrared light, in addition to gamma and X rays. Images are captured in monochrome, often with glitches arising from interactions with cosmic rays. Colour is later added in correlation with the elements that have been detected in the object that has been observed.

In the project *First Light*, I acknowledge the composite nature of astronomical photographs, aiming to remind the viewer of the construction of images produced by institutions such as NASA and the European Space Agency. *First Light* culminated in a solo exhibition at Leeds Art University in 2017.

In *Pillars of Creation (CMYK)* (PP62-64), I worked with Zolt Levay of the Space Science Telescope Institute to reproduce Levay's famous *Pillars of Creation* image using a four colour screen print technique. *Pillars of Creation* was chosen as it is a popular Hubble image, though the general public are often not made aware of the sophisticated editing processes that go into producing the final image. At a distance, the screen print seems to resemble the full colour images that we are used to seeing. However, as one moves closer it is possible to see the idiosyncrasies of the diffusion dither matrix within the CMYK screen printing process. When four colours are combined in a screen print, they form a complex pattern of dots which can create a Moiré pattern. These Moiré patterns are generally undesirable, but I

was keen to use this technique to remind the viewer of the layered construction of the image. It was important for the viewer to become immersed in the image, whilst viewing image artefacts up close. Therefore, the screen print was produced at A2 size.

In addition to the CMYK image, Zolt Levay supplied me with a monochrome and full colour image so that I could produce a lenticular print (PP60). In both instances, the viewer becomes aware that the status of the image is unstable. I chose to create the lenticular print at a scale of one metre squared. At this size, the viewer can fill their field of vision, whilst also detecting the construction of the image. Lenticular prints are created using multiple images which are interlaced. As you change your position in a room, or the angle at which you look at the print, you can see a different image. As the viewer walks past the lenticular print, the image morphs from a colour to a black and white image.

In *First Light: Moon Daguerreotype* (PP70), I used the becquerel daguerreotype process to reproduce a photograph of the Moon taken at Kielder Observatory in 2017. To create a becquerel daguerreotype, a silver-plated copper sheet is exposed to iodine gas. A positive transparency is then placed on top of the sensitised sheet and exposed to light. The daguerreotype then develops in sunlight for around one hour. Finally, the plate is fixed and washed with distilled water. With *First Light: Mercury Daguerreotype* (PP71-72), I used contemporary NASA images of Mercury to produce a becquerel daguerreotype, replicating the exact daguerreotype process. As a viewer moves around a daguerreotype, the image seems to appear and disappear. In similarity to *Pillars Of Creation*, I chose to use the illusory aspect of the daguerreotype to hint towards the construction of the image. In the gallery space, the daguerreotypes were exhibited facing a dark surface, with a light source

pointed from above. These exhibition installation requirements are necessary for the image to be seen clearly.

The portfolio adjacent to this thesis indicates how the individual works can be experienced in a gallery setting. The *Pillars of Creation* works were exhibited at 'To The Edge Of Time' in KU Leuven, Brussels, Belgium (2021), and at Watermans Gallery, London (2020). In the KU Leuven exhibition space, the lenticular print was exhibited in a black frame, with a black mount on a black wall. This allowed for the viewer to further immerse themselves within the work, to minimise distractions from borders.

The Meteotypes (PP73-74) are a series of prints using meteorite-imbued ink. Meteorites were sourced from a reputable supplier, before being photographed in a studio. At the Royal School of Mines at Imperial College London, I ground the meteorites into a fine dust using a large industrial mill. At the Royal College of Art, I carefully mixed carbon black ink with the meteorite dust. Simultaneously, a photographic etching plate was produced of each meteorite. The ink was then spread onto the plate and put through an etching press. I was interested to create a print with hybrid indexicality, where the viewer experiences the indexicality of the photograph itself, in addition to the material connection with the meteorite, which now exists in ink form. At the time of embarking on the *Meteotypes* artwork, I was unsure whether I could make meteorite-imbued ink for etching. The success of this project was defined by the positive outcome of the process with an uncertain starting point. I was able to produce a print, where the photograph could be seen clearly alongside fragments of the meteorite itself.

To summarise, in *First Light,* I worked with astronomical images that were produced by institutions such as NASA and the European Space Agency. Elizabeth Kessler's text helped me to understand how astronomical images are made up of composites of several different light frequencies. I tried out several alternative photography processes and printmaking techniques aiming to disrupt the visitors' viewing of an astronomical image. The artworks allowed visitors to reflect upon mediations made by astronomers in contemporary astronomical imaging. Following initial experimentations in the *First Light* project, I became curious about how it might be possible to make images that have minimal mediations, allowing light from the stars to interact directly with photosensitive material. This curiosity led me to begin creating long exposure photographs of the night sky using Ilford Delta 3200 (high-ISO) film during several residencies in dark sky spaces and at observatories. This process began to produce images for my *Ancient Light* series.

Ancient Light: Embodied Photographic Practice Within A Dark Sky Environment

In this section, I discuss my approach to capturing light from distant stars directly onto photosensitive film, in dark sky areas. As I have spent time underneath the night sky, I have collected data relating to the production of the photographs, including camera settings and exposure times. I have consistently recorded such data in notebooks, to allow myself the option to replicate successful exposure times and settings. In this section, I describe when and where I made images of the night sky. Alongside the technical information, I have also captured my immediate thoughts in the landscape, which have been recorded in short, written vignettes shown below in Figures 4:1-4.

Driving through the mountains

So sublime, I am catching my breath
and on the brink of tears.
Too much too take in ~~Huge~~
~~Huge~~ Each snowflake, each rock.
Deep feelings of love for you
Too overwhelming.

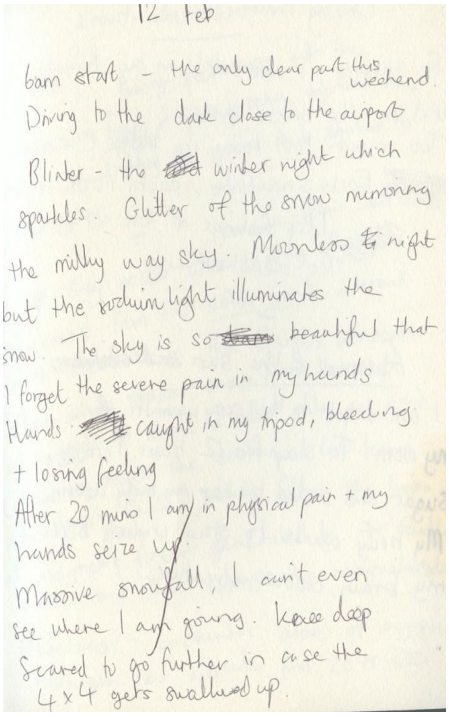
—

Absence of the sun ~~and coldness~~

I am drawn to the cosy warmth of
my room. To sleep for 12 hours. I crave
sugar and stodge to keep my body warm.
My body wants to stay indoors but
my brain craves adventure.

03 Feb 2018

The plane heading North during late
afternoon
The sun to my left, completely in view and
without reference point. Just the sun above
a sea of clouds.
Later, the blue, green, yellow, orange, red
spectrum which coats my brown hair to auburn.
I have come to Iceland for darkness, it feels
appropriate that the Sun should accompany me
on the way there. I am seeking its' emissions
in green form.
Other passengers sit framed with a red ~~box~~,
orange light propelling through the aeroplane
window.
— Body Portrait series of
parts lit by the red light of the
sunset.


12 Feb

6am start - the only clear part this weekend. Driving to the dark close to the airport

Blister - the ~~first~~ winter night which sparkles. Glitter of the snow mirroring the milky way sky. Moonless & night but the sodium light illuminates the snow. The sky is so ~~beautiful~~ beautiful that I forget the severe pain in my hands

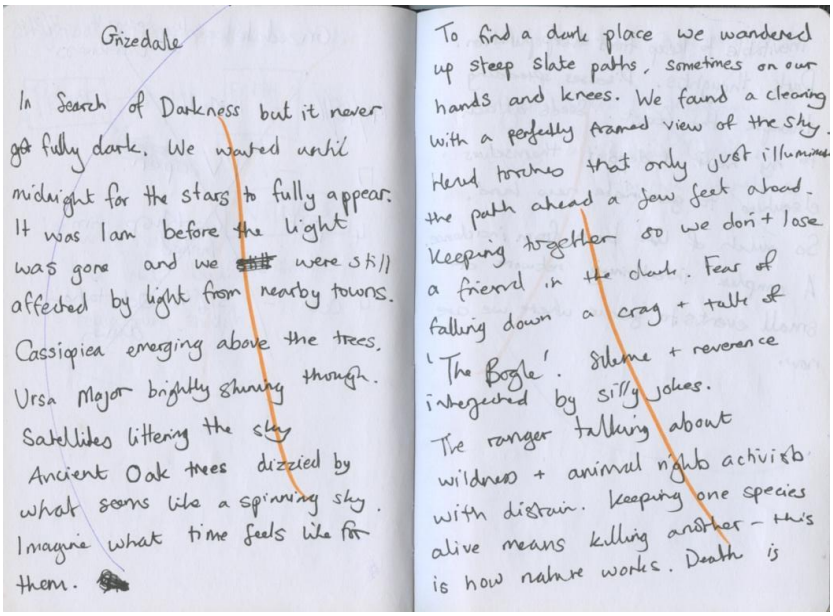
Hands ~~caught~~ caught in my tripod, bleeding + losing feeling

After 20 mins I am in physical pain + my hands seize up.

Massive snowfall, I can't even see where I am going. Knee deep

Scared to go further in case the 4x4 gets swallowed up.

Figure 4:1-3 Melanie King, Written Vignette, Iceland *2018.* These excerpts refer to *portfolio pages 16 and 17.*


Grizedale

In Search of Darkness but it never got fully dark. We waited until midnight for the stars to fully appear. It was 1am before the light was gone and we ~~still~~ were still affected by light from nearby towns. Cassiopeia emerging above the trees. Ursa Major brightly shining through. Satellites littering the sky. Ancient Oak trees dizzied by what seems like a spinning sky. I imagine what time feels like for them.

To find a dark place we wandered up steep slate paths, sometimes on our hands and knees. We found a clearing with a perfectly framed view of the sky. Head torches that only just illuminated the path ahead a few feet ahead. Keeping together so we don't lose a friend in the dark. Fear of falling down a crag + talk of 'The Bogle'. Silence + reverence interjected by silly jokes.

The ranger talking about wildness + animal night activity with distain. Keeping one species alive means killing another - this is how nature works. Death is

Figure 4:4 Melanie King, Written Vignette, Grizedale *2018.* These excerpts refer to *portfolio pages 20 and 21.*

Since 2017, I have travelled to several international dark sky locations to create long exposure photographs of the night sky, to create a series entitled *Ancient Light (PP8-35)*. These experiences have provided me with a unique opportunity to observe the stars and reflect upon my experience of exploring various landscapes at night. To produce these images, I used Ilford Delta 3200 (high-ISO) film during several residencies in dark sky spaces and at observatories. I chose Ilford Delta 3200 film due to its high sensitivity and performance in low light conditions.

I have experimented with several cameras, but I have primarily worked with a Canon Rebel EOS 35mm camera and a Mamiya 645 camera, alongside a carbon-fibre Manfrotto tripod. This equipment was chosen due to portability. Ideally, I would have chosen a large format camera to produce the images, as I would like to see evidence of starlight on the film in greater detail. The Mamiya 645 camera was a good compromise, as it was equipped with a wide-angle lens that could focus to infinity. Figure 4:5-6 features notebook scans which document diagrams and jottings that were used to work out exposure times and camera settings.

I chose exposure times of between thirty seconds and ten minutes to take photographs of the night sky. An exposure of 30 seconds is the longest exposure possible to record the stars as pin pricks of light without an equatorial mount. After thirty seconds, the stars appear as a streak or trail in the sky. To choose the optimum exposure time, I tried out exposures at 10 seconds and increased the exposure incrementally. When I had settled upon optimum exposure times and film stock, I used these parameters to produce images in several locations. In the next section, I will discuss how each environment provided me with new, valuable insights into the unique nature of each landscape.

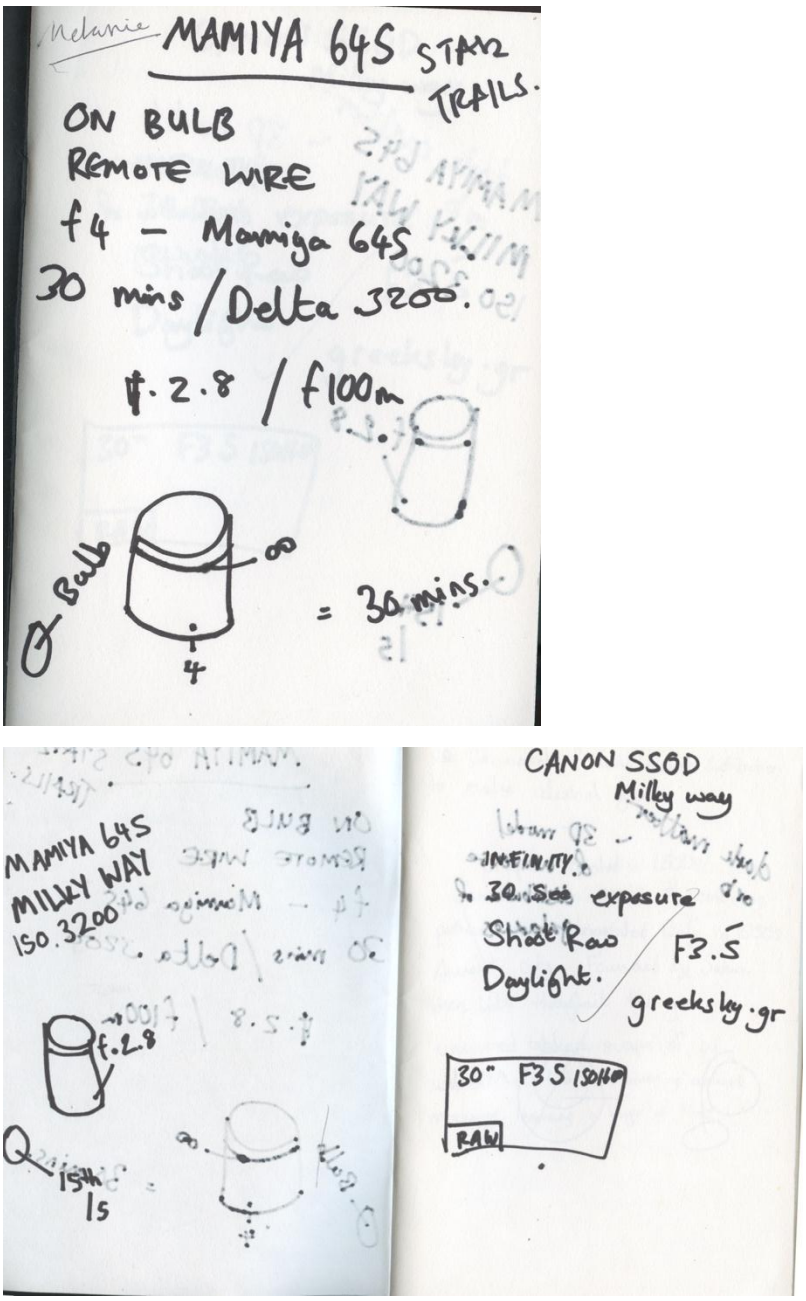


Figure 4:5-6 Melanie King, Working Out Exposure Times, Notebook, *Italy, 2018.*

UCL Observatory

Throughout this research, I have worked with several scientists and engineers to produce collaborative works. In 2017, I met Thomas Schlichter, an engineer based at the UCL Observatory in London. We made contact during the 'School of Light' exhibition, led by Lumen Studios, an organisation that I co-direct. During our first conversation we discussed our mutual interest in analogue film photography and the possibilities of producing analogue photographs using the observatory at UCL. Schlichter generously invited me to the UCL Observatory to try out analogue film photography, using the nineteenth century Fry Telescope.

During my time at the observatory, Schlichter influenced my systematic technique for choosing optimum exposures for my photographs. Prior to the residency, I had an approach to exposure timing which was more intuitive. Schlichter showed me the benefits of using different timings to determine the best exposure, which empowered me to make fewer mistakes. Below, Figure 4:7 shows a photograph of Arcturus which is correctly exposed, with strong contrast. However, Figure 4:8 shows a photograph which is overexposed, with distracting noise from the film grain and low contrast.

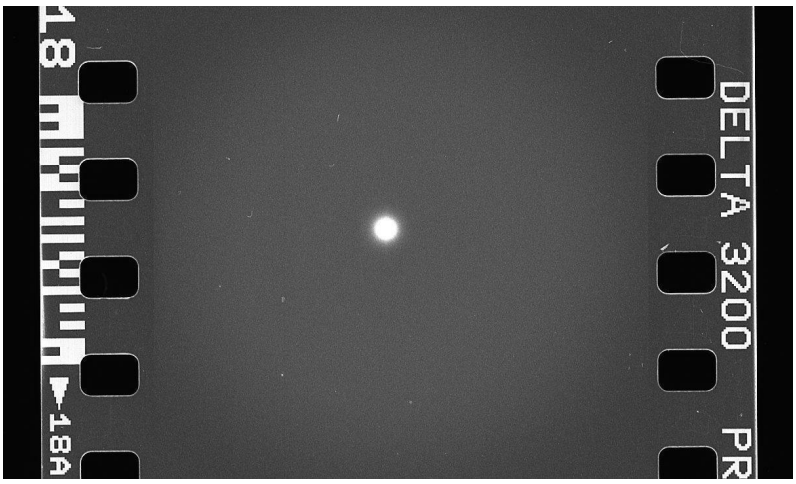


Figure 4:7 Melanie King and Thomas Schlichter, Ancient Light: Arcturus, UCL Observatory, *London, 2017. (Correctly exposed)*

Figure 4-8: Melanie King and Thomas Schlichter, Ancient Light: Arcturus, UCL Observatory, *London, 2017. (Overexposed)*

An observatory can offer a unique and unfamiliar environment to work in. Visits to the observatory took place after 10pm, as observation was optimum after astronomical twilight. We would work in the observatory until the early hours of the morning, and I would often arrive home after sunrise. My circadian rhythm was

regularly interrupted, as I tried to separate myself from the comfortable cycle of rising in the daytime and sleeping at night. However, Thomas had become fully nocturnal during his time of working at the observatory. Thomas and I spent long periods of time making minute adjustments to the nineteenth-century telescope which is still used for teaching observational astronomy. Whilst working in the observatory, we focused in on several different stars and star formations, such as Arcturus and the Double Cluster in Perseus, the latter of which is 7500 light years away. Overall, the experience of working with Thomas Schlichter at UCL Observatory influenced me to work in a structured, methodical manner. Figure 4:8 shows an over exposed image, to create this image we used a longer exposure time, using the same equipment. I decided that this image is inferior because there is a large amount of grain within the image, and there is less contrast in the photograph.

By making fewer mistakes, I was able to produce high quality photographs and minimise the wasting of photographic film and paper

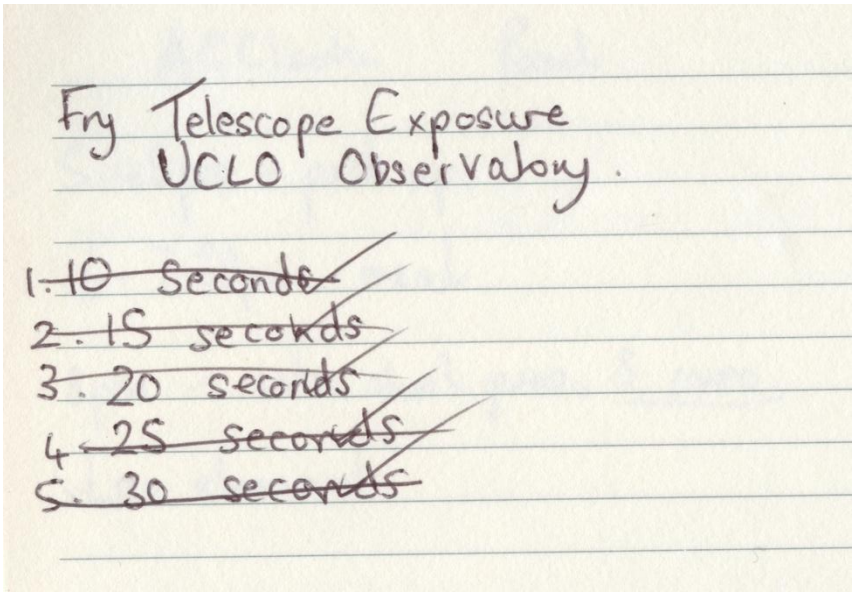
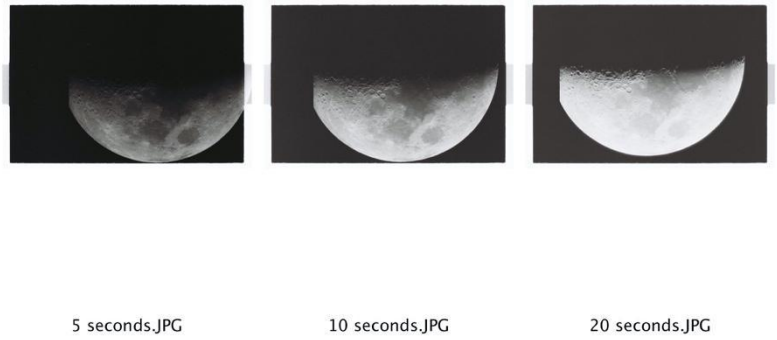


Figure 4:9 Melanie King and Thomas Schlichter, UCL Observatory, Moon Exposure Times, *Notebook, 2018*



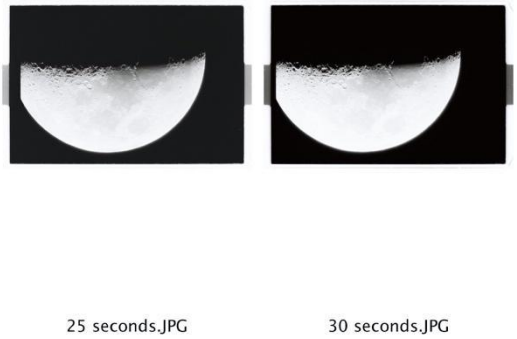


Figure 4:10 Melanie King and Thomas Schlichter, UCL Observatory, Moon, Corresponding Exposure, Digital Contact Sheet of Film Scans, *2018.*

Residencies

In addition to visiting observatories, I have participated in several residencies that have allowed me to visit isolated areas without light pollution.

Iceland

In 2018, I attended the SIM residency in Reykjavik, Iceland (PP16-17). During this residency, I took walks to immerse myself in the landscape. I came across many features of the environment that are not present in the United Kingdom; I observed visible signs of the Earth as a dynamic planet. In Iceland, the Earth belches lava, tectonic plates are visible above sea level, and the subpolar region is awash with snow and ice. During the residency I visited Thingvellir in the South Western area of Iceland, part of a rift valley at the top of the Mid-Atlantic ridge. Here, the boundary between the North American and Eurasian tectonic plates is visible. Such features of landscape can be observed with telescopes on other planets. Observing evidence of lava and tectonic plates on Earth reminds us that we live on a planet that is constantly changing.

During this trip I was impressed by the volatility of the landscape, as I journeyed past volcanoes that could erupt at any moment, fierce ocean waves and snowy ravines. This experience helped me to see the Earth as an active planet in a visceral way that I had not sensed before. The specific landscapes that I visited in Iceland allowed me to understand the Earth as a planetary landscape, in an embodied way. Being at Vík í Mýrdal felt like I was on the edge of the world, facing immense skies and seas. The extended horizon and jagged cliffs enabled me to access a reflective

mindset that I felt mirrored my subject matter: turbulent celestial bodies existing in distant locations.[26]

In May 2019, I attended a residency in Brow Head, West Cork, Ireland (PP26-27). Brow Head is a wind-blown, rugged landscape jutting out into the Atlantic. Walking along the headland, precariously high and narrow cliff sides fall away to the crashing waves below. Looking out to sea at Brow Head, I knew that beyond the horizon there were a thousand more miles of ocean and horizon. This was reminiscent of the feeling I get when I look up to stars, knowing I am gazing at something incomprehensibly distant. The skies at night in Brow Head were darker than many others that I have seen. On some nights, I woke at 3am to see starlight beaming through the windows and stars visible close to the horizon. I was easily able to walk outside with my camera and explore the landscape at night. At the point of these residencies, I had methodically worked out exposures for analogue photographs of the night sky that maintained sharp detail and high contrast. Once I had settled upon camera settings that achieved clarity, contrast and minimal grain, I was then able to work in an intuitive manner, responding to the surrounding environments.

Leading Artist Residencies In Italy

In this section, I will share how my practice has altered through a residency led by Lumen Studios, a collective I co-direct with Louise Beer and Rebecca Huxley. (PP8-13). Lumen Studios was founded in 2014, as an open collective, which explored the relationship between astronomy, light and spirituality. We are interested in finding

[26] In Chapter Three, 'Cosmic New Materialisms', I consider how viewing materiality from a planetary perspective has the potential to alter our collective perceptions of ecology.

out more about differing cultural understandings of the Sun, Moon and Stars. We have worked with several artists from a variety of backgrounds, who explore our understanding of the sky from a number of perspectives. We have worked on multi-dimensional projects looking at astronomy through the lens of Islamic, Pagan and Christian faiths.

During the years of 2016 and 2018, we led artist residencies to Atina in Italy in collaboration with artist Natasha Sabatini. The residency took place in a location with little light pollution, during the time of the Perseid Meteor Shower. Artists were provided with a telescope to observe the night sky and were able to watch the meteors falling from a dark terrace. Additionally, the artists were taken to the Campo Catino Observatory in Cassino, and the Emiliano Nardone Observatory in Casalattico. The artists were then able to respond to their experience through their chosen artistic medium. The communal experience of viewing meteor showers, nebulae and globular clusters was profound. As meteors entered our atmosphere, they burned up like fireballs. We were aware that we had witnessed a rare moment that could not be experienced again in the same circumstances. Similarly, as we looked through telescopes at distant globular clusters and nebulae, we were aware that we had witnessed an object that would be difficult to see in different circumstances.

Due to Lumen Studio's understanding of the cosmic perspective as a transformative experience, it was important for us to give other artists the experience of viewing the night sky as a generative experience for producing new artworks. We led these residencies, as we wanted artists to feel inspired by the practice of observing the night sky. Artist Claire Lymer discussed how the opportunity of viewing the Moon through a telescope altered how she produced work during the residency.

> The weather and lunar phases changed the work I had planned on making. I ended up making video work for the first time which opened up my practice and fostered dynamic change in my process (Claire Lymer, 2016).[27]

Exhibiting Ancient Light

This section of the chapter will focus on various exhibitions of the work produced during this study. I will discuss decisions made during the installation of the various artworks, and my intentions for the display of the work. This component of the research is closely correlated with the portfolio that accompanies the thesis.

In January 2017, I produced a solo exhibition of the *Ancient Light* series at Blyth Gallery, Imperial College London (PP6-7). For the exhibition, I selected images based on the visibility of the stars within the image, and their interaction with the surrounding landscape. The prints were pinned to the wall to limit mediation between the viewer and the surface of the silver gelatin paper.

An important aspect of the exhibition was to show the physical film negatives on a lightbox, which were held underneath a thin layer of acrylic. I intended for the viewer to experience the silver gelatin film that had encountered light from the

[27] Several artists gave testimonials describing their experience on the Lumen residency in Atina. It is possible to view these testimonials on the Lumen website: https://lumenstudiosldn.wixsite.com/lumenstudios/italy

stars. Here, the viewer physically encounters photographic material which has been darkened by stellar photons. The film is directly, materially linked to stars that are thousands, if not millions, of light years away. It was important for the viewer to view the indexical negatives of starlight, so that the viewer can tangibly experience a material object that has been transformed by a distant celestial object. The aim of this decision was to engender a feeling of the cosmic perspective, from a terrestrial standpoint.

For the exhibition at Blyth Gallery, I created two A0 prints from my *Ancient Light* series, produced on the edge of Dartmoor. The images were printed on Hahnemuhle Photo Rag to emphasise the deep black tones within the images, and to contribute to the materiality and texture of the print. At the time, I was unable to produce analogue prints of the night sky close to A0 size. However, I was keen for the viewer to become entranced by the vortex structure of the image, produced by the spin of the Earth as we look up towards the pole star. In the exhibition, I kept a comments book which allowed me to record the thoughts of visitors in order to determine whether visitors responded to the work in the way that I'd hoped.

In 2020, I was commissioned to produce *Ancient Light* prints for the exhibition 'To The Edge Of Time' at KU Leuven in Belgium. Working with the curator Hannah Redler Hawes, I chose three images produced on medium format film, where star trails were evident in the images. Hawes was keen for the star trails to be seen, as the 'To The Edge of Time' exhibition explored Professor Georges Lemaître's research, a theoretical physicist who formulated the Big Bang Theory. The perceived movement in the *Ancient Light* images corresponded to other works in the exhibition, which explore dynamic transformations of matter and movement of celestial material in outer space.

I chose to print the photographs at 16x20 inches for this exhibition. At this scale, viewers were able to walk up to the prints, allowing the image to take up their entire frame of view (PP5.) In an ideal circumstance, the prints would be produced on a larger scale to further enhance this effect. To avoid distraction from the prints themselves, I chose black frames, black mounts and museum glass to exhibit the prints. The frames were then hung on a dark grey wall.

Due to the lack of distraction from the colour of the frames, walls and glass, viewers were able to walk up closely to the prints, so that they were able to immerse themselves within the photographs.

Ancient Light and the Moving Image

As I stood beneath the night sky producing photographs for the *Ancient Light* series of photographs, I was struck by how much the stars seemed to move across the sky as time elapsed during my exposures. (Of course, while the camera and the stars remain stationary, the Earth is spinning). For *Ancient Light,* 16mm Film *(PP37)*, I was keen to document the perceived movement of stars as they appear to pass by. Due to unpredictable weather, the film took nine months to produce. I chose Kodak T 500 colour film, as it is one of the highest ISO films produced in 16mm. I chose to use one hundred feet of film, which roughly equates to four thousand frames, lasting roughly two minutes and thirty seconds at twenty-four frames per second. Each frame took 30 seconds to expose, and the choice of timing was influenced by my experience with the *Ancient Light* series of photographs. Below Figures 3:10-11 document notes taken to determine the correct exposure time, and a written vignette recorded directly after producing the timelapse.

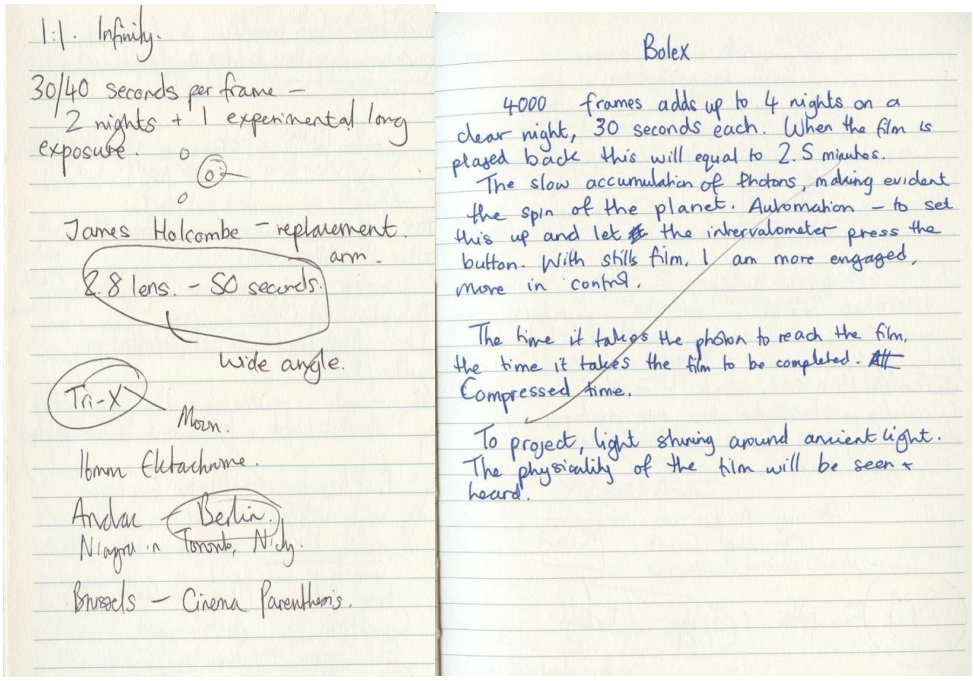


Figure 4:11-12 Melanie King, Ancient Light, 16mm Film Exposure Notes, *Margate, 2018.*

The work is intended to be projected large in an analogue format within a darkened room to give the viewer an immersive experience, which mimics the feeling of being underneath a night sky full of stars. Simultaneously, the viewer can experience the film passing through a projector, which has an indexical relationship to the light that has encountered the film. For the film to be shown in a positive format, I would need to produce a print of the 16mm film, which I intend to do in future with financial support. I did not want the projector to scratch the negative film, due to the fine detail of the stars and irreplaceability of the film itself. In this film, dust and scratches may have been confused with photographic traces of starlight.

In my 16mm film *Searching For The Moon* (PP38), I focused a telescope on the Moon and held my Bolex camera up to the eye piece. I demonstrated the spin of

the Earth by allowing the Moon to sail out of the field of view. In parallel with the *Ancient Light* film, I intend for a print of the analogue film to be projected at a large scale. During a film screening in June 2022 with artist Cathy Rogers (PP39–40), she used a 16mm projector to show my original negative film. Unlike the *Ancient Light* film, I was not worried about the film being scratched as the Moon could not be confused with dust and scratches. Furthermore, the presence of these marks contributes to the analogue film screening experience, allowing film that has been touched by moonlight to be physically seen to animate projections within the space. The *Searching For The Moon* 16mm film was inspired by previous iterations mentioned below, produced using digital cameras attached to telescope eye-pieces.

The first *Moon Rising* digital film (PP43) was produced in 2015, using my personal Celestron Astromaster reflector telescope in London during my first year of PhD study. The second film *Moon Rising* film (PP42) was produced using the Fry Telescope at the UCL Observatory in 2017, with assistance from Theo Schlichter. The digital videos were shown at MOONs, at the Alyce de Roulet Williamson Gallery at ArtCenter College of Design, Pasadena, California. The videos were projected at a height of four metres, allowing the viewer to intimately interact with the work. The 2017 iteration of the film was produced on a day with a small amount of cloud cover. The 2017 film is zoomed in due to the magnification of the telescope which cannot be changed easily. Projected at a scale of four metres in height, the experience of viewing the work enables the audience to observe craters on the surface of the moon. The curator of the MOONs exhibition Stephen Nowlin, commented that it felt as if viewers were floating above the Moon due to the cropping of the image.

Overall, the opportunity to exhibit these moving image works within both screenings and gallery installations, allowed me to test the audiences experience of my artwork in several situations. The dark screening spaces and scale of projection produced an immersive environment where viewers could focus on the work. Feedback from the film screenings confirmed that viewers felt immersed by the screening environment, as there were minimal distractions in the screening rooms. One viewer suggested that the *Ancient Light* timelapse was dizzying, as the stars seem to move so quickly.

Lunar Portraits

Lunar Portraits, 2018-2020 (PP44-57) comprises a series of analogue portraits which were exposed by the light of the Moon. In the first iteration of the project, I worked with members of the London Alternative Photography Collective during a residency at XYZ Books in Lisbon. To minimise light pollution, I entered the grounds of Fundacion Gulbenkian Calouste at 10pm at night, as we waited for the Moon to rise.

Like many other works produced at night in dark sky areas, I had to wait for ideal astronomical and atmospheric conditions to produce the images. Influenced by earlier work with the *Ancient Light* series of photographs, I used a medium format Mamiya 645 analogue camera and Ilford 3200 film. I used the same exposure and aperture to produce the photographs. I then asked sitters to face the Full Moon, with an instruction to gaze upwards and reflect upon the experience of viewing the Moon for thirty seconds. Unlike *Ancient Light*, Lunar *Portraits* includes light from the cosmos, aspects of the landscape and human beings within one image. The moonlight touches the skins' surface and is reflected into the camera. I aimed for

the portrait sitters to reflect on their experience of gazing at the Full Moon, some of which are recorded in the *Lunar Portraits* section of the portfolio (PP58) and below. Sitters from the *Lunar Portaits* series discuss how the experience altered their experience of time, and enhanced their connection to the Moon.

> *On average I spend around an hour a day staring down at the light of the screen of my phone. Sitting in the pitch black and staring up at the moon is something I hardly ever do. It was a truly meditative experience. I was sitting there in the middle of the night focusing on the moon trying to sit still for the image. It made me feel very aware of my tiny little presence on the earth and the mighty galaxy that is surrounding us full of stars, moons and planets that are completely unknown for us. (Copyright: Mudde, 2019. All Rights Reserved)*

> *The moon was so bright. We kept looking around, to check there wasn't another artificial light casting such deep indigo shadows from our feet. But it was only the moon, shining up there above the cliff, glittering on the sea, illuminating every wave. It was cold, but we were wrapped up. Standing there, moongazing, as still as we could. Smiling, trying not to giggle at first, but then in the deepening stillness, losing our sense of time. The long exposure a moment that seemed to stretch out sideways, beyond or outside of everyday time, a moment that seemed more in tune with the moon and the stars than the streetlights and cars at the top of the cliff. (Copyright: Jefferson and Le Couteur, 2019. All Rights Reserved)*

> *Dear Moon Sometimes I wish I could just come to your arms. But I understand...*
>
> *Far and together Entangled*
> *Depending one on another.*

I can feel the texture of your matter
The smell of fresh dust, yet to get oxidised. Constantly shielding us down here.

Light and dark Deity of the waters

I can sense your strength pushing and pulling the tides The tide in me, The tide of my body, also affected by you, dear Moon.

Sonata made for the light you reflect on us, that even the blind can see it.

My veins are synchronised on your phases Sometimes I wonder if you also control my heart.

But I understand Moon. (Copyright: Valente, 2019. All Rights Reserved)

In 2019, I had an opportunity to produce a solo exhibition at my Alma Mater, Leeds Art University (PP44–46). To decide on which image to select, I chose the sharpest, clearest image of each portrait sitter. Due to budget constraints and the size and shape of the rotunda gallery space, I chose to produce the prints at 10x8 inches. The chosen print size encouraged visitors to physically approach the artworks, allowing them to engage with the detail and surface of the prints. As the Ilford Multigrade Fibre-Based Warmtone silver gelatin paper had rendered deep black tones well within my *Ancient Light* series, I chose to use the same paper for *Lunar Portraits*. In contrast, digital A1 prints originating from analogue scans were produced to enlarge and enhance details, such as grain and scratches on the film.

Ancient Light: Sustainable Photographic Practice

In Chapter Two, I considered the concept of more-than representational photography, a phrase originating from Rebecca Najdowski's thesis *Inverted*

Landscapes. Najdowski considers how non-human agents can interact with the photographic surface. Najdowski considers the 'non-human agencies of photographic processes and materials, as well as environmental forces and conditions to produce artwork' (Najdowski, 2020, 3). Najdowski produced photograms using silver gelatin paper, using geyser emissions. Steam, water and minerals produce marks as they fall onto the photographic paper. In the adjacent portfolio, I present cyanotype prints from my *Ancient Light* series that have been toned with organic substances such as green tea (PP84–86).

As I am working with organic substances, I cannot fully control how the final print may turn out; I witnessed this first hand during the experience of viewing silver nitrate and ascorbic acid underneath the microscope (PP80-81). [28]

As I saw the silver nitrate and ascorbic acid crystallise, I observed just how dynamic light-sensitive photographic materials can be. I became acutely aware of the agency of the physical matter that I am using to create my artworks. I have been collecting data as I have developed new recipes and methods for sustainable photographic practice. While producing a new plant-based developer, I have tried and tested several recipes. I have determined which processes work best for certain images — for example, caffenol-c works best with high contrast images.

Earlier in the thesis, I discussed the unsustainability of analogue and digital photographic processes. Below, I discuss several sustainable photographic processes that I have tried and tested.

[28] I discuss the process of producing the silver nitrate images using optical and conformal microscopes in depth on p79 of this thesis.

During the final stages of this research process, it has been important to share my sustainable photographic techniques through a variety of workshops. I have recently led such workshops for Cementfields (2023), MA Students at the Royal College of Art (2023), Norwich University of the Arts (2022), Photofusion (2022) and the Positive View Foundation (2023). It is important for this knowledge to be shared widely and freely, to enable other artists to adapt their own practice to be more sustainable. By sharing my processes in this way, artists can adapt the recipes themselves, which empowers them to produce their own innovative artworks. I determine the success of my workshops by receiving feedback from artists who have successfully used and adapted my processes. In the following sections, I share examples of artists who have followed my recipes. In addition to workshops, I share my recipes through physical publications, and on a Youtube channel where viewers can replicate my processes step-by-step.

As an individual artist, it is difficult to make a significant change to the environmental impact of photography. Cumulatively, however, artists can tackle specific problems with solutions that combine to solve several issues. For example, as one artist develops a bioplastic with the aim of finding a sustainable substrate for cyanotypes, another artist can strive to find a plant-based developer that does not negatively impact water sources.

Caffenol-C

To begin my experimentations with sustainable photographic processes, I chose caffenol-C film developer as a starting point. In place of standard developer, it is possible to use caffenol-C, whose main ingredients are instant coffee, vitamin-C, soda crystals and salt. A caffenol-c film developer recipe can be found in Appendix

4. According to the *Caffenol Cookbook* (Reinhold, 2012), instant coffee works best, since caffeic acid is the primary active agent, which is similar to the pyrogallol in standard, shop-bought developer. The second active chemical is vitamin-C, also known as ascorbic acid, which increases developing time, adds contrast, and reduces fog. Ascorbate, the salt of ascorbic acid, is used in some commercial developer solutions. Thirdly, washing soda crystals are added to the mixture to make it alkaline, which activates the coffee and vitamin-C powder. Kitchen salt can then be added in place of bromide, which then restrains the action of the developer. Firstly, I used an established caffenol-C film developer recipe to try out a test film.

As I became satisfied with images produced using the existing caffenol-C developer, I then produced my own recipe by adapting an existing caffenol-c process for use with high sensitivity film (Ilford Delta 3200). I did this by using longer developing times and varying quantities of soda crystals, vitamin-C and coffee. This recipe was tested out on a film containing photographs of the night sky, produced during a residency at The Fish Factory, Penryn, Cornwall in 2020 (PP86). Previous attempts to develop photographs of the stars using the first recipe in Appendix Four had resulted in underdeveloped negatives. To produce this image, I used the second caffenol recipe (Appendix Four)

Caffenol-C can be mixed to different quantities to produce photographic prints. In the caffenol film development process, the celluloid or acetate is not tinted by the chemistry. However, as photographic paper is more absorbent than film, the prints are coffee-tinged. To begin with, I tried out an established caffenol-c print developer recipe using a negative of the Moon produced at UCL Observatory with Theo Schlichter (PP82). I systematically produced multiple prints using the same

image, and came to the realisation that due to the sepia tint and short tonal range of the developer, it was best to use images with high contrast. Following the success of the Moon print, I selected high-contrast images from the *Ancient Light* series (PP83-85).

Working with more sustainable, organic photographic materials has resulted in a lack of control in my working process. Unlike industrially-made developers, each print made using coffee exhibited several differences. The flavonoids present inside the coffee plant absorb into the surface of the print, leaving a sepia tone behind. The developer becomes slower to react with the paper each time that one makes a print, meaning that it is harder to estimate development times. In contrast to standard shop-bought developers which can be relied upon to provide consistent results, organic developers require a more flexible approach. When producing these prints, it was important to continually observe the print, patiently waiting for the image to emerge from the developer.

Though caffenol is kinder to the environment than shop-bought developer, coffee has a considerable carbon footprint due to its exportation from tropical climates to the UK. With this realisation, it became clear that I needed to expand my knowledge of plant-based developers to include materials that could be sourced locally.

Submerged Landscapes: Seaweed Developer & Oceanic Materiality

Following on from my research with caffenol, I finessed a developer made from bladderwrack seaweed found on the Ramsgate coast. During the four years in which I have lived in Thanet, I have immensely enjoyed being in and by the ocean. The

sea and beaches are sources of discovery. Due to the tides, sands shift daily to reveal new terrains. As I walk by the shore and immerse myself in the water, I am fascinated by what I find. The algae, seagrass and seaweed are sticky and viscous, providing sustenance and shelter for living beings, and I was curious to know the material potential of these substances brought forth by the ocean. In this series, the photographs are co-produced with dynamic phenol content present in the seaweed. The materiality of the seaweed becomes entangled with the image itself as the negatives are tinted with a murky oceanic green.

Submerged Landscapes (PP105-107) is a project focused upon the threat of climate change and tidal rising within my local area of Thanet. Between the last glacial period (around 5000 BC) and the nineteenth century, Thanet was an island surrounded by the North Sea. From 1800 CE, the land around Thanet was drained for farming purposes. Now, as the tides rise, it is possible that Thanet may become an island again as surrounding areas are flooded. This project documented affected areas such as Pegwell Bay, Sarre and Reculver. These photographs were produced using black and white silver-gelatin film. I adapted seaweed film developer recipes which were designed for 16mm film stock. [29]

It was important for me to produce these images using sustainable photographic processes, using materials that can be found in the ocean. The resultant images are grainy and the developer fogs the image, lending a misty appearance. Having systematically tested this recipe with various environments and settings, this developer recipe lends itself to high contrast scenes.

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[29] *The Final Bladderwrack Seaweed Developer Recipe for Black and White Film is documented in Appendix Three.*

The developer contained soda crystals, vitamin-C, and phenol content from seaweed in place of coffee. The seaweed was identified with the help of local ecologist Hannah Scott and collected on daily walks around Ramsgate. Filmmakers Julia Emily Parks and Dagie Brundert had created a seaweed film developer for 16mm film. During the London Alternative Photography Collective Sustainable Darkroom online residency in 2020, I had the idea to create a seaweed film developer for black and white Ilford HP5 film, at 35mm stock. I tried and tested three different recipes using Julie and Dagie's method as a starting point. I firstly tried out their recipe, but the film strip came out severely underdeveloped. I then tried out different temperatures and developing times, until I found a recipe which produced negatives with sufficient levels of clarity and tone.

I have determined the success of the recipe, as my process has now been widely used and adapted. For example, it has now been adapted by artists Esmé Papa, Grace Warne and Elle Pickering to produce a silver-gelatin paper developer. [30] Caffenol paper developer is more difficult to use than shop-bought developer, as the development time alters with every print as the developer becomes increasingly exhausted. This effect is exaggerated with seaweed paper developer, as the development time and temperature are much higher.

[30] It is possible to view artwork produced using my seaweed film and paper developer recipe on the following links:

Esmé Papa: : https://exhibitions.brighton.ac.uk/students/esme-papa/ [Accessed 08/07/2023]

Grace Warne : https://www.source.ie/graduate/2023/artsbourba/artsbourba_student_16_06_11_16-05-23/artsbourba_student_16_06_11_16-05-23.php [Accessed 23/01/2024]

Elle Pickering: https://artonapostcard.com/products/lot-36-elle-pickering-memory-iii-1 [Accessed 23/01/2024]

Precious Metals: Reclaiming Silver From Used Photographic Fixer

Precious Metals (2021–2022) (PP87-103) is a project which considers the materiality of silver and palladium, from their production within the cosmos, extraction from Earth and their uses within our society. The project focused on silver and palladium use in photography, suggesting methods of using the materials that are less harmful to the environment. The project lasted from February 2021 until July 2022 and culminated in a solo exhibition at Photofusion in London. When silver gelatin prints are fixed, the prints release silver into the photographic fixative. If silver is not reclaimed and enters the water system, it can be fatal to aquatic organisms and can interfere with water treatment facilities.

At The University of Birmingham, I worked alongside Dr Leah-Nani Alconcel, using an electrolysis technique to reclaim silver from the photographic fixative produced by the caffenol prints. Myself and Dr Alconcel adapted a method from Charlotte Padgham, a jewellery designer, who makes a circuit with a battery and a power supply which emits 0.3 amps at 6 volts. Padgham uses an anode (graphite stick) and a cathode (copper object).

The circuit is completed when the anode and cathode are put into the photographic fixative. As electrical signals are passed through the fixative, unexposed silver is attracted to the copper. As the fixative is heated up, hydrogen sulphide gas is released. This gas can be fatal in large doses, so we used a fuming hood to extract the gases. We then tried out different amperages to work out an optimum amperage for plating. Our most successful result was at 0.5 amps, running the power supply for 25 minutes (Appendix Five). In addition to copper, we also plated brass, which resulted in a more even finish due to the elevated conductivity of brass

in comparison to copper. We then used Hagerty's Silver Polish and Goddards Silver Dip to seal the surface of the silver. (PP97-100) Since working on this with Dr Alconcel, several artists have replicated the process, including Dominic Rose [31] who has bound a book with wire that was silver plated using waste fixative.

At Photofusion, I chose to display the copper and brass items in a vitrine (PP92-93). I coated copper jewellery that I had handmade, in addition to copper and brass discs that were produced. I chose to make jewellery to signify the precious nature of silver particles that would otherwise be discarded. Additionally, the notion of embodiment is important, as jewellery is worn on the body and is designed to be touched.

The silver-plated jewellery and circular discs were shown alongside the *Ancient Light* prints made from coffee developer, whose unexposed silver had been used to plate the jewellery. (PP82) Overall, this exhibition was designed to prompt the viewer to consider the materiality of silver from several perspectives, from a microscopic scale within the images of silver nitrate and ascorbic acid, to the images of vast supernovae. A guestbook was left in the exhibition space to capture visitors' thoughts. Many visitors commented on how the exhibition led them to think about the sustainability of photographic processes.

A quote from the guestbook is as follows;

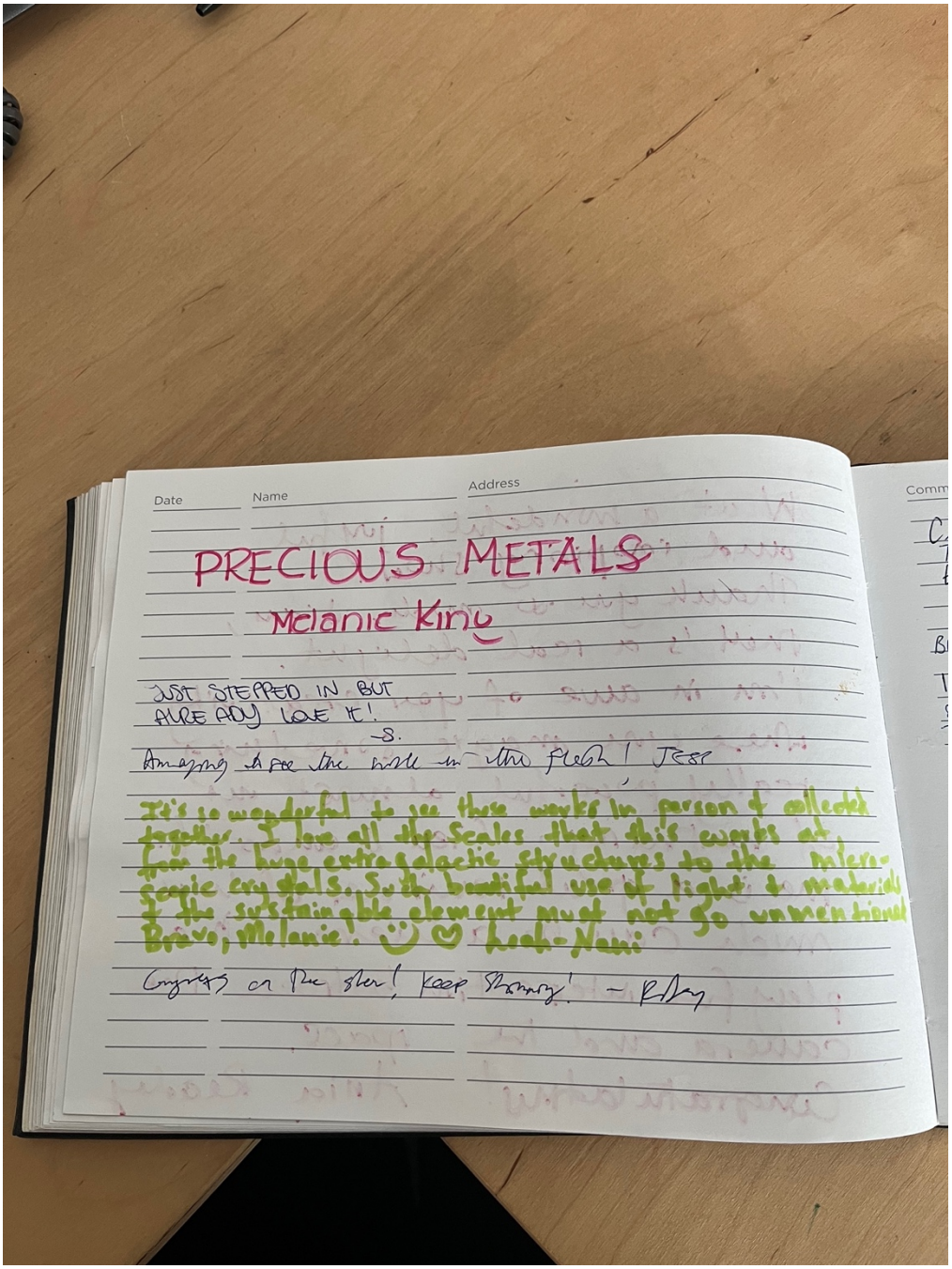
> I went to Parallax to buy a film but got bonuses of a photography exhibition and further knowledge about sustainable developing

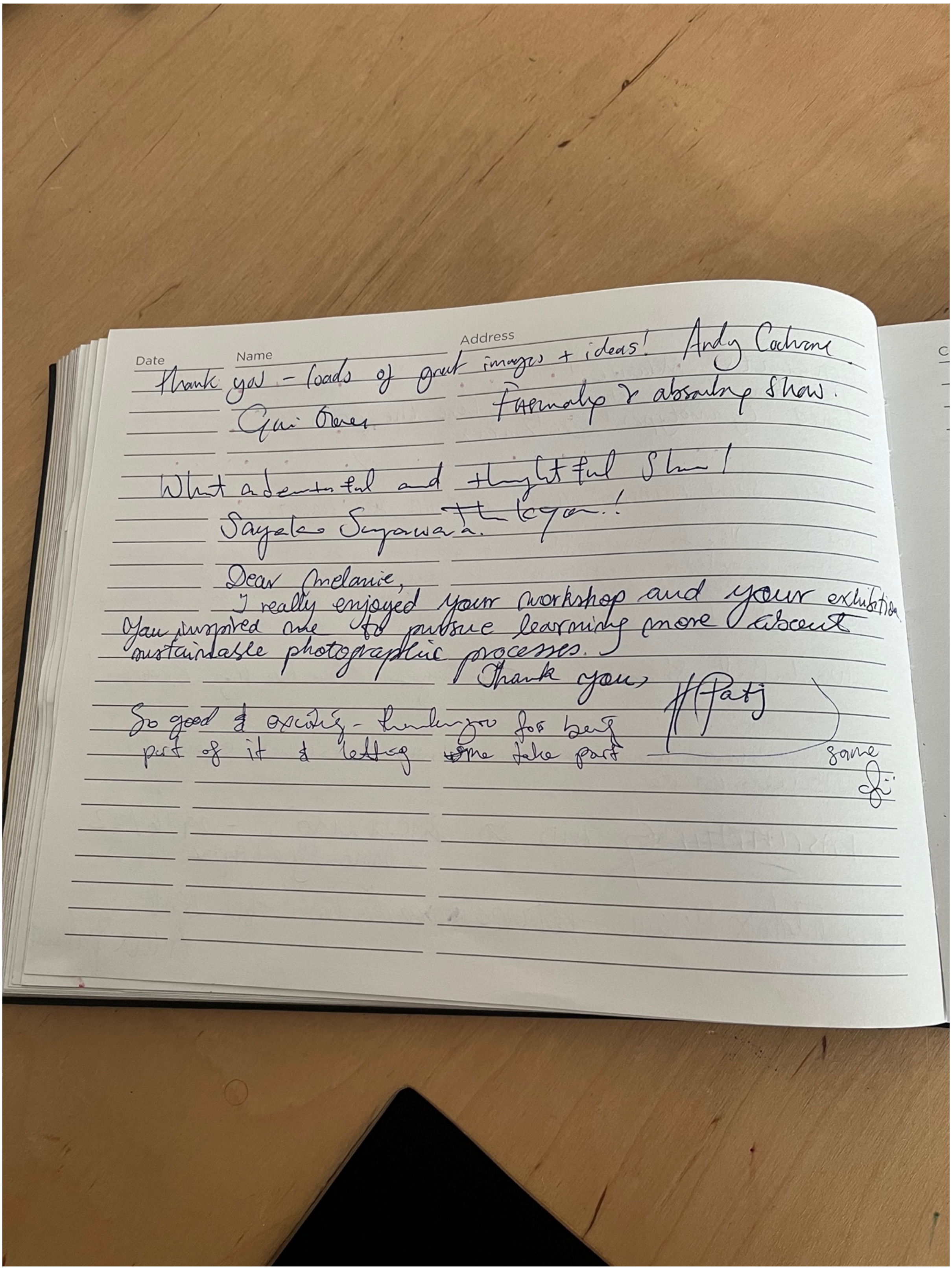
[31] Dominic Rose's handmade book with silver plated binding can be found using the following link http://dominic-rose.com/memoire/ [Accessed 08/07/2023].

processes as well! Thank you for this, I never thought about "sustainability" in film developing process before. Love your work!

Retti from Indonesia

Images from the Precious Metals Exhibition guest book can be seen below, from page 171-173. The comment has encouraged me to continue working with sustainable photography processes, presenting them in an exhibition context with information on how to replicate the results.


Date
Name
Address
PRECIOUS METALS
Melanie King
JUST STEPPED IN BUT
ALREADY LOVE IT!
-S.
Amazing to see the work in the flesh! JESS
It's so wonderful to see these works in person & collected
together. I love all the scales that this exists at,
from the huge cosmic galactic structures to the intera-
gamic crystals. So beautiful use of light & materials
& the sustainable element must not go unmentioned
Bravo, Melanie! ☺ ♡ Leah-Nani
Congrats on the show! Keep shining! - Riley


Date
Name
Address
thank you - loads of great images + ideas!
Fascinating & absorbing show.
What a wonderful and thoughtful show!
thank you!
Dear Melanie,
I really enjoyed your workshop and your exhibition.
You inspired me to pursue learning more about sustainable photographic processes.
Thank you,
So good & exciting - thank you for being part of it & letting me take part

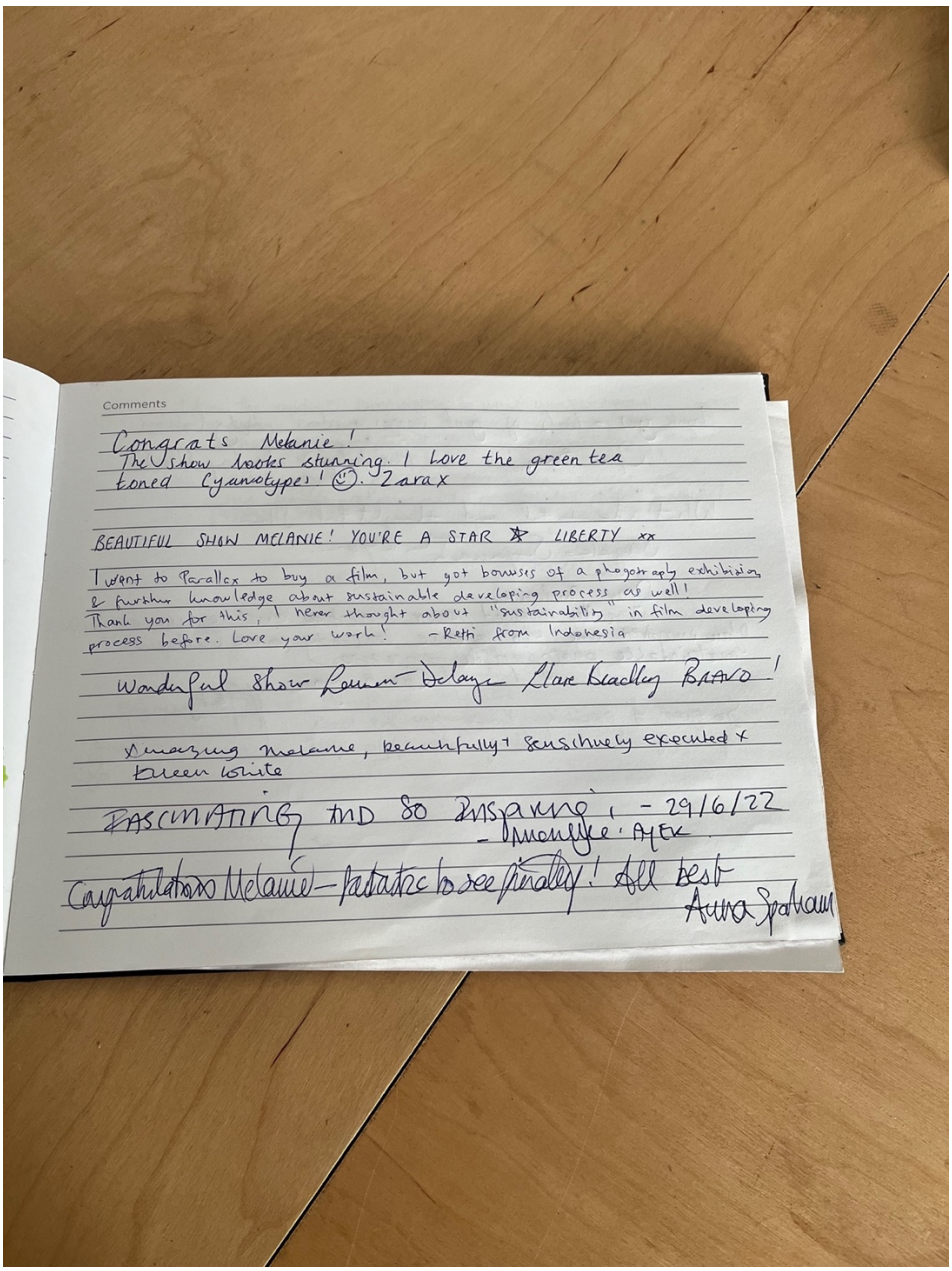


Figure 4:13-15 Guestbook: Melanie King - Precious Metals Exhibition, June-July 2022.

In summary, this chapter has discussed how my practice has evolved during the research degree. Each section of this chapter is influenced by the other sections, as my practice interweaves between the areas of photography, materiality and sustainability.

Conclusion

Summary

This thesis set out to explore the connections between astronomy, photographic materiality and ecology. It began as an enquiry into the parallel histories of photography and astronomy. My interest was inspired by a discussion about astronomical image mediation by Elizabeth Kessler in the *Envisioning The Universe* seminar at the National Maritime Museum in 2013. I had the desire to produce astronomical images with an analogue camera, using limited mediations. The research has led me to participate in residencies in remote locations away from light pollution and work with several observatories. Analogue astronomical photography in dark sky locations engenders a feeling of interconnectivity with ecological and cosmological systems. By extension, sustainable photographic processes can intensify this connection, as the ecological impact of photography is considered.

Overall, my research demonstrates the importance of a transdisciplinary approach. This study combines knowledge and approaches from a range of disciplines, spanning fields of art, science, and philosophy. In the case of the seaweed developer recipe, foraging skills were developed, requiring physical interaction with oceanic materials. The thesis brings together disparate concepts from astronomy, embodied practice, new materialism, and photographic theory and practice, providing a multidimensional response to my research enquiry. This practice-based investigation has provided me with a framework for approaching transdisciplinary

research, whether in residencies with scientific organisations, or while observing natural phenomena in the landscape. In the first chapter, Encountering Ancient Light, I discussed my experience of viewing and documenting night skies in areas away from light pollution, and how this led to an altered perspective. Informed by Donna Haraway and Melody Jue, I have come to value sensory information as a form of building knowledge that can enrich existing data.

This enquiry has been influenced by concerns around the climate catastrophe. Life on Earth is rare in time and space, yet it is being extinguished at an alarming rate as many species become extinct. This thesis offers several suggestions for photographic practices that are sensitive to the ecology of Earth, both in the context of field trips to remote locations, and in the production of works that are less harmful to the environment. The second chapter discussed how contemporary astronomical images are produced using advanced technological techniques, which prompted me to consider an alternative approach which requires less mediation. Rebecca Najdowski's approach to more-than-representational photography helped me to consider how this could be enhanced by sustainable photographic processes. My exploration into astronomy, photography, and ecology has led to a hopeful perspective, which values the importance of small, sustainable innovations.

This outlook has been found during residencies in rural locations, which have cemented my understanding that humans, non-humans, the environment, and the cosmos are interconnected. Research in astronomy led me to understand how rare complex, conscious life is in the enormity of time and space. As I began to understand the precarious balance of life on Earth, I considered that unsustainable photographic practices could negatively impact Earth's environment. As a result, I

was compelled to find out how to make photographic processes more environmentally sound.

In Chapter Three, I discuss Barad's concept of agential realism, where a viewer is entangled with their subject, environment, and apparatus. Through the lens of Parikka, we can imagine minerals, plastics and metals assembled to create telescopes and cameras. In addition, we have become aware of the violent extractive industries of colonialist capitalism that cannot be separated from the production of these materials and processes.

As Jane Bennett suggests, matter is *lively*. On a cosmic scale, stellar matter can create large violent explosions that are unimaginable from our earthbound understanding. On a planetary scale, tectonic plates contribute to geological events that can be observed from a human time scale — for example, volcanic eruptions and earthquakes. The liveliness of matter is experienced directly when working with the dynamic medium of photography, where chemicals and materials can transform rapidly and visibly with the introduction of light. As we understand that we humans are intimately connected with the Earth and the cosmos, it is in the interest of humanity to educate ourselves on the origin and ending point of the materials that we use.

In the fourth chapter, The Practice of Ancient Light, I discuss four strands of my practice, resulting from multiple methods. This chapter sets out the choices made when producing a series of analogue photographs of the night sky, in dark sky locations and in observatories. This section posits that the act of observing the stars in a dark sky location can be a transformative experience, which ultimately enhances our feeling of connection to the universe. In addition, this chapter explains how the

artwork produced as part of this research has been exhibited, using framing techniques, gallery design and projection to create immersive environments for viewing the work. I then present various projects detailing several sustainable photographic processes that I have developed, which ultimately reduced the environmental impact of my artistic practice.

Contribution To Knowledge

Building upon significant astronomical artworks produced by artists such as Katie Paterson, Thomas Ruff, Semiconductor, and Simon Starling, this practice-based research contributes a unique analysis of what it is to capture ancient light from distant stars, and makes the case for analogue, sustainable photographic processes. Instead of using archival astronomical images, these analogue photographs were produced by my own hand in isolated, dark sky environments. I explore the methodological and theoretical implications of such situated practice for astronomical artworks. My work leads on from analogue photographic artworks produced by Garry Fabian Miller and Susan Derges, who explore non-human influences in their practice. I adopt a similar approach, allowing stellar photons and natural materials to interact with the photographic surface. This research explores new sustainable photographic processes from a new materialist perspective, limiting my own impact on the environment whilst allowing for organic materials to influence the final image.

The specific contributions to knowledge in each chapter are as follows:

In Chapter One I put forward the case for embodied photographic practice as a way to enhance our feeling of connection with both the universe and life on Earth. This

section of the text builds upon Melody Jue's *milieu-specific analysis*, Donna Haraway's *situated knowledge* and Schön's *reflective practitioner.* I claim that analogue astronomical photography created from a terrestrial standpoint can engender a feeling of cosmic perspective. I assert that the act of viewing the stars, allowing stellar light to filter into our eyes, allows us to feel our direct connection to the cosmos. I propose the methods and works produced in the *Ancient Light* series can enable others to reflect upon the connections between astronomical magnitudes of time, embodied practice, and sustainable processes. Drawing on Frank White's conception of the *overview effect*, I argue that this experience can result in a shift in perception to a *cosmic perspective*, which compels us to see the Earth as a fragile organism. This research can be used as model of how it is possible to achieve a conceptual shift in the field of astronomical photographic art.

In Chapter Two, I discuss the power of astronomical images to alter our understanding of the scale and age of the universe, allowing us to obtain a cosmic perspective from Earth. In this way, astronomy highlights the precarious nature of life on earth, and — I argue — ultimately urges us to preserve it. All astronomical images have the potential to induce a feeling of the cosmic perspective. However, I argue that analogue astronomical photography produced using sustainable photographic processes further enhances this feeling of connection with the universe and the natural world. I posit that it is of vital importance to obtain a cosmic perspective, to enhance our understanding of how humans, the cosmos and the ecology of earth are interconnected. Our shift in perception is of the utmost urgency due to the intensifying climate crisis and its potential as an existential threat. This perspective can allow us to make decisions that are kinder to the Earth, as we understand that we are part of Earth's ecological systems. Building upon Rebecca Najdowski's *more-than-representational* approach to making photographs

that are co-created with non-human actants, I posit that sustainable photographic processes further the interconnectivity between humans, photographic materiality and ecology, as these processes sensitively consider the impact of photographic processes on the environment.

In Chapter Three, I explore how new materialist theories — including ideas set forward by Karen Barad, Timothy Morton and Jane Bennett — can be enlarged to accommodate cosmic phenomena. The aim of this chapter is to expand our understanding of materiality, considering the materiality of the cosmos itself.
I chart my transdisciplinary methodology, discussing how — as I have developed my knowledge in new materialist texts — my practice has naturally shifted towards a more sustainable approach.

In Chapter Four, I present my own practice-based projects which demonstrate two new, sustainable methods for producing photographs: a seaweed developer recipe for photographic film; and a technique for reclaiming silver from photographic fixer. I show how these methodological contributions to the field have been subsequently replicated by several artists. I discuss my work with sustainable photographic practices in a systematic way, considering how I determine the success of each process. I elaborate on details of these processes, so that future researchers can understand my method, aims and objectives. I demonstrate how future researchers might build upon my findings, and have included examples of artists who have further adapted my processes. The use of sustainable photographic processes, using organic materials to produce an image, further intensifies the connection with our natural world and the cosmos.

Afterword

Dissemination of Research

The *Ancient Light* series of photographs has been exhibited at different stages of production. I have produced solo exhibitions at Leeds Art University (2017, 2020), Blyth Gallery, Imperial College London (2018), Bloomsbury Festival (2019), and at Big Day Film Collective in Philadelphia, USA (2021). The work has also been exhibited in group exhibitions such as 'To The Edge of Time', KU Leuven Library, Brussels (2021) , 'Dark Skies' at An Lanntair, Stornoway (2020), 'Moonlight' at The Hasselblad Foundation in Sweden (2019) Unseen Festival in Amsterdam (2018) and MOONS, Williamson Gallery, Pasadena, Los Angeles, USA (2018).

This research has been presented at conferences including Levels of Life: Photography Imaging and the Vertical Perspective, London College of Communication (2022) eco_media IV: rip, rip, microchip, RMIT University, Melbourne, (2022), Multiple Ecologies, Diverse Ontologies, The University of Plymouth (2021), The Halide Project, Philadelphia, USA (2021), Expanding Dialogues: Art and Engineering, The University of Brighton (2021) and The Art and Science of the Moon, The National Maritime Museum (2019). This research has also been presented at multiple panel discussions in the context of space exploration, in the International Astronautical Congress in Guadalajara, Mexico (2016), and Bremen, Germany (2018).

Throughout this body of work, I have identified communities which may benefit from this study. This research will contribute to scholars looking into embodied and situated knowledge, with a specific focus on astronomy and photography.
It will also be relevant to researchers looking into sustainability in photography, though elements could be applied to other art and design disciplines. I will continue to develop my practice-based research in transdisciplinary fields, with a focus on astronomy, space exploration, and engineering.

Applications of Research

Having recently secured a role as Lecturer in Photography at Canterbury Christ Church University, I intend to translate several of my methods into pedagogical models for critically engaged practice, and test out methods on new research projects in astronomy. For example, I intend to embark on a new project *In Praise Of Raw Data* with Dr Claudia Mignone, an astrophysicist at Istituto Nazionale di Astrofisica.

In Spring 2024, I will begin a new enquiry during a residency at *Photo Canopy* based in Burton on Trent. This research will be directly influenced by the location-specific sustainable photographic processes used in this research. It will allow me to further develop my skills with large format photography and botanical cyanotype toning.

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Appendices

Appendix One

Notebook Excerpts

Grizedale, The Lake District, 2018.

In search of darkness, but it never got fully dark
We waited until midnight for the stars to fully appear – it was 1am before the light was gone and we were still affected by light from nearby towns. Cassiopeia emerging above the trees, Ursa Major brightly shining through, satellites littering the sky. Ancient Oak trees dizzied by what seems like a spinning sky. Imagine what time feels like for them.

To find a dark place we wandered up steep, slate paths, sometimes on our hands and knees.
We found a clearing with a perfectly framed view of the sky. Head torches that only just illuminate the path ahead. Keeping together so we don't lose a friend in the dark. Fear of falling down a crag and talk of 'The Bogle'. Silence and reverence interjected by silly jokes.

UCL Observatory, 2018

Smell of burning allotments and tyres on asphalt, headlights illuminating the dome. A clear night to begin with, winding up the Fry telescope, the spinning motor to keep the equatorial mount on track.

Eventually we focus on the Double Cluster in Perseus. Exquisite crystal cluster held in the eyepiece. It is 3am now, light has travelled 7.5 Kilo-years before reaching my eye. With the shutter open my film is acting like a light bucket collecting photons and storing them up.

I have been tired up until this point but I am instantly rejuvenated by the vision of something spectacular. I am a physical being staring into the depths of space. Exploring the observatory with my camera but it is too bright to see anything but Venus and Jupiter. Capturing the domes against the night sky.

Aftermath

I get home at 5am when the Sun has already begun to rise. I am not able to sleep for longer than 6 hours. My body is used to being awake in the day and asleep at night, my circadian rhythm is out of whack. Astronomers must adjust to this.

Atina, Italy, 2018

The sky rolled through blue and pink through blue, red and orange. The colour of aerogel. Then blue, red and navy before turning black.

Collective awe of meteors burning into the sky. Elated moods on the coach back. Capturing the cosmos digitally. Instant gratification as I must wait for my film to be developed.
Such a beautiful Milky sky, an amazing effect on the mood. The sky as a theatre.

Mars, Saturn, Jupiter, the Hercules Globular Cluster. Like a crystal-clear shining jewel. The light of 1 million stars filtered through the eye piece.

The Milky Way arched high above, evidently a spiral sucking me into the centre. Like looking down into the ocean and wanting to jump in. When I am in the Walpole Bay tidal pool, the expanse of the water and sky allows my mind space to wander. No external thoughts, just a vast space. Alone – the feeling of being one small person in the immensely huge Earth. The airplane in the sky soaring over deserts, as a little dot in the sky to an observer. Looking up at the stars and thick, dense black dust at the centre of a galaxy, feels like a pool to jump into.

A bird tweets in the background, twice at regular intervals. Sounds like the lonely beep of a spaceship which reminds you how distant you are from Earth. Not quite the same, but the Milky Way and almost silence can trick you into thinking you are alone with no other reference point. The crickets bring us back to Earth.

Appendix Two

Melanie King — Garry Fabian-Miller Interview

May 2020

MK: How does photosynthesis relate to your work?

GFM: I began making plant pictures in 1984/1985. I particularly remember the first spring of 1985, when the tree was being activated and coloured by the duration of his exposure to sunlight. The leaf would break on the bud of the tree and as I observed it from the first day onwards. The sunlight produces chlorophyll which slowly turns the tree green. I remember beginning with the Poplar tree which has this remarkable flesh pink leaf when it came from the bud, followed by this remarkable new pink, followed by a deep pink. It would then turn from light pink into the palest of greens, before ending up dark. 20-30 days later, depending on the kind of Spring we were having, I gathered those leaves. I then set up a system where everything stayed the same in the darkroom; the exposure was the same and the filtration was the same. Each day I would come into the darkroom with the next group of leaves from that day's exposure and place the leaf into the enlarger head. I would then print the next picture, which would be different because the sun had made it different. It felt like a collaborative act between the sun, the tree, myself and the photographic materials. I think it was that which made me begin to think about exposure. That was the beginning of cameraless photographs, so it was all about light falling onto a surface, and my relationship with the light and the photographic materials.

MK: Could you talk about your understanding of cumulative exposure to sunlight?

GFM: Whilst in Japan for teaching and an exhibition, I began to develop this idea that we make our brains through our accumulated exposures to the things that we look at. For example, when the light falls upon us, we have both light on our body surface, light entering our eyes and the images it brings into our mind. I began to think of the brain being like a dark rock, which was then filled with light through the accumulated exposure of being alive.

This cumulative exposure to sunlight and moonlight (reflected light of the Sun) is central. It's how we expose ourselves to the sunlight and the quality of the light for me. The key points are at the beginning of the day and the end of the day. So dusk, sunrise and sunset are a kind of profound state which exists at that point. It is important for me to spend a lot of time in those places, to build your exposure and create your perception.

MK: What is your approach to working within a specific location, and having a particular relationship with the local landscape?

GFM: I guess we have a pattern here where all the bodies of work I've made have come from specific places. There are odd exceptions where I've gone somewhere to make a picture, but those instances are so rare. As a child and a teenager, I felt comfortable in the place I lived in. My work has fallen into groups of work based around where I lived. There was a period around 1977-79, when I lived in North Somerset and Clevedon overlooking the sea. It was then when I did the sea horizon

pictures with the camera. I then moved to Lincolnshire and all my work in Lincolnshire really came from the places I walked to from my house. I then moved to Dartmoor 31 years ago and the same pattern continued.

That is based on my belief that in this place are all things I need to see and find. If I look close enough, I'll find these things. It takes time to find them and observe the patterns. There's a familiarity with a small place. You can see it in all its light, seasons, atmospheres and moods. When you are always walking in a familiar place, there is the possibility of encountering something extraordinary. It is the belief that something extraordinary will happen and inevitably it will. It creates a very deep-thinking space, where I observed the smallest things, and I'm aware of the same perspectives, views, trees, horizon lines and weather systems. I would observe these things across a year and an accumulation of years. This means that when something unusual occurs I'm very aware of what happens in the landscape, whether it's a small thing or a very dramatic thing. The studio is like a large studio space. Where things can be found. The method is that I walk in a circle from my house, and that has been the pattern everywhere.

The walk takes in everything that I can see from the edge of the circle. I repeat walks within this circle, perhaps six miles across. Everything beyond the circle is like another country. On Dartmoor there's so much contained within the circle that I can be satisfied. I guess you're probably finding similar things to this living in Margate with your regular engagement with the coastline. The sea and the horizon, the changing position of the rising and setting of the sun.

MK: In your talk and recent radio talk 'The Last Exposure', you referred to the photograph as 'fossil like' and increasing exposure time as 'excavating'. Could

you explain why you might use archaeological terms to talk about your work in the darkroom?

GFM: I feel this a lot living on Dartmoor. It's an incredibly ancient landscape, where embedded into the ground is the deep geological history, but also an equally deep human history. The history goes back 5000 years and you're very conscious of that. Deep time is embedded into the ground. Archaeology attempts to excavate, remove, and reveal traces of things which are hidden. Knowledge and familiarity with the place suggests strategies for doing that.

I believe that in the Cibachrome paper, there are colour palettes and dyes embedded within. There are the obvious surface dyes, which is how most people would make an image using that basic dye base. Over time I've discovered that if you push the material and dig deep into it you activate a whole colour palette which is hidden and buried. It's only the quantity of light falling into it that will reveal the range of yellows, reds and blues. These colours would usually have remained hidden, but it was only by me deciding to increase the exposure more and more, and explore ways of intervening with colour, that I began to find these hidden colours and qualities of light. A lot of darkroom activity is like excavating into the dark to bring an image into the world, just like archaeology. This analogy works, whether it's using advanced scanning type systems from cameras in planes, early aerial photography, or walking the ground and observing small marks, and then beginning to develop ideas as to where things lie hidden. I think that's where the connection lies and obviously the key thing is time. I use exposure time the way vast periods of time pass and can remain in the land, although apparently invisible.

MK: In your talk on the radio, you also said that the invention of photography is more important to you than the Renaissance. You said this referring to seeing Talbot's prints for the first time. Could you talk more about this?

GFM: I suppose the Renaissance is understood as a key western movement, where a whole new art form developed and changed the course of history. I guess the invention of photography I view as being the equivalent of that, and probably as another century passes it is more significant than that. You could think of photography beginning in the late 1700s when a group of people began to conceive of how photography could exist. It then took 20 or 30 years for an image to be created which could be made permanent on a piece of paper.

The 1840s is a starting point, but I would suggest going further back to the Renaissance and earlier, when there was a kind of sense of trying to make an image appear in the world almost like magic. I think poetry and music tried to embody images through words and sounds. Artists knew that art could do that, but painting was a very laborious way to achieve embodying images and sound. I think there was a kind of proto-photography which existed in the mind. Then we have this period of investigation, with the science and the chemistry which enabled photography as we know it to exist. Now we are 200 years on from the invention of photography, which still seems like fairly early days. We're passing out of the chemical phase into the digital phase.

We're in the kind of in between times where both chemical and digital photography exist. I think that eventually chemical photography will fall away. The digital photograph exists and that's an early primitive form of image making, just like the early nineteenth century photographs. It's hard to know where photography is

going to change and where it is leading us. I feel it is somewhere much bigger than where the Renaissance took us. I think it's an evolution in new ways of thinking. It's a way to create a new world through science and images, to make visible the unseen and to bring the sky down to the Earth.

MK: Does astronomy/living within a 'dark sky' area impact upon your work?

GFM: I have an interest in the skyspace, but I don't know that I have such an interest in astronomy. I'm happy to relate to the sky as I see it standing on the earth with my eyes — without needing to use telescopes and computer-generated reading systems. It is a kind of sense of wonder at the night sky, at the Moon's existence and its reflection of the light of the Sun, as well as the light of stars. I feel deep time on Dartmoor intensely at night, more so than the daytime. I really feel I am with people from long ago and also with people way into the future. The night space is this wonderful Other space where something really deep and profound exists, and you're part of it in this moment. It is very profound.

MK: What were your inspirations for the work *Night Cell*?

GFM: The *Night Cell* and *Night Drift* are very simple ways to make images using human ingenuity and everyday ordinary methods so that they exist in the world. It is like magic but alludes to something profound and deep.

Appendix Three

Final Bladderwrack Seaweed Developer Recipe for Black and White Film

Melanie King

This developer is designed for black and white film, with an ISO of 400.
If using washed up seaweed, proceed with caution as seaweed can hold toxins that are found within the ocean. You can wear gloves to prevent contamination.

I used the following technique for a 35mm Ilford HP5 film. Double the recipe for a 120 film.

- Collect a handful (around 100g) of fresh bladderwrack seaweed.
- Boil 500ml of hot water, pour onto the seaweed and leave overnight.
- In a separate jug, mix 50g of soda crystals with 150ml water and dissolve completely.
- In the jug with dissolved soda crystals, mix 12g vitamin C with the dissolved soda crystal solution and dissolve completely.
- Add around 150ml of your seaweed 'brew'.
- Heat to 26 degrees. You can do this by putting the jug of seaweed developer into a larger jug of hot water.
- Pour the developer into your developing tank. Invert the tank every 2 minutes for 60 minutes. You can also stand develop for the full hour but this may create bromide drag.
- Wash for 2 minutes.
- Fix with Ilford Rapid Fix and wash.
- As an alternative, you can use salt water instead of fixative to stabilise your film. Salt has a dissolving limit of 359g per litre. For a 35mm film you should mix the

following solution. 150g salt with 500ml water. You will then need to leave the film in the salt water for 24 hours.

Note: This is the final recipe settled on after four attempts.
Firstly, I tried Dagie's recipe using similar quantities of material for a developing time of 15 minutes at 30 degrees. The film came out blank and underdeveloped.
I then tried a developing time of 30 minutes at 30 degrees. An image could be seen but the negatives were thin and underdeveloped.
Finally, I tried a developing time of 60 minutes at 30 degrees. A clear image could be seen, with strong contrast and sharp details. However, the film seemed fogged due to the seaweed dyeing the film base. Following this attempt, I have settled upon a developing time of 60 minutes with a temperature of 26 degrees. This recipe produces the clearest image.

Appendix Four

Caffenol-C Film Developer (Adapted from https://www.caffenol.org/)

This developer is designed for black and white film, with an ISO of 400, designed for high contrast images. I used the following technique for medium format Ilford HP5 film.

- Pour 300ml of hot water into a jug, add 90g of soda crystals and dissolve completely.
- Add 10.g of vitamin c powder and dissolve completely.
- Add 24g of instant coffee or 50g of used ground coffee.
- Top up mixture to 600ml with cold water.
- If using instant coffee, develop for 15 minutes at 20 degrees Celsius.
- If using ground coffee, develop for 25 minutes at 24 degrees Celsius. This is because ground coffee contains a lower amount of caffeic acid.
- Wash for 2 minutes, then use Rapid Fix for 5 minutes. Final wash for 20 minutes.

Caffenol-C Film Developer for Astrophotography (Adapted from previous recipe)

This developer is designed for Ilford Delta 3200 black and white film, exposed to light from the stars.

- Pour 300ml of hot water into a jug, add 24g of soda crystals and dissolve completely.
- Add 20g of vitamin c powder and dissolve completely.
- Add 45g of instant coffee.
- Top up mixture to 600ml with cold water.
- Develop for 33 minutes at 20 degrees.
- Wash for 2 minutes, then use Rapid Fix for 5 minutes. Final wash for 20 minutes

Appendix Five

Silver Reclamation from Photographic Fixer

This appendix is taken from a feature I wrote that I contributed to r*e:source* (Fletcher, 2022). This recipe is adapted from Charlotte Padgham's recipe in "This Is (Still) Not A Solution" (Fletcher, 2021)

In Pagham's recipe, she makes a circuit using a battery and a power supply emitting 0.3 amps at 6 volts, with an anode (graphite stick) and a cathode (copper to be plated). The circuit is completed when the anode and cathode are placed into the fixative. As the electrical energy passes through the fixative, silver is attracted to the copper. When the silver-plated copper is taken out of the fixer, it needs to dry before the surface is touched.

I first produced copper pendants and collected old clock faces that were made of a copper and brass alloy. I then worked with Dr Leah-Nani Alconcel, in the School of Metallurgy and Materials at the University of Birmingham. It is important to use a fuming cabinet or to have adequate ventilation as the reaction gives off hydrogen sulfide gas.

We used a laboratory which had a fuming cabinet, which filtered and removed any unwanted gases. It also enabled us to use more heat safely. We tried out several different amplitudes and timings. We used 1.5 litres of used fixative in total, that was used to fix 2 35mm silver gelatin films and 10 silver gelatin 16x20" prints.

The timings and amperages are below:

1. 0.1 Amp, 6V, 30 mins. Silver rubs off.
2. 0.3 Amp, 6V. 23 mins. Silver doesn't rub off.
3. 0.3 Amp, 6V, 15 mins. Silver doesn't rub off.
4. 0.3 Amp, 6V, 10 mins. Silver doesn't rub off.
5. 0.5 Amp, 6V, 20 mins. Strong plating.
6. 0.5 Amp, 6V, 25 mins. Strong plating.

From our experiments, we chose timing six as the optimum time for even plating and strong adherence.