

Optics and Cosmology: from Euclid to Freud

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Abstract. This paper explores how the scientific materialist worldview, where any inexplicable phenomenon is regarded as an artefact of incomplete understanding or error, arose from earlier models of the cosmos. In these earlier cosmologies, the mysterious remained an important component and the role of light was a key factor in expressing an ordered hierarchical ontology.

Demonstrating the role of optics in the development and evolution of our understanding of the cosmos, the conception of light in the writings of Euclid, Plato and Ficino is surveyed. It is postulated that light starts off as an aspect of divine ineffability, and through the Scientific Revolution and Enlightenment becomes the light of human understanding. This development in understanding is traced through an examination of the optical studies of Descartes, Kircher and Bentham, and explored through four optical technologies: the spyglass, the camera obscura, the magic lantern, and the panopticon. As Jean Gebser points out in *The Ever Present Origin*, darkness must necessarily accompany the light, and this paper also examines the idea that the darkness that exists as the opposite of the Enlightenment, ends up located in the mind itself.¹ This is investigated through an examination of Freud's use of the metaphor of the optical phenomenon of projection.

Max Weber described the development of the modern world view as the result of a long process of disenchantment; an advance from animism towards rationalism.² That is to say, a movement from a cosmos controlled by occult entities to one governed by impersonal fixed forces operating within mathematically expressible laws.³ However, long before the

¹ Jean Gebser, *The Ever Present Origin* (Athens, OH: Ohio University Press, 1985), p.72.

² Egil Asprem, 'The Problem of Disenchantment and Modern Transformations of the Supernatural', in J. J. Kripal, ed., *Super Religion: From the Supernatural to the Paranormal* (Basingstoke: Macmillan Reference Series, 2016), pp.27–42, p.30

³ Steven Weinberg, *To Explain the World - the discovery of modern science* (New York: Harper 2015), p.248.

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adoption of the scientific materialist paradigm of modernity, individuals observed, investigated, and described natural phenomena, and one such phenomena was light.⁴ A study of the changing way light has been understood during this period, covering the disenchantment of western thought, can be used to examine how a cosmology rooted in the mysterious gave rise to one founded on logic and mathematics.

As early as 300 BC Euclid described the geometry of perspective.⁵ This mathematical treatment of how light behaved was accompanied by a mystery as to the nature of light and the mechanism by which the eye was able to perceive it. The ineffable aspect of light seems to have suggested to the ancient mind a linkage or symmetry between the cosmos and the eye. In Plato's *Timaeus* (c. 360 BCE), the planets and stars revolving about the Earth are likened to the pupil of a great cosmic eye.⁶ So key is light to a comprehension of the cosmos, that the cosmos can be described as an eye. If the cosmos is a great eye, then light is its omnipresent and perplexing organising principle.

In the *Republic*, Plato describes the unknowable origin of forms, the One, manifesting the lower levels of reality from itself, 'like the sun giving off light'.⁷ Cosmic order is analogous to light. The universe is fundamentally optical and ordered, in some occulted way, by light.

In 150 CE Ptolemy applied Euclid's work to the behaviour of light, specifically to the action of curved mirrors and the bending of light on its passing between air and water.⁸ But he is best known as the writer whose *Almagest* told people how to look at the night sky for almost a millennium and a half.⁹ Light is our direct, sensual experience of the cosmos: the Sun, the Moon and the stars are celestial lights, and the point from which we view them is the apparent centre of their motions. Ptolemy presented a geocentric cosmos organised as a series of concentric regions. This structure reflects the pupil at the centre of the eye and the eye at the centre of the field of vision. The Earth as the point of view from which sight

⁴ Koen Vermeir, 'Wonder, Magic, and Natural Philosophy: The Disenchantment Thesis Revisited', in M.F. Deckaed and P. Losonczi, eds, *Philosophy Begins in Wonder* (Cambridge: James Clarke & Co Ltd., 2011), p.52

⁵ Weinberg, *Explain the World*, p.35

⁶ Angela. Voss, *Marsilio Ficino, Western Esoteric Masters series* (California: North Atlantic Books 2006), p.6

⁷ Peter Struck, *Birth of the Symbol: ancient readers at the limit of their texts* (Woodstock: Princeton University Press, 2004), p.207.

⁸ Weinberg, *Explain the World*, p.35.

⁹ Brian Appleyard, *Aliens - why they are here* (London: Scribner, 2006), p.178.

radiates is therefore the centre of the cosmos. Ptolemaic cosmology reflects the visual experience of stars and planets which seem to move about us, and the accompanying mental experience of being at the centre of our field of vision.

The continuing significance of light can be seen in Marsilio Ficino's, *On obtaining life from the heaven*, published in 1489, an elaboration on Plotinian metaphysics which sought, as Angela Voss said, 'to establish the function of the world soul... [which contains the] seeds of the Ideas in the Divine Mind and sows them in the material world'.¹⁰ These seeds are in everything, but light with its immaterial materiality expresses this notion of the divine within the physical most directly. This idea of light as a symbol of the divine order of creation was expanded on by Ficino in *The Book of the Sun*, published in 1494, in which he laid out layers of symbolic discourse which move from the Sun's manifest light in the world of the senses to the Sun's hidden, intelligible light which 'kindles the inner spiritual eye'.¹¹ The evident physical phenomenon of sunlight illuminates an underlying divinity. The Sun is in 'the deepest mystical sense... God'.¹²

For Ficino, the nature of light is non-dualistically both divine and material. In its everyday mysticism light enables us to see the creation but also to experience the thought of the creator. The strange immateriality of light transmits an extraordinary significance to the organ associated with light; as 'the windows of the soul', the eyes connect our spiritual and material natures, giving us an essence that escapes strict materialism while being essentially part of the sensual, physical world.¹³

For much of pre-modernity the eye was understood as shining with its own light, the *lumen oculorum*; this emission from the eye mingled with the light from objects, enabling sight.¹⁴ The eye had a 'natural light to alter visible... [appearances] and make them commensurate with visual power'.¹⁵ This eye shine enabled objects to be perceived and to become one with our interior world of memory and imagination. The object would 'kindle the eye' and this in turn could lead to knowledge.¹⁶ This occurred

¹⁰ Voss, *Marsilio Ficino*, p.20.

¹¹ Voss, *Marsilio Ficino*, p.22.

¹² Voss, *Marsilio Ficino*, p.22.

¹³ Appleyard, *Aliens*, p.190.

¹⁴ Ivan Illich, *In the Vineyard of the Text* (London: University of Chicago Press, 1993), p.20.

¹⁵ Marina Warner, *Phantasmagoria* (Oxford: Oxford University Press, 2008), p.122.

¹⁶ Illich, *In the Vineyard*, p.18.

through *adaequatio* – ‘the affinity between thought and object’.¹⁷ Light is not passively received by the eye, the seen and the seer are part of the cosmic order. There is a joining of the eye, light, thought and divinity. The act of sight is a microcosm of creation, and thus any investigation of the processes of sight is a mapping of humanity’s place in the cosmos.

Alchemical diagrams, such as those produced by the English alchemist Robert Fludd, are aglow then with the hidden light given off from the seeds of the Divine mind secreted in them. Their light is the ‘uncommon gold’ of alchemy.¹⁸ The lustre of gold is both a material reality and a sign of transcendence. The functioning of the *lumen oculorum* provides the mechanism by which the dissemination of alchemical images, as well as conveying practical information to the adept, were understood as part of the alchemical project to raise up creation from its fallen state.¹⁹

In this 1617 CE image, Robert Fludd depicts the creation as described in Genesis (See Fig. 1).²⁰ Fludd saw this event as an alchemical process, with God dividing ‘primal, dark chaos, the prima materia... into... primary elements of light, darkness and spiritual waters’.²¹ This is a representation of the creation encompassed as an image resembling the visible part of the human eye; the creation as an *unus mundus*.²² Through such images, Fludd sought to bring about a realisation of the divine origins of the cosmos. This representation of the divine creation mirrors the eye that perceives the image, moving us to achieve a Platonic anamnesis, a remembering of our own divine nature as part of an ensouled cosmos.²³ The symbolism of the image combines with the viewer’s imagination to impart an experience, rather than logical reasoning persuading the viewer. As Tom Cheetham puts it, ‘thought and thing, mind and body, soul and world come together in the living process of the psyche.’²⁴ Looking at Fludd’s image, light and eye combine to view a representation of the cosmic order which triggers awareness of the observer’s own participation in that order. Vision and light operate as part of the ordering of a coherent creation from a fruitful but chaotic darkness.

¹⁷ Voss, *Marsilio Ficino*, p.7.

¹⁸ Joseph Campbell, *The Mythic Image* (New York: MJF Books, 1973), p.111.

¹⁹ Alexander Roob, *Alchemy and mysticism* (Koln: Taschen, 2006), p.28.

²⁰ Roob, *Alchemy and mysticism*, p.99.

²¹ Roob, *Alchemy and mysticism*, p.94.

²² James Hillman, *Alchemical Psychology* (1983; Repr. Putnam: Spring Publications, 2014), p.328.

²³ Voss, *Marsilio Ficino*, p.8.

²⁴ Tom Cheetham, *Imaginal Love* (Thompson: Spring Publications, 2015), p.45.

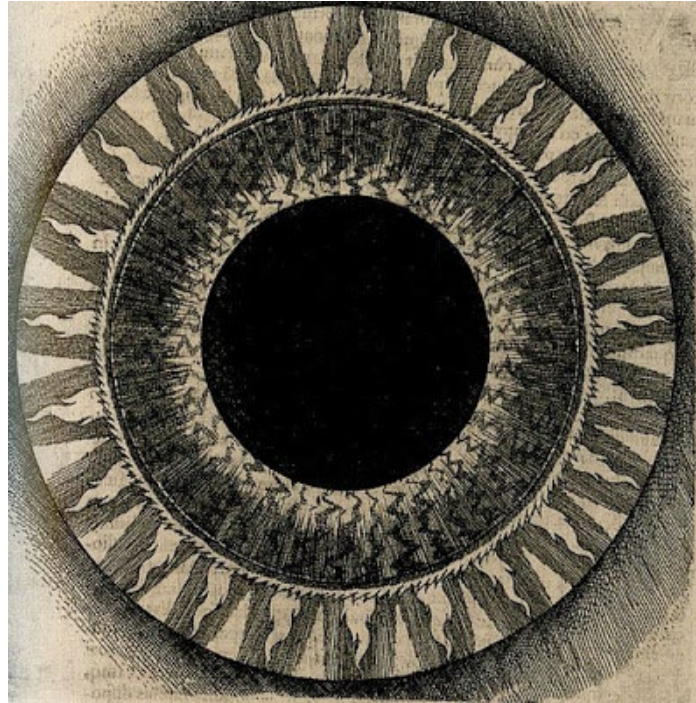


Figure 1. Robert Fludd, 'De metaphysico macrosmi...ortu', 1617.
Wikimedia commons

Bryan Appleyard identifies Ptolemy as a 'magus of sight', whose eyes informed the sight of others for generations.²⁵ Copernicus used the data from the *Almagest* to construct his heliocentric celestial landscape.²⁶ Copernicus did not doubt Ptolemy's astronomical observations, but by 1500 CE the attempts to fit all subsequent astronomical observation into the geocentric model resulted in a highly complex schema – Copernicus's insight was that by placing the sun at the centre of the observed orbits of celestial bodies, the existing intricate extra-terrestrial map was reformed into an uncomplicatedly elegant one.

Copernicus's model remained theoretical until confirmed by Galileo's astronomical observations of Venus, using not the naked eye of all previous observers, but the sixteenth century optical innovation of the

²⁵ Appleyard, *Aliens*, p.178.

²⁶ Weinberg, *Explain the World*, p.149.

spyglass.²⁷ The cyborg observations of Galileo proved the purely biological eye of Ptolemy to be flawed; only the technological enhancement of the optical organ could decisively displace the eye of the observer from the centre of the cosmos.

So humanity was displaced from the physical centre of creation: the observer is no longer central in the observed cosmos. In the new arrangement, the source of light, the Sun, is physically central, but this new order is achieved through human optical ingenuity with light as a tool of human investigation. Physical light is central but is no longer fundamental as a divine force powering creation; the Sun is the physical orientating central point in the solar system, but no longer the ordering spiritual principle of creation.

If we see the cosmos more accurately with the aid of a product of human skill then the *lumen oculorum* is transformed into the light of questioning intelligence shining into the world and making it manifest to understanding. It is the light of intelligence within us that is illuminating the world. Light is no longer divine thought but the aspect of the human mind that is god-like. Humans are part of creation but our ingenuity renders us inimitably capable of understanding that creation.

This idea is expanded in Descartes' investigations, a key figure in ushering in the modern scientific world view. Steven Weinberg regards Descartes' work on optics as an example of modern science; for example, in his investigation of the rainbow, Descartes formed a theory that explains how light is bent by raindrops, and tested his theory by shining light on a thin-walled glass globe filled with water. He then demonstrated mathematically that the results of his experiments followed from his theory.²⁸

Descartes excluded the seat of consciousness, for him the immortal soul, from his deterministic cosmology.²⁹ In doing so he intended to allow God to continue to play a role in an otherwise mechanistic universe and to secure the primacy of the mind. It could be said that he continued Ficino's idea of seeds of divine reason, but these fragments of supernatural thought are implanted exclusively in human consciousness. They now function, not to join us to the rest of creation, but to separate us exceptionally. It is given to the human mind only to comprehend the laws that underlie the workings

²⁷ Jean Gebser, *The Ever Present Origin* (Athens, OH: Ohio University Press 1985), p.21.

²⁸ Weinberg, *Explain the World*, p.212.

²⁹ Jill H. Casid, *Scenes of Projection - Recasting the Enlightenment Subject* (Minneapolis, MI: University of Minnesota Press, 2015), p.50.

of the cosmos, laws that exist partly to be comprehended. We no longer see ourselves as looking out from the physical centre of the cosmos, but as isolated within the cosmos as the sole observers capable of comprehension.

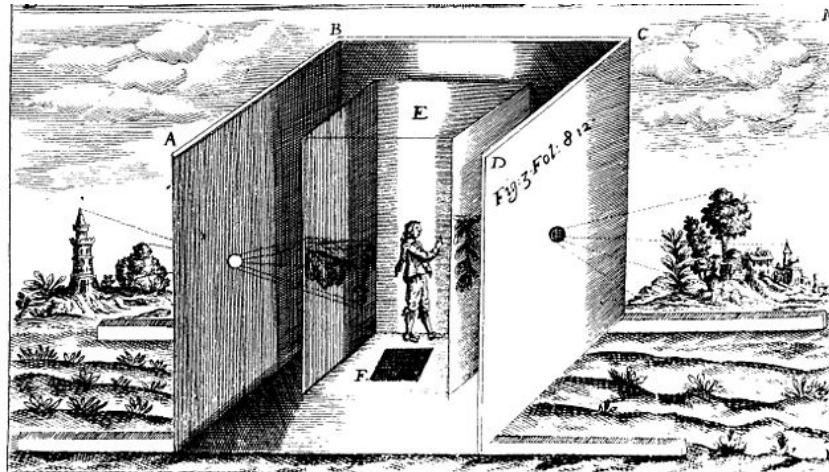


Figure 2. Illustration of 'portable' camera obscura (similar to Risner's proposal) in Athanasius Kircher's *Ars Magna Lucis Et Umbrae* (1645)

Descartes used the analogy of a particular optical machine – the *Camera Obscura* – to explain the relationship between consciousness and the material world. The human body is material; like the *Camera Obscura*, it is a machine. The body functions according to physical laws to provide an experience of the outside world for the mind, as the *Camera Obscura* focuses images for an observer inside it. The mind receives information from the senses while being separate from, but within the body; consciousness exists within the body, but like the spectator sitting within the *Camera Obscura*, the mind is of an essentially different, separable substance.³⁰ In Descartes' analogy, an optical apparatus became the model of the self. Human understanding is identified with sight, observing has become the essence of being.

Jill Casid writes of the pinhole lens of the *Camera Obscura* becoming understood, as 'identical with the mathematically determinable point where the world could be logically derived and represented'.³¹ The pinhole functions due to the laws of optical physics, as mathematics functions due

³⁰ Casid, *Scenes of Projection*, p.57.

³¹ Casid, *Scenes of Projection*, p.79.

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to the laws of logic. Light and human mathematical logic are elided, so that the fidelity of both is incontestable, as it arises from the physical nature of the cosmos. Our part in the order of the cosmos is as observers who are uniquely able to derive an understanding of its workings. The cosmos has meaning to the extent to which we can explain it.

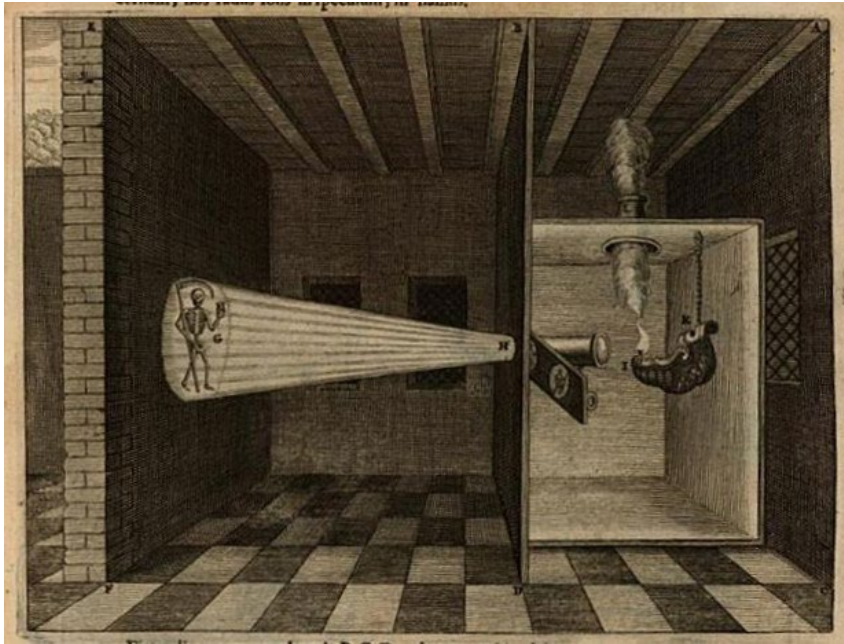


Figure 3. Illustration of the magic lantern in Athanasius Kircher's *Ars Magna Lucis et Umbrae*, 1671.

Athanasius Kircher seems to have embraced the theatrical possibilities of the ancient *Camera Obscura* and newer *Magic Lantern*. Fellow Jesuit Domenico Giardina describes Kircher's lantern performances as 'the enchantments of the reverend father', suggesting an atmosphere bathed in a sense of the mysterious.³² And the illustrations of the 1671 CE edition of Kircher's *The Great Art of Light and Shadow* include examples of the images projected,³³ nearly all of which are of supernatural beings.³⁴ Yet

³² Warner, *Phantasmagoria*, p.139.

³³ Warner, *Phantasmagoria*, p.138.

³⁴ Warne, *Phantasmagoria*, p.139.

when Giardina and Kircher exchanged letters about the *fata morgana*, a famous meteorological phenomena, Giardina wrote that he had glimpsed 'a trace of paradise'.³⁵ Kircher wrote back sternly reminding him that only miracles attested to by scripture could be regarded as genuine and therefore what Giardina had witnessed was a trick of the light.³⁶

This exchange confirms Marina Warner's view that the polymath Kircher was 'above all a scientist'.³⁷ But, Kircher chose to show to 'cardinals and grandees from all over the world'³⁸ images of dancing skeletons, leering devils and the souls of the dead.³⁹ When employing his own tricks of the light he chose to project images that he would deny as valid phenomena. Paradoxically, he employed his vast array of flamboyantly orchestrated effects, in Casid's words, 'to dispel superstition and teach the rules of nature'.⁴⁰ The production of immanently explicable phantoms is a way of training the sight of the audience. The alarm naturally felt by an audience unfamiliar with such events was dispelled by the elucidation of the mechanism of production. There is not only the demonstration of technical knowhow at these events, but an induction into the power over the self that such knowledge can bring, the attaining of 'a certain kind of mastery over... the seduction of the senses'.⁴¹ The imagination may be taken in by 'the power of the eye, but the rational, informed mind steadies and enlightens it'.⁴² The audience member is initiated into the new rational age of sight and can go on to apply this paradigm elsewhere.

Visions can be both produced and dismissed in the same act. The eye is fooled, so as to throw doubt on all such apparitions. Light is now reason dispelling the darkness of superstitious imaginings. The eye may not emit light but optical technology can project an image into the world. But while an unaware observer may mistake them for such, manufactured images are not miraculous or supernatural, but products of reason and ingenuity. Belief in the inexplicable and the mysterious is a product of a benighted mind.

³⁵ Warner, *Phantasmagoria*, p.95.

³⁶ Warner, *Phantasmagoria*, p.95.

³⁷ Warner, *Phantasmagoria*, p.96.

³⁸ Warner, *Phantasmagoria*, p.96.

³⁹ Warner, *Phantasmagoria*, p.139.

⁴⁰ Casid, *Scenes of Projection*, p.67.

⁴¹ Casid, *Scenes of Projection*, p.78.

⁴² Casid, *Scenes of Projection*, p.74.

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Reason can be used to overcome the fallible body, but logic is unassailable: the informed, reasoning mind knows the truth as it can know optical geometry. Mere physical illumination can be deceiving, it contains no mysterious divine knowledge, but harnessed by knowledge and skill it can be used to elucidate the truth.



Figure 4.

The Panopticon prison built on the Isla de la Juventud, in Cuba under President Gerardo Machado.⁴³

The educational aspect of this new conception of light is clearly seen in Jeremy Bentham's Panopticon, the panopticon being a design for a prison that allowed for constant surveillance.⁴⁴ The constant invisible observation of the Panopticon is designed to enforce efficiency and order on those who are incapable of achieving such behaviour on their own. The central tower

⁴³ <https://img.atlasobscura.com/qmHz-bDi19HoOmj9uIsKpjAzLT-2wOgOYn9gEfHVyQ/rt:fit/w:1280/q:81/sm:1/scp:1/ar:1/aHR0cHM6Ly9hdGxh/cy1kZXYuczMuYW1h/em9uYXdzLmNvbS91/cGxvYWRzL2Fzc2V0/cy8yY2MyMmQ2ZWVk/MDNIYTgyNjRfUGFu/b3B0aWNvblByaXNv/bi1Ub2RTZWVsaWUtNS5qcGc.jpg>

⁴⁴ Jeremy Bentham, *Panopticon* (n/p, Sofia Publishers, 2022 [1791])

is surrounded by a circular building consisting of rooms, each with a window on the inner and outer wall. Light streaming through the outer window silhouettes the rooms' contents for the central tower's observer. The occupant of each room is therefore constantly viewable to the hidden inhabitant of the central tower.⁴⁵ It is strikingly like a vast *Camera Obscura*: the Panopticon's denizens are displayed to the central observation tower in the same way a silhouette can be projected into the *Camera Obscura* by placing a form in front of the aperture. In its intention it resembles Kircher's optical extravaganzas. Visibility ensures and instils the required conduct, it is an optical machine to train people how to behave. Like Kircher, Bentham conceived of the exploitation of optical knowledge as a means of shaping people's reactions to the world.

Iain McGilchrist describes this optical architecture as a 'powerful all-surveying, all-capturing eye', but, viewed from the outside it resembles a fortress, a building that excludes and keeps out.⁴⁶ The Panopticon turns its gaze inwards, never attending to that which lies outside of itself. It is during the Enlightenment period that the word reflection, rather than referring to the interaction of light and a mirror, starts to be used to refer to 'that notice which the mind takes of its own operations'.⁴⁷

In the Enlightenment project, to make ourselves perfect and perfectly modern we reform ourselves through our unique human capacity of rational will, as Mary Midgley defines it, our ability to 'battle against a merely animal... body'.⁴⁸ Our attention turns away from looking outside of ourselves for answers – civilisation had to 'supersede and annihilate its past'.⁴⁹ A past blighted by 'the irrational... a dark, blind force'.⁵⁰ While those past ages once proclaimed mysterious forces as central to human existence, Bentham's machine of observation is in Michel Foucault's words, a 'house of certainty'.⁵¹

Panoptical observation is not passive – the population of the Panopticon is atomized into rows and columns of individual cells. All interactions are

⁴⁵ Michel Foucault, *Discipline and Punish: The Birth of the Prison* (New York: Vintage Books, 1977), p.197.

⁴⁶ Iain McGilchrist, *The Master and His Emissary - The Divided Brain and the Making of the Western World* (Princeton, NJ: Yale University Press, 2009), p.339.

⁴⁷ McGilchrist, *Master and Emissary*, p. 338.

⁴⁸ Mary Midgley, *The myths We Live By* (London: Routledge 2003), p.89.

⁴⁹ Daniel Deardorff, *The Other Within* (Oregon: White Cloud Press, 2004), p.64.

⁵⁰ Martin Shaw, *A Branch from the Lightning Tree* (Oregon; White Cloud Press, 2011), p.xiv.

⁵¹ Foucault, *Discipline and Punish*, p.199.

controlled and monitored. It is the imposition of a grid on the homogeneous space of the world, bringing the mysterious, the complex and ever changing interconnectivity of the world into an ordering hierarchy. McGilchrist suggests that ‘Vision has become a more alienating process as we have progressed in self-consciousness’: in modernity we see the observing self as essentially and necessarily separate from the world it views.⁵² Its rationality is maintained through a distancing from the immediate, multivalent fecundity of experience. Just as in the Panopticon, the central tower is separate from and enclosed by the annular wall of cells.

The Panopticon organises space to make the world fully knowable and irons out the vagaries of human nature in order to transcend, as McGilchrist puts it, ‘the limitations of the contingent and the physical, the incarnate and unique’.⁵³ In this age, human reason is the light that systematizes the cosmos. To be enlightened is to be filled with light, not divine light or optical light, but clear, rational understanding. The occult, as in that hidden, but also that which is troublingly mysterious, is outside the order and certainty of the Panopticon, a shadowy hinterland lying outside its walls.

Freud, in *Civilization and Its Discontents* (1930), writes of civilisation as characterized by a desire to banish the ‘barbarous’ and to cultivate ‘higher mental activities’.⁵⁴ He is describing the goals of the Enlightenment as embodied in the Panopticon. Post the Enlightenment, the eye, according to Jean Gebser, ‘comes to dominate mental structure’; James Hillman identifies it as the stand in for human consciousness.⁵⁵ We are now expected to live within the Panopticon – the frightening shadows of the irrational banished from collective experience, according to Weber, ‘into the transcendental realm of mystic life or into... personal human relations’.⁵⁶

It is from the operation of the *Magic Lantern* that Freud would borrow his image for the psychological activity he called projection.⁵⁷ We can read this idea back into the performances of Kircher and his fellow projectionists; they projected images of what they wished to remove from

⁵² McGilchrist, *Master and Emissary*, p.338.

⁵³ McGilchrist, *Master and Emissary*, p.340.

⁵⁴ Sigmund Freud, *Civilisation and its Discontents*, trans. D. McIntock (1930; Repr. London; Penguin Books, 2004), p.38; Freud, *Civilisation*, p.39.

⁵⁵ Gebser, *Ever Present Origin*, p.146; Hillman, *Alchemical Psychology*, p.85.

⁵⁶ Terry Eagleton, *Culture and the Death of God* (Princeton, NJ: Yale University Press 2014), p.1.

⁵⁷ Casid, *Scenes of Projection*, p.128.

their own psyches. Casid sees those using optical technologies doing so to 'cast out... [their own] passions and... susceptibility'.⁵⁸ Indeed, the degree to which the performances affected the audience could be seen as a measure of how successfully the projectionist had rationalised the mysterious for him/herself, and so was able to manipulate its effect on others.

The darkness that the projectionists and the Panopticon sought to expunge was, for Freud, still present within us. Our efforts to exile it are doomed to fail in Freud's view, as humanity 'shall never wholly control nature... [or ourselves, as our constitution is] itself part of this nature'.⁵⁹ So for Freud, the occult – the hidden, fearful and mysterious – is within us. In his wake, modernity has come to conceive of the inside of our heads as full of ethereal but real presences. Unable to locate the seat of consciousness anatomically, it has become the darkness reason cannot illuminate. Consciousness itself is, in the words of Gilbert Ryle, 'the ghost in the machine'.⁶⁰ The ghosts and phantasms banished by the light of reason are now part of us. As Terry Castle puts it 'the rationalists did not so much negate the traditional spirit world as displace it into the realm of psychology'.⁶¹

At the same time as we have come to discount external mysterious forces as a source of apparitions and learned to equate seeing them with having too much imagination, Castle contends we have also come 'to figure imaginative activity itself... as a kind of ghost-seeing'.⁶²

James Hillman writes that we should see imagination not as exclusively part of 'human psychology, but... like grace... something descending into our lives from an imaginal realm'.⁶³ Hillman adopts the term imaginal from Henry Corbin's study of Islamic mysticism. Corbin himself adopted it from nineteenth century studies of telepathy and mediumship.⁶⁴ As we reflect on our own natures we come to wonder if the same organising intelligence that in Weber's view carried out the 'rationalization ...[and]

⁵⁸ Casid, *Scenes of Projection*, p.127.

⁵⁹ Freud, *Civilisation*, p.29.

⁶⁰ David Lewis-Williams, *The Mind in the Cave* (London: Thames and Hudson, 2002), p.105.

⁶¹ Terry Castle, 'Phantasmagoria: Spectral Technology and the Metaphorics of Modern Reverie', *Critical Inquiry* 15, no.1 (1988): p.52.

⁶² Castle, 'Phantasmagoria: Spectral Technology', p.29.

⁶³ Hillman, *Alchemical Psychology*, p.116.

⁶⁴ Jeffrey J. Kripal, *Comparing Religions* (Chichester: John Wiley and Sons, 2014), p.252.

disenchantment' of the cosmos itself exists in part outside of the well illuminated 'house of certainty'.⁶⁵ The human mind partially dwells in what Martin Shaw describes as the 'hinterland between forest and village... a place of dreams, fear and homage' – the liminal, twilight region outside the Panopticon.⁶⁶ Having erected an edifice of reason we discover that the occult must always accompany the knowable. Fundamentally we are as much creatures of the transpersonal, subterranean lucidity of psyche, as we are of the unambiguous brightness of reason.

In reflecting on the historical understanding of light and the development of optics we see that it closely follows Weber's narrative of disenchantment – a clear move from a belief in mysterious entities governing the cosmos to a knowable universe controlled by impersonal mathematical laws. However, by focusing on light a number of points are elucidated: the antecedents of modern scientific rationality are revealed in the archaic systems of thought it set out to replace. Through concentrating on optics we see, as Alfred Gell points out, the often overlooked influence of technical innovation on wider society – optical technology – can be seen as key in forming the concepts underlying the scientific materialist view of humanity's place in the cosmos.⁶⁷ Centring the study of light in the creation of modernity also highlights the limits of disenchantment; through all its various interpretations, light remains forever linked to its shadowy twin. As much as light is valorised it cannot escape its 'unspoken polar complement'.⁶⁸

⁶⁵ George. Hansen, *Trickster and the Paranormal* (Bloomington, IN: Xlibris, 2001), p.26; Foucault, *Discipline and Punish*, p.19.

⁶⁶ Shaw, *Branch*, p.4.

⁶⁷ Alfred Gell, *The Art of Anthropology*, e (1999; Repr. Oxford: Berg, 2006), p.178.

⁶⁸ Gebser, *Ever Present Origin*, p.72.