

## “Hail, holy light, offspring of heaven first-born”: The Physics of Light in *Paradise Lost*

*Paradise Lost* (1667, 1674) demonstrates a complex physics of light informed by the development of scientific theories of light in the seventeenth century. The differences between Milton’s representations of light in *Paradise Lost* and Descartes’ theory of light in *The World* (or *Treatise on Light*) (1629-1633) and *Meteors* (1637), suggest the significance of role of light in the poem, both in the creation of the cosmos, and the different motions of light in the universe. Past studies of light in *Paradise Lost* have mostly focused the topics of optics and vision, particularly with reference to the telescope, rather than the physics of light itself. Ultimately, reading *Paradise Lost* in relation to the Cartesian theory of light shows how Milton is preoccupied with crafting a coherent monist cosmos, in which light is the fifth element – a divine emanation, as well as physical life-giving force.

The invocation to light at 3.1-55, and hymns to light at 3.708-32, 4.660-73, 7.243-60, 7.338-87 and 6.472-82 (Satan’s)<sup>1</sup> demonstrate the significant role of light in creating and sustaining the cosmos of *Paradise Lost*. In *The World* (or *Treatise on Light*) (1629-1633), Descartes outlines his mechanical model of light. This is very important for looking at the cosmogony of *Paradise Lost*, especially at 3.708-25 when Uriel describes his experience of witnessing creation. In respect to the creation of the cosmology there are three main areas where Milton differs from Descartes. Firstly, Descartes argues that the universe consists of three elements: fire, air, and earth, which are “three different kinds of corpuscle [matter]: very fine, fine and gross respectively”.<sup>2</sup> Conversely, in the creation of the universe in *Paradise Lost* 3.708-25, Milton uses the Platonic theory of five different elements: “[t]he cumbrous elements, earth, flood, air, fire, / And this ethereal quintessence of heaven” (3.715-6). Some of this quintessence forms stars, and “[t]he rest in circuit walls this universe” (3.721),

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<sup>1</sup> John Milton, and Alastair Fowler. *Paradise Lost*. Second ed. Oxfordshire, England; New York, 2013. Longman Annotated English Poets, p. 166

<sup>2</sup> René Descartes, and Stephen. Gaukroger. *The World and Other Writings*. Cambridge; New York: Cambridge UP, 1998. Cambridge Texts in the History of Philosophy. Web., p. xvi

enclosing the universe in a sphere, so that it is finite.<sup>3</sup> Whereas for Descartes, the cosmos is made from three different kinds of matter controlled by the laws of nature, for Milton, the cosmos is made from four different kinds of matter, and bounded by the fifth. Later, in the hymn to light at 7.243-60, closely modelled on Genesis 1:3, Milton clearly suggests that the fifth element, divine “quintessence”, is light: “[l]et there be light, said God, and forthwith light / Ethereal, first of things, quintessence pure / Sprung from the deep” (7.243-45, this sense is also present in “pure ethereal stream” at 3.7). In this way, light is “not one of the four warring elements of chaos but a fifth element”,<sup>4</sup> with a “primogeniture”<sup>5</sup> status, “offspring of heaven first-born” (3.1). As some critics have argued, this means that light is both a physical entity, to “light the day” (7.251; “light / his day” 3.724-5), as well as a divine quintessence and emanation.<sup>6</sup> In addition, this alludes to the Cartesian theory of “instantaneous propagation” of light, where corpuscles have “instantaneous tendencies to motion”.<sup>7</sup> Descartes means “propagation” in purely a physical sense, viz. *OED* “6. *Physics* The passage of movement, energy, a vibration, a wave, etc., in a particular direction or through a medium”. For Descartes, this means instant collisions of corpuscles in a straight line. However, in characterising light as “offspring of heaven first-born”, Milton puns on theology,<sup>8</sup> as well as incorporating Descartes’ physical theory of “instantaneous propagation” under a monistic understanding of light. At the end of chapter five, ‘On the number of elements and their qualities’, Descartes warns the reader that “as to make this long discourse less boring to you”, he is going to “wrap up part of it in the guise of a fable”.<sup>9</sup> Even Descartes, then, concedes the point that a fictional or imaginative space may be better suited to discussions of the cosmos, just as, by using epic blank verse to rewrite genesis, Milton is able to use puns and ambiguities to suggest the different theological and physical roles and identities of light in the creation of the cosmos.

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<sup>3</sup> *Paradise Lost*, p. 213, 721n

<sup>4</sup> Fletcher, 1956-61 ii 191 in *Paradise Lost*, p. 404, 243-9n

<sup>5</sup> *Paradise Lost*, p. 404, 243-9n

<sup>6</sup> See *Paradise Lost*, p. 165, 1-55n

<sup>7</sup> Nolan, Lawrence, editor. *The Cambridge Descartes Lexicon*, Cambridge University Press, Cambridge, 2015, p. 452

<sup>8</sup> Sewall takes “offspring” to mean “Son of God” *Paradise Lost* 1-55n, p. 165

<sup>9</sup> Descartes, *The World and Other Writings*, p. 21

Secondly, Milton and Descartes disagree about the role of God in creating and sustaining the cosmos. For Descartes, God “divide[s]” the matter “into many such parts, some larger, some smaller” – the process that forms the different kinds of corpuscle. Then, “He causes some to start moving in one direction and others in another, some faster and others slower...and He causes them to continue moving thereafter in accordance with the ordinary laws of nature.”<sup>10</sup> Hence, God generates the initial “mechanical pressure”<sup>11</sup> in the Cartesian cosmological system, “sufficient to cause the parts of this chaos to disentangle themselves and arrange themselves in such good order that they will have the form of a most perfect world”.<sup>12</sup> In *Paradise Lost*, chaos is ordered through God’s light: “I saw when at his word the formless mass, / This world’s material mould, came to a heap: / Confusion heard his voice and wild uproar / Stood ruled, stood vast infinitude confined; / Till at his second bidding darkness fled, / Light shone, and order from disorder sprung” (3.708-13). In *Paradise Lost*, divine light is both ontological, “God is light” (3.3), and an emanation, the fifth element of quintessence, viz. “pure ethereal stream” (3.7). Both of these divine properties of light are neatly contained in the line “[b]right effluence of bright essence increate” (3.6) – light is the celestial quintessence invoked by God, “[l]et there be light...” (7.243, 7.338), as well as part of his uncreated being. Whereas, in the Cartesian cosmos, God has a role in creation, but the laws of nature sustain the universe, in *Paradise Lost* God is omnipresent in the light of creation, and the light that sustains daily life. This is shown by Marjara in his analysis of “[m]inistering light” (4.664) – light which emanates through the sun’s rays by day and is reflected by the moon and stars at night. Likewise, this is both physical and divine light, sustaining physical life and Neoplatonic spiritual virtue: “with kindly heat / Of various influence formant and warm, / Temper or nourish, or in part shed down / Their stellar virtue on all kinds that grow / On earth, made hereby after to receive / Perfection from the sun’s more potent ray” (4.668-73). The tactile verbs convey a sense of physical light as a life-giving force, yet Descartes renounces the sensations in the mind associated with physical light, instead establishing laws of the collision and motion of light. Whereas the Cartesian matter which operating in the mechanistic system is inert,

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<sup>10</sup> Descartes, *The World and Other Writings*, p. 23

<sup>11</sup> Gaunkroger, ‘Introduction’ to *The World and Other Writings*, p xvi

<sup>12</sup> Descartes, *The World and Other Writings*, p. 23

*Paradise Lost* still holds onto ideas of light both as a spiritual ontology and emanated quintessence, as well as physical warmth and illumination.

This leads onto the third important difference of between Descartes' and Milton's views of the cosmos, how light travels within the system of the universe.<sup>13</sup> Gaukroger identifies how "Descartes' aim is to provide a mechanistic cosmology, resting on the basis of quantitative 'laws of nature'."<sup>14</sup> In part five of the *Discourse on Method*, Descartes notes that, in *The World* "I undertook to expound fully only what I knew about light. Then, as the opportunity arose, I added something about the Sun and the fixed stars, because almost all of it comes from them, the heavens, because they transmit it; the planets, comets, and the earth, because they reflect light; and especially bodies on the earth, because they are coloured, or transparent, or luminous; and finally about man, because he observes these bodies" (*AT* vi 41-2). This model clearly identifies the two connected ideas of luminary motion, as well as luminary vision. In the Cartesian system, light behaves differently in each of the three elemental bodies, which correspond to a different kind of luminary motion. Fiery elements produce light, airy elements "transmit" light, and earthy elements refract and reflect light.<sup>15</sup> In *Paradise Lost*, the divinely ordained function of the "celestial bodies" (7.354) of the sun, moon, and stars is "[t]o give light on the earth" (7.345). The sun, the "greater" (7.347) of the two "celestial bodies" is "of ethereal mould" (7.356), made of the fifth element of quintessence, and thus for Milton, a "fountain" (3.8) and source of physical and spiritual light, as opposed to only physical for Descartes. In Milton's cosmos, the stars emit light, but also reflect light from the sun. The stars, "[b]y tincture of reflection...augment / their small peculiar" (7.367-8). The *OED* senses 5b, 6b, for are "tincture: (1) infusion of a quality; imbuing with an active principle".<sup>16</sup> In addition, "peculiar" (7.368) is used in the astronomical sense,<sup>17</sup> i.e., "'proper' light, as opposed to 'strange' or borrowed"<sup>18</sup> light of the moon,

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<sup>13</sup> It is important to note that Milton's conception of the universe is Ptolemaic, whereas Descartes' is Copernican.

<sup>14</sup> Gaukroger, *The World and Other Writings*, p. vii

<sup>15</sup> Gaukroger, 'Introduction' to *The World and Other Writings*, p. xvi

<sup>16</sup> *Paradise Lost*, p. 411, 63-68n, *OED* 'tincture'

<sup>17</sup> *OED online*, peculiar

<sup>18</sup> *Paradise Lost*, p. 411, 63-8n

which is “made porous to receive / And drink the liquid light...Her gathered beams” (7.361-3). Milton establishes a celestial hierarchy. The sun produces solar light, the stars produce less light and reflect the sun’s light, and the moon reflects the light of the sun (3.723). The ultimate origin point of physical light in Milton’s universe is God, whereas for Descartes it is celestial objects which consist of matter corresponding to the element of fire.

The motion of light in Milton’s cosmos significantly differs from Descartes – there is less emphasis on the transmission of light through air, as well as the mechanical necessity of a “transmitting medium” or vehicle for light as well as “the luminous object” itself.<sup>19</sup> In the Renaissance atmosphere, the sun’s heat was believed to behave differently in the three regions of the Renaissance atmosphere, the hot upper region (*suprema*), cold and vaporous middle region (*media regio*) and hot lowest region (*infima*), reflecting the physics of radiation,<sup>20</sup> but not the refraction of light.<sup>21</sup> Svendsen is concomitant on the structure of the Miltonic atmosphere: “the middle region [is depicted] as cold because the upper protects it from the region of fire and the lower blankets it from the beams of the sun, which rebound from earth and warm the lower region itself. Above these three and the element of fire was the “pure marble Air” of the “worlds first Region” into which Satan projects himself.”<sup>22</sup> However, this refers to heat radiation, not the refraction of light. In Book 1, Satan is described as “the excess / Of glory obscured: as when the sun new ris’n / Looks through the horizontal misty air / Shorn of his beams” (1.594-6). This is primarily an example of diffraction, as opposed to refraction, as the poem evidences an understanding of the bending and obfuscation of light as it travels through different densities of medium. The epic simile personifies the celestial body as vulnerable and disempowered, conveying the lack of physical and spiritual light emanating from the sun, and thus

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<sup>19</sup> Sabra, A. I. *Theories of Light: From Descartes to Newton*. London: Oldbourne, 1967. Print. Oldbourne History of Science Library, p. 48

<sup>20</sup> Milton, John. *Paradise Lost, Edited by A. W. Verity*. England: UP, 1910, 1910. Web., p. 674-6

<sup>21</sup> As a caveat, it is important to note that the idea of a tripartite atmosphere may have been becoming an archaicism in light of scientific advancements of the late seventeenth century, especially Huygen’s principle of wave propagation in *Traité de la Lumière* (1678).

<sup>22</sup> The “region of fire”, Svendsen notes, was “sublunary”, existing below the moon but above the upper region, and the cause of comets, and other “portentous” fiery signs. Kester Svendsen, *Milton and Science*. 1956, reprinted 2014 ed. Cambridge, MA, 2014. Web, p. 87

how Satan's glory has been "obscured" by his rebellion and fall from heaven. Moreover, the following epic simile of the eclipse also works by the principle of light obfuscation: "or from behind the moon / In dim eclipse disastrous twilight sheds / On half the nations, and with fear of change / Perplexes monarchs" (l. 596-99). Alastair Fowler notes how "the ominous solar eclipse presages doom for creation in general and the sun king Charles in particular."<sup>23</sup> The portentous astronomical implications of the eclipse are foregrounded by the epic simile (the only other eclipse in the poem appears at 10.413, when Sin and Death pass into the worldly kingdom). Crucially, the physical mechanics of the eclipse are precisely conveyed the effect of "twilight" caused by the umbra cast by the moon, and the "dim" light of the surrounding penumbra, "[t]he lighter periphery of a sunspot".<sup>24</sup> Hence, in both epic similes Satan's fallen appearance is likened to obscured solar light, indicative of the divine significance Milton attributes to the lack of light in the poem. This is most apparent in Book 1, where heavenly light does not refract from the empyrean through chaos into hell. In Pandemonium "one great furnace flamed, yet from those flames / No light, but rather darkness visible" (l.62-3), the rebel angels are "[i]n utter darkness, and their portion set / As far removed from God and light of heaven / As from the centre thrice to the utmost pole" (l.72-4). This light in Pandemonium is physical, not divine light – yet Descartes would see no distinction between the physics and motion of light between the furnaces in Hell and the Empyrean.

In *Paradise Lost*, Milton includes Descartes' most famous exemplar of the law of refraction in the image of the rainbow. Descartes opens the eighth discourse of *Meteors* (1637), for which the subject is the rainbow, with the following: "[t]he rainbow is such a remarkable phenomenon of nature, and its cause has been so meticulously sought after by inquiring minds throughout the ages, that I could not choose a more appropriate subject for demonstrating how, with the method I am using, we can arrive at *knowledge* not possessed at all by those whose writings are available to us" (*AT VI* 325, *O* 332, my emphasis).<sup>25</sup> In *Paradise Lost*, there are two references to the rainbow; the first appearing

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<sup>23</sup> *Paradise Lost*, p. 97, 596-9n

<sup>24</sup> *OED online*, 1b. penumbra

<sup>25</sup> René Descartes, and René Olscamp. *Discourse on Method, Optics, Geometry, and Meteorology*. Indianapolis: Bobbs-Merrill, 1965. Print. Library of Liberal Arts, p. 332

in Paradise and thus highly suggestive of the kinds of forbidden knowledge available to Adam and Eve. In the garden there are “[b]lossoms and fruits at once of golden hue / Appeared, with gay enamelled colours mixed: / On which the sun more glad impressed his beams / Than in fair evening cloud, or humid bow, / When God hath showered the earth; so lovely seemed / That landscape” (4.148-151). The adjective “enamelled”, connotes that which is “lustrous, bright; variegated (without suggesting hardness)”,<sup>26</sup> thus the “humid bow” (rainbow), is associated with a profusion and amplification of the spectrum of colour. Significantly, when seen in light of Descartes’ discussion of the physics of the rainbow, this vision of Eden both suggests the multicoloured and variegated beauty, as well as implying the human desire to know the method behind the beauty. The knowledge of the physical principles on which Paradise operates are forbidden to Adam and Eve. In Book 11, Raphael’s clothing is rainbow-coloured: “Iris had dipped the woof” (11.244), where woof connotes the image of “(threads woven across a warp), because the iris flower was *lilium purpureum*, and because she was the rainbow, sign of God’s covenant or *truce*.”<sup>27</sup> Raphael is also associated with different kinds of knowledge, in Book 5 he declares to Adam and Eve that “what surmounts the reach / Of human sense, I shall delineate so, / By likening spiritual to corporeal forms, / As may express them best” (5.571). Ultimately, Raphael’s warning to Adam is unheeded. Raphael’s “corporeal” knowledge, i.e., put in terms Adam and Eve can understand, is not enough to save them from temptation and the Fall, since Eve still strives for the divine knowledge that is forbidden. Thus, again, the rainbow appears to suggest both “remarkable” visual appearances, as well as the desire for divine knowledge.

In conclusion, in both the areas of the creation of the cosmos, and the motion of light, *Paradise Lost* takes a markedly different position to the mechanistic Cartesian theory of light. Although light has immense symbolic and theological significance in Milton’s cosmological vision, the comparison to *The World (or Treatise on Light)* and *Meteors* shows a surprising coherence to Milton’s physics of light in creating and sustaining the cosmos, as well as remarkable precision in isolated depictions of

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<sup>26</sup> *Paradise Lost*, p. 224, 149n

<sup>27</sup> *Paradise Lost*, p. 610, 240-8n

the diffraction of the eclipse and refraction of the rainbow, suggesting a reevaluation of views that Milton's physics of light are anachronistic, confused, or contradictory.

Word Count: 2,560

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