Exoplanets and Astrotheology

with Andreas Losch, "Astrotheology: Exoplanets, Christian Concerns, and Human Hopes"; David Wilkinson, "Searching for Another Earth: The Recent History of the Discovery of Exoplanets"; Michael J. Crowe, "William Whewell, the Plurality of Worlds, and the Modern Solar System"; David Dunér, "Swedenborg and the Plurality of Worlds: Astrotheology in the Eighteenth Century"; Ted Peters, "Astrobiology and Astrochristology"; Howard Smith, "Alone in the Universe"; and Lucas John Mix, "Life-Value Narratives and the Impact of Astrobiology on Christian Ethics."

WILLIAM WHEWELL, THE PLURALITY OF WORLDS, AND THE MODERN SOLAR SYSTEM

by Michael J. Crowe

Abstract. Astronomers of the first half of the nineteenth century viewed our solar system entirely differently from the way twentieth-century astronomers viewed it. In the earlier period the dominant image was of a set of planets and moons, both of which kinds of bodies were inhabited by intelligent beings comparable to humans. By the early twentieth century, science had driven these beings from every planet in our system except the Earth, leaving our solar system (and perhaps others) as more or less desolate regions for the most part bereft of intelligent life. This essay traces this extinction and its relation to religious thought, noting the role played in it by Sir John Herschel and especially by William Whewell. The inverse square laws for gravitation, heat radiation, and light receive special attention, as does the question of the relevance of the Christian notions of a divine incarnation and redemption.

Keywords: astrobiology; Christianity; John Herschel; incarnation; plurality of worlds; principle of plenitude; redemption; solar system; William Whewell

---

Readers of this essay may be helped by knowing that the essay is based on research and publications extending over nearly four decades. Because of this, the evidence for some of its claims is more extensive than could be included in this largely synthetic analysis. References for much of this research are available in the publications by me listed below, especially the Crowe (1986) volume (esp. 265–355). On the other hand, the overall thesis

Michael J. Crowe is the Rev. John Cavanaugh, C.S.C., Professor Emeritus in the Program of Liberal Studies and the Graduate Program in History and Philosophy of Science at the University of Notre Dame, Notre Dame, IN 46556 USA; e-mail: crowe.1@nd.edu.

 ISSN 0591-2385

of this essay, especially its stress on the inverse square laws, is relatively recent and has resulted in good part from teaching these materials over the last decade, especially in conjunction with my Notre Dame colleague Matthew Dowd.

This essay addresses three sets of questions. (1) In the period between Copernicus and about 1850, what was the status of the idea of extraterrestrial intelligent life? In what ways, if at all, was this issue related to religious thought? (2) Who first discerned the solar system characteristic of twentieth-century astronomy and thereby challenged the conception of the solar system of the first half of the nineteenth century? How was this change related to religious thought? (3) How did the conception of the solar system of the early twentieth century gradually emerge after 1853?

Question One: Plurality of Worlds from Copernicus to 1850

Part One: Copernicus to 1800. One might assume that persons in the early nineteenth century, because of either religious objections or the less advanced state of astronomy, gave scant attention to ideas of extraterrestrial intelligent life. In fact, during this period educated persons took great interest in the idea of a plurality of worlds and for the most part believed that intelligent beings roam the planets of our system and of other systems.

Why was this the case? This enthusiasm derived partly from various philosophical or religious claims. Let us consider some influential authors.

It is a striking fact that the person who first opened (albeit very slightly) the door through which extraterrestrial intelligent (hereafter ETI) beings entered the modern world never mentioned them. This was Nicholas Copernicus (1473–1543), who in 1543 published his book on the heliocentric theory. Very slowly, European intellectuals accepted this system, which made Earth into a planet, which in turn suggested that planets must be earths and stars must be suns. An influential result of this change was the widespread acceptance of what was much later called the Copernican principle, which is the idea that there is nothing special about our region of space. This implied that other regions must share with Earth the presence of intelligent beings.

Another very influential scientist was Christiaan Huygens (1629–1695), whose *Cosmotheoros* (1698) endorsed the idea that all planets of our solar system are inhabited and also that planets circle other stars. He justifies this claim in good part by citing a version of the Copernican principle:

> That which makes me of this Opinion, that those Worlds are not without such a Creature endued with Reason, is that otherwise our Earth would have too much the Advantage of them, in being the only part of the Universe that could boast of such a Creature so far above, not only Plants and Trees, but all Animals whatsoever. (Huygens 1968, 37–38)

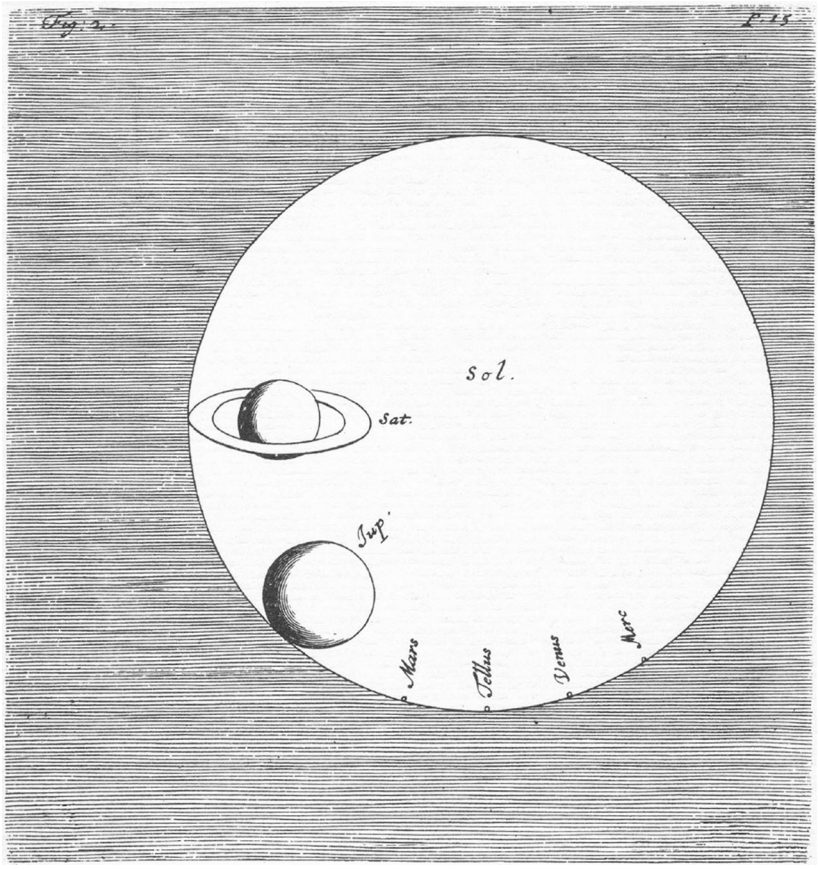

Figure 1. Huygens's diagram of the relative sizes of the main bodies in our solar system (Huygens 1968).

Strikingly, Huygens makes the above claim in a book containing a diagram (Figure 1) that points not to the homogeneity among the objects in the solar system, but rather to their heterogeneity. Moreover, he based the construction of this diagram on the Copernican system and the improvements in telescope quality; it could not have been made many decades earlier.

Another popular basis for belief in ETI is called the principle of plenitude, an idea the ancient Epicureans developed and that authors as prominent as Immanuel Kant later endorsed, and that appears in contemporary publications as evidence for ETI. Arthur Lovejoy formulated the principle in this way:

> [N]o genuine potentiality of being can remain unfulfilled, that the extent and abundance of the creation must be as great as the possibility of existence and

> commensurate with the productive capacity of a "perfect" and inexhaustible Source, and that the world is better, the more things that it contains. (Lovejoy 1960, 520)

Table 1. Information that Newton Provided in the Third Edition of his *Principia* (Leverington 2003, 124–25)

	Sun	Jupiter	Saturn	Earth
Mass	1	1/1,076	1/3,021	1/169,282
Density	100	94.5	67	400
Weight of person on	10,000	943	529	435

Put in simpler parlance, the principle of plenitude it asserts that God or Nature would not waste the efforts involved in producing the universe without placing within it widespread ETI. As one can imagine, many philosophers, poets, religious writers, and scientists delighted in this doctrine.

Another prominent scientist who advocated a plurality of words was Isaac Newton (1642–1726). In the third edition of his *Mathematical Principles of Natural Philosophy*, Newton used the new mathematical and physical methods that he had developed, especially the inverse square law governing gravitational attraction, to produce a comparison of the masses, densities, and the weights of persons on the Sun, Jupiter, Saturn, and Earth (see Table 1).

This table, it would seem, created problems for the ETIs of the Sun, Jupiter, and Saturn. Were we transported to Jupiter, for example, our weight would be more than double and would increase over twenty times on the Sun. Moreover, we see that our Earth is far denser than these other bodies.

The enthusiasm for ETI that arose among late eighteenth-century astronomers can be best illustrated by a consideration of the work of Sir William Herschel (1738–1822), the most creative astronomer of this period. Herschel constructed and put to good use telescopes far larger than any previously assembled. With these, Herschel succeeded in sighting forests on the Moon, which research he withheld from publication but continued to pursue. He did not, however, hesitate to publish observations indicative of life on the Sun, which observations his contemporaries typically accepted as plausible (Crowe 2011).

A few Christian authors writing before this time had hesitated to accept claims for ETI. Serious tensions, however, surfaced in 1793 when Thomas Paine (1737–1809) in his *Age of Reason* argued that astronomy had made it impossible for any thinking person to accept the central Christian notions of a divine incarnation and redeemer. He recounts that astronomical lectures by James Ferguson had convinced him that a good and generous

God must have populated the Moon and planets. When Paine confronted Christianity with this astronomical claim, he became a deist, that is, a person accepting a remote, impersonal God, but denying such central Christian doctrines as Christ's incarnation and redemption. In his book Paine argues that although the existence of intelligent life only on the Earth is not a specific Christian doctrine, it is nonetheless "so worked up therewith from . . . the story of Eve and the apple, and the counterpart of that story—the death of the Son of God, that to believe otherwise . . . renders the Christian system of faith at once little and ridiculous" (Paine 1961, 276). Paine presses the same point in even stronger language by writing:

> From whence . . . could arise the . . . strange conceit that the Almighty . . . should . . . come to die in our world because, they say, one man and one woman had eaten an apple! And, on the other hand, are we to suppose that every world in the boundless creation had an Eve, an apple, a serpent, and a redeemer? In this case, the person who is irreverently called the Son of God, and sometimes God himself, would have nothing else to do than to travel from world to world, in an endless succession of death, with scarcely a momentary interval of life. (Paine 1961, 283)

Paine's conclusion was stark: either reject belief in extraterrestrial life—a doctrine that he claimed had been established by astronomy—or reject Christianity.

Paine's *Age of Reason* attracted an immense readership both in Britain, where 60,000 copies of it were printed, and in America, where even a single Philadelphia bookshop sold over 15,000 copies. It also generated more than fifty published responses, some explicitly opposing Paine's extraterrestrial life attack on Christianity.

Part Two: The idea of a plurality of worlds in the first half of the nineteenth century. Numerous Christian authors took up Paine's challenge, three of the most successful being Timothy Dwight (1752–1817), Thomas Chalmers (1780–1847), and Thomas Dick (1774–1857). Dwight, president of Yale University from 1795 until his death in 1817, hoping to confront deism, prepared a series of 173 sermons that he repeated every four years lest any Yale undergraduate miss his message. In these sermons, Dwight not only urged students to good actions but also marshaled extraterrestrials on behalf of his evangelical urgings. For example, in his fifth sermon, Dwight states that God "called into existence . . . the countless multitude of Worlds [which] he stored, and adorned, with a rich and unceasing variety of beauty and magnificence, and with the most suitable means of virtue and happiness" (Dwight 1818, 78–79). In his next sermon, Dwight calls Yale students to repentance by asking them: "How different will be the appearance, which pride, ambition, and avarice, sloth, lust, and intemperance, will wear in the sight of God, in the sight of the assembled universe?" (Dwight 1818, 105).

	Square Miles.	Population.	Solid Contents.
Mercury	32,000,000	8,960,000,000	17,157,324,800
Venus	191,134,944	53,500,000,000	248,475,427,200
Mars	55,417,824	15,500,000,000	38,792,000,000
Vesta	229,000	64,000,000	10,035,000
Juno	6,380,000	1,786,000,000	1,515,250,000
Ceres	8,285,580	2,319,962,400	2,242,630,320
Pallas	14,000,000	4,000,000,000	4,900,000,000
Jupiter	24,884,000,000	6,967,520,000,000	368,283,200,000,000
Saturn	19,600,000,000	5,488,000,000,000	261,326,800,000,000
Outer ring of Saturn.	9,058,803,600		
Inner ring	19,791,561,636	8,141,963,826,080	1,442,518,261,800
Edges of the rings	228,077,000		
Uranus	3,848,460,000	1,077,568,800,000	22,437,804,620,000
The Moon	15,000,000	4,200,000,000	5,455,000,000
Satellites of Jupiter	95,000,000	26,673,000,000	45,693,970,126
Satellites of Saturn	197,920,800	55,417,824,000	98,960,400,000
Satellites of Uranus	169,646,400	47,500 992,000	84,823,200,000
Amount	78,195,916,784	21,894,974,404,480	654,038,348,119,246

Figure 2. Thomas Dick's population table from his *Celestial Scenery* (1838) (Dick 1848).

Ideas of ETI played an even larger role in the evangelical movement in Scotland, where Thomas Chalmers was not only the leading evangelical but also the most prominent Scottish religious figure of his day. Chalmers's rise to fame began with a series of sermons he delivered in Glasgow in 1815. In these sermons, Chalmers mixes evangelical piety with extraterrestrial themes similar to those of Dwight, thereby delighting hundreds who waited hours to experience his eloquence. His sermons, when published as *Astronomical Discourses on the Christian Revelation,* went through dozens of editions in both Britain and America.

Even more energetic in employing extraterrestrials in the service of religion was another Scotsman, Thomas Dick. From his observatory near Dundee, Dick deluged English-speaking countries with books blending ideas of extraterrestrial life with various religious themes. He edified readers of his first book, *The Christian Philosopher* (1823), by stating that the wisdom of God is shown by our Sun being placed at just such a distance as best to benefit us. Dick hastens, however, to add that the Sun's position does not prevent other planets from being happily inhabited by beings appropriately formed for their varying distances from the Sun. We learn from this book that rational beings dwell not only on all the planets but also on the Moon and Sun. For example, Dick states that God placed within the immense body of the Sun "a number of worlds . . . and peopled them with intelligent beings" (Dick 1844a, 81). Turning to the Moon, he predicts that "direct proofs" of the Moon's habitability will be forthcoming, supplementing this by appendices in which he discusses whether the observations of the German astronomers Schröter and Gruithuisen provide such proofs

(Dick 1844a, 150–52). Dick, moreover, boldly claims that the existence of extraterrestrial life "is more than once asserted in Scripture" (Dick 1844a, 153).

Dick presents similar ideas in his *Philosophy of Religion* (1826) and his *Philosophy of a Future State* (1828). In the former book, he asserts that "the grand principles of morality . . . are not to be viewed as confined merely to the inhabitants of our globe, but extend to all intelligent beings . . . through the vast universe [in which] *there is but one religion*" (Dick 1844b, 65). In the latter book, he calculates that 2,400,000,000 inhabited worlds exist in the visible creation (Dick 1844c, 89). In his *Celestial Scenery* (1836), he provides a table of the population of each planet, including even the ring, and the edge of the ring, of Saturn! (Dick 1848, 135) (Figure 2).

The degree to which belief in ETI had permeated the public in the first half of the nineteenth century is indicated by an event that occurred in 1835. In that year, Richard Locke (1800–1871), a writer with the *New York Sun* newspaper, created a sensation by publishing a series of articles reporting that astronomer Sir John Herschel had telescopically detected intelligent beings on the Moon. The noteworthy feature of this event is that nearly everyone believed Locke's report, even though substantial evidence had already shown that the Moon lacks an atmosphere. Locke's articles won him a place in the history of journalism as the author of what is now called "The Great Moon Hoax."

Evidence from this period indicates that Locke's goal was not to perpetrate a hoax but rather to create a satire, a satire that misfired because of the gullibility of his readership. Moreover, it appears that what inspired Locke to create his satire was above all the writings of Thomas Dick. Whatever the case, the widespread acceptance of Locke's articles suggests how ready many of Locke's contemporaries were to accept claims for ETI, including reports of two astronomers that they had detected buildings on the Moon (Crowe 1986, 210–15) (Figure 3).

Did the writings of Dick indicate that astronomy had triumphed over religion? I suggest that it is evident that religion—especially the principle of plenitude and the idea that God would not waste efforts creating uninhabited celestial objects—had trumped the fact that there was almost no scientific evidence for ETIs and significant evidence against them.

Question Two: Rev. William Whewell, Sir John Herschel, and the Recognition of the Modern Solar System

By 1915, ETIs had been driven from our conception of the solar system, never to return. Who launched this assault on ETIs and who supported this person's efforts? Did this constitute evidence that other solar systems are similarly barren of ETI? The answers to these questions that I am proposing are quite surprising.

Figure 3. Locke's Lunarians Lithograph.

The key person—although certainly not the only person—was not an astronomer, although in 1827 and in 1833 he had come forward as a supporter of ETI (Crowe 1986, 265–71). He brought on this change by publishing in 1853 an anonymous book that deeply upset both scientists and the public, including religious writers. He lost the battle brought on by his book, but by 1915 the war had been won. This is a person whose name does not appear in most history of astronomy books, including histories of planetary astronomy. For example, his name cannot be located in the indexes in David Leverington's *Babylon to Voyager and Beyond: A History of Planetary Astronomy* (2003) nor in Ronald Schorn's *Planetary Astronomy: From Ancient Times to the Third Millennium* (1998) nor in John North's *Norton History of Astronomy and Cosmology*, all large and thorough books. Moreover, this author, who was a priest in the Church of England, played a major role in removing religion from the ETI debate and is now most often remembered as a historian and philosopher of science. This is Rev. William Whewell (1794–1866), Master of Trinity College of Cambridge University, who in 1853 anonymously published his *Of the Plurality of Worlds: An Essay* (Figure 4).

A key type of evidence Whewell presents consists in what may be called inverse-square-law evidence, under which I include what could be learned from the inverse square laws for gravitational force, light, and heat radiation. What this means in regard to heat radiation, for example, is that as

we move twice as far from a heat source, the amount of warmth we receive decreases to one fourth. Similarly for light: if you double your distance from a source of light, you receive one fourth as much light. It is not uncommon for some present-day astrobiology books when discussing our solar system to include an inverse square law analysis of the amount of heat and light that each of the planets receives from the Sun compared to what we receive on Earth (Grady 2001, 18–19). As shown in the earlier discussion of Newton, the inverse square law for gravitational attraction generated information inimical to belief in ETI or at the very least to the existence of creatures comparable to humans. For example, a person weighing 200 pounds on Earth would weigh twenty-three times as much on the Sun. Whereas the inverse square law for gravitational attraction became available in 1687 with Newton's *Principia*, the inverse square laws for light and for heat radiation were fully understood only in the first half of the nineteenth century. The inverse square laws for light and for heat indicate that Mercury receives about seven times more light and heat per unit area than the Earth, whereas Uranus receives over 300 times less. One might well expect that this was bad news for believers in ETI. Let us take as a sample response the discussion provided by Sir John Herschel (1792–1871), the son of Sir William Herschel, and an astronomer whom his contemporaries recognized as Britain's leading astronomer, possibly even Britain's leading scientist (Figure 5).

To prove that this evidence was available before 1850, I submit some quotations from Sir John Herschel's highly respected *Treatise on Astronomy* (1833). Regarding the heat/light problem, Herschel states: "The intensity of solar radiation is nearly seven times greater on Mercury than on the Earth, and on Uranus 330 times less; the proportion between these two extremes being that of upwards of 2000 to one" (Herschel 1833, 277). Moreover, regarding gravity, Herschel declares "the intensity of gravity, or

Figure 4. William Whewell.

its efficacy in . . . repressing animal activity on Jupiter is nearly three times that on the Earth, on Mars not more than one third, and on the four smaller planets probably not more than one twentieth; giving a scale of which the extremes are in the proportion of sixty to one" (Herschel 1833, 278). Regarding the density issue, Herschel states that the density of Saturn is about one eighth of the Earth's, "so that it must consist of materials not much heavier than cork" (Herschel 1833, 278).

Did such facts lead John Herschel to conclude against ETIs in our solar system? Not at all. Instead he remarks on "what immense diversity must we not admit in the conditions of that great problem, the maintenance of animal and intellectual existence and happiness, which seems . . . to form an unceasing and worthy object of the exercise of the Benevolence and Wisdom which presides over all!" (Herschel 1833, 278). It is significant that all four of the statements quoted from Herschel cited in this paragraph appear unchanged in his far larger *Outlines of Astronomy* (Herschel 1850, 310–311). Thus Herschel falls back on religious thought and thereby passes over important scientific evidence against ETIs.

I will later suggest why Whewell became unfriendly to ETIs. But first, let us ask: Why did Whewell, formerly an ETI advocate, in 1853 author his *Of the Plurality of Worlds: An Essay,* a volume that challenged the existence of ETI? It should be evident from what I have already said that he could find such evidence simply by reading the astronomical texts written by one of his closest friends, John Herschel, whom I just quoted. Whewell's book has numerous references to Herschel's *Treatise on Astronomy* and also to his *Outlines of Astronomy* published in 1850.[1] However, one of the most important ideas that Whewell formulated in his book was not in Herschel, namely, that the solar system has a "temperate zone," a narrow zone possessing conditions supportive of life. Whewell's idea is essentially identical to

Figure 5. Portrait of Sir John Herschel by Henry William Pickersgill. ©National Portrait Gallery, London. Reprinted with permission.

what contemporary astrobiologists call the "habitable zone." Whewell also marshaled evidence from such respected astronomers as Friedrich Bessel, who was very critical of claims for lunar life. And Whewell drew upon the writings of Alexander von Humboldt, in particular his *Cosmos*.

Whewell also made effective use of Herschel's observations of the Magellanic clouds to argue against the island universe theory, which is the claim that the nebular patches seen in the skies are actually clusters of large numbers of stars held together by gravitational attraction and are thus other universes comparable to our Milky Way universe (Crowe 1986, 286–87). He discussed Herschel's determination that there are large numbers of binary stars, adding the suggestion that binaries make stable planetary systems unlikely (Crowe 1986, 287).

Whewell challenged another key claim for widespread ETIs, the claim that God's efforts would have been wasted if other stars were not surrounded by inhabited planets. In combating this argument, Whewell drew on his expertise in geology, indicated by the fact that he had been elected president of England's Geological Society. Whewell's argument was that evidence for the age of the Earth showed that throughout most of Earth's history it had been bereft of intelligent life, which suggested that the Creator's plan for the cosmos was capacious enough to leave vast regions of it lacking ETIs for long periods of time.

In short, Whewell drew heavily on widely available scientific information to counter belief in ETIs. Moreover, he treats the question of extraterrestrial life as a scientific question, rather than an issue that must be decided on religious grounds.

Just as Whewell was publishing his book, he sent a copy to his close friend Sir John Herschel, describing the book as the work of a "friend" whose ideas, although "so much at variance with opinions which you have countenanced," deserve not to be suppressed. In words that scarcely reveal the cosmic holocaust that Whewell had attempted in his *Essay*, he suggests: "Perhaps you would not take it much to heart if the inhabitants of Jupiter, or of the systems revolving about double stars which you have so carefully provided for, should be eliminated out of the universe" (Todhunter 1876, 399).

Herschel's remarkable response is simultaneously a fine example of his commitment to ETIs and of his willingness to consider contrary evidence. Moreover, it suggests which quasi-religious ideas influenced his commitment.[2] The first two points are evident early in the letter when Herschel admits that

> I should not have thought there was so much to be said on the non-plurality side of the question. True, Humboldt drew attention to the fact of the Classification of the planets into heavy & light and shewed that the little ones are heavy & the large ones light.—But peoples thoughts (most people's) are sluggish—and really though somewhere I have myself stated that taken

> in a lump Saturn might be regarded as made of Cork—it *never did* occur to me to draw the conclusion that *ergo* the *surface* of Saturn must be of extreme tenuity. (Crowe 2009, 358)

After proceeding to speculate freely on the aquatic creatures that must exist on Saturn, Herschel turns in a more religious or metaphysical direction by suggesting:

> So *this* then is the best of all possible worlds—the *ne plus ultra* between which and the 7th heaven there is nothing intermediate. Oh dear! Oh dear! 'Tis a sad cutting down. Look only at the Russians & Turks.[3]— . . . I can't give in my adhesion to the doctrine that *between* this and the angelic there are not some dozen or two grades of intellectual and moral creatures. (Crowe 2008, 359)

The letter concludes with Herschel again praising some of Whewell's arguments (Crowe 2008, 360).

A distinctive feature of Whewell's book is that its author speculated on what lower forms of life might be able to survive on the other planets, for example, planets of low density such as Jupiter and Saturn. This was very different from the approach taken in most earlier plurality of worlds publications whose authors typically assumed that the inhabitants of other worlds were quite similar to the forms of life on Earth. These authors rarely speculated on what form lower creatures on planets beyond the Earth might have. No doubt this was partly because the Darwin-Wallace theory of evolution by natural selection dated from the late 1850s. Whewell broke from this tradition, speculating for example that on Jupiter "we must either suppose that he has no inhabitants; or that they are aqueous, gelatinous creatures; too sluggish, almost, to be deemed alive, floating on their ice-cold water, shrouded forever by their humid skies" (Whewell 2001a, 185–86).

Up to this point, I have offered no explanation of why Whewell, who around 1830 had twice endorsed ETIs, would twenty years later come out in opposition to them. This much seems clear: his change of mind cannot be traced to some new scientific evidence. Rather something must have happened that led him to see available astronomical information in a new manner.[4] A number of scholars have addressed this question (Burnham 1977; Brooke 1977), myself included (Crowe, 1986, 277–82). I shall briefly summarize my analysis because it is relevant to this discussion. It is based on an unfinished manuscript of Whewell that I located in the Wren Library of Trinity College, Cambridge. My claim is that around 1850 Whewell began to draft a dialogue on religion and ETIs. In the process, Whewell painfully came to suspect that significant tensions exist between belief in ETIs and belief in the central Christian doctrines of a divine incarnation and redemption. This led him to rethink arguments for ETIs based on such ideas as that an omnipotent God would not

waste the vastness of the universe by not filling it with ETIs. Whewell thus came to believe that tensions exist between revealed religion and natural religion. And he felt drawn to defend revealed religion (Crowe 1986, 287–92). Although Whewell never asserts that the existence of ETIs is contrary to Christianity, he does state in his 1853 book that God

> made preparation for the mission of a special Messenger, whom . . . he sent upon the earth in the form of a man: and who both taught men the Law of God in a purer and clearer form than any in which it had yet been given . . . and established the means by which the spirit of man, when alienated from God by transgression, may be again reconciled to Him. The arrival of this especial Message of Holiness, Judgment, and Redemption, forms the great event in the history of the earth, considered in a religious view, as the abode of God's servants. (Whewell 2001a, 44)

Whewell soon adds:

> The earth, thus selected as the theatre of such a scheme of Teaching and of Redemption, cannot, in the eyes of any one who accepts this Christian faith, be regarded as being on a level with any other domiciles. It is the Stage of the Great Drama of God's Mercy and Man's Salvation; the Sanctuary of the Universe; the Holy Land of Creation; the Royal Abode, for a time at least, of the Eternal King. (Whewell 2001a, 44)

Coming to this conviction left Whewell in a difficult position. It appeared to him that there was a tension between Christianity and belief in widespread ETI, which belief was very common among his contemporaries and very strongly sanctioned as they thought by natural theology.

In support of this view, it is relevant to mention that Whewell requested his friend Sir James Stephen to read the draft of his book. Stephen provided numerous insightful comments. On 10 November 1853 Stephen warned that the doctrine of a plurality of worlds "aims formidable blows at the foundation of our faith in Christianity. The opposite doctrine aims blows scarcely less formidable at the foundation of our faith in natural religion." And he warns: "If one or the other of the two must be abandoned, it is impossible not to see that [men will tend] . . . to disbelieve the Evangelists, rather than to disbelieve the Natural Theologians" (Crowe 1986, 295).

Moreover, Whewell's book contains such statements as the following on the Christian doctrine of Christ's incarnation and redemption:

> The arrival of this especial Message of Holiness, Judgment, and Redemption, forms the great event in the history of the earth, considered in a religious view, as the abode of God's servants. It was attended with the sufferings and cruel death of the Divine Messenger thus sent; was preceded by prophetic announcements of his coming; and the history of the world, for the two thousand years that have since elapsed, has been in a great measure occupied with the consequences of that advent. Such a proceeding shows, of course, that God has an especial care for the race of man. The earth, thus selected

> as the theatre of such a scheme of Teaching and of Redemption, cannot, in the eyes of any one who accepts this Christian faith, be regarded as being on a level with any other domiciles. It is the Stage of the Great Drama of God's Mercy and Man's Salvation; the Sanctuary of the Universe; the Holy Land of Creation; the Royal Abode, for a time at least, of the Eternal King. This being the character which has thus been conferred upon it, how can we assent to the assertions of Astronomers, when they tell us that it is only one among millions of similar habitations, not distinguishable from them, except that it is smaller than most of them that we can measure: confused and rude in its materials like them? Or if we believe the Astronomers, will not such a belief lead us to doubt the truth of the great scheme of Christianity, which thus makes the earth the scene of a special dispensation? (Whewell 2001a, 44–45)

Such passages as this make it clear that, broadly speaking, what brought on Whewell's resistance to the idea of a plurality of worlds was his recognition that it created serious tensions for Christianity. Moreover, they make it understandable why some of Whewell's opponents accused him of mixing science and religion and why moreover some historians have adopted the same view. It is important, however, to ask what sorts of evidence Whewell marshaled against ETIs. A careful reading of Whewell's book shows that he was scrupulous about basing his anti-pluralist claims on scientific information, as illustrated earlier in this presentation. Moreover, we have a direct statement from Whewell that shows that such was both his position and practice. In 1854, in his "Dialogue on a Plurality of Worlds (2001b)," Whewell responded to critics of his book. In replying to a critic who according to Whewell had chastised him for building "the philosophy of your Essay on a religious basis [and taking] for granted the truths of Revealed Religion, and reason[ing] from them," Whewell stressed that "I do not reason in the way which you ascribe to me. I obtain my views of the physical universe from the acknowledged genuine sources: observation and calculation" (Whewell 2001b, 454). Thus I am claiming that what historically happened is that Whewell's concern for revealed religion led him to question belief in ETIs, but that in his book he intended to and suceeded in relying *exclusively on scientific arguments*. In this sense, it was many of his opponents in the debate generated by his book who persisted in taking positions based on religion, particularly the sort of religion that takes the principle of plenitude as foundational.[5]

I wish to add one more suggestion about the the process by which Whewell came to write his 1853 book, a suggestion that I view as more speculative than the other claims. The speculation relates to the question of what happened between the time Whewell in drafting his unpublished plurality of worlds manuscript began to believe that the traditional natural theology claims for ETI may conflict with Christianity, and his publication of his 1853 volume. Where might Whewell, who was not an astronomer, have turned for evidence? Given his close friendship with John Herschel

and the high regard in which their contemporaries held Herschel's *Treatise on Astronomy* and *Outlines of Astronomy*, it is very likely that he turned to those volumes. When in this process he read the passages from these books previously cited in this essay, for example, Herschel's statement that "The intensity of solar radiation is nearly seven times greater on Mercury than on the earth, and on Uranus 330 times less; the proportion between these two extremes being that of upwards of 2000 to one," he saw the path that he could successfully follow. Thus he focused his analysis of the solar system above all on the inverse square laws.

Whewell's book created a major controversy, resulting in twenty books, over fifty journal publications, and involving nearly a hundred participants. Seventy-two percent of the published responses opposed Whewell's position (Crowe 1986, 300–55). This major debate was eclipsed five years later by another debate of far larger magnitude, that debate running in parallel on some issues, and being immensely different on others. This debate was of course the controversy sparked by Charles Darwin's *Origin of Species.*

In the long run, Whewell not only played a key role in driving ETI from our conception of the solar system, but also and thereby from around other stars. If one assumes that stars are more or less comparable to our nearest star, the Sun, then it follows that the systems of these stars will be comparable to the system in which we find ourselves. In this sense, Whewell not only discerned that our solar system is a desolate region with ETIs located only on one planet, but also this insight suggested that, given that stars are comparable to our Sun, it is probably the case that all or most stars are surrounded by a retinue of planets, but most of these may be as barren of ETIs as are the regions outside our Sun's temperate zone. In this way, Whewell can be seen as the first person to see the desolate solar system of the twentieth century, but also the first to recognize this pattern not only in solar systems, but in the universe as a whole. Moreover, Whewell attempted to drive arguments based on natural religion or the principle of plenitude from the extraterrestrial life debate.

Question Three: How Did the Solar System of the Second Half of the Nineteenth Century Gradually Emerge After 1853?

Of course, Whewell did not immediately lead astronomers of the second half of the nineteenth century away from the astronomy of the period before 1850. Gradually, however, some recognized the reasonableness of his message. Thomas Hockey gives a nice illustration from an 1872 report by British astronomer Edward Firmstone, who commented in regard to Jupiter: "When we find a theorist gravely arguing from one class of analogies that Jupiter is inhabited by giants fourteen or fifteen feet high, while another

shows, with at least equal force from other premises that his people must be pigmies of thirty inches [because of the presumed high surface gravity]; we see at once how futile, not to say absurd, such theorizing is, and how vain is the idea that the purposes of Creation are limited to such objects as we can understand" (Hockey 1999, 166).

The most influential response to Whewell's claims came (gradually) from Richard Anthony Proctor (1837–1888), a British astronomer and prolific expositor of that science. Proctor's first success as an author came in 1870, by which time spectroscopy was transforming astronomy into astrophysics and astrochemistry. In that year, Proctor published his *Other Worlds than Ours*, an immensely popular discussion of extraterrestrial life ideas, one theme of which was an analysis of the Whewell debate. Although in many cases opposing Whewell's claims, Proctor jettisoned Jupiterians precisely for the reasons that Whewell had indicated. Also, because William Huggins's spectroscopic work had shown that earlier observational claims that Orion consists of a vast number of stars, indicating that it may be an island universe, could not possibly be correct because Orion gives a bright line spectrum, which spectrum is produced by glowing gases, Proctor showed hesitation at the island universe theory, a core component of the strong plurality of worlds position. Whewell's analysis of Herschel's observations of the Magellanic clouds also influenced Proctor's argument.

By 1875, Proctor had moved further in what he called a "Whewellite" direction. A key essay in this shift is Proctor's 1875 essay "A New Theory of Life in Other Worlds." In this essay, Proctor withdraws intelligent extraterrestrials not only from most planets of our solar system but also of other systems. Writing in this Darwinian period Proctor suggests that planets are evolving: "Each planet, according to its dimensions, has a certain length of planetary life, the youth and age of which include the following eras:—a sunlike state; a state like that of Jupiter or Saturn, when much heat but little light is evolved; a condition like that of our earth; and lastly, the stage through which our moon is passing, which may be regarded as planetary decrepitude" (Crowe 2008, 402). Within this perspective, he admits that not only most planets but also most solar systems lack intelligent life. But then he adds:

> Have we then been led to the Whewellite theory that our earth is the sole abode of life? Far from it. For not only have we adopted a method of reasoning which teaches us to regard every planet in existence, every moon, every sun, every orb in fact in space, as having its period as the abode of life, but the very argument from probability which leads us to regard any given sun as not the centre of a scheme in which at this moment there is life, forces upon us the conclusion that among the millions on millions, nay, the millions of millions of suns which people space, millions have orbs circling round them which are at this present time the abode of living creatures. (Crowe 2008, 404)

One wonders whether Whewell, dead nearly a decade by then, would have been pleased by Proctor's analysis or rather would have commented: "Pluralism dies hard!"

Another very important development at the end of the nineteenth century was the debate over the claims made by Giovanni Schiaparelli, Percival Lowell, and others that they had sighted canals on Mars. By1915, with Walter Maunder and Eugene Antoniadi leading the way, astronomers recognized that our solar system (except for our diminutive planet) is bereft of intelligent life. And this left the entire universe far less friendly to ETIs than the universe of 1800 (Crowe 1986, 480–546). It is an interesting and relevant aspect of the canal controversy that significant evidence suggests that Maunder, like Whewell, was initially led to question the existence of Martians because of his attachment to Christian concerns; in his case, however, he avoided revealing this in his scientific writings, almost certainly because he believed that he was dealing with an issue that should be discussed strictly on a scientific level (Crowe 2001, 220–24; Crowe 1986, 491).

Thus William Whewell's book played the key role in humans coming to see our solar system as a rather desolate place. We have now found far more solar system objects, including numerous moons. Nonetheless, we see our system wherein there is intelligent life but only on one object, and that object of rather unimpressive size. The desolation that Whewell detected in the solar system was not confined to our system. If intelligent life, in fact any sort of life, is confined only to one body circling our Sun, intelligent life may be as rare around other stars as we know it to be around our Sun. Thus the long range effect of our recognition of the analysis first put forward by Whewell is that not just our system is a rather desolate domain, but also that intelligent life may be rather rare in our universe.

Conclusion

It would be mistaken to see this article as an argument for the introduction of religious considerations (or such claims as the principle of plenitude) into astronomy; quite the reverse is closer to my message. It would, however, be accurate to understand what I have presented as primarily being about the importance of relying on scientific information to settle scientific questions. I have also sought to suggest that it is sometimes quite a complex matter to determine whether and if extraneous considerations have entered into a scientific investigation or analysis. And finally I see this article as friendly to Professor Howard Smith's (2016) recommendation that theologians who have devoted abundant time to discussing how to reconcile their theology with a well populated universe should also devote some effort to exploring what it might mean theologically if we were somehow to conclude that the sole location in the universe of intelligent life is our Earth.

Notes

1. Footnotes referring to John Herschel occur most frequently in the more technical chapters; the "Nebulae" chapter has four, whereas "Fixed Stars" has eleven, "Planets" has six, and "Theory of the Solar System" has three.

2. For a full transcription of the letter along with extensive notes on it, see Crowe 1986, 358–60. The original of the letter is at Trinity College Library (Cambridge), Whewell Papers Add.Ms.a. 20790. I have also compared my transcription with the transcription at the Royal Society Herschel papers, RS:HS.23.140.

3. This phrase, "Look only at the Russians & Turks," needs some commentary. Recently another scholar has not only made a very different transcription of this portion of the letter, but also made her reading quite prominent by featuring it in the title of her publication. Dr. Laura Snyder's publication is "'Lord only of the Ruffians and Fiends'? William Whewell and the Plurality of Worlds Debate" (Snyder, 2007). When her paper was at an early stage—announced as a paper to be read at a conference—I emailed her suggesting that this was a mistranscription and suggesting my own transcription. She acknowledged the email but did not directly deal with the suggestion or change her transcription. Having devoted ten years of my research career to working on John Herschel correspondence, I know the difficulties of his handwriting. In this case, however, I am quite certain of the correctness of my transcription. At least three reasons support this confidence. First, my transcription agrees with that made shortly after John Herschel's death under the direction of his son, Col. John Herschel, which transcription is preserved in the John Herschel papers at the Royal Society. Second, I have run tests with four professors who are experienced in nineteenth-century orthography, all of whom support my reading. Third, Herschel in a letter to Adam Sedgwick dated March 11, 1854 also mentions the Russians and Turks, who were much in the news at that time because of the Crimean War. Persons interested in this issue may wish to examine the original at the Wren Library (Trinity College, Cambridge University) and the transcription at the Royal Society (London).

4. One of the chief theses I am developing can be clarified by mentioning an explanation of why Whewell changed his mind. In her *Philosophical Breakfast Club*, Laura Snyder comments regarding Whewell's change of mind: "Whewell drew heavily upon the most recent astronomical studies of Jupiter. The observational evidence pointed to Jupiter being composed mainly of water and water vapor. Given the known density of the planet, gravity on its surface would be 2.5 times that on the earth; therefore it is not likely that any of its inhabitants could have a skeletal system" (Snyder 2011, 307). It is true that Whewell was aware of and cited this information about Jupiter, but this was not from "the most recent astronomical studies of Jupiter." This information had already been available for a century and a half since Newton provided this information in his *Principia.* In other words, in this case what Whewell did was to take seriously long available information.

5. I can cite three brief supports for my analysis of how Whewell came to adopt this position. The first is that religious concerns were very important to Whewell as a priest and educator; in fact, it seems plausible that a religiously grounded argument would in his mind trump a philosophically based argument. Also, Professor John Hedley Brooke has remarked: "As Michael Crowe has recently suggested, [Whewell's] antipathy to extraterrestrial life probably had its deepest roots in a theology of Incarnation which he had gradually come to appreciate was difficult, if not impossible, to translate to other spheres of intelligent life" (Brooke 1991, 158). Harvey Becher has also remarked: "For an extensive review of the plurality of world literature following Whewell's publication and for a most convincing demonstration that Whewell perceived a fundamental conflict between the existence of a plurality of worlds inhabited by intelligent life and the fundamental tenets of Christianity, see Crowe (1986, 265–355)." (Becher 1991, 22).

References

Becher, Harvey. 1991. "William Whewell's Odyssey: From Mathematics to Moral Philosophy." In *William Whewell: A Composite Portrait*, edited by Menachem Fisch and Simon Schaffer, 1–29. Oxford, UK: Clarendon Press.

Brooke, John Hedley. 1977. "Natural Theology and the Plurality of Worlds: Observations on the Brewster-Whewell Debate." *Annals of Science* 34: 221–86.

———. 1991. "Indications of a Creator: Whewell as Apologist and Priest." In *William Whewell: A Composite Portrait*, edited by Menachem Fisch and Simon Schaffer, 149–73. Oxford, UK: Clarendon Press.
Burnham, F. B. 1977. "Religion and the Extraterrestrial Intelligent Life Debate in the Nineteenth Century." Paper presented at a meeting of the History of Science Society, Dec. 30.
Crowe, Michael J. 1986. *The Extraterrestrial Life Debate 1750–1900: The Idea of a Plurality of Worlds from Kant to Lowell*. Cambridge, UK: Cambridge University Press. Reprinted. Mineola, NY: Dover, 1999.
———. 2001. "Astronomy and Religion (1780–1915): Four Case Studies Involving Ideas of Extraterrestrial Life." *Osiris*, 2nd. ser., 16: 209–26.
———, ed. 2008. *The Extraterrestrial Life Debate, Antiquity to 1900: A Source Book*. Notre Dame, IN: University of Notre Dame Press.
———. 2011. "The Surprising History of Claims for Life on the Sun." *Journal of Astronomical History and Heritage* 14 (3): 169–79.
Dick, Thomas. 1844a. *The Christian Philosopher* (1823). In *The Works of Thomas Dick*. Hartford, CT: Sumner & Goodman.
———. 1844b. *The Philosophy of Religion* (1826). In *The Works of Thomas Dick*. Hartford, CT: Sumner & Goodman.
———. 1844c. *The Philosophy of a Future State* (1828). In *The Works of Thomas Dick*. Hartford, CT: Sumner & Goodman.
———. 1848. *Celestial Scenery* (1836). In *The Works of Thomas Dick*. Hartford, CT: Sumner & Goodman.
Dwight, Timothy. 1818. *Theology Explained and Defended in a Series of Sermons*, Vol. 1. Middletown, CT: Clark & Lyman.
Grady, Monica. 2001. *Astrobiology*. Washington, DC: Smithsonian Institution Press.
Herschel, John. 1833. *Treatise on Astronomy*. London, UK: Longman.
———. 1850. *Outlines of Astronomy*. 3rd edn. London, UK: Longman.
Hockey, Thomas. 1999. *Galileo's Planet: Observing Jupiter Before Photography*. Bristol, UK: Institute of Physics Publishing.
Huygens, Christiaan. 1968. *The Celestial Worlds Discover'd: or, Conjectures Concerning the Inhabitants, Plants and Productions of the Worlds in the Planets*. London, UK: Frank Cass. Facsimile reprinting of the 1698 edition.
Leverington, David. 2003. *Babylon to Voyager and Beyond: A History of Planetary Astronomy*. Cambridge, UK: Cambridge University Press.
Lovejoy, Arthur. 1960. *The Great Chain of Being*. New York, NY: Harper and Row.
Paine, Thomas. 1961. *The Age of Reason*. In *Thomas Paine, Representative Selections*, edited by Harry Hayden Clark, 234–335. New York, NY: Hill and Wang.
Schorn, Ronald. 1998. *Planetary Astronomy: From Ancient Times to the Third Millennium*. College Station: Texas A&M University Press.
Smith, Howard A. 2016. "Alone in the Universe." *Zygon: Journal of Religion and Science* 51 (this issue): 497–519.
Snyder, Laura J. 2007. "'Lord Only of the Ruffians and Fiends?' William Whewell and the Plurality of Worlds Debate." *Studies in the History and Philosophy of Science* 38: 584–92.
———. 2011. *The Philosophical Breakfast Club: Four Remarkable Friends Who Transformed Science and Changed the World*. New York, NY: Broadway Books.
Todhunter, Isaac. 1876. *William Whewell*. Vol. 2. London, UK: Macmillan.
Whewell, William. 2001a. *Of the Plurality of Worlds*, edited by Michael Ruse. Chicago, IL: University of Chicago Press.
———. 2001b. "A Dialogue on the Plurality of Worlds." In *Of the Plurality of Worlds*, edited by Michael Ruse, 429–507. Chicago, IL: University of Chicago Press.