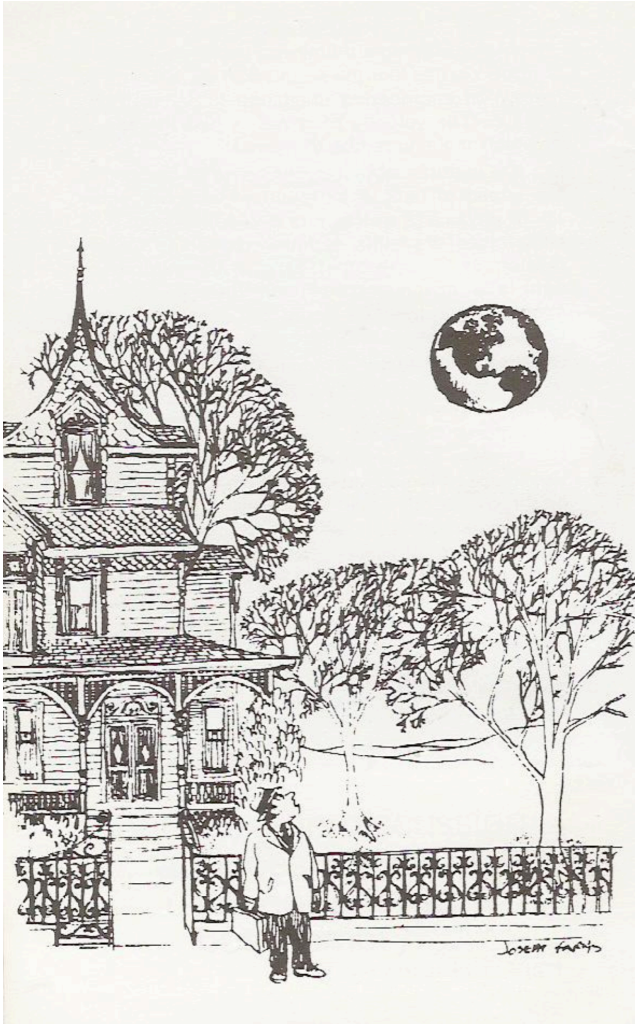
Assignment II for Class Taught by Prof. Michael J. Crowe

There are two assigned readings for this class.
First Reading. The first asks you to attempt to read a handwritten letter composed by the astronomer Sir John Herschel, which he wrote in response to a letter from his close friend William Whewell, Master of Trinity College at Cambridge University. **You are asked to spend no more than 15 minutes attempting to read that letter.** The point is to remind you that there can be a significant difference between letters as originally written as compared to what eventually emerges after transcribers complete their work. When we meet, I will provide you with a typed transcription of the entire letter.
Second Reading: This consists of an eleven-page paper reporting on some research that I have done regarding the history of ideas of extraterrestrial intelligent life. Some of you may find the paper rather controversial. On one level, it is a discussion of the relations and differences between Natural Theology and Revealed Theology. On another level, it is a discussion of the question of from where did we get the twentieth-century notion of our solar system. It may require careful reading.
Looking forward to seeing you again and talking to you about these issues—
Professor Michael J. Crowe



William Whewell, the Plurality of Worlds, and the Modern Solar System

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This paper addresses three questions:

1. Who first discerned the solar system of twentieth-century astronomy and thereby challenged the conception of the solar system that was widely accepted during much of the nineteenth century?
2. How did this person come to and support his conception of the solar system? And who helped him?
3. Why did this person come to adopt his new conception? And did it have a connection with religion?

Question One

The solar system of the first half of the nineteenth century was a wondrous structure. It contained the Sun, an array of planets, numerous moons, and miscellaneous other bodies, nearly all of which most informed people believed are inhabited by extraterrestrial intelligent beings (hereafter ETI). One astronomer Thomas Dick (admittedly an extreme case) in an 1838 book provided population figures not only for Saturn, but also for the rings of Saturn, the edges of the rings of Saturn, the Sun, and each of the known asteroids.

	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	8,141,963,826,080	1,442,518,261,800
Inner ring	19,791,561,636		
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

Thomas Dick's Population Table from His *Celestial Scenery* (1838)

What motivated Dick to adopt these figures was the notion that were these bodies not inhabited, God's efforts would have been wasted in creating them. This is called the Principle of Plenitude. In 1838 there was almost no scientific evidence for ETI; in fact, there was substantial evidence against ETI. Now we know that the only intelligent beings in our solar system exist on Earth. This means that Dick's figure for the population of the solar system of 2.2×10^{13} was not only wrong, but off by a factor of 27,368. A recent article on Dick describes his results as not only wrong, but "Fantastically Wrong."[1]

Did this solar system indicate that astronomy had triumphed over religion? I suggest that it is evidence 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 no scientific evidence indicated the existence for ETI. In fact, most evidence was against ETI.

[1] Matt Simon, "Fantasically Wrong: The Scientist Who Thought 22 Trillion Aliens Live in Our Solar System." See http://www.wired.com/2014/12/fantastically-wrong-thomas-dick/ viewed 2015.1.6.

By 1915, however, ETIs had been driven from the solar system, never to return. Did this constitute evidence that other solar systems are similarly barren of ETI? Who launched this assault and who supported this person's efforts?

The key person—certainly not the only person—was not an astronomer, although he had been known as a supporter of ETI. He brought on this change by publishing in 1953 an anonymous book, which 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.[2] 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, Master of Trinity College of Cambridge University, who in 1853 anonymously published his *Of the Plurality of Worlds: An Essay*.

William Whewell

Question Two

A key type of evidence Whewell presented was inverse-square-law evidence, under which I include what could be learned from the inverse-square laws for gravitational force, light, and heat.[3] The inverse square law for gravitation indicates that the force of attraction between two bodies varies with the inverse square of the distance between them. For example, if you double the distance between our Earth and an apple or satellite, the force of attraction between them will one fourth as much. Similarly for light, if you double the distance of a light from you, it will appear one fourth as bright. Triple the distance and it will be one

[2] For example, Whewell's name does not appear in (Leverington, 2003) nor in (Schorn, 1998) nor in John North's *Norton History of Astronomy and Cosmology*, all large and thorough books.

[3] For an essay focused especially on the how the history of these three laws interrelates with the history of extraterrestrtial life debate, see (Crowe, 2013).

ninth as bright. Same for heat: move twice as far from a fire and the rays will be one fourth as intense.

Newton in his *Principia* (1687) had used the gravitational inverse square law to produce the following information.

	Sun	**Jupiter**	**Saturn**	**Earth**
Mass	1	1/1076	1/3021	1/169282
Density	100	94.5	67	400
Weight of person on	10000	943	529	435

Information that Newton provided in the 3rd edition of his *Principia*.
Newton's values as given in the first edition were somewhat different (Leverington, 124–5).

This table created problems for the ETIs of the Sun, Jupiter, and Saturn. Were we transported to Jupiter, for example, our weight would 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 inverse square laws for light and for heat indicate that Mercury receives from the Sun about seven times more light and heat per unit surface area than the Earth, whereas Uranus receives over 300 times less. Modern astronomy books repeatedly cite this information as evidence that no ETIs exist in our solar system. This evidence was available long before 1853, but enthusiasts for ETIs neglected it.

John Herschel (1792–1871)

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 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 force John Herschel to conclude against ETIs in our solar system? 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).[4] Thus Herschel falls back on religious thought and thereby passes over important scientific evidence *against* ETIs.

I will later suggest why Whewell became so unfriendly to ETIs. But first, let us ask: where did Whewell find scientific evidence against ETIs? 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.[5] One of the most important ideas that Whewell formulated in his book was not in Herschel. This is the idea that the solar system has a "temperate zone, " a narrow zone possessing conditions supportive of life. Whewell's idea is essentially identical to what contemporary astrobiologists call the "habitable zone." Whewell also marshaled evidence from such respected astronomers as Friedrich Bessel, who

[4] It is significant that all four of the quotations from Herschel cited in this paragraph appear unchanged in his far larger *Outlines of Astronomy* (Herschel 1850, 310–311).

[5] Footnotes referring to John Herschel occur most frequently in the more technical chapters; the "Nebulae" chapter has 4, whereas "Fixed Stars" has 11, "Planets" has 6, and "Theory of the Solar System" has 3.

was very critical of claims for lunar life. And Whewell drew upon the writings of Alexander von Humboldt, in particular, Humboldt's *Cosmos*.

Whewell also drew on Herschel's observations of the Magellanic Clouds to argue against the Island Universe theory. He drew on Herschel's determination that there are large numbers of binary stars, adding the suggestion that binaries make stable planetary systems unlikely.

Whewell, having been president of the Geological Society, had an up-to-date knowledge of geology. This helped him formulate an answer to the question of how it could be that God would leave large regions of space lacking ETIs. Whewell suggested that geology showed that during nearly all of its history, Earth lacked intelligent life. This suggested that the Creator's plan for the cosmos was capacious enough to have vast regions of it lacking ETIs.

In short, Whewell drew heavily on scientific information to counter belief in ETIs.

Question Three

A number of authors have investigated why Whewell (who earlier had advocated ETIs) came around 1850 to attack them. Time does not permit me to mention these; in fact, it barely allows me to suggest my own view and to specify the role of religion in it.[6] My claim is that around 1850 Whewell began to draft a dialogue on religion and ETIs. In the process, Whewell painfully concluded that significant tensions exist between belief in ETIs and belief in the central Christian doctrines of a divine incarnation and redeemer. This led him to rethink arguments for ETIs based on such ideas as that an omnipotent God would not waste the vastness of the

[6] I can cite three brief supports for this view. 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 philosophical 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 Incaranation 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 demostration 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."

universe by not filling it with ETIs. Whewell thus came to believe that tensions exist between revealed religion and natural religion, which Thomas Dick, for example, championed. And Whewell felt compelled to defend revealed religion (Crowe 1986, 287–292). Although Whewell never asserts that the existence of ETIs is contrary to Christianity, he does state 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 Ruse, p. 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 Ruse, p. 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.[7]

Whewell not only played a key role in driving ETI from the solar system, but also and thereby from around other stars. Moreover, Whewell attempted to drive arguments based on Natural Religion from the debate. Of course, Whewell

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[7] 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 "[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. ... 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).

did not accomplish this immediately nor solely by himself. Later authors such as Richard Proctor, and in regard to the Martians, Walter Maunder and Eugene Antoniadi, had succeeded by 1915 in convincing astronomers and much of the public that our solar system lacks ETIs.[8] And this in turn suggested that other suns may lack planets inhabited by ETIs. And this left the entire universe far less friendly to ETIs than the universe of 1800.

It is important to ask what sort of evidence did Whewell direct 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,* 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 2001, 54). Thus I am claiming that what historically happened is that his concern for revealed religion led him to question belief in ETIs, but that in his book he both intended to and succeeded in relying exclusively on scientific arguments.

In summary, I am suggesting that Whewell was the first person to discern the solar system of the early twentieth century, that he provided an array of solid *scientific* arguments for this system in his book, and that he was initally led to investigate this possibility for *religious* reasons.

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[8] The process was gradual. 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 surgace 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" (as quoted in Hockey, p. 166).

I will conclude by making an effort to ensure that this essay is not misunderstood.

1. I am *not* saying that we can draw the conclusion from the central Christian notions of a divine Incarnation and Redemption that intelligent life exists only on the Earth.
2. I am, however, making a far more modest, historically based claim that Christianity's central doctrines of the Divine Incarnation and Redemption played a role in the leading Whewell to be skeptical about the notion, popular in the nineteenth century, that intelligent life is very widespread in the universe. Eventually, the scientific evidence that Whewell brought forth convinced the scientific community that intelligent life is very rare in our solar system and possibly in other systems as well.

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Note: This paper is based on far more detailed research than is indicated in this bibliography. References to this research are available in the publications by me listed below, especially my 1986 volume; see pp. 265–355.

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