## Chapter One

# Prelude to the Space Age

by Roger D. Launius

Curiosity about the universe and other worlds has been one of the few constants in the history of humankind. Prior to the twentieth century, however, there was little opportunity to explore the universe except in fiction and through astronomical observations. These early explorations led to the compilation of a body of knowledge that inspired and in some respects informed the efforts of a body of scientists and engineers who began to think about applying rocket technology to the challenge of spaceflight in the early part of the twentieth century. These individuals were essentially the first spaceflight pioneers, translating centuries of dreams into a reality that matched in some measure the expectations of the public that watched and the governments that supported their efforts. During the period between 1926—when Robert H. Goddard launched his first rocket—and 1957—when the first orbital spacecraft was launched—a dedicated group of spaceflight enthusiasts, scientists, and engineers worked hard to inaugurate the space age.

## Early Explorations of the Observable Universe

From ancient times civilizations around the globe have erected great observatories to chart the paths of the Sun, Moon, planets, and stars. Much of this observation became a central part of religion, science, and philosophy, and as a result has informed modern thinking on these subjects. The prehistoric people who built Stonehenge in England apparently used their observations of celestial bodies to chart planting seasons and measure other events, assigning this study a religious significance as well. Astronomers in Babylon about 700 B.C. charted the paths of planets and compiled observations of fixed stars. Later, around 400 B.C., the Babylonians devised the zodiac, the first such mechanism to divide the year into lunar periods and to assign significance to a person's date of birth in foretelling the future. In what became the Americas, the ancient Incan and Aztec cultures built astronomical observatories. North American Indians also observed the supernova of 1054 which created the Crab Nebula—not seen in Europe.[1]

By 150 A.D. the great mathematician, geographer, and astronomer Ptolemy of Alexandria had systematized a large amount of ancient information, and in some cases misinformation, about the universe. Ptolemy based his understanding on classical conceptions of the universe inherited from the Greeks. His great synthesis, *Megiste Syntaxis*, sometimes called the *Almagest*, argued that the Earth was at the center of the universe, and that the Sun, stars, and planets were embedded as jewels in a setting of spheres circling around it. [I-1] The Roman Cicero summarized the Ptolemaic belief this way:

*The Universe consists of nine circles, or rather of nine moving globes. The outersphere is that of the heavens, which embraces all the others and under which the stars are fixed. Underneath this, seven globes rotate in the opposite direction from that of the heavens. The first circle carries the star known to*

1. E.C. Krup, *Echoes of the Ancient Skies: The Astronomy of Lost Civilizations* (New York: Harper and Row, 1983), pp. 27-29; Edward R. Harrison, *Cosmology: The Science of the Universe* (New York: Cambridge University Press, 1981), pp. 10-23, 73; Eugene M. Emme, *A History of Space Flight* (New York: Holt, Rinehart and Winston, 1965), pp. 12-16; Ray A. Williamson, *Living the Sky: The Cosmos of the American Indian* (Norman: University of Oklahoma Press, 1984); Anthony F. Aveni, *Skywatchers of Ancient Mexico* (Austin: University of Texas Press, 1980).

*men as Saturn; the second carries Jupiter, benevolent and propitious to humanity; then comes Mars, gleaming red and hateful; below this, occupying the middle region, shines the Sun, the chief, prince and regulator of the other celestial bodies, and the soul of the world which is illuminated and filled by the light of its immense globe. After it, like two companions, come Venus and Mercury. Finally, the lowest orb is occupied by the Moon, which borrows its light from the Sun. Below this last celestial circle there is nothing by what is mortal and perishable except for the minds granted by the gods to the human race. Above the Moon, all things are eternal. Our Earth, placed at the center of the world, and remote from the heavens on all sides, stays motionless and all heavy bodies are impelled towards it by their own weight. The motion of the spheres creates a harmony formed out of their unequal but well-proportioned intervals, combining various bass and treble notes into a melodious concert.*[2]

Ptolemy's position accepted the geometric and static harmony of the universe and placed humanity squarely at its center, a view not inconsistent with Christian religious ideals about humanity's special relationship with God.

While this world view was modified to some degree during the following centuries, it was not until the sixteenth century that it began to change appreciably. The Polish astronomer-mathematician Nicolaus Copernicus saw that the irregular flight of some planets could not be explained using the Ptolemaic construct of the universe, so he placed the Earth in orbit around the Sun. [I-2] He was, however, circumspect in his public statements about this finding. Others followed his observation to its logical conclusion, most importantly Galileo Galilei, who used the newly invented telescope to show that the Earth and the planets revolved around the Sun in a dynamic and ever-changing universe. He also learned that the Moon revolved around the Earth and that other planets had satellites as well.[3] "On the seventh day of January in the present year, 1610," Galileo wrote in *Sidereus Nuncius* (*Sidereal Messenger*),

*when I was viewing the constellations of the heavens through a telescope, the planet Jupiter presented itself to my view, and as I had prepared for myself a very excellent instrument, I noticed a circumstance which I had never been able to notice before, namely that three little stars, small but very bright, were very near the planet.*

He concluded "unhesitatingly, that there are three stars in the heavens moving about Jupiter, as Venus and Mercury around the Sun."[4] Additionally, Galileo's observations of sunspots also led to a view of a dynamic, ever-changing universe.

In 1616 Galileo was brought before the Inquisition in Rome and his ideas were declared heretical because they challenged more than 1,000 years of Christian tradition about humans being at the center of the universe. He received no punishment by agreeing not to teach these ideas, but in 1632 Galileo was brought to trial again for violating his previous compact and was forced into retirement at his home in Florence. He was also compelled to recant his belief that the Earth revolves around the Sun. His legendary response was reported only later, "*E pur si muove*" ("Yet it does move").[5]

Disregarding the narrow position of the church, others took up the cause after Galileo. An Englishman, Isaac Newton, was one of the most important. He formulated the three laws of motion that have been central to the development of space traveling vehicles, and placed both astronomy and physics on a firm scientific foundation. He established physical laws governing all matter that could be both mathematically proven and scientifically

2. Quoted in Wernher von Braun and Frederick I. Ordway III, *History of Rocketry and Space Travel* (New York: Thomas Y. Crowell Co., 1975 ed.), p. 9.

3. On this astronomical revolution see Clive Morphet, *Galileo and Copernican Astronomy: A Scientific World View Defined* (London: Butterworths, 1977); Thomas S. Kuhn, *The Copernican Revolution: Planetary Astronomy in the Development of Western Thought* (Cambridge, MA: Harvard University Press, 1957); David C. Knight, *Copernicus: Titan of Modern Astronomy* (New York: Franklin Watts, 1965).

4. Stillman Drake, ed. and trans., *Discoveries and Opinions of Galileo* (Garden City, NY: Doubleday & Co., 1957), pp. 31-34.

5. Lloyd Motz and Jefferson Hane Weaver, *The Story of Physics* (New York: Avon Books, 1989), pp. 37-38.

observed. Newton's observations on motion suggested that the universe was in constant flux and that motion in a predictable pattern was the natural condition. Universal gravitation, Newton argued, accounted for the physical actions of celestial bodies. In particular, he demonstrated that the attraction of the Sun to a planet was directly proportional to the product of the two masses and inversely proportional to the square of the distance separating them. Newton's ideas, so critical to the development of spaceflight, became the established method of explaining the universe during his lifetime and remained so until the twentieth century. During this period the history of astronomy and physics was mainly a story of working out a Newtonian "system of the world."[6]

## The Dream of Spaceflight

Not until the twentieth century did technology develop to the extent that actual travel into the observable universe could take place, although many people had posited that it was theoretically possible and longed for the time when humanity could venture beyond Earth. When Galileo first broadcast his findings about the solar system in 1610, he sparked a flood of speculation about lunar flight. Johann Kepler, himself a pathbreaking astronomer, posthumously published a novel, *Somnium* (*Dream*) (1634), that recounted a dream of a supernatural voyage to the Moon in which the visitors encountered serpentine creatures. He also included much scientific information in the book, speculating on the difficulties of overcoming the Earth's gravitational field, the nature of the elliptical paths of planets, the problems of maintaining life in the vacuum of space, and the geographical features of the Moon.[7]

Other writings sparked by the invention of the telescope and the success of *Somnium* also described fictional trips into space. Cyrano de Bergerac, for example, wrote *Voyage dans la Lune* (*The Voyage to the Moon*) (1649), describing several attempts by the hero to travel to the Moon. First, he tied a string of bottles filled with dew around himself, so that when the heat of the Sun evaporated the dew he would be drawn upward, but the hero only made it as far as Canada on that attempt. Next, he tried to launch a vehicle from the top of a mountain by means of a spring-loaded catapult, "but because I had not taken my measures aright, I fell with a slosh on the Valley below." Returning to his vehicle, Cyrano's hero found some soldiers mischievously tying firecrackers to it. As they lit the fuse, he jumped into the craft and tier upon tier of explosives ignited like rockets and launched him to the Moon. Thus Cyrano's hero became the first flyer in fiction to reach the Moon by means of rocket thrust, a premonition of Newton's third law of gravity about every action having an equal and opposite reaction. Once on the Moon, the character in this novel had several adventures, and later in the book he also journeyed to the Sun.[8]

Other writers picked up the science fiction format and used it to discuss the possibilities of space travel in the years that followed. For example, Edward Everett Hale, a New England writer and social critic, published in 1869 a short story in the *Atlantic Monthly* entitled "The Brick Moon." [I-3] The first known proposal for an orbital satellite around the Earth, Hale described how a satellite in polar orbit could be used as a navigational aid to ocean-going vessels. "For you see that if, by good luck," he explained,

*there were a ring like Saturn's which stretched around the world, above Greenwich and the meridian of Greenwich,...anyone who wanted to measure his longitude or distance from Greenwich would look out of his window and see how high this ring was above his horizon...So if we only had a*

6. *Ibid.*, pp. 43-88; Harrison, *Cosmology*, pp. 103-203.

7. Edward Rosen, trans., *Kepler's Somnium: The Dream or Posthumous Work on Lunar Astronomy* (Madison: University of Wisconsin Press, 1967), pp. 17-122; Steven J. Dick, *Plurality of Worlds: The Origins of the Extraterrestrial Life Debate from Democritus to Kant* (Cambridge: Cambridge University Press, 1982), pp. 77-84.

8. Von Braun and Ordway, *History of Rocketry and Space Travel*, p. 12; Emme, *History of Space Flight*, pp. 37-38.

*ring like that... vertical to the plane of the equator, as the brass ring of an artificial globe goes, only far higher in proportion... we could calculate the longitude.*[9]

When the heroes of the story substitute a brick moon for this ring—brick because it could withstand fire—it is to be hurled into orbit 5,000 miles above the Earth. An accident sends the brick moon off prematurely, however, while 37 construction workers and other people were aboard it. In contrast to what is now known about the vacuum of space, these people lived on the outer part of the brick moon, raised food, and enjoyed an almost utopian existence.

Perhaps the most important development in the literary consideration of space travel came following the publication of work by Italian astronomer Giovanni Schiaparelli in 1877 concerning the possibility of canals on Mars. He, and especially others, concluded that the features that he saw on Mars and called canals were the work of intelligent life. This was a startling observation because it meant that science had now validated the speculations of some fiction writers, lending credibility to their claims. Moreover, other scientists sought to explore these ideas, and in the United States Percival Lowell built what became the Lowell Observatory near Flagstaff, Arizona, to study the planets. In 1906 he published *Mars and Its Canals,* which argued that Mars had once been a watery planet and that the topographical features known as canals had been built by intelligent beings. [I-4] Over the course of the next forty years, a steady stream of other works was based upon Lowell's theories about the red planet.[10]

While many of these writings were not scientifically valid, that became less true as time passed and more modern science fiction writers such as Jules Verne and H.G. Wells appeared. Both were well aware of the scientific underpinnings of spaceflight, and their speculations reflected reasonably well what was known at the time about its problems and the nature of other worlds. Both Wells and Verne incorporated into their novels a much more sophisticated understanding of the realities of space than had been seen before. Their space vehicles became enclosed capsules powered by electricity, and they possessed some aerodynamic soundness. Most of Wells' and Verne's concepts stood up under some, although not all, scientific scrutiny. For example, in 1865 Verne published *De la Terre à la Lune* (*From the Earth to the Moon*). The scientific principles informing this book were very accurate for the period. It described the problems of building a vehicle and launch mechanism to visit the Moon. At the end of the book, Verne's characters were shot into space by a 900-foot-long cannon. Verne picked up the story in a second novel, *Autour de la Lune* (*Around the Moon*), describing a lunar orbital flight, but he did not allow his characters actually to land. Wells published *War of the Worlds* in 1897 and *The First Men in the Moon* immediately thereafter. Both used sound scientific principles to describe space travel and encounters with aliens.[11]

*War of the Worlds,* furthermore, played upon a theme in space exploration that had been present for many centuries and would continue to appear throughout the twentieth century, humanity's fascination and terror about contact with alien species. Excitement

9. Edward E. Hale, "The Brick Moon," *The Atlantic Monthly,* October 1869, pp. 451-460; November 1869, pp. 603-611; December 1869, pp. 679-688.

10. Edward C. Ezell and Linda Neumann Ezell, *On Mars: Exploration of the Red Planet, 1958-1978* (Washington, DC: NASA SP-4212, 1984), pp. 3-5; William Graves Hoyt, *Lowell and Mars* (Tucson: University of Arizona Press, 1976); Frederick I. Ordway III, "The Legacy of Schiaparelli and Lowell," *Journal of the British Interplanetary Society,* January 1986, pp. 18-22.

11. General studies of science fiction can be found in Brian Ash, ed., *The Visual Encyclopedia of Science Fiction* (New York: Harmony Books, 1977); James Gunn, *Alternate Worlds: The Illustrated History of Science Fiction* (Englewood Cliffs, NJ: Prentice-Hall, 1975); Ed Naha, *The Science Fictionary* (New York: Wideview Books, 1980); Franz Rottensteiner, *The Science Fiction Book: An Illustrated History* (New York: Seabury Press, 1975); Jean-Claude Suares, Richard Siegel, and David Owen, *Fantastic Planets* (Danbury, CT: Addison House, 1979); Jules Verne, *De la Terre à la Lune* (Paris: J. Hetzel, 1866); H.G. Wells, *The First Men in the Moon* (London: George Newness, 1901); H.G. Wells, *The Shape of Things to Come* (London: Hutchinson, 1933); H.G. Wells, *The Ultimate Revolution* (New York: Macmillan, 1933); H.G. Wells, *The War of the Worlds* (London: William Heinemann, 1898).

about the prospect that humanity is not alone in the universe, that contact is possible, and that both cultures might be made richer through interaction has been a persistent theme for advocates of the exploration of space. Some science fiction positively expressed this image of contact with aliens—as examples, three novels by C.S. Lewis, *Out of the Silent Planet* (1938), *Perelandra* (1943), and *That Hideous Strength* (1945). At the same time, there has long been a fear that an alien civilization might attack Earth and either enslave or destroy humanity. In *War of the Worlds* the Earth was attacked by invaders from Mars, and eventually only defeated by terrestrial bacteria harmless to humans but deadly to an alien without generations of built-up immunity. These stories, both positive and negative examples of contact, provided some of the inspiration for many scientists and engineers who developed modern rocketry.[12]

## The Technology of Rockets

Until the twentieth century, study about the universe and speculation about the nature of spaceflight were not closely related to the technical developments that led to rocket propulsion. A merging of these ideas had to take place before the space age could truly begin. The rocket is a reaction device, based on Newton's Third Law of Motion. Without explicitly understanding that law, humanity had known of the rocket's practicality for centuries. Although it is unclear who first invented rockets, many investigators link the development of the first crude rockets with the discovery of gunpowder. The Chinese, moreover, had been using gunpowder for more than 2,000 years. The first firecrackers appeared during the first two centuries after the beginning of the common era, and the Chinese were using rockets in warfare at least by the time of Genghis Khan (ca. 1155-1227).[13] Not long thereafter the use of rockets in warfare began to spread to the West, and they were in use by the time of the German Albert Magnus, who gave a recipe for making gunpowder and wrapping it "in a skin of paper for flying or for making thunder" in *De Mirabilibus Mundi* (*On the Wonders of the World*). By the time of Konrad Kyser von Eichstadt, who wrote *Bellfortis* in 1405, the use of rockets in military operations was reasonably well known in Europe.[14]

The application of gunpowder rockets was refined through the first part of the nineteenth century. Essentially, the military role of rocketry was as a type of artillery. Sir William Congreve carried rocket technology just about as far as it was to go for another century, developing incendiary barrage missiles for the British military that could be fired from either land or sea. They were used with effect against the United States in the War of 1812; it was probably Congreve's weapons that Francis Scott Key wrote about in the "Star Spangled Banner" while imprisoned on a British warship during the bombardment of Fort McHenry at Baltimore. The military use of the rocket was soon outmoded in the nineteenth century by developments in artillery which became more accurate and more destructive, but new uses for rockets were found in other industries such as whaling and for sea-going shipping where rocket-powered harpoons and rescue lines began to be employed.[15]

12. On the issue of contact of two cultures in space see, M. Jane Young, "'Pity the Indians of Outer Space': Native American Views of the Space Program," *Western Folklore* 46 (October 1987): 269-79; Patricia Nelson Limerick, "The Final Frontier?," *Wilson Quarterly* 14 (Summer 1990): 82-83; Ray A. Williamson, "Outer Space as Frontier: Lessons for Today," *Western Folklore* 46 (October 1987): 255-67.

13. Frank H. Winter, "The Genesis of the Rocket in China and its Spread to the East and West," pp. 3-23; Fang-Toh Sun, "Rockets and Rocket Propulsion Devices in Ancient China," pp. 25-40, both in A. Ingemar Skoog, ed., *History of Rocketry and Astronautics: Proceedings of the Twelfth, Thirteenth, and Fourteenth History Symposia of the International Academy of Astronautics* (San Diego: Univelt, Inc., 1990).

14. Von Braun and Ordway, *History of Rocketry and Space Travel*, p. 28.

15. Frank H. Winter, *The First Golden Age of Rocketry: Congreve and Hale Rockets of the Nineteenth Century* (Washington, DC: Smithsonian Institution Press, 1990).

# Progenitors of the Space Age

While the technology of rocketry was moving forward on other fronts, some individuals began to see its use for space travel. There were three great pioneering figures in this category. Collectively, they were the progenitors of the modern space age. The earliest was the Russian theoretician Konstantin Eduardovich Tsiolkovskiy. An obscure schoolteacher in a remote part of Tsarist Russia in 1898, he submitted for publication to the Russian journal, *Nauchnoye Obozreniye* (*Science Review*), a work based upon years of calculations that laid out many of the principles of modern spaceflight. His article was not published until 1903, but it opened the door to future writings on the subject. In it Tsiolkovskiy described in depth the use of rockets for launching orbital space ships. [I-5] Tsiolkovskiy continued to theorize on the subject of spaceflight until his death, describing in great detail both methods of flight and the technical requirements of space stations. Significantly, he never had the resources—nor perhaps the inclination—to experiment with rockets himself. His theoretical work, however, influenced later rocketeers both in his native land and abroad, and served as the foundation of the Soviet space program.[16]

A second rocketry pioneer was Hermann Oberth, by birth a Transylvanian but by nationality a German. Oberth began studying the nature of spaceflight about the time of World War I and published his classic study, *Die Rakete zu den Planetenraumen* (*Rockets in Planetary Space*) in 1923. [I-6] It was a thorough discussion of almost every phase of rocket travel. He posited that a rocket could travel in the void of space and that it could move faster than the velocity of its own exhaust gases. He noted that with the proper velocity a rocket could launch a payload into orbit around the Earth, and to accomplish this goal he reviewed several propellant mixtures to increase speed. He also designed a rocket that he believed had the capability to reach the upper atmosphere by using a combination of alcohol and hydrogen as fuel. Oberth followed this up with a long series of publications on rocketry and the prospects of space travel. He became the father of German rocketry.[17] Among his proteges was Wernher von Braun, the senior member of the rocket team that built NASA's Saturn launch vehicle for the trip to the Moon in the 1960s.[18]

Finally, the American Robert H. Goddard pioneered the use of rockets for spaceflight.[19] Motivated by reading science fiction as a boy, Goddard became excited by the possibility of exploring space. In 1901 he wrote a short paper, "The Navigation of Space," that argued that movement could take place by firing several cannons, "arranged like a 'nest' of beakers." He tried unsuccessfully to publish this article in *Popular Science News*.[20] At his high school oration in 1904 he summarized his future life's work: "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."[21] In 1907 he wrote another paper on the possibility of using radioactive materials to propel a rocket through interplanetary space. He sent this article to several magazines, and all rejected it.[22] Still not dissuaded, as a young physics graduate student he worked on

16. Konstantin E. Tsiolkovskiy, *Aerodynamics* (Washington, DC: NASA TT F-236, 1965); Konstantin E. Tsiolkovskiy, *Reactive Flying Machines* (Washington, DC: NASA TT F-237, 1965); Konstantin E. Tsiolkovskiy, *Works on Rocket Technology* (Washington, DC: NASA TT F-243, 1965); Arkady Kosmodemyansky, *Konstantin Tsiolkovskiy* (Moscow: Nauka, 1985).

17. Hermann Oberth, *Ways to Spaceflight* (Washington, D.C.: NASA, TT F-622, 1972); Hermann Oberth, *Rockets into Planetary Space* (Washington, DC: NASA TT F-9227, 1972); H.B. Walters, *Hermann Oberth: Father of Space Travel* (New York: Macmillan, 1962).

18. Interestingly, in 1969 Oberth attended the launch in the United States of Apollo 11 at the request of von Braun, who was then directing a major component of the lunar project.

19. The standard biography of Goddard is Milton Lehman, *This High Man* (New York: Farrar, Straus, 1963), although it is outdated and deserving of replacement.

20. Robert H. Goddard, "Material for an Autobiography," in Esther C. Goddard, ed., and G. Edward Pendray, assoc. ed., *The Papers of Robert H. Goddard* (New York: McGraw-Hill Book Co., 1970), 1:10.

21. Robert H. Goddard, "Of Taking Things for Granted," in *ibid.*, 1:63-66.

22. Robert H. Goddard, "On the Possibility of Navigating Interplanetary Space," in *ibid.*, pp. 81-87; *Scientific American* to R.H. Goddard, October 9, 1907, in *ibid.*, p. 87; William W. Payne to R.H. Goddard, January 15, 1908, in *ibid.*, p. 88.

rocket propulsion and actually received two patents in 1914. One was the first for a rocket using solid and liquid fuel and the other for a multi-stage rocket.[23]

After a stint with the military in World War I, where he worked on solid rocket technology for use in combat, Goddard became a professor of physics at Clark College in Worcester, Massachusetts. There he turned his attention to liquid rocket propulsion, theorizing that liquid oxygen and liquid hydrogen were the best fuels, but learning that oxygen and gasoline were less volatile and therefore more practical. To support his investigations, Goddard applied to the Smithsonian Institution for assistance in 1916 and received a $5,000 grant from its Hodgkins Fund.[24] His research was ultimately published by the Smithsonian as the classic study, *A Method of Reaching Extreme Altitudes,* in 1919. [I-7] In it Goddard argued from a firm theoretical base that rockets could be used to explore the upper atmosphere. Moreover, he suggested that with a velocity of 6.95 miles/second, without air resistance, an object could escape Earth's gravity and head into infinity, or to other celestial bodies.[25] This became known as the Earth's "escape velocity."

It also became the great joke for those who believed spaceflight either impossible or impractical. Some ridiculed Goddard's ideas in the popular press, much to the consternation of the already shy Goddard. Soon after the appearance of his publication, he commented that he had been "interviewed a number of times, and on each occasion have been as uncommunicative as possible."[26] The *New York Times* was especially harsh in its criticisms, referring to him as a dreamer whose ideas had no scientific validity. It also compared his theories to those advanced by novelist Jules Verne, indicating that such musing is "pardonable enough in him as a romancer, but its like is not so easily explained when made by a savant who isn't writing a novel of adventure." [I-8] The *Times* questioned both Goddard's credentials as a scientist and the Smithsonian's rationale for funding his research and publishing his results.[27]

The negative press Goddard received prompted him to be even more secretive and reclusive. It did not, however, stop his work, and he eventually registered 214 patents on various components of rockets. He concentrated on the design of a liquid-fueled rocket, the first such development, and the attendant fuel pumps, motors, and control components. On March 16, 1926 near Auburn, Massachusetts, Goddard launched his first rocket, a liquid oxygen and gasoline vehicle that rose 184 feet in 2.5 seconds.[28] This event heralded the modern age of rocketry. He continued to experiment with rockets and fuels for the next several years. A spectacular launch took place on July 17, 1929, when he flew the first instrumented payload—an aneroid barometer, a thermometer, and a camera—to record the readings. The launch failed; after rising about 90 feet the rocket turned and struck the ground 171 feet away. It caused such a fire that neighbors complained to the state fire marshal and Goddard was enjoined from making further tests in Massachusetts.[29]

This experience, as well as his personal shyness, led him to seek a more remote setting to conduct his experiments. His ability to shroud his research in mystery was greatly enhanced by Charles A. Lindbergh, fresh from his trans-Atlantic solo flight, who helped Goddard obtain a series of grants from the Guggenheim Fund fostering aeronautical activities. This enabled him to obtain a large tract of desolate land near Roswell, New Mexico,

23. Robert H. Goddard, "Material for an Autobiography," in *ibid.*, 1:19-20; R.H. Goddard to Josephus Daniels, July 25, 1914, in *ibid.*, 1:126-27.

24. C.D. Walcott to R.H. Goddard, January 5, 1917, in *ibid.*, 1:190; Frederick C. Durant III, "Robert H. Goddard and the Smithsonian Institution," in Frederick C. Durant III and George S. James, eds., *First Steps Toward Space: Proceedings of the First and Second History Symposia of the International Academy of Astronautics* (Washington, DC: Smithsonian Institution Press, 1974), pp. 57-69.

25. Robert H. Goddard, *A Method of Reaching Extreme Altitudes* (Washington, DC: Smithsonian Miscellaneous Collections, Volume 71, Number 2, 1919), p. 54.

26. Robert H. Goddard, "Statement by R.H. Goddard for Newspapers," January 18, 1920, in *ibid.*, 1:409-10.

27. "Topics of the Times," *New York Times,* January 18, 1920, p. 12.

28. Robert H. Goddard, "R.H. Goddard's Diary," March 16-17, 1926, in Goddard and Pendray, *Papers of Goddard,* 2:580-81; Lehman, *This High Man,* pp. 140-44.

29. Lehman, *This High Man,* pp. 156-62.

and to set up an independent laboratory to conduct rocket experiments far away from anyone else. Between 1930 and 1941 Goddard carried out ever more ambitious tests of rocket components in the relative isolation of New Mexico, much of which he summarized in a 1936 study, *Liquid-Propellant Rocket Development.* [I-9] The culmination of this effort was a successful launch of a rocket to an altitude of nearly 9,000 feet in 1937.[30] In late 1941 Goddard entered naval service and spent the duration of World War II developing a Jet-Assisted Takeoff (JATO) rocket to shorten the distance required for heavy aircraft launches. Some of this work led to the development of the throttleable Curtis-Wright XLR25-CW-1 rocket engine that later powered the Bell X-2 and helped overcome the transonic barrier in 1947. Goddard did not live to see this; he died in Baltimore, Maryland, on August 10, 1945.[31]

Goddard accomplished much, but because of his secrecy most people did not know about his achievements during his lifetime. These included the following pioneering activities:

1. Theorizing on the possibilities of jet-powered aircraft, rocket-borne mail and express, passenger travel in space, nuclear-powered rockets; and journeys to the Moon and other planets (1904-1945).
2. First mathematical exploration of the practicality of using rockets to reach high altitudes and achieve escape velocity (1912).
3. First patent on the idea of multi-stage rockets (1914).
4. First experimental proof that a rocket could provide thrust in a vacuum (1915).
5. The basic idea of anti-tank missiles, developed and demonstrated during work for the Army in World War I. This was the prototype for the "Bazooka" infantry weapon (1918).
6. First publication in the United States of the basic mathematical theory underlying rocket propulsion and spaceflight (1919).
7. First development of a rocket motor burning liquid propellants (1920-1926).
8. First development of self-cooling rocket motors, variable-thrust rocket motors, practical rocket landing devices, pumps suitable for liquid fuels, and associated components (1920-1945).
9. First design, construction, and launch of a successful liquid fueled rocket (1926).
10. First development of gyro-stabilization equipment for rockets (1932).
11. First use of deflector vanes in the blast of the rocket motor as a method of stabilizing and guiding rockets (1932).[32]

The U.S. government's recognition of Goddard's work came in 1960 when the Department of Defense and the National Aeronautics and Space Administration (NASA) awarded his estate $1 million for the use of his patents.[33]

# Parallel Developments

Concomitant with Goddard's research into liquid fuel rockets, and perhaps more immediately significant because the results were more widely disseminated, were activities in several other quarters. Among the most important of these ventures were those undertaken by the various rocket societies. The largest and most significant was the German organization, the "Verein fur Raumschiffahrt" (Society for Spaceship Travel, or VfR). Although spaceflight aficionados and technicians had organized at other times and in other

30. *Ibid.*, 161-312; von Braun and Ordway, *History of Rocketry and Space Travel*, pp. 46-53. Many of these experiments were summarized in Robert H. Goddard, *Liquid-Propellant Rocket Development* (Washington, DC: Smithsonian Miscellaneous Collections, Volume 95, Number 3, 1936).

31. Frank H. Winter, *Rockets into Space* (Cambridge, MA: Harvard University Press, 1990), pp. 33-34.

32. G. Edward Pendray, "Pioneer Rocket Development in the United States," in Eugene M. Emme, ed. *The History of Rocket Technology* (Detroit: Wayne State University Press, 1964), pp. 19-23.

33. See the extensive documentation on this settlement in the "Goddard Patent Infringement" Folders, Biographical Collection, NASA Historical Reference Collection, Washington, D.C.

places, the VfR under the able leadership of Berlin aviator Max Valier emerged soon after its founding on July 5, 1927, as the leading space travel group. It was specifically organized to raise money to test Oberth's rocketry ideas. It was successful in building a base of support in Germany, publishing a magazine and scholarly studies, and of constructing and launching small rockets. One of its strengths from the beginning, however, was the VfR's ability to publicize both its activities and the dream of spaceflight.[34]

The VfR made good on some of those dreams on February 21, 1931, when it launched the LOX-methane liquid-fuel rocket HW-1 near Dessau to an altitude of approximately 2,000 feet. The organization's public relations arm went into high gear after this mission, and emphasized the launch's importance as the first successful European liquid-fuel rocket flight.[35] Wernher von Braun, then a neophyte learning the principles of rocketry from Oberth and Valier, was both enthralled with this flight and impressed with the publicity it engendered. Later, he became the quintessential and movingly eloquent advocate for the dream of spaceflight and a leading architect of its technical development. He began developing both skills while working with the VfR.[36]

There were other national rocketry societies that sprang up during this same period, each contributing to the base of technical knowledge and the popular conception of spaceflight. The American Interplanetary Society (AIS) was one of the more powerful of these institutions. Organized in 1930, within two years the AIS had begun a program of rocket experimentation. On November 12, 1932, the AIS tested its first static test of a LOX-gasoline rocket. It actually launched a rocket on May 14, 1932, attaining an altitude of only 250 feet. But its second and last launch on September 9, 1934, rose over 1,300 feet. Because of the great cost and risk to people involved, after this launch the group concentrated throughout the rest of the 1930s on static firings of engines and published results of its research, the cumulation of which proved significant for later experimentation in rocketry. Almost concomitant with its withdrawal from rocket experimentation, and out of a desire to improve the image of the organization, the AIS changed its name to the American Rocket Society.[37]

That name change may also have been prompted in part by the organization of the British Interplanetary Society (BIS) on October 13, 1933, at Liverpool, England. More oriented toward theoretical studies than rocket experimentation, in the 1930s the BIS became a haven for writers and other intellectuals interested in the idea of spaceflight. By September 1939, at the beginning of World War II, the BIS numbered about 100 members, including several Germans. The BIS periodical, the *Journal of the British Interplanetary Society*, began publication in January 1934, and it quickly became a persistent and powerful voice on behalf of space exploration. The BIS did not undertake field work with rockets (although several members did conduct some crude experiments with potential solid propellants), but in 1938-1939 its members designed a lunar landing vehicle which influenced the Lunar Module used in Project Apollo during the 1960s.[38] [I-10]

34. The standard work on the rocket societies is Frank H. Winter, *Prelude to the Space Age: The Rocket Societies, 1924-1940* (Washington, D.C.: Smithsonian Institution Press, 1983). A briefer discussion is available in Winter, *Rockets into Space*, pp. 34-42.

35. Winter, *Rockets into Space*, p. 37.

36. Wernher von Braun, "German Rocketry," in Arthur C. Clarke, ed., *The Coming of the Space Age* (New York: Meredith Press, 1967), pp. 33-55. Von Braun's public relations skills were exceptional throughout his career. Evidence of this can be found in the more than eight linear feet of materials by von Braun held in the Biographical Files of the NASA Historical Reference Collection.

37. Winter, *Prelude to the Space Age*, pp. 73-85; Eugene M. Emme, ed., *Aeronautics and Astronautics: An American Chronology of Science and Technology in the Exploration of Space, 1915-1960* (Washington, DC: National Aeronautics and Space Administration, 1961), p. 31.

38. Winter, *Prelude to the Space Age*, pp. 87-97; *The British Interplanetary Society: Origin and History* (London: British Interplanetary Society Diamond Jubilee Handbook, 1993), pp. 6, 17; H.E. Ross, "The British Interplanetary Society's Astronautical Studies, 1937-1939," in Durant and James, eds., *First Steps Toward Space*, pp. 209-16; H.E. Ross, "The British Interplanetary Society Spaceship," *Journal of the British Interplanetary Society* 5 (January 1939): 4-9.

While both the individual and societal precursors of spaceflight struggled along as best they could, beginning in 1936 the Guggenheim Aeronautical Laboratory, California Institute of Technology (GALCIT), in Pasadena, California, began to pursue its own rocket research program.[39] Frank J. Malina, a young Caltech Ph.D. student at the time, persuaded GALCIT to adopt a research agenda for the design of a high-altitude sounding rocket and enthusiastically began experimentation. Using some of the ideas from the research of Eugen Sänger in Austria and Goddard in New Mexico, Malina and a design team—composed of, among others, H.S. Tsien, a Chinese national who was later deported and became the architect of the ICBM and space launcher programs for the People's Republic of China—began work. Nobel Prize-winning physicist Robert A. Millikan, chair of the Caltech executive council, was especially supportive of this work because he wanted to use sounding rockets for cosmic ray research. Millikan tried to persuade Goddard to join this research project—Malina even visited him at his complex near Roswell, New Mexico, in August 1936—but Goddard refused.[40] In a letter revealing much of Goddard's secretiveness, in September 1936 he wrote disparagingly of Malina to Robert Millikan. Goddard commented that he had tried to help Malina with some of his questions, but "I naturally cannot turn over the results of many years of investigation, still incomplete, for use as a student's thesis."[41]

Beginning in late 1936 Malina and his colleagues started the static testing of rocket engines in the canyons above the Rose Bowl, with mixed results. It was not until November 28, 1936, for example, that the motor ran at all, and then only for 15 seconds. A series of tests thereafter brought incremental improvements; a year later Malina and an associate had learned enough to distill the results into the first scholarly paper on rocketry to come out of GALCIT. [I-11] The test results showed that with proper fuels and motor efficiency a rocket could be constructed with the capability to ascend as high as 1,000 miles.[42]

Because of this research GALCIT's rocketry team obtained funding from outside sources, among them General H.H. (Hap) Arnold, soon to become the Army Air Corps Chief of Staff; he visited GALCIT in the spring of 1938 and was enthusiastic about the work on rockets he saw Malina and co-workers doing. That fall he arranged for additional funding from the National Academy of Sciences to proceed with the project, with the specific goal of research on the possibilities of rocket-assisted takeoff for aircraft. The committee that approved this funding did so with some consternation that it might be money poorly spent. Finally, Jerome C. Hunsaker, head of the Aeronautics Department of the Massachusetts Institute of Technology, told the committee that he would be glad to have Theodore von Kármán, director of GALCIT, "take the Buck Rogers job."[43] GALCIT accepted the task, and beginning in 1939 Malina and his rocket team began working on what became the JATO project. Although Malina always expressed misgivings about working on weaponry, and after World War II accepted employment with the United Nations so he could help prevent such conflict from taking place again, the difficult political climate in 1939 prompted him to support the development of U.S. military capability as a deterrent to

39. The history of this organization has been explored in Clayton R. Koppes, *JPL and the American Space Program: A History of the Jet Propulsion Laboratory* (New Haven: Yale University Press, 1982).

40. Malina reflected that while Goddard was pleasant during a visit to his Roswell, New Mexico, facility in August 1936, he left two specific impressions. First, he was bitter toward the press, and therefore exceptionally secretive about his work. Second, "he felt that rockets were his private preserve, so that others working on them took on the aspect of intruders." Malina recalled that Goddard showed him no technical details and declined to participate in the GALCIT program. See Frank J. Malina, "On the GALCIT Rocket Research Project, 1936-1938," in Durant and James, eds., *First Steps Toward Space*, pp. 113-27, quote from p. 117.

41. R.H. Goddard to Robert A. Millikan, September 1, 1936, in Goddard and Pendray, eds., *Papers of Goddard*, 2:1012-13.

42. Frank J. Malina and Apollo M.O. Smith, "Flight Analysis of the Sounding Rocket," *Journal of Aeronautical Sciences* 5 (1938): 199-202; Frank J. Malina, "The Jet Propulsion Laboratory: Its Origins and First Decade of Work," *Spaceflight* 6 (1964): 216-23; Frank J. Malina, "The Rocket Pioneers: Memoirs of the Infant Days of Rocketry at Caltech," *Engineering and Science* 31 (February 1968): 9-13, 30-32.

43. Theodore von Kármán with Lee Edson, *The Wind and Beyond: Theodore von Kármán, Pioneer in Aviation and Pathfinder in Space* (Boston: Little, Brown, 1967), p. 243.

fascism. As a result, Malina and GALCIT engaged throughout the war years in rocketry research for military purposes.[44]

## The Rocket and Modern War

Although the work of Goddard, Oberth, and others was pathbreaking, World War II truly altered the course of rocket development. Prior to that conflict technological progress in rocketry had been erratic. The war, however, forced nations to focus attention on the activity and to fund research and development. Such research and development was oriented, of course, toward the advancement of rocket-borne weapons rather than rockets for space exploration and other peaceful purposes. This would remain the case even after the war, as competing nations perceived and supported advances in space technology largely because of their military potential and the national prestige associated with them. The security role of the Department of Defense and the function of NASA as a civilian space agency have been inextricably related ever since.

During World War II virtually every belligerent was involved in developing some type of rocket technology. As an example, the Soviet Union fielded the "Katusha," a solid-fuel rocket six feet in length that carried nearly fifty pounds of explosives and could be fired from either a ground- or truck-mounted launcher. Italy conducted research on solid- and liquid-fuel rockets for small, infantry-carried weapons and torpedoes. Other nations developed various types of hand-held anti-tank and anti-aircraft rockets.[45]

Just before the entry of the United States into World War II, the nation's military began in earnest to acquire a rocket capability, and several efforts were aimed in that direction. One of the most significant was at GALCIT, renamed the Jet Propulsion Laboratory (JPL) in 1943, where von Kármán, Malina, and a group of talented young engineers made important strides based on their research from the latter 1930s. They developed in 1941, for instance, the first JATO solid-fuel rocket system.[46]

In March 1942 the GALCIT team that had developed the JATO system founded Aerojet Engineering Corporation as a vehicle for mass-producing and marketing this new technology; the new company quickly became one of the leading manufacturers of rockets in the United States. Malina recalled that the movement of scientists and engineers into business did not sit well with the military. Within two months of creating Aerojet, von Kármán had brought in two big military production contracts for JATO systems, but the Army Air Forces—successor to the Army Air Corps—canceled its contract even before production began. Von Kármán and Malina flew to Washington, D.C., to protest the decision, and learned that concerns about conflict of interest had prompted the cancellation. "We like you very much, doctor," Colonel Benjamin Chidlaw told von Kármán, "but only in cap and gown to advise us what to do in science. The derby hat of the businessman doesn't befit you." The leaders of Aerojet were able to overcome this problem only because of the dearth of rocket expertise in the United States, but it ceased to be a problem after 1944 when the General Tire and Rubber Company bought a controlling interest in Aerojet and divorced it from its JPL ties.[47]

44. Frank J. Malina to parents, October 24, 1938, in "Rocket Research and Development: Excerpts from Letters Written Home by Frank J. Malina between 1936 and 1946," pp. 22-23, Frank J. Malina Folder, Biographical Files, NASA Historical Reference Collection; von Kármán with Edson, *Wind and Beyond*, p. 244; Frank J. Malina, "The U.S. Army Air Corps Jet Propulsion Research Project, GALCIT Project No. 1, 1939-1946: A Memoir," in R. Cargill Hall, ed., *Essays on the History of Rocketry and Astronautics: Proceedings of the Third through the Sixth History Symposia of the International Academy of Astronautics* (San Diego: Univelt, Inc., 1986), pp. 154-60.

45. Frank J. Malina, "A History of Rocket Propulsion up to 1945," in *Jet Propulsion Engines* (Princeton: Princeton University Press, 1959), pp. 18, 22-23.

46. Koppes, *JPL and the American Space Program*, pp. 11-16; von Kármán with Edson, *Wind and Beyond*, pp. 244-56; Theodore von Kármán, "Jet Assisted Take-off," *Interavia*, July 1952, pp. 376-77.

47. Von Kármán with Edson, *Wind and Beyond*, p. 258-60; Malina, "GALCIT Project No. 1," pp. 195-95; Michael H. Gorn, *The Universal Man: Theodore von Kármán's Life in Aeronautics* (Washington, DC: Smithsonian Institution Press, 1992), pp. 90-92; Koppes, *JPL and the American Space Program*, pp. 16-17.

Even as these activities were taking place, in 1943 JPL engineers concluded in a report to the Army Air Forces that "the development of a long-range rocket projectile is within engineering feasibility" and asked for funding to bring it to a reality.[48] [I-12] With some investment financing from the Army, JPL conducted research on engines and other components. Then on January 16, 1945, Malina sent to the Army Ordnance Section a proposal for a liquid-fuel "sounding" rocket that would be able to launch a 25-pound payload to an altitude of 100,000 feet. What emerged from these recommendations was a decision to develop the WAC Corporal, first flown on October 11, 1945; the WAC Corporal became a significant launch vehicle in post-war rocket research.[49]

Less significant, but deserving of attention if only because it was the first U.S. corporation dedicated solely to the development of liquid rocket engines and accessory equipment, Reaction Motors, Inc. (RMI), came into being less than two weeks after the United States entered World War II. Based at Pompton Plains, New Jersey, its founders had been longtime rocket enthusiasts intimately connected with the American Interplanetary Society/American Rocket Society. All were convinced of the military and business potential of the rocket in the expanding world conflict. The company's leadership negotiated a contract with the Navy's Bureau of Aeronautics to develop a 445-Newton (100-pound) thrust regeneratively cooled rocket motor, which was to be employed by the Navy to assist large, heavily laden flying boats during takeoff. By the end of November 1943, RMI was heavily involved with naval research in Annapolis. There, a nitric acid-based rocket program was underway at the Naval Engineering Experiment Station (NEES) where Robert H. Goddard was working on pumps and turbines. Goddard's work was put to good use by RMI, which by early 1944 had succeeded in testing a liquid-fueled engine mounted in a Navy PBM3C flying boat. The company then went on to develop the rocket engine that propelled the first piloted aircraft to fly faster than the speed of sound, the Air Force X-1 in 1947. Thereafter, RMI contributed critical engine components to virtually all U.S. rocket programs.[50]

While the developments in the United States ultimately proved more significant, laying as they did the foundation of much post-war rocket technology, it was in Germany that the most spectacular early successes in developing an operational rocket capability took place. This was probably the case largely because in 1932 the German army hired the charismatic and politically astute Wernher von Braun, then only twenty years old, to work in its military rocket program. While he was the first VfR member to go to work for the German military, he was far from the last.

Von Braun's motivations for this move, with the hindsight of Hitler's rise to power in Germany and the devastation and terror of World War II, have been questioned and criticized. For some he was a visionary who foresaw the potential of human spaceflight, but for others he was little more than an arms merchant who developed brutal weapons of mass destruction. In reality, he seems to have been something of both, all the while never evincing Malina's type of hesitancy about the morality of using scientific and technical knowledge to kill as many people and destroy as many resources as possible. In the 1960s, as the United States was involved in a race with the Soviet Union to see who could land a human on the Moon first, political humorist Tom Lehrer wrote a song about von Braun's pragmatic approach to serving whoever would let him build rockets regardless of their purpose. "Don't say that he's hypocritical, say rather that he's apolitical," Lehrer wrote. "'Once the rockets are up, who cares where they come down? That's not my department,' says Wernher von Braun." Lehrer's biting satire captured the ambivalence of von Braun's atti-

48. Theodore von Kármán, "Memorandum on the Possibilities of Long-Range Rocket Projectiles," November 20, 1943, Frank J. Malina Folder, Biographical Files, NASA Historical Reference Collection.

49. Frank J. Malina, "America's First Long-Range-Missile and Space Exploration Program: The ORDCIT Project of the Jet Propulsion Laboratory, 1943-1946, a Memoir," in Hall, ed., *Essays on the History of Rocketry and Astronautics*, pp. 339-83; William R. Corliss, *NASA Sounding Rockets, 1958-1968: A Historical Summary* (Washington, DC: NASA SP-4401, 1971), pp. 17-18.

50. James H. Wyld, "The Liquid Propellant Rocket Engine," *Mechanical Engineering*, June 1947, p. 5; Frederick I. Ordway, III and Frank H. Winter, "Reaction Motors, Inc.: A Corporate History, 1941-1958," Parts I and II, in Roger D. Launius, ed., *History of Rocketry and Astronautics: Proceedings of the Fifteenth and Sixteenth Symposia of the International Academy of Astronautics* (San Diego: Univelt, Inc., 1994), pp. 75-100, 101-27.

tude on moral questions associated with the use of rocket technology.[51]

With military oversight provided by General Walter Dornberger, Germany developed two important aerospace weapons, the V-1 "Buzz Bomb" and the V-2 rocket, the latter built under von Braun's direction. The V-1, first used in June 1944, had one substantial weakness; it was relatively slow, with a top speed of 400 miles per hour. This made it possible for allied pilots and anti-aircraft operators to destroy it. Of the more than 8,000 of these weapons launched, over half were destroyed before reaching their targets. But the "Buzz Bombs" that reached London extracted a toll: several thousand people were killed and wounded.[52]

While the V-1 was essentially an air-breathing cruise missile, the second German weapon was the first true ballistic missile. The brainchild of Wernher von Braun's rocket team operating at a secret laboratory at Peenemünde on the Baltic coast, this rocket was the immediate antecedent of some of those used in the U.S. space program. A liquid propellant missile 46 feet in height and weighing 27,000 pounds at launch, the V-2, called the A-4 by the Germans involved in the project, flew at speeds in excess of 3,500 miles per hour and delivered a 2,200-pound warhead 200 miles away. First successfully flown in October 1942, it was employed against targets in Europe beginning in September 1944, and by the end of the war 1,155 had been fired against England and another 1,675 had been launched against Antwerp and other continental targets. The guidance system for these missiles was imperfect, and many did not reach their targets, but they struck without warning and there was no defense against them. As a result the V-2s had a terror factor far beyond their capabilities.[53]

Germany's astounding success in developing a ballistic missile while the other combatants had not done so was no accident, and it was in no small measure the result of personalities involved in the research. Before 1941 the United States had led the world in rocket technology, chiefly because of Goddard's work. But he failed to gain the significant support of either other scientists or the U.S. government. On the other hand, the energetic Oberth courted his scientific colleagues and those in the German government. For instance, as early as 1929 Oberth had helped kindle the fires of rocketry's promise in Walter Dornberger, later the military commander of the German rocket program. No similar level of salesmanship took place in any other nation. Popular and top-level support was therefore lacking, and Germany was able to capitalize on this with the V-2 development during the war.

## Post-War Rocket Technology and Space Science

As World War II was winding down, U.S. military forces brought captured V-1s and V-2s back to the United States for examination. Clearly the technology employed in both of these weapons was worthy of study, and they were the top priority for military intelligence officials sifting through what remained of the impressive array of German military technology. Along with them—as part of a secret military operation called Project Paperclip—came many of the scientists and engineers who had developed these weapons, notably von Braun who intentionally surrendered to the United States in hopes that he could continue his rocketry experiments under U.S. sponsorship. He calculated that his work would be better supported and he would have a freer hand in the United States than in the Soviet Union. The German rocket team was installed at Fort Bliss in El Paso, Texas, and launch facilities for the V-2 test program were set up at the nearby White Sands Proving Ground in New Mexico. Later, in 1950 von Braun's team of over 100 people was moved

51. Wayne Biddle, "Science, Morality and the V-2," *New York Times*, October 2, 1992, p. A31; Tom Lehrer, "Wernher von Braun," on the album *That was the Year That Was* (1965).

52. Stanley M. Ulanoff, *Illustrated Guide to U.S. Missiles and Rockets* (Garden City, NY: Doubleday & Co., 1962), pp. 126-27; Kenneth P. Werrell, *The Evolution of the Cruise Missile* (Maxwell Air Force Base: Air University Press, 1987), pp. 40-81.

53. Michael J. Neufeld, "Hitler, the V-2, and the Battle for Priority, 1939-1943," *Journal of Military History* 57 (July 1993): 511-38; Walter Dornberger, *V-2: The Nazi Rocket Weapon* (New York: Viking Press, 1954), p. 97.

to the Redstone Arsenal near Huntsville, Alabama, to concentrate on the development of a new missile for the Army. Meanwhile, in an operation named Project Hermes, the first successful U.S. test firing of the captured V-2s took place at White Sands on April 16, 1946. Between 1946 and 1951, 67 captured V-2s were test-launched on non-orbital flights. The result was a significant expansion of the U.S. knowledge of rocketry.[54]

Although the U.S. Army was using these captured V-2 rockets to learn more about the technology, late in 1945 it offered scientists the opportunity to put experiments on them to study the upper atmosphere. Immediately thereafter the War Department established an Upper Atmosphere Research Panel, and although its name and scope of responsibilities changed periodically during the next several years it continued to coordinate these activities until the birth of NASA in 1958. It prioritized the use of these sounding rockets to study solar and stellar ultraviolet radiation, the aurora, and the nature of the upper atmosphere. As a result, the panel served as the "godfather" of the infant field of space science. Scientific data, while desired, was not the primary purpose of these flights, for Army Ordnance was interested mostly in learning about rocketry to aid in the development of a more advanced generation of weapons.[55]

Throughout the late 1940s and early 1950s rocket technicians conducted ever more demanding test flights and scientists conducted increasingly more complex scientific investigations made possible by the rocket technology. One of the most important series of flights was Project Bumper, which utilized a smaller Army WAC Corporal missile, produced at JPL, as a second stage of a V-2 to obtain data on both high altitudes and the principles of two-stage rockets. The only fully successful launch took place on February 24, 1949, when the V-2/WAC Corporal system reached an altitude of 244 miles and a velocity of 5,150 miles per hour. Much more useful was the Aerobee, a scaled-up version of the WAC Corporal developed by JPL, which could launch at a very economical cost a sizable payload to an altitude of 130 miles. The reliable little booster enjoyed a long career from its first instrumented firing on November 24, 1947, until the January 17, 1985, launch of the 1,037th and last Aerobee. Additionally, the Naval Research Laboratory was involved in sounding rocket research, non-orbital instrument launches, using the Viking launch vehicle built by the Glenn L. Martin Company. Viking 1 was launched from White Sands on May 3, 1949, while the twelfth and last Viking took off on February 4, 1955. The program produced significant scientific information about the upper atmosphere and took impressive high-altitude photographs of Earth. Most important, the Viking pioneered the use of a gimballed engine to control flight and paved the way for later orbiting scientific satellites.[56]

In virtually every instance, rockets developed during the 1950s resulted from the adoption of a basic system built on components that had been tested earlier and mated together into a new booster. For instance, the Scout booster began in 1957 as an attempt by the National Advisory Committee for Aeronautics to build a solid-fuel rocket that could launch a small scientific payload into orbit. To achieve this end, researchers investigated various solid-rocket configurations and finally decided to combine a Jupiter Senior (100,000 pounds of thrust), built by the Aerojet Corporation, with a second stage composed of a Sergeant missile base and two new upper stages descended from the research effort that produced the Vanguard. The Scout's four-stage booster could place a 330-pound satellite into orbit, and it quickly became a workhorse in orbiting small scientific payloads. It was first launched on July 1, 1960, and despite some early deficiencies, by the end of 1968, had

54. This effort has been discussed in James McGovern, *Crossbow and Overcast* (New York: William Morrow, 1964); Clarence G. Lasby, *Project Paperclip: German Scientists and the Cold War* (New York: Athenaeum, 1971); Frederick I. Ordway III and Mitchell R. Sharpe, *The Rocket Team* (New York: Crowell, 1979); Linda Hunt, *Secret Agenda: The United States Government, Nazi Scientists, and Project Paperclip, 1945-1990* (New York: St. Martin's Press, 1991). On the rocketry tests at White Sands see Corliss, *NASA Sounding Rockets*, pp. 11-15; Homer E. Newell, *High Altitude Rocket Research* (New York: Academic Press, 1953); David H. DeVorkin, *Science with a Vengeance: How the Military Created the US Space Sciences After World War II* (New York: Springer-Verlag, 1992).

55. John E. Naugle, *First Among Equals: The Selection of NASA Space Science Experiments* (Washington, DC: NASA SP-4215, 1991), pp. 1-4. The scientific research program for space has been discussed in "History of NASA Space Science," by John E. Naugle in this series.

56. DeVorkin, *Science with a Vengeance*, pp. 167-92.

achieved an 85-percent launch success rate.[57]

The Army also developed the Redstone rocket during this same period, a missile capable of sending a small warhead a maximum of 500 miles. Built under the direction of von Braun and his German rocket team in the early 1950s, the Redstone took many features from the V-2, added an engine from the Navaho test missile, and incorporated some of the electronic components from other rocket test programs. The first Redstone was launched from Cape Canaveral, Florida, on August 20, 1953. An additional 36 Redstone launches took place through 1958. This rocket led to the development of the Jupiter C, an intermediate-range ballistic missile that could deliver a nuclear warhead to a target after a non-orbital flight through space. Its capability for this mission was tested on May 16, 1958, when combat-ready troops first fired the rocket. The missile was placed on active service with U.S. units in Germany the next month, and served until 1963. The Redstone later served as the launch vehicle for the first U.S. suborbital launches of astronauts Alan B. Shepard and Gus Grissom in 1961.[58]

# The Development of Ballistic Missiles

During this same era all the U.S. armed services worked toward the fielding of intercontinental ballistic missiles (ICBMs) that could deliver warheads to targets half a world away. Competition was keen among the services for a mission in the new "high ground" of space, whose military importance was not lost on the leaders of the world. In April 1946 the Army Air Forces gave the Consolidated Vultee Aircraft (Convair) Division a study contract for an ICBM. This led directly to the development of the Atlas ICBM in the 1950s. At first many engineers believed Atlas to be a high-risk proposition. To limit its weight, Convair Corp. engineers under the direction of Karel J. Bossart, a pre-World War II immigrant from Belgium, designed the booster with a very thin, internally pressurized fuselage instead of massive struts and a thick metal skin. The "steel balloon," as it was sometimes called, employed engineering techniques that ran counter to the conservative engineering approach used by Wernher von Braun and his "Rocket Team" at Huntsville, Alabama. Von Braun, according to Bossart, needlessly designed his boosters like "bridges," to withstand any possible shock. For his part, von Braun thought the Atlas was too flimsy to hold up during launch. The reservations began to melt away, however, when Bossart's team pressurized one of the boosters and dared one of von Braun's engineers to knock a hole in it with a sledge hammer. The blow left the booster unharmed, but the recoil from the hammer nearly clubbed the engineer.[59]

The Titan ICBM effort emerged not long thereafter, and proved to be an enormously important ICBM program and later a civil and military space launch asset. To consolidate efforts, Secretary of Defense Charles E. Wilson issued a decision on November 26, 1956, that effectively took the Army out of the ICBM business and assigned responsibility for land-based systems to the Air Force and sea-launched missiles to the Navy. The Navy immediately stepped up work for the development of the submarine-launched Polaris ICBM, which first successfully operated in January 1960.

The Air Force did the same with land-based ICBMs, and its efforts were already well-developed at the time of the 1956 decision. The Atlas received high priority from the White House and hard-driving management from Brigadier General Bernard A. Schriever,

57. Linda Neuman Ezell, *NASA Historical Data Book, Vol II: Programs and Projects, 1958-1968* (Washington, DC: NASA SP-4012, 1988), pp. 61-67; Richard P. Hallion, "The Development of American Launch Vehicles Since 1945," in Paul A. Hanle and Von Del Chamberlain, eds., *Space Science Comes of Age: Perspectives in the History of the Space Sciences* (Washington, DC: Smithsonian Institution Press, 1981), pp. 126-27.

58. Wernher von Braun, "The Redstone, Jupiter, and Juno," in Emme, ed., *History of Rocket Technology*, pp. 107-121.

59. Richard E. Martin, *The Atlas and Centaur "Steel Balloon" Tanks: A Legacy of Karel Bossart* (San Diego: General Dynamics Corp., 1989); Robert L. Perry, "The Atlas, Thor, Titan, and Minuteman," in Emme, ed., *History of Rocket Technology*, pp. 143-55; John L. Sloop, *Liquid Hydrogen as a Propulsion Fuel, 1945-1959* (Washington, DC: NASA SP-4404, 1978), pp. 173-77.

a flamboyant and intense Air Force leader. The first Atlas rocket was test fired on June 11, 1955, and a later generation rocket became operational in 1959. These systems were followed in quick succession by the Titan ICBM and the Thor intermediate-range ballistic missile. By the latter 1950s, therefore, rocket technology had developed sufficiently for the creation of a viable ballistic missile capability. This was a revolutionary development that gave humanity for the first time in its history the ability to attack one continent from another. It effectively shrank the size of the globe, and the United States—which had always before been protected from outside attack by two massive oceans—could no longer rely on natural defensive boundaries or distance from its enemies.[60]

## Space and the American Imagination

The development of the United States' rocketry capability, especially with the work on the ICBMs, signaled for the rest of the world that the United States could project military might anywhere in the world. In addition, this military capability could be used for the peaceful projection of a human presence into space. The dreams of Verne and Wells were combined with the pioneering rocketry work of Goddard and Oberth and later developments in technology to create the probability of a dawning space age. Another ingredient entered into this arena, however—imagination, the intangible quality that prompted humans to want to move beyond the atmosphere. There was an especially significant spaceflight "imagination" that came to the fore after World War II and that urged the implementation of an aggressive spaceflight program. It was seen in science fiction books and film, but more importantly, it was fostered by serious and respected scientists, engineers, and politicians. The popular culture became imbued with the romance of spaceflight, and the practical developments in technology reinforced these perceptions that space travel might actually be, for the first time in human history, possible.[61]

The decade following the war brought a change in perceptions, as most Americans went from skepticism about the probabilities of spaceflight to an acceptance of it as a near-term reality. This can be seen in the public opinion polls of the era. For instance, in December 1949 Gallup pollsters found that only 15 percent of Americans believed humans would reach the Moon within 50 years, while 15 percent had no opinion and a whopping 70 percent believed that it would not happen within that time. In October 1957, at the same time as the launching of Sputnik I, only 25 percent believed that it would take longer than 25 years for humanity to reach the Moon, while 41 percent believed firmly that it would happen within 25 years and 34 percent were not sure. An important shift in perceptions took place during that era, and it was largely the result of well-known advances in rocket technology coupled with a public relations campaign based on the real possibility of spaceflight.[62]

Clearly, one of the most important groups that had been consistently enthralled with the promise of spaceflight were the science fiction aficionados and the futurists, many of whom were one and the same. Many science fiction writers were basically hacks writing for a specialized market, but a few broke the boundaries of the genre in the post-war era and contributed significantly to public perceptions of space travel. Perhaps the three most significant authors in this category were Robert A. Heinlein, Isaac Asimov, and Arthur C. Clarke, all of whom took pains to make their science fiction novels and short stories both believable as reality and exciting as works of literature. They found a ready audience in the

60. This story is told in Edmund Beard, *Developing the ICBM: A Study in Bureaucratic Politics* (New York: Columbia University Press, 1976); Jacob Neufeld, *Ballistic Missiles in the United States Air Force, 1945-1960* (Washington, DC: Office of Air Force History, 1990).

61. This is the thesis of William Sims Bainbridge, *The Spaceflight Revolution: A Sociological Study* (New York: Wiley, 1976). See also Willy Ley and Chesley Bonestell, *The Conquest of Space* (New York: Viking, 1949).

62. George H. Gallup, *The Gallup Poll: Public Opinion, 1935-1971* (New York: Random House, 1972), 1:875, 1152.

environment of the Cold War, as ever-increasing numbers of Americans could both envision and understand the advance of technology and technocracy, and the merger of bureaucratic and technical expertise in government. Asimov, for one, featured robots in his writings, something more and more Americans could understand as machines of all types took over an ever-increasing part of the workload. Both Asimov and Heinlein played out their stories within the context of complex galactic politics, not unlike those perceived by Americans in the world situation.[63]

Asimov and Clarke also bridged the gap between science fiction and science fact in some very fundamental ways. They each wrote both fiction and popular scientific studies relative to spaceflight, physics, and astronomy. They also identified some interesting potential uses for space technology. For example, in February 1945 Clarke described the use of the German V-2 as a launcher for ionospheric research, even as the war was going on. He specifically suggested that by putting a second stage on a V-2 the rocket could generate enough velocity to launch a small satellite into orbit. "Both of these developments demand nothing in the way of technical resources," he wrote, adding that they "should come within the next five or ten years." He later described the possibility of placing three satellites in geosynchronous orbit 120 degrees apart to "give television and microwave coverage to the entire planet."[64] Later that same year Clarke elaborated on the communications implications of satellites and set in motion the ideas that eventually led to the global communications system first put in place during the 1960s.[65]

Another important way in which the U.S. public became aware that flight into space was a possibility revolved around the rise of films depicting space travel that were firmly rooted in scientific reality. One of the keys in this process was the work of film producer-director George Pal, a master of special effects, who made several space-oriented movies in the 1950s.[66] Especially memorable were two films, *The Day the Earth Stood Still* (1950), directed by Robert Wise, in which the benevolent alien Klaatu warns the Earth to shape up and control its aggressiveness by disarming, and *Forbidden Planet* (1956), about the extinct Krell superintelligent society and the Monster from the Id.[67] These films excited the public with ideas of spaceflight, exploration, and contact with alien civilizations. It is often easy to forget that these sophisticated visions of space travel occurred *before* Sputnik.

Even more important than science fiction literature and film were the public writings and speeches of serious and respected scientists, engineers, and politicians who fostered dreams of spaceflight. Among the most important of these was Wernher von Braun, ensconced in his Army rocket center at Huntsville, Alabama. Von Braun, in addition to being a superbly effective technological entrepreneur within the governmental system, by the early 1950s had learned and was applying daily the skills of public relations on behalf of space travel. His background as a serious rocket engineer, a German emigré, a handsome aristocrat, and a charismatic leader all combined to create a positive impression on the U.S. public. When he managed to seize the powerful print and electronic communication media that the science fiction writers and film makers had been using, no one during the 1950s was a more effective promoter of spaceflight to the public than von Braun.[68]

In 1952 von Braun burst on the broad public stage with a series of articles in *Collier's*

63. Sam Moskowitz, "The Growth of Science Fiction from 1900 to the early 1950s," in Frederick I. Ordway III and Randy Lieberman, eds., *Blueprint for Space: Science Fiction to Science Fact* (Washington, DC: Smithsonian Institution Press, 1992), pp. 69-82; Eric Burgess, "Into Space," *Aeronautics*, November 1946, pp. 52-57.

64. Arthur C. Clarke, "V2 for Ionospheric Research?," *Wireless World*, February 1945, p. 58.

65. Arthur C. Clarke, "Extra-Terrestrial Relays: Can Rocket Stations Give World-Wide Radio Coverage?," *Wireless World*, October 1945, pp. 305-308.

66. On Pal's career see, Gail Morgan Hickman, *The Films of George Pal* (South Berwick: A.S. Barnes, 1977); Robert A. Heinlein, "Shooting Destination Moon," *Astounding Science Fiction*, July 1950, p. 6.

67. W.J. Stuart, *Forbidden Planet* (New York: Farrar, Straus & Cudahy, 1956); H. Bates, "Farewell to the Master," *Astounding Science Fiction*, October 1940, p. 58ff.

68. See, as an example of his exceptionally sophisticated spaceflight promoting, Wernher von Braun, *The Mars Project* (Urbana: University of Illinois Press, 1953), based on a German-language series of articles appearing in the magazine *Weltraumfahrt* in 1952.

magazine about the possibilities of spaceflight. The genesis of this series began innocently enough. In 1951 Willy Ley, a former member of the German VfR and himself a skilled promoter of spaceflight, organized a Space Travel Symposium that took place on Columbus Day at the Hayden Planetarium in New York City. Ley wrote to participants that "the time is now ripe to make the public realize that the problem of space travel is to be regarded as a serious branch of science and technology," and he urged them to emphasize that fact in their lectures.[69] By happenstance, two *Collier's* writers attended this meeting. They were most impressed with the ideas presented and suggested to *Collier's* managing editor, Gordon Manning, that his magazine publish several articles promoting the scientific possibility of spaceflight. Recognizing that this idea might have real appeal, Manning asked an assistant editor, Cornelius Ryan, to organize some discussions with Ley and others, among them von Braun. Out of this came a series of important *Collier's* articles over a two-year period, each expertly illustrated with striking images by some of the best illustrators of the era.[70]

The first issue of *Collier's* devoted to space appeared on March 22, 1952. In it readers were asked "What Are We Waiting For?" and were urged to support an aggressive space program. An editorial suggested that spaceflight was possible, not just science fiction, and that it was inevitable that humanity would venture outward. It framed the exploration of space in the context of the Cold War rivalry with the Soviet Union and concluded that "Collier's believes that the time has come for Washington to give priority of attention to the matter of space superiority. The rearmament gap between the East and West has been steadily closing. And nothing, in our opinion, should be left undone that might guarantee the peace of the world. It's as simple as that."[71] [I-13]

Von Braun led off the *Collier's* issue with an impressionistic article describing the overall features of an aggressive spaceflight program. He advocated the orbiting of an artificial satellite to learn more about spaceflight followed by the first orbital flights by humans, development of a reusable spacecraft for travel to and from Earth orbit, the building of a permanently inhabited space station, and finally human exploration of the Moon and planets by spacecraft launched from the space station. [I-14] Willy Ley and several other writers then followed with elaborations on various aspects of spaceflight, ranging from technological viability to space law to biomedicine.[72] The series concluded with a special issue of the magazine devoted to Mars, in which von Braun and others described how to get there and predicted what might be found based on recent scientific data.[73] [I-15, I-16]

The *Collier's* series catapulted von Braun into the public spotlight like none of his previous research activities had been able to do. The magazine was one of the four highest-circulation periodicals in the United States during the early 1950s, with over 3 million copies produced each week. If estimates of readership were indeed four or five people per copy, as the magazine claimed, something on the order of 15 million people were exposed to these spaceflight ideas. *Collier's*, seeing that it had a potential blockbuster, did its part by hyping the series with window ads of the space artwork appearing in the magazine, sending out more than 12,000 press releases, and preparing media kits. It set up interviews on radio and television for von Braun and the other space writers, but especially von Braun, whose natural charisma and enthusiasm for spaceflight translated well through that medium. Von Braun appeared on NBC's "Camel News Caravan" with John Cameron Swayze, on NBC's "Today" show with Dave Garroway, and on CBS's "Gary Moore" program. While *Collier's* was interested in selling magazines with these public appearances, von Braun was

69. Willy Ley to Heinz Haber, *et al.*, June 13, 1951, Hayden Planetarium Library, New York, NY.

70. On these articles see Randy Liebermann, "The *Collier's* and Disney Series," in Ordway and Leibermann, eds., *Blueprint for Space*, pp. 135-44.

71. "What Are We Waiting For?," *Collier's*, March 22, 1952, p. 23.

72. "Man Will Conquer Space *Soon*" series, *Collier's*, March 22, 1952, pp. 23-76ff.

73. Wernher von Braun with Cornelius Ryan, "Can We Get to Mars?," *Collier's*, April 30, 1954, pp. 22-28.

interested in selling the idea of space travel to the public.[74]

Following close on the heels of the *Collier's* series, Walt Disney Productions contacted von Braun—through Willy Ley—and asked his assistance in the production of three shows for Disney's weekly television series. The first of these, "Man in Space," premiered on Disney's show on March 9, 1955, with an estimated audience of 42 million. The second show, "Man and the Moon," also aired in 1955 and sported the powerful image of a wheel-like space station as a launching point for a mission to the Moon. The final show, "Mars and Beyond," premiered on December 4, 1957, after the launching of Sputnik I. Von Braun appeared in all three films to explain his concepts for human spaceflight, while Disney's characteristic animation illustrated the basic principles and ideas with wit and humor.[75]

While some scientists and engineers criticized von Braun for his blatant promotion of both spaceflight and himself, the *Collier's* series of articles and especially the three Disney television programs were exceptionally important in changing public attitudes toward spaceflight. Media observers noted the favorable response to the three Disney shows from the public, and recognized that "the thinking of the best scientific minds working on space projects today" went into them, "making the picture[s] more fact than fantasy."[76]

Although an overstatement, some have suggested that the airing of the first Disney space film on March 9, 1955, contributed to President Dwight D. Eisenhower's July 1955 decision to embrace the launching of a scientific satellite as part of the U.S.'s contribution to research during the International Geophysical Year (IGY) in 1957-1958. [I-17] When Disney studio executives wanted to emphasize this possibility, however, von Braun told them, "For God's sake don't put it that this show triggered the presidential announcement." He was apparently concerned that Eisenhower might be embarrassed at the suggestion that a media event influenced his support for the IGY satellite.[77] Regardless of the impetus for Eisenhower's decision, von Braun and the Disney series helped shape the public's perception of spaceflight as something that was no longer fantasy.

Closely tied to the growing public perception of spaceflight as a possibility in the 1950s was the postwar Unidentified Flying Object (UFO) craze that took place in the United States. Between 1947 and 1960 a total of 6,523 UFO sightings were reported in the United States. Many people considered them to be of extraterrestrial origin. The reports slowly began to increase, with 79 reported in 1947, and remained stable until 1951, when 1,501 were recorded. There seems to be a direct tie between public perception of the reality of space travel and these UFO sightings, especially when considering that 701 of the 1957 reports came after the launch of Sputnik I on October 4.[78]

The U.S. Air Force considered the UFO phenomenon significant enough to begin in December 1947 a project to investigate occurrences, especially with a view to learn if "some foreign nation had a form of propulsion possibly nuclear, which is outside our domestic knowledge."[79] Although the researchers recognized the possibility that the UFOs might be extraterrestrial, few thought it was probable and emphasized explanations of the phenomena that were more earthly. For instance, the Scientific Advisory Panel of the Central Intel-

74. Liebermann, "The *Collier's* and Disney Series," in Ordway and Liebermann, *Blueprint for Space*, p. 141; Ron Miller, "Days of Future Past," *Omni*, October 1986, pp. 76-81.

75. Liebermann, "The *Collier's* and Disney Series," in Ordway and Liebermann, *Blueprint for Space*, pp. 144-46; David R. Smith, "They're Following Our Script: Walt Disney's Trip to Tomorrowland," *Future*, May 1978, pp. 59-60; Mike Wright, "The Disney-Von Braun Collaboration and Its Influence on Space Exploration," paper presented at conference, "Inner Space, Outer Space: Humanities, Technology, and the Postmodern World," February 12-14, 1993; Willy Ley, *Rockets, Missiles, and Space Travel* (New York: The Viking Press, 1961 ed.), p. 331.

76. *TV Guide*, March 5, 1955, p. 9.

77. Wernher Von Braun to Ward Kimball, August 30, 1955, quoted in Smith, "They're Following Our Script," p. 59. This episode has been discussed in Rip Bulkeley, *The Sputniks Crisis and Early United States Space Policy* (Bloomington: Indiana University Press, 1991), pp. 128-29.

78. Lawrence J. Tacker, *Flying Saucers and the U.S. Air Force* (Princeton: D. van Nostrand Co., 1960), p. 82.

79. Lt. Gen. Nathan F. Twining, Commander Air Material Command, to Commanding General, Army Air Forces, "Flying Discs," September 23, 1947, reprinted in Edward U. Condon, *Final Report of the Scientific Study of Unidentified Flying Objects* (New York: Bantam Books, 1969), p. 895. The letter setting up the study is Maj. Gen. L.C. Craigie to Commanding General, Wright Field, "Flying Discs," December 30, 1947, in Condon, *Final Report*, pp. 896-97.

ligence Agency considered in January 1953 the UFO issue in the United States. [I-18] After a lengthy discussion, members of the panel "concluded that reasonable explanations could be suggested for most sightings." Moreover, concerning one of the central questions this body had about UFOs, it "concluded unanimously that there was no evidence of a direct threat to national security in the objects sighted."[80]

A report released by the Air Force in 1957 reached similar conclusions. It said:

> *first, there is no evidence that the "unknowns" were inimical or hostile; second, there is no evidence that these "unknowns" were interplanetary space ships; third, there is no evidence that these unknowns represented technological developments or principles outside the range of our present day scientific knowledge; fourth, there is no evidence that these "unknowns" were a threat to the security of the country; and finally there was no physical evidence or material evidence, not even a minute fragment, of a so-called "flying saucer" was ever found.*[81]

Even with these studies, however, a fair percentage of Americans still believed that UFOs were probably of extraterrestrial origin.

Explanations of why several thousand people saw something they could not identify and thought was an extraterrestrial spacecraft have ranged far and wide. Humanity has long been intensely interested in supernatural occurrences. The ancient Greeks had their gods who came down from Mount Olympus; people of the Medieval era saw appearances of angels, the Virgin, and devils, as well as fairies and elves. UFO sightings in the 1940s and 1950s—none of which apparently produced any physical evidence—are essentially in the same category.

Humans have always been fascinated and terrified of the unknown. While some feared the stars and planets, others studied them. While some spoke of "the harmony of the spheres," others warned that comets and other stellar phenomena foretold of humanity's destruction. Reports of encounters with extraterrestrials were a response to the duality of fascination and terror of humanity over contact with alien species. Some of the reports were in part a Cold War phenomenon, as Americans longed for the help of a benevolent, wise, and powerful alien race who could chaperon humanity through the possibility of nuclear holocaust *à la* Klaatu from *The Day the Earth Stood Still.* Some reported incidents were negative, harkening back to the terror expressed in Wells' *War of the Worlds.* Some reports reflected American perception of the technological possibilities of space travel. Moreover, if the Earth was on the verge of a space age, what about more advanced civilizations on other worlds? Might they someday journey to Earth? To some the UFOs spoke to the nightmares of humanity. But to others they spoke to some of the sublime dreams of humanity, and they were therefore significant at the time because of what they signaled about public perceptions of what was possible in the emergent space age.[82]

## Conclusion

The combination of technological and scientific advance, political competition with the Soviet Union, and changes in popular opinion about spaceflight came together in a very specific way in the 1950s to affect public policy in favor of an aggressive space program. This found tangible expression in 1952 when the International Council of Scientific

80. "Report of Meetings of Scientific Advisory Panel on Unidentified Flying Objects Convened by Office of Scientific Intelligence, CIA, January 14-18, 1953," copy in "NACA-UFO, 1948-1958," folder, NASA Historical Reference Collection.

81. "Air Force's 10 Year Study of Unidentified Flying Objects," Department of Defense, Office of Public Information, News Release No. 1083-58, November 5, 1957, copy in "NACA-UFO, 1948-1958," folder, NASA Historical Reference Collection.

82. Carl Sagan, *Broca's Brain: Reflections on the Romance of Science* (New York: Ballantine Books, 1974), pp. 65-70; Philip Klass, *UFOs Explained* (New York: Random House, 1974); Carl Sagan and Thornton Page, eds., *UFOs: A Scientific Debate* (New York: W.W. Norton and Co., 1973).

Unions (ICSU) started planning for an International Polar Year, the third in a series of scientific activities designed to study geophysical phenomena in remote reaches of the planet. The Council agreed that July 1, 1957, to December 31, 1958, would be the period of emphasis in polar research, in part because of a predicted expansion of solar activity; the previous polar years had taken place in 1882-1883 and 1932-1933. Late in 1952 the ICSU expanded the scope of the scientific research effort to include studies that would be conducted using rockets with instrument packages in the upper atmosphere and changed the name to the International Geophysical Year (IGY) to reflect the larger scientific objectives. In October 1954 at a meeting in Rome, Italy, the Council adopted another resolution calling for the launch of artificial satellites during the IGY to help map the Earth's surface. The Soviet Union immediately announced plans to orbit an IGY satellite, virtually assuring that the United States would respond, and this, coupled with the military satellite program, set both the agenda and the stage for most space efforts through 1958. The next year the United States announced Project Vanguard, its own IGY scientific satellite program.[83]

By the end of 1956, less than a year before the launch of Sputnik, the United States was involved in two modest space programs that were moving ahead slowly and staying within strict budgetary constraints. One was a highly visible scientific program as part of the IGY, and the other was a highly classified program to orbit a military reconnaissance satellite. They shared two attributes. They each were separate from the ballistic missile program underway in the Department of Defense, but they shared in the fruits of its research and adapted some of its launch vehicles. They also were oriented toward satisfying a national goal of establishing "freedom of space" for all orbiting satellites. The IGY scientific effort could help establish the precedent of access to space, while a military satellite might excite other nations to press for limiting such access. Because of this goal a military satellite, in which the Eisenhower Administration was most interested, could not under any circumstances precede scientific satellites into orbit. The IGY satellite program, therefore, was a means of securing the larger goal of open access to space. Before it could do so, on October 4, 1957, the Soviet Union launched Sputnik I and began the space age in a way that had not been anticipated by the leaders of the United States.

83. A good account of the IGY satellite projects can be found in Bulkeley, *Sputniks Crisis and Early United States Space Policy*, pp. 89-122.

## Documents I-1 and I-2

**Document title: Medieval universe at the time of Dante, as presented in *The Divine Comedy*, from Edward R. Harrison, *Cosmology: The Science of the Universe* (Cambridge: Cambridge University Press, 1981), p. 77.**

**Document title: The infinite universe of Thomas Digges, from Edward R. Harrison, *Cosmology: The Science of the Universe* (Cambridge: Cambridge University Press, 1981), p. 79.**

**Source: Reprinted with the permission of Cambridge University Press.**

The ancient conception of the universe as Christianized by Thomas Aquinas in the thirteenth century was carried to its logical conclusion by Dante in his classic work, *The Divine Comedy*. In this representation, I-1, hell became a nether-region inside the Earth's crust, purgatory was the sunlunar region, and the ethereal regions were found to be ideal for the residence of hierarchies of angelic beings. The astronomer and mathematician Thomas Digges modified Dante's medieval conceptions of the universe in his *Description of the Caelestiall Orbes* (1576), I-2, by adopting a Copernican view that placed the Sun in the center of the universe and by eliminating the outermost of the crystalline orbs and dispersing stars throughout an infinite universe beyond.

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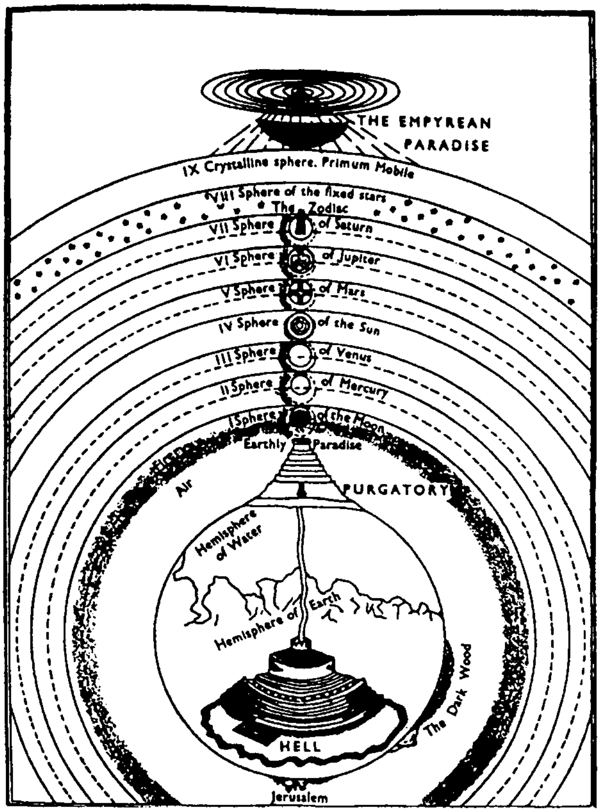
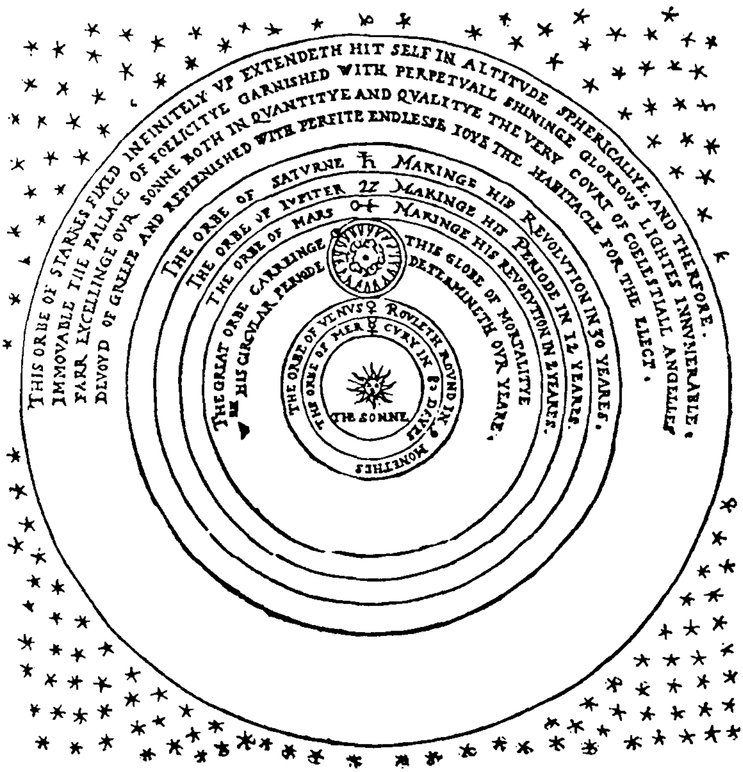
## Document I-1



## Document I-2




## Document I-3

**Document title: Edward E. Hale, "The Brick Moon," *The Atlantic Monthly*, October 1869, pp. 451-60, November 1869, pp. 603-11, December 1869, pp. 679-88, February 1870, pp. 215-22. Also published in *His Level Best, and Other Stories* (Boston: James R. Osgood & Co., 1873) pp. 30-124.**

Edward Everett Hale was an author and clergyman who was best known for his 1863 short story "The Man Without a Country" (about a member of the Burr Conspiracy being exiled from the United States) He was widely regarded as one of the foremost literary figures of his time and was the primary speaker at Gettysburg in 1863 when Lincoln gave his famous address.

According to Hale, the idea for "The Brick Moon" was inspired by Richard Adams Locke's *Moon Hoax.* Hale further stated that while attending Cambridge University in 1838, the idea came from "an old chart, dreams and plans of college days" and was written while working in a room of his brother's, a professor, at Union College, Schenectady, New York, in 1869. The story was serialized in October, November, and December 1869 in *The Atlantic Monthly,* and a short sequel, "Life in the Brick Moon," appeared in the same magazine in February 1870.

Despite claims by both the Germans and Russians that Oberth and Tsiolkovskiy were the first to discuss Earth satellites, Hale's story is the first account of an artificial Earth satellite. In addition to being the first to mention the concept, Hale also outlined several uses for such an object, navigation being the most important in his view.

# The Brick Moon

FROM THE PAPERS OF CAPTAIN FREDERIC INGHAM

## I.—PREPARATION.

[451] I have no sort of objection now to telling the whole story. The subscribers, of course, have a right to know what became of their money. The astronomers may as well know all about it, before they announce any more asteroids with an enormous movement in declination. And experimenters on the longitude may as well know, so that they may act advisedly in attempting another brick moon or in refusing to do so.

It all began more than thirty years ago, when we were in college; as most good things begin. We were studying in the book which has gray sides and a green back, and is called "Cambridge Astronomy" because it is translated from the French. We came across this business of the longitude, and, as we talked, in the gloom and glamour of the old South Middle dining-hall, we had going the usual number of students' stories about rewards offered by the Board of Longitude for discoveries in that matter,—stories, all of which, so far as I know, are lies. Like all boys, we had tried our hands at perpetual motion. For me, I was sure I could square the circle, if they would give me chalk enough. But as to this business of the longitude, it was reserved for Q, to make the happy hit and to explain it to the rest of us.

I wonder if I can explain it to an unlearned world, which has not studies the book with gray sides and a green cambric back. Let us try.

You know then, dear world that when you look at the North Star, it always appears to you at just the same height above the horizon or what is between you and the horizon: say the Dwight School-house, or the houses in Concord Street; or to me, just now, North College. You know also that, if you were to travel to the North Pole, the North Star would be just over your head. And, if you were to travel to the equator, it would be just on your horizon, if you could see it at all through the red, dusty, hazy mist in the north,—as you could not. If you were just half-way between pole and equator, on the line [452] between us and Canada, the North Star would be half-way up, or 45° from the horizon. So you would know there that you were 45° from the equator. There in Boston, you would find it was 42°20' from the horizon. So you know there that you are 42°20' from the equator. At Seattle again you would find it was 47°40' high, so our friends at Seattle know that they are at 47°40' from the equator. The latitude of a place, in other words, is found very easily by any observation which shows how high the North Star is; if you do not want to measure the North Star, you may take any star when it is just to north of you, and measure its height; wait twelve hours, and if you can find it, measure its height again. Split the difference, and that is the altitude of the pole, or the latitude of you, the observer.

"Of course we know this," says the graduating world. "Do you suppose that is what we borrow your book for, to have you spell out your miserable elementary astronomy?" At which rebuff I should shrink distressed, but that a chorus of voices an octave higher comes up with, "Dear Mr. Ingham, we are ever so much obliged to you; we did not know it at all before, and you make it perfectly clear."

Thank you, my dear, and you, and you. We will not care what the others say. If you do understand it, or do know it, it is more than Mr. Charles Reade knew, or he would not have made his two lovers on the island guess at their latitude, as they did. If they had either of them been educated at a respectable academy for the Middle Classes, they would have fared better.

Now about the longitude.

The latitude, which you have found, measures your distance north or south from the equator or the pole. To find your longitude, you want to find your distance east or west from the meridian of Greenwich. Now if any one would build a good tall tower at Greenwich, straight into the sky,—say a hundred miles into the sky,—of course if you and I were east or west of it, and could see it, we could tell how far east or west we were by measuring the apparent height of the tower above our horizon. If we could see so far, when the lantern with a Drummond's light, "ever so bright," on they very top of the tower, appeared to be on our horizon, we should know we were eight hundred and seventy-three miles away from it. The top of the tower would answer for us as the North Star does when we are measuring the latitude. If we were nearer, our horizon would make a longer angle with the line from the top to our place of vision. If we were farther away, we should need a higher tower.

But nobody will build any such tower at Greenwich, or elsewhere on that meridian, or on any meridian. You see that to be of use to the half the world nearest to it, it would have to be so high that the diameter of the world would seem nothing in proportion. And then, for the other half of the world you would have to erect another tower as high on the other side. It was this difficulty that made Q. suggest the expedient of the Brick Moon.

For you see that if, by good luck, there were a ring like Saturn's which stretched round the world, above greenwich and the meridian of Greenwich, and if it would stay above Greenwich, turning with the world, any one who wanted to measure his longitude or distance from Greenwich would look out of window and see how high this ring was above his horizon. At Greenwich it would be over his head exactly. At New Orleans, which is quarter round the world from Greenwich, it would be just in his horizon. A little west of New Orleans you would begin to look for the other half of the ring on the west instead of the east; and if you went a little west of the Feejee Islands the ring would be over your head again. So if we only had a ring like that, not round the equator of the world,—as Saturn's ring is around Saturn,—but vertical to the plane of the equator, as the brass ring of an artificial globe goes, only far higher in proportion,— [453] "from that ring," said Q., pensively, "we could calculate the longitude."

Failing that, after various propositions, he suggested the Brick Moon. The plan was this: If from the surface of the earth, by a gigantic pea-shooter, you could shoot a pea upward from Greenwich, aimed northward as well as upward; if you drove it so fast and far that when its power of ascent was exhausted, and it began to fall, it should clear the earth, and pass outside the North Pole; if you had given it sufficient power to get it half round the earth without touching, that pea would clear the earth forever. It would continue to rotate above the North Pole, above the Feejee Island place, above the South Pole and Greenwich, forever, with the impulse with which it had first cleared our atmosphere and attraction. If only we could see that pea as it revolved in that convenient orbit, then we could measure the longitude from that, as soon as we knew how high the orbit was, as well as if it were the ring of Saturn.

"But a pea is so small!"

"Yes," said Q., "but we must make a large pea." Then we fell to work on plans for making the pea very large and very light. Large,—that it might be seen far away by storm-tossed navigators: light,—that it might be the easier blown four thousand and odd miles into the air; lest it should fall on the heads of the Greenlanders or the Patagonians; lest they should be injured and the world lose its new moon. But, of course, all this lath-and-plaster had to be given up. For the motion through the air would set fire to this moon just as it does to other aerolites, and all your lath-and-plaster would gather into a few white drops, which no Rosse telescope even could discern. "No," said Q. bravely, "at the least it must be very substantial. It must stand fire well, very well. Iron will not answer. It must be brick; we must have Brick Moon.

Then we had to calculate its size. You can see, on the old moon, an edifice two hundred feet long with any of the fine refractors of our day. But no such refractors as those can be carried by the poor little fishermen whom we wanted to befriend, the bones of whose ships lie white on so many cliffs, their names unreported at any Lloyd's or by any Ross,—themselves the owners and their sons the crew. On the other hand, we did not want our moon two hundred and fifty thousand miles away, as the old moon is, which I will call the Thornbush moon, for distinction. We did not care how near it was, indeed, if it were only far enough away to be seen, in practice, from almost the whole world. There must be a little strip where they could not see it from the surface, unless we threw it infinitely high. "But they need not look from the surface," said Q.; "they might climb to the mast-head. And if they did not see it at all, they would know that they were ninety degrees from the meridian."

This difficulty about what we call "the strip," however, led to an improvement in the plan, which made it better in every way. It was clear that even if "the strip" were quite wide, the moon would have to be a good way off, and, in proportion, hard to see. If, however, we would satisfy ourselves with a moon four thousand miles away, *that* could be seen on the earth's surface for three or four thousand miles on each side; and twice three thousand, or six thousand, is one fourth of the largest circumference of the earth. We did not dare have it nearer than four thousand miles, since even at that distance, it would be eclipsed three hours out of every night; and we wanted it bright and distinct, and not of that lurid, copper, eclipse color. But at four thousand miles' distance the moon could be seen by a belt of observers six or eight thousand miles in diameter. "Start, then, two moon,"—this was my contribution to the plan. "Suppose one over the meridian or Greenwich, and the other over that of New Orleans. Take care that there is a little difference in the radii of their orbits, lest they 'collide' some foul day. Then, in most places, one or other, perhaps [454] two will come in sight. So much the less risk of clouds: and everywhere there may be one, except when it is cloudy. Neither need be more than four thousand miles off; so much the larger and more beautiful will they be. If on the old Thornbush moon old Herschel with his reflector could see a town-house two hundred feet long, on the Brick Moon young Herschel will be able to see a dab of mortar a foot and half long, if he wants to. And people without the reflector, with their opera-glasses, will be able to see sufficiently well." And to this they agreed: that eventually there must be two Brick Moons. Indeed, it were better that there should be four, as each must be below the horizon half the time. That is only as many as Jupiter has. But it was also agreed that we might begin with one.

Why we settled on two hundred feet of diameter I hardly know. I think it was from the statement of dear John Farrar's about the impossibility of there being a state house two hundred feet long not yet discovered, on the sunny side of old Thornbush. That, somehow, made two hundred our fixed point. Besides, a moon of two hundred feet diameter did not seem quite unmanageable. Yet it was evident that a smaller moon would be of no use, unless we meant to have them near the world, when there would be so many that they would be confusing, and eclipsed most of the time. And four thousand miles is a good way off to see a moon even two hundred feet in diameter.

Small though we made them on paper, these two-hundred-foot moons were still too much for us. Of course we meant to build them hollow. But even if hollow there must be some thickness, and the quantity of brick would at best be enormous. Then, to get them up! The pea-shooter, of course, was only an illustration. It was long after that time that Rodman and other guns sent iron balls five or six miles in distance,—say two miles, more or less, in height.

Iron is much heavier than hollow brick, but you can build no gun with a bore of two hundred feet now,—far less could you then. No. Q. again suggested the method of shooting off the moon. It was not to be by any of your sudden explosions. It was to be done as all great things are done,—by the gradual and silent accumulation of power. You all know that a fly-wheel—heavy, very heavy on the circumference, light, very light within it—was made to save up power, from the time when it was produced to the time when it was wanted. Yes? Then, before we began even to build the moon, before we even began to make the brick, we would build two gigantic fly-wheels, the diameter of each should be "ever so great," the circumference heavy beyond all precedent, and thundering strong, so that no temptation might burst it. They should revolve, their edges nearly touching, in opposite directions, for years, if it were necessary, to accumulate power, driven by some waterfall now wasted to the world. One should be a little heavier than the other. When the Brick Moon was finished, and all was ready, it should be gently rolled down a gigantic groove provided for it, till it lighted on the edge of both wheels at the same instant. Of course it would not rest there, not the ten-thousandth part of a second. It would be snapped upward, as a drop of water from a grindstone. Upward and upward; but the heavier wheel would have deflected it a little from the vertical. Upward and northward it would rise, therefore, till it had passed the axis of the world. It would, of course, feel the world's attraction all the time, which would bend its flight gently, but still it would leave the world more and more behind. Upward still, but now southward, till it had traversed more than one hundred and eighty degrees of a circle. Little resistance, indeed, after it had cleared the forty or fifty miles of visible atmosphere. "Now let it fall," said Q., inspired with the vision. "Let it fall, and the sooner the better! The curve it is now on will forever clear the world; [455] and over the meridian of that lonely waterfall,—if only we have rightly adjusted the gigantic flies,—will forever revolve, in its obedient orbit, the Brick Moon, the blessing of all seamen,—as constant in all change as its older sister has been fickle, and the second cynosure of all lovers upon the waves, and of all girls left behind them." "Amen," we cried, and then we sat in silence till the clock struck ten; then shook each other gravely by the hand, and left the South Middle dining-hall.

Of waterfalls there were plenty that we knew.

Fly-wheels could be built of oak and pine, and hooped with iron. Fly-wheels did not discourage us.

But brick? One brick is, say, sixty-four cubic inches only. This moon,—though we made it hollow,—see,—it must take twelve million brick.

The brick alone will cost sixty thousand dollars!

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The brick alone would cost sixty thousand dollars. There the scheme of the Brick Moon hung, an airy vision, for seventeen years,—the years that changed us from young men into men. The brick alone, sixty thousand dollars! For, to boys who have still left a few of their college bills unpaid, who cannot think of buying that lovely little Elzevir which Smith has for sale at auction, of which Smith does not dream of the value, sixty thousand dollars seems as intangible as sixty million sestertia. Clarke, second, how much are sixty million sestertia stated in cowries? How much in currency, gold being at 1.37 $^{1}/_{4}$? Right; go up. Stop, I forget myself!

So, to resume, the project of the Brick Moon hung in the ideal, an airy vision, a vision as lovely and as distant as the Brick Moon itself, at this calm moment of midnight when I write, as it poises itself over the shoulder of Orion, in my southern horizon. Stop! I anticipate. Let me keep—as we say in Beadle's Dime Series—to the even current of my story.

Seventeen years passed by, we were no longer boys, though we felt so. For myself, to this hour, I never enter board meeting, committee meeting, or synod, without the queer question, what would happen should any one discover that this bearded man was only a big boy disguised? that the frock-coat and the round hat are none of mine, and that, if I should be spurned from the assembly as an interloper, a judicious public, learning all the facts, would give a verdict, "Served him right." This consideration helps me through many bored meetings which would be else so dismal. What did my old copy say? "Boards are made of wood, they are long and narrow." But we do not get on!

Seventeen years after, I say, or should have said, dear Orcutt entered my room at Haguadavick again. I had not seen him since the Commencement day when we parted at Cambridge. He looked the same, and yet not the same. His smile was the same, his voice, his tender look of sympathy when I spoke to him of a great sorrow, his childlike love of fun. His waistband was different, his pantaloons were different, his smooth chin was buried in a full beard, and he weighed two hundred pounds if he weighed a gramme. O, the good time we had, so like the times of old! Those were happy days for me in Naguadavick. At that moment my double was at work for me at a meeting of the publishing committee of the Sandemanian Review, so I called Orcutt up to my own snuggery, and we talked over old times; talked till tea was ready. Polly came up through the orchard and made tea for us herself there. We talked on and on, till nine, ten at night, and then it was that dear Orcutt asked me if I remembered the Brick Moon. Remember it? of course I did. And without leaving my chair I opened the drawer of my writing-desk, and handed him a portfolio full of working-drawings on which I had engaged myself for my "third"[1] all that winter.

[456] Orcutt was delighted. He turned them over hastily but intelligently, and said: "I am so glad. I could not think you had forgotten. And I have seen Brannan, and Brannan has not forgotten." "Now do you know," said he, "In all this railroading of mine, I have not forgotten. I have learned many things that will help. When I built the great tunnel for the Cattawissa and Opelousas, by which we got rid of the old inclined planes, there was never a stone bigger than a peach-stone within two hundred miles of us. I baked the brick of that tunnel on the line with my own kilns. Ingham, I have made more brick, I believe, than any man living in the world!"

"You are the providential man," said I.

"Am I not, Fred? More than that," said he; "I have succeeded in things the world counts worth more than brick. I have made brick, and I have made money!"

"One of us make money?" asked I, amazed.

"Even so," said dear Orcutt; "one of us has made money." And he proceeded to tell me how. It was not in building tunnels, nor in making brick. No! It was by buying up the original stock of the Cattawissa and Opelousas, at a moment when that stock had hardly a nominal price in the market. There were the first mortgage bonds, and the second mortgage bonds, and the third, and I know not how much floating debt; and, worse than all, the reputation of the road lost, and deservedly lost. Every locomotive it had was asthmatic. Every car it had bore the marks of unprecedented accidents, for which no one was to blame. Rival lines, I know not how many, were cutting each other's throats for its legitimate business. At this juncture, dear George invested all his earnings as a contractor, in the despised original stock,—he actually bought it for 3 ¼ per cent,—good shares that had cost a round hundred to every wretch who had subscribed. Six thousand eight hundred dollars—every cent he had—did George thus invest. Then he went himself to the trustees of the first mortgage, to the trustees of the second, and to the trustees of the third, and told them what he had done.

Now it is personal presence that moves the world. Dear Orcutt has found that out since, if he did not know it before. The trustees who would have sniffed had George written to them, turned round from their desks, and begged him to take a chair, when he came to talk with them. Had he put every penny he was worth into that stock? Then it was worth something which they did not know of, for George Orcutt was no fool about railroads. The man who bridged the Lower Rapidan when a freshet was running was no fool.

"What were his plans?"

George did not tell—no, not to lordly trustees—what his plans were. He had plans, but he kept them to himself. All he told them was that he had plans. On those plans he had staked his all. Now would they or would they not agree to put him in charge of the running of that road, for twelve months, on a nominal salary. The superintendent they had was a rascal. He had proved that by running away. They knew that George was not a rascal. He knew that he could make this road pay expenses, pay bond-holders, and pay a dividend,—a thing no one else had dreamed of for twenty years. Could they do better than try him?

Of course they could not, and they knew they could not. Of course, they sniffed and talked, and waited, and pretended they did not know, and that they must consult, and so forth and so on. But of course they all did try him, on his own terms. He was put in charge of the running of that road.

In one week he showed he should redeem it. In three months he did redeem it!

He advertised boldly the first day: *"Infant children at treble price."*

The novelty attracted instant remark. And it showed many things. First, it showed he was a humane man, who wished to save human life. He would [457] leave these innocents in their cradles, where they belonged.

Second, and chiefly, the world of travellers saw that the Crichton, the Amadis, the

1. "Every man," says Dr. Peabody, "should have a vocation and an avocation." To which I add, "A third."

perfect chevalier of the future, had arisen,—a railroad manager caring for the comfort of his passengers!

The first week the number of the C. and O.'s passengers was doubled: in a week or two more freight began to come in, in driblets, on the line which its owners had gone over. As soon as the shops could turn them out, some cars were put on, with arms on which travellers could rest their elbows, with headrests where they could take naps if they were weary. These excited so much curiosity that one was exhibited in the museum at Cattawissa and another at Opelousas. It may not be generally known that the received car of the American roads was devised to secure a premium offered by the Pawtucket and Podunk Company. Their receipts were growing so large that they feared they should forfeit their charter. They advertised, therefore, for a car in which no man could sleep at night or rest by day,—in which the backs should be straight, the heads of passengers unsupported, the feet entangled in the vice, the elbows always knocked by the passing conductor. The pattern was produced which immediately came into use on all the American roads. But on the Cattawissa and Opelousas this time-honored pattern was set aside.

Of course you see the result. Men went hundreds of miles out of their way to ride on the C. and O. The third mortgage was paid off; a reserve fund was piled up for the second; the trustees of the first lived in dread of being paid; and George's stock, which he bought at 3 $^1/_4$, rose to 147 before two years had gone by! So was it that, as we sat together in the snuggery, George was worth wellnigh three hundred thousand dollars. Some of his eggs were in the basket where they were laid; some he had taken out and placed in other baskets; some in nests where various hens were brooding over them. Sound eggs they were, wherever placed; and such was the victory of which George had come to tell.

One of us had made money!

On his way he had seen Brannan. Brannan, the pure-minded, right-minded, shifty man of tact, man of brain, man of heart, and man of word, who held New Altona in the hollow of his hand. Brannan had made no money. Not he, nor ever will. But Brannan could do much what he pleased in this world, without money. For whenever Brannan studied the rights and the wrongs of any enterprise, all men knew that what Brannan decided about it was wellnigh the eternal truth; and therefore all men of sense were accustomed to place great confidence in his prophecies. But, more than this, and better, Brannan was an unconscious dog, who believed in the people. So, when he knew what was the right and what was the wrong, he could stand up before two or three thousand people and tell them what was right and what was wrong, and tell them with the same simplicity and freshness with which he would talk to little Horace on his knee. Of the thousands who heard him there would not be one in a hundred who knew that this was eloquence. They were fain to say, as they sat in their shops, talking, that Brannan was not eloquent. Nay, they went so far as to regret that Brannan was not eloquent! If he were only as eloquent as Carker was or as Barker was, how excellent he would be! But when a month after, it was necessary for them to do anything about the thing he had been speaking of, they did what Brannan had told them to do; forgetting, most likely, that he had ever told them, and fancying that these were their own ideas, which, in fact, had, from his liquid, ponderous, transparent, and invisible common sense, distilled unconsciously into their being. I wonder whether Brannan ever knew that he was eloquent. What I knew, and what dear George knew, was, that he was one of the leaders of men!

Courage, my friends, we are steadily advancing to the Brick Moon!

[458] For George had stopped, and seen Brannan; and Brannan had not forgotten. Seventeen years Brannan had remembered, and not a ship had been lost on a lee-shore because her longitude was wrong,—not a baby had wailed its last as it was ground between wrecked spar and cruel rock,—not a swollen corpse unknown had been flung up upon the sand and been buried with a nameless epitaph,—but Brannan had recollected the Brick Moon, and had, in the memory-chamber which rejected nothing, stored away the story of the horror. And now, George was ready to consecrate a round hundred thousand to the building of the Moon; and Brannan was ready, in the thousand ways in which wise men move the people to and fro, to persuade them to give to us a hundred thousand more; and

George had come to ask me if I were not ready to undertake with them the final great effort, of which our old calculations were the embryo. For this I was now to contribute the mathematical certainty and the lore borrowed from naval science, which should blossom and bear fruit when the Brick Moon was snapped like a cherry from the ways on which it was built, was launched into the air by power gathered from a thousand freshets, and, poised at last in its own pre-calculated region of the ether, should begin its course of eternal blessings in one unchanging meridian!

Vision of Beneficence and Wonder! Of course I consented.

O that you were not so eager for the end! O that I might tell you, what now you will never know,—of the great campaign which we then and there inaugurated! How the horrible loss of the Royal Martyr, whose longitude was three degrees awry, startled the whole world, and gave us a point to start from. How I explained to George that he must not subscribe the one hundred thousand dollars in a moment. It must come in bits, when "the cause" needed a stimulus, or the public needed encouragement. How we caught neophyte editors, and explained to them enough to make them think the Moon was wellnigh their own invention and their own thunder. How, beginning in Boston, we sent round to all the men of science, all those of philanthropy, and all those of commerce, three thousand circulars, inviting them to a private meeting at George's parlors at the Revere. How, besides ourselves, and some nice, respectable-looking old gentlemen Brannan had brought over from Podunk with him, paying their fares both ways, there were present only three men,—all adventurers whose projects had failed,—besides the representatives of the press. How, of these representatives, some understood the whole, and some understood nothing. How, the next day, all gave us "first-rate notices." How, a few days after, in the lower Horticultural Hall, we had our first public meeting. How Haliburton brought us fifty people who loved him,—his Bible class, most of them,—to help fill up; how, besides these there were not three persons whom we had not asked personally, or one who could invent an excuse to stay away. How we had hung the walls with intelligible and unintelligible diagrams. How I opened the meeting. Of that meeting, indeed, I must tell something.

First, I spoke. I did not pretend to unfold the scheme. I did not attempt any rhetoric. But I did not make any apologies. I told them simply of the dangers of lee-shores. I told them where they were most dangerous,—when seamen came upon them unawares. I explained to them that, though the costly chronometer, frequently adjusted, made a delusive guide to the voyager who often made a harbor, still the adjustment was treacherous, the instrument beyond the use of the poor, and that, once astray, its error increased forever. I said that we believed we had a method which, if the means were supplied for the experiment, would give the humblest fisherman the very certainty of sunrise and of sunset in his calculations of his place upon the world. And I said that whenever a man knew his place in this world it [459] was always likely all would go well. Then I sat down.

Then dear George spoke,—simply, but very briefly. He said he was a stranger to the Boston people, and that those who knew him at all knew he was not a talking man. He was a civil engineer, and his business was to calculate and to build, and not to talk. But he had come here to say that he had studied this new plan for the longitude from the Top to the Bottom, and that he believed in it through and through. There was his opinion, if that was worth anything to anybody. If that meeting resolved to go forward with the enterprise, or if anybody proposed to, he should offer his services in any capacity, and without any pay, for its success. If he might only work as a bricklayer, he would work as a bricklayer. For he believed, on his soul, that the success of this enterprise promised more for mankind than any enterprise which was ever likely to call for the devotion of his life. "And to the good of mankind," he said, very simply, "my life is devoted." Then he sat down.

Then Brannan got up. Up to this time, excepting that George had dropped this hint about bricklaying, nobody had said a word about the Moon, far less hinted what it was to be made of. So Ben had the whole to open. He did it as if he had been talking to a bright boy of ten years old. He made those people think that he respected them as his equals. But, in fact, he chose every word, as if not one of them knew anything. He explained, as if it were rather more simple to explain than to take for granted. But he explained as if, were they talking, they might be explaining to him. He led them from point to point,—oh! so much more clearly than I have been leading you,—till, as their mouths dropped a little open in their eager interest, and their lids forgot to wink in their gaze upon his face, and so their eyebrows seemed a little lifted in curiosity,—till, I say, each man felt as if he were himself the inventor, who had bridged difficulty after difficulty; as if, indeed, the whole were too simple to be called difficult or complicated. The only wonder was that the Board of Longitude, or the Emperor Napoleon, or the Smithsonian, or somebody, had not sent this little planet on its voyage of blessing long before. Not a syllable that you would have called rhetoric, not a word that you would have thought prepared; and then Brannan sat down.

That was Ben Brannan's way. For my part, I like it better than eloquence.

Then I got up again. We would answer any questions, I said. We represented people who were eager to go forward with this work. (Alas! except Q., all of those represented were on the stage.) We could not go forward without the general assistance of the community. It was not an enterprise which the government could be asked to favor. It was not an enterprise which would yield one penny of profit to any human being. We had therefore, purely on the ground of its benefit to mankind, brought it before an assembly of Boston men and women.

Then there was a pause, and we could hear our watches tick, and our hearts beat. Dear George asked me in a whisper if he should say anything more, but I thought not. The pause became painful, and then Tom Coram, prince of merchants, rose. Had any calculation been made of the probable cost of the experiment of one moon?

I said the calculations were on the table. The brick alone would cost $60,000. Mr. Orcutt had computed that $214,729 would complete two fly-wheels and one moon. This made no allowance for whitewashing the moon, which was not strictly necessary. The fly-wheels and water-power would be equally valuable for the succeeding moons, if any were attempted, and therefore the second moon could be turned off, it was hoped, for $159,732.

Thomas Coram had been standing all the time I spoke, and in an instant he said: "I am no mathematician. But I have had a ship ground to pieces under me on the Laccaqdives because our [460] chronometer was wrong. You need $250,000 to build your first moon. I will be one of twenty men to furnish the money; or I will pay $10,000 tomorrow for this purpose, to any person who may be named as treasurer, to be repaid to me if the moon is not finished this day twenty years."

That was as long a speech as Tom Coram ever made. But it was pointed. The small audience tapped applause.

Orcutt looked at me, and I nodded. "I will be another of the twenty men," cried he. "And I another," said an old bluff Englishman, whom nobody had invited; who proved to be a Mr. Robert Boll, a Sheffield man, who came in from curiosity. He stopped after the meeting; said he should leave the country the next week, and I have never seen him since. But his bill of exchange came all the same.

That was all the public subscribing. Enough more than we had hoped for. We tried to make Coram treasurer, but he refused. We had to make Haliburton treasurer, though we should have liked a man better known than he then was. Then we adjourned. Some nice ladies then came up, and gave, one a dollar, and one five dollars, and one fifty, and so, on,—and some men who have stuck by ever since. I always, in my own mind, call each of those women Damaris, and each of those man Dionysus. But those are not their real names.

How I am wasting time on an old story! Then some of these ladies came the next day and proposed a fair; and out of that, six months after, grew the great Longitude Fair, that you will all remember, if you went to it, I am sure. And the papers the next day gave us first-rate reports; and then, two by two, with our subscription-books, we went at it. But I must not tell the details of that subscription. There were two or three men who subscribed $5,000 each, because they were perfectly certain the amount would never be raised. They wanted, for once, to get the credit of liberality for nothing. There were many men and many women who subscribed from one dollar up to one thousand, not because they cared a straw for the longitude, nor because they believed in the least in the project; but because they believed in Brannan, in Orcutt, in Q., or in me. Love goes far in this world of ours. Some few men subscribed because others had done it: it was the thing to do, and they must not be out of fashion. And three or four, at least, subscribed because each hour of their lives there came up the memory of the day when the news came that the —— was lost, George, or Harry, or John, in the ——, and they knew that George, or Harry, or John might have been at home, had it been easier than it is to read the courses of the stars!

Fair, subscriptions, and Orcutt's reserve,—we counted up $162,000, or nearly so. There would be a little more when all was paid in.

But we could not use a cent, except Orcutt's and our own little subscriptions, till we had got the whole. And at this point it seemed as if the whole world was sick of us, and that we had gathered every penny that was in store for us. The orange was squeezed dry!

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## II.—HOW WE BUILT IT.

[603] The orange was squeezed dry! And how little any of us knew,—skilful George Orcutt, thoughtful Ben Brannan, loyal Haliburton, ingenious Q., or poor painstaking I,—how little we knew, or any of us, where was another orange, or how we could mix malic acid and tartaric acid, and citric acid and auric acid and sugar and water so as to imitate orange-juice, and fill up the bank-account enough to draw in the conditioned subscriptions, and so begin to build the Moon. How often, as I lay awake at night, have I added up the different subscriptions in some new order, as if that would help the matter: and how steadily they have come out one hundred and sixty-two thousand dollars, or even less, when I must needs, in my sleepiness, forget somebody's name! So Haliburton put into railroad stocks all the money he collected, and the rest of us ground on at our mills, or flew up on our own wings towards Heaven. Thus Orcutt built more tunnels, Q. prepared for more commencements, Haliburton calculated more policies, Ben Brannan created more civilization, and I, as I could, healed the hurt of my people of Naguadavick for the months there were left to me of my stay in that thriving town.

None of us had the wit to see how the problem was to be wrought out further. No. The best things come to us when we have faithfully and well made all the preparation and done our best; but they come in some way that is none of ours. So was it now, that to build the BRICK MOON it was necessary that I should be turned out of Naguadavick ignominiously, and that Jeff. Davis and some seven or eight other bad men should create the Great Rebellion. Hear how it happened.

Dennis Shea, my Double,—otherwise, indeed, called by my name and legally so,—undid me, as my friends supposed, one evening at a public meeting called by poor Isaacs in Naguadavick. Of that transaction I have no occasion here to tell the story. But of that transaction one consequence is that the BRICK MOON now moves in ether. I stop writing, to rest my eye upon it, through a little telescope of Alvan Clark's here, which is always trained near it. It is moving on as placidly as ever.

It came about thus. The morning after poor Dennis, whom I have long since forgiven, made his extraordinary speeches, without any authority from me, in the Town Hall at Naguadavick, I thought, and my wife agreed with me, that we had better both leave town with the children. Auchmuty, our dear friend, thought so too. We left in the ten-thirty Accommodation for Skowhegan, and so came to Township No. 9 in the 3d Range, and there for years we resided. That whole range of townships [604] was set off under a provision admirable in its character, that the first settled minister in each town should receive one hundred acres of land as the "minister's grant," and the first settled schoolmaster eighty. To No. 9, therefore, I came. I constituted a little Sandemanian church. Auchmuty and Delafield came up and installed me, and with these hands I built the cabin in which, with Polly and the little ones, I have since spent many happy nights and days. This is not the place for me to publish a map, which I have by me, of No. 9, nor an account of its many advantages for settlers. Should I ever print my papers called "Stay-at-home Robinsons," it will be easy with them to explain its topography and geography. Suffice it now to say, that, with Alice and Bertha and Polly, I took tramps up and down through the lumbermen's roads, and soon knew the general features of the lay of the land. Nor was it long, of course, before we came out one day upon the curious land-slides, which have more than once averted the flow of the Little Carrotook River, where it has washed the rocks away so far as to let down one section more of the overlying yielding yellow clay.

Think how my eyes flashed, and my wife's, as, struggling through a wilderness of moosewood, we came out one afternoon on this front of yellow clay! Yellow clay, of course, when properly treated by fire, is brick! Here we were surrounded by forests, only waiting to be burned; yonder was clay, only waiting to be baked. Polly looked at me, and I looked at her, and with one voice, we cried out, "The MOON!"

For here was this shouting river at our feet, whose power had been running to waste since the day when the Laurentian hills first heaved themselves above the hot Atlantic; and that day, I am informed by Mr. Agassiz, was the first day in the history of this solid world. Here was water-power enough for forty fly-wheels, were it necessary to send heavenward twenty moons. Here was solid timber enough for a hundred dams, yet only one was necessary to give motion to the fly-wheels. Here was retirement,—freedom from criticism, an escape from the journalists, who would not embarrass us by telling of every cracked brick which had to be rejected from the structure. We had lived in No. 9 now for six weeks, and not an "own correspondent" of them all had yet told what Rev. Mr. Ingham had for dinner.

Of course I wrote to George Orcutt at once of our great discovery, and he came up at once to examine the situation. On the whole, it pleased him. He could not take the site proposed for the dam, because this very clay there made the channel treacherous, and there was danger that the stream would work out a new career. But lower down we found a stony gorge with which George was satisfied; he traced out a line for a railway by which, of their own weight, the brick-cars could run to the centrings; he showed us where, with some excavations, the fly-wheels could be placed exactly above the great mill-wheels, that no power might be wasted, and explained to us how, when the gigantic structure was finished, the BRICK MOON would gently roll down its ways upon the rapid wheels, to be launched instant into the sky!

Shall I ever forget that happy October day of anticipation!

We spent many of those October days in tentative surveys. Alice and Bertha were our chain-men, intelligent and obedient. I drove for George his stakes, or I cut away his brush, or I raised and lowered the shield at which he sighted; and at noon Polly appeared with her baskets, and we would dine *al fresco*, on a pretty point which, not many months after, was wholly covered by the eastern end of the dam. When the fieldwork was finished we retired to the cabin for days, and calculated and drew, and drew and calculated. Estimates for feeding Irishmen, estimates of hay for mules,—George was sure he could work mules better than oxen,—estimates for cement, estimates [605] for the preliminary saw-mills, estimates for rail for the little brickroad, for wheels, for spikes, and for cutting ties; what did we not estimate for—on a basis almost wholly new, you will observe. For here the brick would cost us less than our old conceptions,—our water-power cost us almost nothing,—but our stores and our wages would cost us much more.

These estimates are now to me very curious,—a monument, indeed, to dear George's memory, that in the result they proved so accurate. I would gladly print them here at length, with some illustrative cuts, but that I know the impatience of the public, and its indifference to detail. If we are ever able to print a proper memorial of George, that, perhaps, will be the fitter place for them. Suffice it to say that with the subtractions thus made from the original estimates,—even with the additions forced upon us by working in a wilderness,—George was satisfied that a money charge of $197,327 would build and start THE MOON. As soon as we had determined the site, we marked off eighty acres, which contained all the essential localities, up and down the little Carrotook River,—I engaged George for the first schoolmaster in No. 9, and he took these eighty acres for the schoolmaster's reservation. Alice and Bertha went to school to him the next day, taking lessons in civil engineering; and I wrote to the Brigham trustees to notify them that I had engaged a teacher, and that he had selected his land.

Of course we remembered, still, that we were near forty thousand dollars short of the new estimates, and also that much of our money would not be paid us but on condition that two hundred and fifty thousand were raised. But George said that his own subscription was wholly unhampered: with that we would go to work on the preliminary work of the dam, and on the flies. Then, if the flies would hold together,—and they should hold if mortise and iron could hold them,—they might be at work summers and winters, days and nights, storing up Power for us. This would encourage the subscribers, nay, would encourage us; and all this preliminary work would be out of the way when we were really ready to begin upon the MOON.

Brannan, Haliburton, and Q. readily agreed to this when they were consulted. They were the other trustees under an instrument which we had got St. Leger to draw up. George gave up, as soon as he might, his other appointments; and taught me, meanwhile, where and how I was to rig a little saw-mill, to cut some necessary lumber. I engaged a gang of men to cut the timber for the dam, and to have it ready; and, with the next spring, we were well at work on the dam and on the flies! These needed, of course, the most solid foundation. The least irregularity of their movement might send the MOON awry.

Ah me! would I not gladly tell the history of every bar of iron which was bent into the tires of those flies, and of every log which was mortised into its place in the dam, nay, of every curling mass of foam which played in the eddies beneath, when the dam was finished, and the waste water ran so smoothly over? Alas! that one drop should be wasted of water that might move a world, although a small one! I almost dare say that I remember each and all these,—with such hope and happiness did I lend myself, as I could, each day to the great enterprise; lending to dear George, who was here and there and everywhere, and was this and that and everybody,—lending to him, I say, such a poor help as I could lend, in whatever way. We waked, in the two cabins, in those happy days, just before the sun came up, when the birds were in their loudest clamor of morning joy. Wrapped each in a blanket, George and I stepped out from our doors, each trying to call the other, and often meeting on the grass between. We ran to the river and plunged in,—O, how cold it was!—laughed and screamed like boys, rubbed ourselves aglow, and ran home to [606] build Polly's fire beneath the open chimney which stood beside my cabin. The bread had risen in the night. The water soon boiled above the logs. The children came, laughing, out upon the grass, barefoot, and fearless of the dew. Then Polly appeared with her gridiron and bear-steak, or with her griddle and eggs, and, in fewer minutes than this page has cost me, the breakfast was ready for Alice to carry, dish by dish, to the white-clad table on the piazza. Not Raphael and Adam more enjoyed their watermelons, fox-grapes, and late blueberries! And, in the long croon of the breakfast, lingering at the board, we revenged ourselves for the haste with which it had been prepared.

When we were well at table, a horn from the cabins below sounded the reveille for the drowsier workmen. Soon above the larches rose the blue of their smokes; and when we were at last nodding to the children, to say that they might leave the table, and Polly was folding her napkin as to say she wished we were gone, we would see tall Asaph Langdon, then foreman of the carpenters, sauntering up the valley with a roll of paper, or an adze, or a shingle with some calculations on it,—with something on which he wanted Mr. Orcutt's directions for the day.

An hour of nothings set the carnal machinery of the day agoing. We fed the horses, the cows, the pigs, and the hens. We collected the eggs and cleaned the hen-houses and the barns. We brought in wood enough for the day's fire, and water enough for the day's cooking and cleanliness. These heads describe what I and the children did. Polly's life during that hour was more mysterious. That great first hour of the day is devoted with women to the deepest arcana of the Eleusinian mysteries of the divine science of housekeeping. She who can meet the requisitions of that hour wisely and bravely conquers in the Day's Battle. But what she does in it, let no man try to say! It can be named, but not described, in the comprehensive formula, "Just stepping round."

That hour well given to chores and to digestion, the children went to Mr. Orcutt's open-air school, and I to my rustic study,—a separate cabin, with a rough square table in it, and some book-boxes equally rude. No man entered it, excepting George and me. Here for two hours I worked undisturbed,—how happy the world, had it neither postman nor door-bell!—worked upon my Traces of Sandemanianism in the Sixth and Seventh Centuries, and then was ready to render such service to The Cause and to George as the day might demand. Thus I rode to Lincoln or to Foxcroft to order supplies; I took my gun and lay in wait on Chairback for a bear; I transferred to the hewn lumber the angles or bevels from the careful drawings: as best I could, I filled an apostle's part, and became all things to all these men around me. Happy those days!—and thus the dam was built; in such Arcadian simplicity was reared the mighty wheel; thus grew on each side the towers which were to support the flies; and thus, to our delight not unmixed with wonder, at one day, nor in ten; but in a year or two of happy life,—full of the joy of joys,—the "joy of eventful living."

Yet, for all this, $162,000 was not $197,000, far less was it $250,000; and but for Jeff. Davis and his crew the BRICK MOON would not have been born.

But at last Jeff. Davis was ready. "My preparations being completed," wrote General Beauregard, "I opened fire on Fort Sumter." Little did he know it,—but in that explosion the BRICK MOON also was lifted into the sky!

Little did we know it, when, four weeks after, George came up from the settlements, all excited with the news! The wheels had been turning now for four days, faster of course and faster. George had gone down for money to pay off [607] the men, and he brought us up the news that the Rebellion had begun.

"The last of this happy life," he said; "the last, alas, of our dear MOON." How little he knew and we!

But he paid off the men, and they packed their traps and disappeared, and, before two months were over, were in the lines before the enemy. George packed up, bade us sadly good by, and before a week had offered his service to Governor Fenton in Albany. For us, it took rather longer; but we were soon packed; Polly took the children to her sister's, and I went on to the Department to offer my service there. No sign of life left in No. 9, but the two gigantic Fly-Wheels, moving faster and faster by day and by night, and accumulating Power till it was needed. If only they would hold together till the moment came!

So we all ground through the first slow year of the war. George in his place, I in mine, Brannan in his,—we lifted as we could. But how heavy the weight seemed! It was in the second year, when the second large loan was placed, that Haliburton wrote to me,—I got the letter, I think at Hilton Head,—that he had sold out every penny of our railroad stocks, at the high prices which railroad stocks then bore, and had invested the whole fifty-nine thousand in the new Governments. "I could not call a board meeting," said Haliburton, "for I am here only on leave of absence, and the rest are all away. But the case is clear enough. If the government goes up, the MOON will never go up; and, for one, I do not look beyond the veil." So he wrote to us all, and of course we all approved.

So it was that Jeff. Davis also served. Deep must that man go into the Pit who does not serve, though unconscious. For thus it was that, in the fourth year of the war, when gold was at 290, Haliburton was receiving on his fifty-nine thousand dollars seventeen per cent interest in currency; thus was it that, before the war was over, he had piled up, compounding his interest, more than fifty per cent addition to his capital; thus was it that, as soon as peace came, all his stocks were at a handsome percentage; thus was it that, before I returned from South America, he reported to all the subscribers that the full quarter-million was secured; thus was it that, when I returned after that long cruise of mine in the Florida, I found Polly and the children again at No. 9, George there also, directing a working party of nearly eighty bricklayers and hodmen, the lower centrings wellnigh filled to their diameter, and the BRICK MOON, to the eye, seeming almost half completed.

Here it is that I regret most of all that I cannot print the working-drawings with this paper. If you will cut open the seed-vessel of Spergularia Rubra, or any other carpel that has a free central placenta, and observe how the circular seeds cling around the circular centre, you will have some idea of the arrangement of a transverse horizontal section of the completed MOON. Lay three croquet-balls on the piazza, and call one or two of the children to help you poise seven in one place above the three; then let another child place three more above the seven, and you have the *core* of the MOON completely. If you want a more poetical illustration, it was what Mr. Wordsworth calls a mass

"Of conglobated bubbles undissolved."

Any section through any diameter looked like an immense rose-window, of six circles grouped round a seventh. In truth, each of these sections would reveal the existence of seven chambers in the moon,—each a sphere itself,—whose arches gave solidity to the whole; while yet, of the whole moon, the greater part was air. In all there were thirteen of these moonlets, if I am so to call them; though no one section, of course, would reveal so many. Sustained on each side by their groined arches, the surface of the whole moon was built over them and under them,—simply two domes connected at the bases. The chambers themselves were [608] made lighter by leaving large, round windows or open circles in the parts of their vaults farthest from their points of contact, so that each of them looked not unlike the outer sphere of a Japanese ivory nest of concentric balls. You see the object was to make a moon, which, when left to its own gravity, should be fitly supported or braced within. Dear George was sure that, by this constant repetition of arches, we should with the least weight unite the greatest strength. I believe it still, and experience has proved that there is strength enough.

When I went up to No. 9, on my return from South America, I found the lower centring up, and half full of the working-bees,—who were really Keltic laborers,—all busy in bringing up the lower half-dome of the shell. This lower centring was of wood, in form exactly like a Roman amphitheatre if the seats of it be circular; on this the lower or inverted brick dome was laid. The whole fabric was on one of the terraces which were heaved up in some old geological cataclysm, when some lake gave way, and the Carratook River was born. The level was higher than that of the top of the fly-wheels, which, with an awful velocity now, were circling in their wild career in the ravine below. Three of the lowest moonlets, as I have called them,—separate croquet-balls, if you take my other illustration,—had been completed; their centrings had been taken to pieces and drawn out through the holes, and were now set up again with other new centrings for the second story of cells.

I was received with wonder and delight. I had telegraphed my arrival, but the despatches had never been forwarded from Skowhegan. Of course, we all had a deal to tell; and, for me, there was no end to inquiries which I had to make in turn. I was never tired of exploring the various spheres, and the nameless spaces between them. I was never tired of talking with the laborers. All of us, indeed, became skilful bricklayers; and on a pleasant afternoon you might see Alice and Bertha, and George and me, all laying brick together,—Polly sitting in the shade of some wall which had been built high enough, and reading to us from Jean Ingelow or Monte-Cristo or Jane Austen, while little Clara brought to us our mortar. Happily and lightly went by that summer. Haliburton and his wife made us a visit; Ben Brannan brought up his wife and children; Mrs. Haliburton herself put in the keystone to the central chamber, which had always been named G. on the plans; and at her suggestion, it was named Grace now, because her mother's name was Hannah. Before winter we had passed the diameter of I, J, and K, the three uppermost cells of all; and the surrounding shell was closing in upon them. On the whole, the funds had held out amazingly well. The wages had been rather higher than we meant; but the men had no chances at liquor or dissipation, and had worked faster than we expected; and, with our new brick-machines, we made brick inconceivably fast, while their quality was so good that dear George said there was never so little waste. We celebrated Thanksgiving of that year together,—my family and his family. We had paid off all the laborers; and there were left, of that busy village, only Asaph Langdon and his family, Levi Jordan and Levi Ross, Horace Leonard and Seth Whitman with theirs. "Theirs," I say, but Ross had no family. He was a nice young fellow who was there as Haliburton's representative, to take care of the accounts and the pay-roll; Jordan was the head of the brick-kilns; Leonard, of the carpenters; and Whitman, of the commissariat,—and a good commissary Whitman was.

We celebrated Thanksgiving together! Ah me! what a cheerful, pleasant time we had; how happy the children were together! Polly and I and our bairns were to go to Boston the next day. I was to spend the winter in one final effort to get twenty-five thousand dollars more if I could, with which we might paint the MOON, or put on some ground felspathic granite dust, in a sort of paste, which in its hot flight [609] through the air might fuse into a white enamel. All of us who saw the MOON were so delighted with its success that we felt sure "the friends" would not pause about this trifle. The rest of them were to stay there to watch the winter, and to be ready to begin work the moment the snow had gone. Thanksgiving afternoon,—how well I remember it,—that good fellow, Whitman, came and asked Polly and me to visit his family in their new quarters. They had moved for the winter into cells B and E, so lofty, spacious, and warm, and so much drier than their log cabins. Mrs. Whitman, I remember, was very cheerful and jolly; made my children eat another piece of pie, and stuffed their pockets with raisins; and then with great ceremony and fun we christened room B by the name of Bertha, and E, Ellen, which was Mrs. Whitman's name. And the next day we bade them all good by, little thinking what we said, and with endless promises of what we would send and bring them in the spring.

Here are the scraps of letters from Orcutt, dear fellow, which tell what more there is left to tell:—

"December 10th.

".... After you left we were a little blue, and hung round loose for a day or two. Sunday we missed you especially, but Asaph made a good substitute, and Mrs. Leonard led the singing. The next day we moved the Leonards into L and M, which we christened Leonard and Mary (Mary is for your wife). They are pretty dark, but very dry. Leonard has swung hammocks, as Whitman did.

"Asaph came to me Tuesday and said he thought they had better turn to and put a shed over the unfinished circle, and so take occasion of warm days for dry work there. This we have done, and the occupation is good for us...."

"December 25th.

"I have had no chance to write for a fortnight. The truth is, that the weather has been so open that I let Asaph go down to No. 7 and to Wilder's, and engage five-and-twenty of the best of the men, who, we knew, were hanging round there. We have all been at work most of the time since, with very good success. H is now wholly covered in, and the centring is out. The men have named it Haliburton. I is well advanced. J is as you left it. The work has been good for us all, morally."

"February 11th.

".... We got your mail unexpectedly by some lumbermen on their way to the 9th Range. One of them has cut himself, and takes this down.

"You will be amazed to hear that I and K are both done. We have had splendid weather, and have worked half the time. We had a great jollification when K was closed in,—called it Kilpatrick, for Seth's old general. I wish you could just run up and see us. You must be quick, if you want to put in any of the last licks...."

"March 12th.

"DEAR FRED,—I have but an instant. By all means made your preparations to be here by the end of the month or early in next month. The weather has been faultless, you know. Asaph got in a dozen more men, and we have brought up the surface farther than you could dream. The ways are well forward, and I cannot see why, if the freshet hold off a little, we should not launch her by the 10th or 12th. I do not think it worth while to wait for paint or enamel. Telegraph Brannan that he must be here. You will be amused by our quarters. We, who were the last outsiders, move into A and D tomorrow, for a few weeks. It is much warmer there.

"Ever yours,

"G.O."

I telegraphed Brannan, and in reply he came with his wife and his children to Boston. I told him that he could not possibly get up there, as the roads then were; but Ben said he would go to Skowhegan, and take his chance there. He would, of course, communicate with me as soon as he got there. Accordingly I got a note from him at [610] Skowhegan, saying he had hired a sleigh to go over to No. 9; and in four days more I got this letter:—

"March 27th.

"DEAR FRED,—I am most glad I came, and I beg you to bring your wife as soon as possible. The river is very full, the wheels, to which Leonard has added two auxiliaries, are moving as if they could not hold out long, the ways are all but ready, and we thing we must not wait. Start with all hands as soon as you can. I had no difficulty in coming over from Skowhegan. We did it in two days."

This note I sent at once to Haliburton; and we got all the children ready for a winter journey, as the spectacle of the launch of the MOON was one to be remembered their life long. But it was clearly impossible to attempt, at that season, to get the subscribers together. Just as we started, this despatch from Skowhegan was brought me,—the last word I got from them:—

"Stop for nothing. There is a jam below us in the stream, and we fear back-water.

"ORCUTT."

Of course we could not go faster than we could. We missed no connection. At Skowhegan, Haliburton and I took a cutter, leaving the ladies and children to follow at once in larger sleighs. We drove all night, changed horses at Prospect, and kept on all the next day. At No. 7 we had to wait over night. We started early in the morning, and came down the Spoonwood Bill at four in the afternoon, in full sight of our little village.

It was quiet as the grave! Not a smoke, not man, not an adze-blow, nor the tick of a trowel. Only the gigantic fly-wheels were whirling as I saw them last.

There was the lower Coliseum-like centring, somewhat as I first saw it.

But where was the Brick Dome of the MOON?

"Good Heavens! has it fallen on them all? cried I.

Haliburton lashed the beast till he fairly ran down that steep hill. We turned a little point, and came out in front of the centring. There was no MOON there! An empty amphitheatre, with not a brick nor a splinter within!

We were speechless. We left the cutter. We ran up the stairways to the terrace. We ran by the familiar paths into the centring. We came out upon the ways, which we had never seen before. These told the story too well! The ground and crushed surface of the timbers, scorched by the rapidity with which THE MOON had slid down, told that they had done the duty for which they were built.

It was too clear that in some wild rush of the waters the ground had yielded a trifle. We could not find that the foundations had sunk more than six inches, but that was enough. In that fatal six inches' decline of the centring, the MOON had been launched upon the ways just as George had intended that it should be when he was ready. But it had slid, not rolled, down upon these angry fly-wheels, and in an instant, with all our friends, it had been hurled into the sky!

"They have gone up!" said Haliburton; "She has gone up!" said I;—both in one breath. And with a common instinct, we looked up into the blue.

But of course she was not there.

Not a shred of letter or any other tidings could we find in any of the shanties. It was indeed six weeks since George and Fanny and their children had moved into Annie and Diamond,—two unoccupied cells of the MOON,—so much more comfortable had the cells proved than the cabins, for winter life. Returning to No. 7, we found there many of the laborers, who were astonished at what we told them. They had been paid off on the 30th, and told to come up again on the 15th of April, to see the launch. One of them, a man named Rob. Shea, told me that George kept his cousin Peter to help [611] him move back into his house the beginning of the next week.

And that was the last I knew of any of them for more than a year. At first I expected, each hour, to hear that they had fallen somewhere. But time passed by, and of such a fall, where man knows the world's surface, there was no tale. I answered, as best I could, the letters of their friends, by saying I did not know where they were, and had not heard from them. My real thought was, that if this fatal MOON did indeed pass our atmosphere, all in it must have been burned to death in the transit. But this I whispered to no one save to Polly and Annie and Haliburton. In this terrible doubt I remained, till I noticed one day in the "Astronomical Record" the memorandum, which you perhaps remember, of the observation, by Dr. Zitta, of a new asteroid, with an enormous movement in declination.

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## III.—FULFILMENT.

[679] Looking back upon it now, it seems inconceivable that we said as little to each other as we did, of this horrible catastrophe. That night we did not pretend to sleep. We sat in one of the deserted cabins, now talking fast, now sitting and brooding, without speaking, perhaps, for hours. Riding back the next day to meet the women and children, we still brooded, or we discussed this "if," that "if," and yet others. But after we had once opened it all to them,—and when we had once answered the children's horribly naive questions as best we could,—we very seldom spoke to each other of it again. It was too hateful, all of it, to talk about. I went round to Tom Coram's office one day, and told him all I knew. He saw it was dreadful to me, and, with his eyes full, just squeezed my hand, and never said one word more. We lay awake nights, pondering an wondering, but hardly ever did I to Haliburton or he to me explain our respective notions as they came and went. I believe my general impression was that of which I have spoken, that they were all burned to death on the instant, as the little aerolite fused in its passage through our atmosphere. I believe Haliburton's thought more often was that they were conscious of what had happened, and gasped out their lives in one or two breathless minutes,—so horrible long!—as they shot outside of our atmosphere. But it was all too terrible for words. And that which we could not but think upon, in those dreadful waking nights, we scarcely whispered even to our wives.

Of course I looked and he looked for the miserable thing. But we looked in vain. I returned to the few subscribers the money which I had scraped together towards whitewashing the moon,— "shrouding its guilty face with innocent white" indeed! But we agreed to spend the wretched trifle of the other money, left in the treasury after paying the last bills, for the largest Alvan Clark telescope that we could buy; and we were fortunate in obtaining cheap a second-hand one which came to the hammer when the property of the Shubeal Academy was sold by the mortgagees. But we had, of course, scarce a hint whatever as to where the miserable object was to be found. All we could do was to carry the glass to No. 9, to train it there on the meridian of No. 9, and take turns every night in watching the field, in the hope that this child of sorrow might drift across it in its path of ruin. But, though everything else seemed to drift by, from east to west, nothing came from south to north, as we expected. For a whole month of spring, another of autumn, another of summer, and another of winter, did Haliburton and his wife and Polly and I glue our eyes to that eye-glass, from the twilight of evening to the twilight of morning, and the dead hulk never hove in sight. Wherever else it was, it seemed not to be on that meridian, which was where it ought to be and was made to be! Had ever any dead mass of matter wrought such ruin to its makers, and, of its own stupid inertia, so falsified all the prophecies of its birth! O, the total depravity of things!

It was more than a year after the fatal night,—if it all happened in the night, as I suppose,—that, as I dreamily read through the "Astronomical Record" in the new reading-room of the College Library at Cambridge, I lighted on this scrap:—

"Professor Karl Zitta of Breslau writes to the *Astronomische Nachrichten* to claim the discovery of a new asteroid observed by him on the night of March 31st.

[680]

| | | (92) App. A.R. | App. Decl. | |
|---|---|---|---|---|
| Bresl. M T | h. m. s. | h. m. s. | _ ° ' " | Size. |
| March 31 | 12 53 51.9 | 15 39 52.32 | —23 50 26.1 | 12.9 |
| April 1 | 1 3 2.1 | 15 39 52.32 | —23 9 1.9 | 12.9 |

"He proposes for the asteroid the name of Phoebe. Dr. Zitta states that in the short period which he had for observing Phoebe, for an hour after midnight, her motion in R. A. seemed slight and her motion in declination very rapid."

After this, however, for months, nay even to this moment, nothing more was heard of Dr. Zitta of Breslau.

But, one morning, before I was up, Haliburton came banging at my door on D Street. The mood had taken him, as he returned from some private theatricals at Cambridge, to take the comfort of the new reading-room at night, and thus express in practice his gratitude to the overseers of the college for keeping it open through all the twenty-four hours. Poor Haliburton, he did not sleep well in those times! Well, as he read away on the *Astronomische Nachrichten* itself, what should he find but this in German, which he copied for me, and then, all on foot in the rain and darkness, tramped over with, to South Boston:—

"The most enlightened head professor Dr. Gmelin writes to the director of the Porpol Astronomik at St. Petersburg, to claim the discovery of an asteroid in a very high southern latitude, of a wider inclination of the orbit, as will be noticed, than any asteroid yet observed.

"Planet's apparent $\alpha$ $21^{h}\ 20^{m}\ 51^{s}.40$. Planet's apparent $\partial$—39° 31' 11".9. Comparison star $\alpha$.

"Dr. Gmelin publishes no separate second observation, but is confident that the declination is diminishing. Dr. Gmelin suggests for the name of this extra-zodiacal planet "Io," as appropriate to its wanderings from the accustomed ways of planetary life, and trusts that the very distinguished Herr Peters, the godfather of so many planets, will relinquish this name, already claimed for the asteroid (85) observed by him, September 15, 1865."

I had run down stairs almost as I was, slippers and dressing-gown being the only claims I had on society. But to me, as to Haliburton, this stuff about "extra-zodiacal wandering" blazed out upon the page, and though there was no evidence that the "most enlightened" Gmelin found anything the next night, yet, if his "diminishing" meant anything, there was, with Zitta's observation,—whoever Zitta might be,—something to start upon. We rushed upon some old bound volumes of the Record and spotted the "enlightened Gmelin." He was chief of a college at Taganrog, where perhaps they had a spyglass. This gave us the parallax of his observation. Breslau, of course, we knew, and so we could place Zitta's, and with these poor data I went to work to construct, if I could, an orbit for this Io-Phoebe mass of brick and mortar. Haliburton, not strong in spherical trigonometry, looked out logarithms for me till breakfast, and, as soon as it would do, went over to Mrs. Bowdoin, to borrow her telescope, ours being left at No. 9.

Mrs. Bowdoin was kind, as she always was, and at noon Haliburton appeared in triumph with the boxes on P. Nolan's job-wagon. We always employ P., in memory of dear old Phil. We got the telescope rigged, and waited for night, only, alas! to be disappointed again. Io had wandered somewhere else, and, with all our sweeping back and forth on the tentative curve I had laid out, Io would not appear. We spent that night in vain.

But we were not going to give it up so. Phoebe might have gone round the world twice before she became Io; might have gone three times, four, five, six,—nay, six hundred,—who knew! Nay, who knew how far off Phoeb-Io [681] was or Io-Phoebe? We sent over for Annie, and she and Polly and George and I went to work again. We calculated in the next week sixty-seven orbits on the supposition of so many different distances from our surface. I laid out on a paper, which we stuck up on the wall opposite, the formula, and then one woman and one man attacked each set of elements, each having the Logarithmic Tables, and so in a week's working-time, the sixty-seven orbits were completed. Sixty-seven possible places for Io-Phoebe to be in on the forthcoming Friday evening. Of these sixty-seven, forty-one were observable above our horizon that night.

She was not in one of the forty-one, nor near it.

But Despair, if Giotto be correct, is the chief of sins. So has he depicted her in the fresco of the Arena in Padua. No sin, that, of ours! After searching all that Friday night, we slept all Saturday (sleeping after sweeping). We all came to the Chapel, Sunday, kept awake there, and taught our Sunday classes special lessons on Perseverance. On Monday we began again, and that week we calculated sixty-seven more orbits. I am sure I do not know why we stopped at sixty-seven. All of these were on the supposition that the revolution of the Brick Moon, or Io-Phoebe, was so fast that it would require either fifteen days to complete its orbit, or sixteen days, or seventeen days, and so on up to eighty-one days. And, with these orbits, on the next Friday we waited for the darkness. As we sat at tea, I asked if I should begin observing at the smallest or at the largest orbit. And there was a great clamor of diverse opinions. But little Bertha said, "Begin in the middle."

"And what is the middle?" said George, chaffing the little girl.

But she was not to be dismayed. She had been in and out all the week, and knew that the first orbit was of fifteen days and the last of eighty-one; and, with true Lincoln School precision, she said, "The mean of the smallest orbit and the largest orbit is forty-eight days."

"Amen!:" said I, as we all laughed. "On forty-eight days we will begin."

Alice ran to the sheets, turned up that number, and read, "R. A. 27° 11'. South declination 34° 49'."

"Convenient places," said George; "good omen, Bertha, my darling! If we find her there, Alice and Bertha and Clara shall all have new dolls."

It was the first word of pleasantry that had been spoken about the horrid thing since Spoonwood Hill!

Night came at last. We trained the glass on the fated spot. I bade Polly take the eye-glass. She did so, shook her head uneasily, screwed the tube northward herself a moment, and then screamed, "It is there! it is there,—a clear disk,—gibbous shape,—and very sharp on the upper edge. Look! look! as big again as Jupiter!"

Polly was right! The Brick Moon was found!

Now we had found it, we never lost it. Zitta and Gmelin, I suppose, had had foggy nights and stormy weather often. But we had some one at the eye-glass all that night, and before morning had very respectable elements, good measurements of angular distance when we got one, and another star in the field of our lowest power. For we could see her even with a good French opera-glass I had, and with a night-glass which I used to carry on the South Atlantic Station. It certainly was an extraordinary illustration of Orcutt's engineering ability, that, flying off as she did, without leave or license, she should have gained so nearly the orbit of our original plan,—nine thousand miles from the earth's centre, five thousand from the surface. He had always stuck to the hope of this, and on his very last tests of the Flies he had said they were almost up to it. But for this accuracy of his, I can hardly suppose we should have found her to this hour, since she had failed, by what cause I then did not know, to take her intended place on the meridian of No. 9. At five thousand miles the MOON appeared as large as the largest satellite of Jupiter [682] appears. And Polly was right in that first observation, when she said she got a good disk with that admirable glass of Mrs. Bowdoin.

The orbit was not on the meridian of No. 9, nor did it remain on any meridian. But it was very nearly South and North.—an enormous motion in declination with a very slight retrograde motion in Right Ascension. At five thousand miles the MOON showed as large as a circle two miles and a third in diameter would have shown on old Thornbush, as we always called her older sister. We longed for an eclipse of Thornbush by B. M., but no such lucky chance is on the cards in any place accessible to us for many years. Of course, with a MOON so near us the terrestrial parallax is enormous.

Now, you know, dear reader, that the gigantic reflector of Lord Rosse, and the exquisite fifteen-inch refractors of the modern observatories, eliminate from the chaotic rubbish-heap of the surface of old Thornbush much smaller objects than such a circle as I have named. If you have read Mr. Locke's amusing Moon Hoax as often as I have, you have those details fresh in your memory. As John Farrar taught us when all this began,—and as I have said already,—if there were a State House in Thornbush two hundred feet long, the first Herschel would have seen it. His magnifying power was 6450; that would have brought this deaf and dumb State House within some forty miles. Go up on Mt. Washington and see white sails eighty miles away, beyond Portland, with your naked eye, and you will find how well he would have seen that State House with his reflector. Lord Rosse's statement is, that with his reflector he can see objects on old Thornbush two hundred and fifty-two feet long. If he can do that he can see on our B. M. objects which are five feet long; and, of course, we were beside ourselves to get control of some instrument which had some approach to such power. Haliburton was for at once building a reflector at No. 9; and perhaps he will do it yet, for Haliburton has been successful in his paper-making and lumbering. But I went to work more promptly.

I remembered, not an apothecary, but an observatory, which had been dormant, as we say of volcanoes, now for ten or a dozen years,—no matter why! The trustees had quarrelled with the director, or the funds had given out, or the director had been shot at the head of his division,—one of those accidents had happened which will happen even in observatories which have fifteen-inch equatorials; and so the equatorial here had been left as useless as a cannon whose metal has been strained or its reputation stained in an experiment. The observatory at Tamworth, dedicated with such enthusiasm,—"another lighthouse in the skies,"—had been, so long as I have said, worthless to the world. To Tamworth, therefore, I travelled. In the neighborhood of the observatory I took lodgings. To the church where worshipped the family which lived in the observatory buildings I repaired; after two Sundays I established acquaintance with John Donald, the head of this family. On the evening of the third, I made acquaintance with his wife in a visit to them. Before three Sundays more he had recommended me to the surviving trustees as his successor as janitor to the buildings. He himself had accepted promotion, and gone, with his household, to keep a store for Haliburton in North Ovid. I sent for Polly and the children, to establish them in the janitor's rooms; and, after writing to her, with trembling eye I waited for the Brick Moon to pass over the field of the fifteen-inch equatorial.

Night came. I was "sole lone!" B. M. came, more than filled the field of vision, of course! but for that I was ready. Heavens! how changed. Red no longer, but green as a meadow in the spring. Still I could see—black on the green—the large twenty-foot circles which I remembered so well, which broke the concave of the dome; and, on the upper edge—were these palm-trees! They were. No, they [683] were hemlocks by their shape, and among them were moving to and fro——flies? Of course, I cannot see flies! But something is moving,—coming, going. One, two, three, ten; there are more than thirty in all!

They are men and women and their children!

Could it be possible! It was possible! Orcutt and Brannan and the rest of them had survived that giddy flight through the ether, and were going and coming on the surface of their own little world, bound to it by its own attraction and living by its own laws!

As I watched, I saw one of them leap from that surface. He passed wholly out of my field of vision, but in a minute, more or less, returned. Why not! Of course, the attraction of his world must be very small, while he retained the same power of muscle he had when he was here. They must be horribly crowded, I thought. No. They had three acres of surface, and there were but thirty-seven of them. Not so much crowded as people are in Roxbury, not nearly so much as in Boston; and, besides, these people are living underground, and have the whole of their surface for their exercise.

I watched their every movement as they approached the edge and as they left it. Often they passed beyond it, so that I could see them no more. Often they sheltered themselves from that tropical sun beneath the trees. Think of living on a world where from the vertical heat of the hottest noon of the equator to the twilight of the poles is a walk of only fifth paces! What atmosphere they had, to temper and diffuse those rays, I could not then conjecture.

I knew that at half past ten they would pass into the inevitable eclipse which struck them every night at this period of their orbit, and must, I thought, be a luxury to them, as recalling old memories of night when they were on this world. As they approached the line of shadow, some fifteen minutes before it was due, I counted on the edge thirty-seven specks arranged evidently in order; and, at one moment, as by one signal, all thirty-seven jumped into the air,—high jumps. Again they did it, and again. Then a low jump; then a high one. I caught the idea in a moment. They were telegraphing to our world, in the hope of an observer. Long leaps and short leaps,—the long and short of Morse's Telegraph Alphabet,—were communicating ideas. My paper and pencil had been of course before me. I jotted down the despatch, whose language I knew perfectly:—

"Show 'I understand' on the Saw-Mill Flat."

"Show 'I understand' on the Saw-Mill Flat."

"Show 'I understand' on the Saw-Mill Flat."

By "I understand" they meant the responsive signal given, in all telegraphy, by an operator who has received and understood a message.

As soon as this exercise had been three times repeated, they proceeded in a solid body—much the most apparent object I had had until now—to Circle No. 3, and then evidently descended into the MOON

The eclipse soon began, but I knew the MOON's path now, and followed the dusky, coppery spot without difficulty. At 1.33 it emerged, and in a very few moments I saw the solid column pass from Circle No. 3 again, deploy on the edge again, and repeat three times the signal:—

"Show 'I understand' on the Saw-Mill Flat."

"Show 'I understand' on the Saw-Mill Flat."

"Show 'I understand' on the Saw-Mill Flat."

It was clear that Orcutt had known that the edge of his little world would be most easy of observation, and that he had guessed that the moments of obscuration and of emersion were the moments when observers would be most careful. After this signal they broke up again, and I could not follow them. With daylight I sent off a despatch to [684] Haliburton, and, grateful and happy in comparison, sank into the first sleep not haunted by horrid dreams, which I had known for years.

Haliburton knew that George Orcutt had taken with him a good Dolland's refractor, which he had bought in London, of a two-inch glass. He knew that this would give Orcutt a very considerable power, if he could only adjust it accurately enough to find No. 9 in the 3d Range. Orcutt had chosen well in selecting the "Saw-Mill Flat," a large meadow, easily distinguished by the peculiar shape of the mill-pond which we had made. Eager though

Haliburton was, to join me, he loyally took moneys, caught the first train to Skowhegan, and, travelling thence, in thirty-six hours more was again descending Spoonwood Hill, for the first time since our futile observations. The snow lay white upon the Flat. With Bob Shea's help, he rapidly unrolled a piece of black cambric twenty yards long, and pinned it to the crust upon the snow; another by its side, and another. Much cambric had he left. They had carried down with them enough for the funerals of two Presidents. Haliburton showed the symbols for "I understand," but he could not resist also displaying · — · —, which are the dots and lines to represent O.K., which, he says is the shortest message of comfort. And not having exhausted the space on the Flat, he and Robert, before night closed in, made a gigantic **O.K.**, fifteen yards from top to bottom, and in marks that were fifteen feet through.

I had telegraphed my great news to Haliburton on Monday night. Tuesday night he was at Skowhegan. Thursday night he was at No. 9. Friday he and Rob. stretched their cambric. Meanwhile, every day I slept. Every night I was glued to the eye-piece. Fifteen minutes before the eclipse every night this weird dance of leaps two hundred feet high, followed by hops of twenty feet high, mingled always in the steady order I have described, spelt out the ghastly message:—

"Show 'I understand' on the Saw-Mill Flat."

And every morning, as the eclipse ended, I saw the column creep along to the horizon, and again, as the duty of opening day, spell out the same:—

"Show 'I understand' on the Saw-Mill Flat."

They had done this twice in every twenty-four hours for nearly two years. For three nights steadily, I read these signals twice each night; only these, and nothing more.

But Friday night all was changed. After "Attention," that dreadful "Show" did not come, but this cheerful signal:—

"Hurrah. All well. Air, food, and friends! what more can man require? Hurrah."

How like George! How like Ben Brannan! How like George's wife! How like them all! And they were all well! Yet poor *I* could not answer. Nay, I could only guess what Haliburton had done. But I have never, I believe, been so grateful since I was born!

After a pause, the united line of leapers resumed their jumps and hops. Long and short spelled out:—

"Your O.K. is twice as large as it need be."

Of the meaning of this, lonely *I* had, of course, no idea.

"I have a power of seven hundred," continued George. How did he get that? He has never told us. But this I can see, that all our analogies deceive us,—of views of the sea from Mt. Washington, or of the Boston State House from Wachusett. For in these views we look through forty or eighty miles of dense terrestrial atmosphere. But Orcutt was looking nearly vertically through an atmosphere which was, most of it, rare indeed, and pure indeed, compared with its lowest stratum.

In the record-book of my observations these despatches are entered as 12 and 13. Of course it was impossible for me to reply. All I could do was to telegraph these in the morning to Skowhegan, sending them to the [685] care of the Moores, that they might forward them. But the next night showed that this had not been necessary.

Friday night George and the others went on for a quarter of an hour. Then they would rest, saying "two," "three," or whatever their next signal time would be. Before morning I had these despatches:—

14. "Write to all hands that we are doing well. Langdon's baby is named Io, and Leonard's is named Phoebe."

How queer that was! What a coincidence! And they had some humor there.

15 was: "Our atmosphere stuck to us. It weighs three tenths of an inch—our weight."

16. "Our rain-fall is regular as the clock. We have made a cistern of Kilpatrick." This meant the spherical chamber of that name.

17. "Write to Darwin that he is all right. We began with lichens and have come as far as palms and hemlocks."

These were the first night's messages. I had scarcely covered the eye-glasses, and adjusted the equatorial for the day, when the bell announced the carriage in which Polly and the children came from the station to relieve me in my solitary service as janitor. I had the joy of showing her the good news. This night's work seemed to fill our cup. For all the day before, when I was awake, I had been haunted by the fear of famine for them. True, I knew that they had stored away in chambers H, I, and J the pork and flour which we had sent up for the workmen through the summer, and the corn and oats for the horses. But this could not last forever.

Now, however, that it proved that in a tropical climate they were forming their own soil, developing their own palms, and eventually even their bread-fruit and bananas, planting their own oats and maize, and developing rice, wheat, and all other cereals, harvesting these six, eight, or ten times—for aught I could see—in one of our years,—why then, there was no danger of famine for them. If, as I thought, they carried up with them heavy drifts of ice and snow in the two chambers which were not covered in when they started, why, they had waters in their firmament quite sufficient for all purposes of thirst and of ablution. And what I had seen of their exercise showed that they were in strength sufficient for the proper development of their little world.

Polly had the messages by heart before an hour was over, and the little girls, of course, knew them sooner than she.

Haliburton, meanwhile, had brought out the Shubael refractor (Alvan Clark), and by night of Friday was in readiness to see what he could see. Shubael of course gave him no such luxury of detail as did my fifteen-inch equatorial. But still he had no difficulty in making out groves of hemlock, and the circular openings. And although he could not make out my thirty-seven flies, still when 10.15 came he saw distinctly the black square crossing from hole Mary to the edge, and begin its Dervish dances. They were on his edge more precisely than on mine. For Orcutt knew nothing of Tamworth, and had thought his best chance was to display for No. 9. So was it that, at the same moment with me, Haliburton also was spelling out Orcutt & Co.'s joyous "Hurrah!"

"Thtephen," lisps Celia, "promith that you will look at yon moon [old Thornbush] at the inthtant I do." So was it with me and Haliburton.

He was of course informed long before the Moores' messenger came, that, in Orcutt's judgment, twenty feet of length were sufficient for his signals. Orcutt's atmosphere, of course, must be exquisitely clear.

So, on Saturday, Rob. and Haliburton pulled up all their cambric and arranged it on the Flat again, in letters of twenty feet, in this legend:—

**RAH. AL WEL.**

Haliburton said he could not waste flat or cambric on spelling.

[686] He had had all night since half past ten to consider what next was most important for them to know; and a very difficult question it was, you will observe. They had been gone nearly two years, and much had happened. Which thing was, on the whole, the most interesting and important? He had said we were all well. What then? Did you never find yourself in the same difficulty? When your husband had come home from sea, and kissed you and the children, and wondered at their size, did you never sit silent, and have to think what you should say? Were you never fairly relieved when little Phil said, blustering, "I got three eggs today." The truth is, that silence is very satisfactory intercourse, if we only know all is well. When De Sauty got his original cable going, he had not much to tell after all; only that consols were a quarter per cent higher than they were the day before. "Send me news," lisped he—poor lonely myth!—from Bull's Bay to Valentia,—"send me news; they are mad for news." But how if there be no news worth sending? What do I read in my cable despatch to-day? Only that the Harvard crew pulled at Putney yesterday, which I knew before I opened the paper, and that there had been a riot in Spain, which I also knew. Here is a letter just brought me by the mail from Moreau, Tazewell County, Iowa. It is written by Follansbee, in a good cheerful hand. How glad I am to hear from Follansbee!

Yes; but do I care one straw whether Follansbee planted spring wheat or winter wheat? Not I. All I care for is Follansbee's way of telling it. All these are the remarks by which Haliburton explains the character of the messages he sent in reply to George Orcutt's autographs, which were so thoroughly satisfactory.

Should he say Mr. Borie had left the Navy Department, and Mr. Robeson come in? Should he say the Lords had backed down on the Disendowment Bill? Should he say the telegraph had been landed at Duxbury? Should he say Ingham had removed to Tamworth? What did they care for this? What does anybody ever care for facts? Should he say that the State Constable was enforcing the liquor law on whiskey, but was winking at lager? All this would take him a week, in the most severe condensation,—and for what good? as Haliburton asked. Yet these were the things that the newspapers told, and they told nothing else. There was a nice little poem of Jean Ingelow's in a Transcript Haliburton had with him. He said he was really tempted to spell that out. It was better worth it than all the rest of the newspaper stuff, and would be remembered a thousand years after that was forgotten. "What they wanted," says Haliburton, "was sentiment. That is all that survives and is eternal." So he and Rob. laid out their cambric thus:—

**RAH. AL WEL. SO GLAD.**

Haliburton hesitated whether he would not add, "Power 5000," to indicate the full power I was using at Tamworth. But he determined not to, and, I think, wisely. The convenience was so great, of receiving the signal at the spot where it could be answered, that for the present he thought it best that they should go on as they did. That night, however, to his dismay, clouds gathered and a grim snow-storm began. He got no observations; and the next day it stormed so heavily that he could not lay his signals out. For me at Tamworth, I had a heavy storm all day, but at midnight it was clear; and as soon as the regular eclipse was past George began with what we saw was an account of the great anaclysm which sent them there. You observe that Orcutt had far greater power of communicating with us than we had with him. He knew this. And it was fortunate he had. For he had, on his little world, much more of interest to tell than we had, on our large one.

18. "It stormed hard. We were all asleep, and knew nothing till morning; the hammocks turned so slowly."

Here was another revelation and relief. I had always supposed that, if [687] they knew anything before they were roasted to death, they had had one wild moment of horror. Instead of this, the gentle slide of the MOON had not wakened them; the flight upward had been as easy as it was rapid, the change from one centre of gravity to another had of course been slow,—and they had actually slept through the whole. After the dancers had rested once, Orcutt continued:—

19. "We cleared E.A. in two seconds, I think. Our outer surface fused and cracked somewhat. So much the better for us."

They moved so fast that the heat of their friction through the air could not propagate itself through the whole brick surface. Indeed, there could have been but little friction after the first five or ten miles. By E.A. he means earth's atmosphere.

His 20th despatch is: "I have no observations of ascent. But by theory our positive ascent ceased in two minutes five seconds, when we fell into our proper orbit, which, as I calculate, is 5,100 miles from your mean surface."

In all this, observe, George dropped no word of regret through these five thousand miles.

His 21st despatch is: "Our rotation on our axis is made once in seven hours, our axis being exactly vertical to the plane of our own orbit. But in each of your daily rotations we get sunned all round."

Of course, they never had lost their identity with us, so far as our rotation and revolution went: our inertia was theirs; all the fatal Fly-Wheels had given them was an additional motion in space of their own.

This was the last despatch before daylight of Sunday morning; and the terrible snow-storm of March, sweeping our hemisphere, cut off our communication with them, both at Tamworth and No. 9, for several days.

But here was ample food for reflection. Our friends were in a world of their own, all thirty-seven of them well, and it seemed they had two more little girls added to their number since they started. They had plenty of vegetables to eat, with prospect of new tropical varieties according to Dr. Darwin. Rob. Shea was sure that they carried up hens; he said he knew Mrs. Whitman had several Middlesexes and Mrs. Leonard two or three Black Spanish fowls, which had been given her by some friends in Foxcroft. Even if they had not yet had time enough for these to develop into Alderneys and venison, they would not be without animal food.

When at last it cleared off, Haliburton had to telegraph: "Repeat from 21"; and this took all his cambric, though he had doubled his stock. Orcutt replied the next night:—

22. "I can see your storms. We have none. When we want to change climate we can walk in less than a minute from midsummer to the depth of winter. But in the inside we have eleven different temperatures, which do not change."

On the whole there is a certain convenience in such an arrangement. With No. 23 he went back to his story:—

"It took us many days, one or two of our months, to adjust ourselves to our new condition. Our greatest grief is that we are not on the meridian. Do you know why?"

Loyal George! He was willing to exile himself and his race from the most of mankind, if only the great purpose of his life could be fulfilled. But his great regret was that it was not fulfilled. He was not on the meridian. I did not know why. But Haliburton, with infinite labor, spelt out on the Flat,

**CYC. PROJECT. AD FIN.,**

by which he meant, "See article Projectiles in the Cyclopaedia at the end"; and there indeed is the only explanation to be given. When you fire a shot, why does it ever go to the right or left of the plane in which it is projected? Dr. Hutton ascribes it to a whirling motion acquired by the bullet by friction with the gun. Euler thinks it due chiefly to the irregularity of the shape of the ball. In our case the B. M. was regular enough. But on one side, being wholly unprepared for flight, she [688] was heavily stored with pork and corn, while her other chambers had in some of them heavy drifts of snow, and some only a few men and women and hens.

Before Orcutt saw Haliburton's advice, he had sent us 24 and 25.

24. "We have established a Sandemanian church, and Brannan preaches. My son Edward and Alice Whitman are to be married this evening."

This despatch unfortunately did not reach Haliburton, though I got it. So, all the happy pair received for our wedding-present was the advice to look in the Cyclopaedia at article Projectiles near the end.

25 was:—

"We shall act 'As You Like It' after the wedding. Dead-head tickets for all of the old set who will come."

Actually, in one week's reunion we had come to joking.

The next night we got 26:—

"Alice says she will not read the Cyclopaedia in the honeymoon, but is much obliged to Mr. Haliburton for his advice."

"How did she ever know it was I?" wrote the matter-of-fact Haliburton to me.

27. "Alice wants to know if Mr. Haliburton will not send here for some rags; says we have plenty, with little need for clothes."

And then despatches began to be more serious again. Brannan and Orcutt had failed in the great scheme for the longitude, to which they had sacrificed their lives,—if, indeed, it were a sacrifice to retire with those they love best to a world of their own. But none the less did they devote themselves, with the rare power of observation they had, to the benefit of our world. Thus, in 28:—

"Your North Pole is an open ocean. It was black, which we think means water, from August 1st to September 29th. Your South Pole is on an island bigger than New Holland. Your Antarctic Continent is a great cluster of islands."

29. "Your Nyanzas are only two of a large group of African lakes. The green of Africa, where there is no water, is wonderful at our distance."

30. "We have not the last numbers of 'Foul Play.' Tell us, in a word or two, how they got home. We can see what we suppose their island was."

31. "We should like to know who proved Right in 'He Knew He was Right.'"

This was a good night's work, as they were then telegraphing. As soon as it cleared, Haliburton displayed,—

**BEST HOPES. CARRIER DUCKS.**

This was Haliburton's masterpiece. He had no room for more, however, and was obliged to reserve for the next day his answer to No. 31, which was simply,

**SHE.**

A real equinoctial now parted us for nearly a week, and at the end of that time they were so low in our northern horizon that we could not make out their signals; we and they were obliged to wait till they had passed through two thirds of their month before we could communicate again. I used the time in speeding to No. 9. We got a few carpenters together, and arranged on the Flat two long movable black platforms, which ran in and out on railroad-wheels on tracks, from under green platforms; so that we could display one or both as we chose, and then withdraw them. With this apparatus we could give forty-five signals in a minute, corresponding to the line and dot of the telegraph; and thus could compass some twenty letters in that time, and make out perhaps two hundred and fifty words in an hour. Haliburton thought that, with some improvements, he could send one of Mr. Buchanan's messages up in thirty-seven working-nights.

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[215]

## IV.—INDEPENDENCE.

I own to a certain mortification in confessing that after this interregnum, forced upon us by so long a period of non-intercourse, we never resumed precisely the same constancy of communication as that which I have tried to describe at the beginning. The apology for this benumbment, if I may so call it, will suggest itself to the thoughtful reader.

It is indeed astonishing to think that we so readily accept a position when we once understand it. You buy a new house. You are fool enough to take out a staircase that you may put in a bathing-room. This will be done in a fortnight, everybody tells you, and then everybody begins. Plumbers, masons, carpenters, plasterers, skimmers, bell-hangers, speaking-tube men, men who make furnace-pipe, paper-hangers, men who scrape off the old paper, and other men who take off the old paint with alkali, gas men, city water men, and painters begin. To them are joined a considerable number of furnace-men's assistants, stovepipe-men's assistants, mason's assistants, and hodmen who assist the assistants of the masons, the furnace-men, and the pipe-men. For a day or two these all take possession of the house and reduce it to chaos. In the language of Scripture, they enter in and dwell there. Compare, for the details, Matt. xii.45. Then you revisit it at the end of the fortnight, and find it in chaos, with the woman whom you employed to wash the attics the only person on the scene. You ask her where the paper-hanger is; and she says he can do nothing because the plaster is not dry. You ask why the plaster is not dry, and are told it is because the furnace-man has not come. You send for him, and he says he did come, but the stove-pipe man was away. You send for him, and he says he lost a day in coming, but that the mason had not cut the right hole in the chimney. You go and find the mason, and he says they are all fools, and that there is nothing in the house that need take two days to finish.

Then you curse, not the day in which you were born, but the day in which bath-rooms were invented. You say, truly, that your father and mother, from whom you inherit every moral and physical faculty you prize, never had a bath-room till they were past sixty, yet they thrived, and their children. You sneak through back streets, fearful lest your friends shall ask you when your house will be finished. You are sunk in wretchedness, unable even to read you proofs accurately, far less able to attend the primary meetings of the party with which you vote, or to discharge any of the duties of a good citizen. Life is wholly embittered to you.

Yet, six weeks after, you sit before a soft-coal fire, in your new house, with the feeling that you have always lived there. You are not even grateful that you are there. You have forgotten the plumber's name; and if you met in the street that nice carpenter that drove things through, you would just nod to him, and would not think of kissing him or embracing him.

Thus completely have you accepted the situation.

Let me confess that the same experience is that with which, at this writing, I regard the BRICK MOON. It is there in ether. I cannot keep it. I cannot get it down. I cannot well go to it,—though possibly that might be done, as you will see. They are all very happy there,—much happier, as far as I can see, than if they lived in sixth floors in Paris, in lodgings in London, or even in tenement-houses in Phoenix Place, Boston. There are disadvantages attached to their position; but there are also advantages. And what most of all tends to our accepting the situation is, that there is "nothing that we can do about it," as Q. says, but to keep up our correspondence with them, and to express our sympathies.

For them, their responsibilities are reduced, in somewhat the same proportion [216] as the gravitation which binds them down,—I had almost said to earth,—which binds them down to brick, I mean. This decrease of responsibility must make them as light-hearted as the loss of gravitation makes them light-bodied.

On which point I ask for a moment's attention. And as these sheets leave my hand, an illustration turns up, which well serves me. It is the 23rd of October. Yesterday morning all wakeful women in New England were sure there was some one under the bed. This is a certain sign of an earthquake. And when we read the evening newspapers we were made sure there had been an earthquake. What blessings the newspapers are,—and how much information they give us! Well, they said it was not very severe here, but perhaps it was more severe elsewhere; hopes really arising in the editorial mind, that in some Caraccas or Lisbon all churches and the cathedral might have fallen. I did not hope for that. But I did have just the faintest feeling, that *if*—if—if—it should prove that the world had blown up into six or eight pieces, and they had gone off into separate orbits, life would be vastly easier for all of us, on whichever bit we happened to be.

That thing has happened, they say, once. Whenever the big planet between Mars and Jupiter blew up, and divided himself into one hundred and two or more asteroids, the people on each one only knew there had been an earthquake, until they read their morning journals. And then, all that they knew at first was that telegraphic communication had ceased beyond—say two hundred miles. Gradually people and despatches came in, who said that they had parted company with some of the other islands and continents. But, as I say, on each piece the people not only weighed much less, but were much lighter-hearted, had less responsibility.

Now will you imagine the enthusiasm here, at Miss Hale's school, when it should be announced that geography, in future, would be confined to the study of the region east of the Mississippi and west of the Atlantic,—the earth having parted at the seams so named. No more study of Italian, German, French, or Sclavonic,—the people speaking those languages being now in different orbits or other worlds. Imagine also the superior ease of the office-work of the A.B.C.F.M. and kindred societies, the duties of instruction and civilizing, of evangelizing in general, being reduced within so much narrower bounds. For you and me also, who cannot decide what Mr. Gladstone ought to do with the land tenure in Ireland, and who distress ourselves so much about it in conversation, what a satisfaction to know that Great Britain is flung off with one rate of movement, Ireland with another, and the Isle of Man with another, into space, with no more chance of meeting again than there is that you shall have the same hand at whist tonight that you had last night! Even Victoria would sleep easier, and I am sure Mr. Gladstone would.

Thus, I say, were Orcutt's and Brannan's responsibilities so diminished, that after the first I began to see that their contracted position had its decided compensating ameliorations.

In these views, I need not say, the women of our little circle never shared. After we got the new telegraph arrangement in good running-order, I observed that Polly and Annie Haliburton had many private conversations, and the secret came out one morning, when, rising early in the cabins, we men found they had deserted us, and then, going in search of them, found them running the signal boards in and out as rapidly as they could, to tell Mrs. Brannan and the bride Alice Orcutt that flounces were worn an inch and half deeper, and that people trimmed now with harmonizing colors and not with contrasts. I did not say that I believed they wore fig-leaves in B. M., but that was my private impression.

After all, it was hard to laugh at the [217] girls, as these ladies will be called, should they live to be as old as Helen was when she charmed the Trojan senate (that was ninety-three, if Heyne be right in his calculations). It was hard to laugh at them, because this was simple benevolence, and the same benevolence led to a much more practical suggestion, when Polly came to me and told me she had been putting up some baby things for little Io and Phoebe, and some playthings for the older children, and she thought we might "sen dup a bundle."

Of course we could. There were the Flies still moving! or we might go ourselves!

*[And here the reader must indulge me in a long parenthesis. I beg him to bear me witness that I never made one before. This parenthesis is on the tense that I am obliged to use in sending to the press these minutes. The reader observes that the last transactions mentioned happen in April and May, 1871. Those to be narrated are the sequence of those already told. Speaking of them in 1870 with the coarse tenses of the English language is very difficult. One needs, for accuracy, a pure future, a second future, a paulo-post future, and a paulum-ante future, none of which does this language have. Failing this, one would be glad of an a-orist,—tense without time,—if the grammarians will not swoon at hearing such language. But the English tongue hath not that either. Doth the learned reader remember that the Hebrew,—language of history and prophecy,—hath only a past and a future tense, but hath no present? Yet that language succeeded tolerably in expressing the present griefs or joys of David and of Solomon. Bear with me, then, O critic! if even in 1870 I use the so-called past tenses in narrating what remaineth of this history up to the summer of 1872. End of the parenthesis.]*

On careful consideration, however, no one volunteers to go. To go, if you observe, would require that a man envelope himself thickly in asbestos or some similar non-conducting substance, leap boldly on the rapid Flies, and so be shot through the earth's atmosphere in two seconds and a fraction, carrying with him all the time in a non-conducting receiver the condensed air he needed, and landing quietly on B.M. by a pre-calculated orbit. At the bottom of our hearts I think we were all afraid. Some of us confessed to fear; others said, and said truly, that the population of the Moon was already dense, and that it did not seem reasonable or worth while, on any account, to make it denser. Nor has any movement been renewed for going. But the plan of the bundle of "things" seemed more feasible, as the things would not require oxygen. The only precaution seemed to be that which was necessary for protecting the parcel against combustion as it shot through the earth's atmosphere. We had not asbestos enough. It was at first proposed to pack them all in one of Professor Horsford's safes. But when I telegraphed this plan to Orcutt, he demurred. Their atmosphere was but shallow, and with a little too much force the corner of the safe night knock a very bad hole in the surface of his world. He said if we would send up first a collection of things of no great weight, but of considerable bulk, he would risk that, but he would rather have no compact metals.

I satisfied myself, therefore, with a plan which I still think good. Making the parcel up in heavy old woollen carpets, and cording it with worsted cords, we would case it in a carpet-bag larger than itself, and fill in the interstice with dry sand, as our best nonconductor; cording this tightly again, we would renew the same casing, with more sand; and so continually offer surfaces of sand and woollen, till we had five separate layers between the parcel and the air. Our calculation was that a perceptible time would be necessary for the burning and disintegrating of each sand-bag. If each one, on the average, would stand two fifths of a second, the inner parcel would get [218] through the earth's atmosphere unconsumed. If, on the other hand, they lasted a little longer, the bag, as it fell on B.M., would not be unduly heavy. Of course we could take their night for the experiment, so that we might be sure they should all be in bed and out of the way.

We had very funny and very merry times in selecting things important enough and at the same time bulky and light enough to be safe. Alice and Bertha at once insisted that there must be room for the children's playthings. They wanted to send the most approved of the old ones, and to add some new presents. There was a woolly sheep in particular, and a watering-pot that Rose had given Fanny, about which there was some sentiment; boxes of dominos, packs of cards, magnetic fishes, bows and arrows, checker-boards and croquet sets. Polly and Annie were more considerate. Down to Coleman and Company they sent an order for pins, needles, hooks and eyes, buttons, tapes, and I know not what essentials. India-rubber shoes for the children Mrs. Haliburton insisted on sending. Haliburton himself bought open-eye-shut-eye dolls, though I felt that wax had been, since Icarus's days, the worst article in such an adventure. For the babies he had india-rubber rings: he had tin cows and carved wooden lions for the bigger children, drawing-tools for those older yet, and a box of crochet tools for the ladies. For my part I piled in literature,—a set of my own works, the Legislative Reports of the State of Maine, Jean Ingelow, as I said or intimated, and both volumes of the Earthly Paradise. All these were packed in sand, bagged, and corded,—bagged, sanded, and corded again,—yet again and again,—five times. Then the whole awaited Orcutt's orders and our calculations.

At last the moment came. We had, at Orcutt's order, read the revolutions of the Flies to 7230, which was, as nearly as he knew, the speed on the fatal night. We had soaked the bag for near twelve hours, and, at the moment agreed upon, rolled it on the Flies, and saw it shot into the air. It was so small that it went out of sight too soon for us to see it take fire.

Of course we watched eagerly for signal time. They were all in bed on B.M. when we let fly. But the despatch was a sad disappointment.

107. "Nothing has come through but two croquet balls and a china horse. But we shall send the boys hunting in bushes, and we may find more."

108. "Two Harpers and an Atlantic, badly singed. But we can read all but the parts which were most dry."

109. "We see many small articles revolving round us which may perhaps fall in."

They never did fall in, however. The truth was, that all the bags had burned through. The sand, I suppose, went to its own place, wherever that was. And all the other things in our bundle became little asteroids or aerolites in orbits of their own, except a well-disposed score or two, which persevered far enough to get within the attraction of Brick Moon, and to take to revolving there, not having hit quite square, as the croquet balls did. They had five volumes of the Congressional Globe whirling round like bats within a hundred feet of their heads. Another body, which I am afraid was "The Ingham Papers," flew a little higher, not quite so heavy. Then there was an absurd procession of the woolly sheep, a china cow, an pair of india-rubbers, a lobster Haliburton had chosen to send, a wooden lion, the wax doll, a Salter's balance, the New York Observer, the bow and arrows, a Nuremberg nanny-goat, Rose's watering-pot, and the magnetic fishes, which gravely circled round and round them slowly, and made the petty zodiac of their petty world.

We have never sent another parcel since, but we probably shall at Christmas, gauging the Flies perhaps to one revolution more. The truth is, that although [219] we have never stated to each other in words our difference of opinion or feeling, there is a difference of habit of thought in our little circle as to the position which the B.M. holds. Somewhat similar is the difference to habit of thought in which different statesmen of England regard their colonies.

Is B.M. a part of our world, or is it not? Should its inhabitants be encouraged to maintain their connections with us, or is it better for them to "accept the situation" and gradually wean themselves from us and from our affairs? It would be idle to determine this question in the abstract: it is perhaps idle to decide any question of casuistry in the abstract. But, in practice, there are constantly arising questions which really require some decision of this abstract problem for their solution.

For instance, when that terrible breach occurred in the Sandemanian church, which parted it into the Old School and New School parties, Haliburton thought it very important that Brannan and Orcutt and the church in B.M. under Brannan's ministry should give in their adhesion to our side. Their church would count one more in our registry, and the weight of its influence would not be lost. He therefore spent eight or nine days in telegraphing, from the early proofs, a copy of the address of the chatauque Synod to Brannan, and asked Brannan if he were not willing to have his name signed to it when it was printed. And the only thing which Haliburton takes sorely in the whole experience of the Brick Moon, for the beginning, is that neither Orcutt nor Brannan has ever sent one word of acknowledgment of the despatch. Once, when Haliburton was very low-spirited, I heard him even say that he believed they had never read a word of it, and that he thought he and Rob. Shea had had their labor for their pains in running the signals out and in.

Then he felt quite sure that they would have to establish civil government there. So he made up an excellent collection of books,—De Lolme on the British Constitution; Montesquieu on Laws; Story, Kent, John Adams, and all the authorities here; with ten copies of his own address delivered before the Young Men's Mutual Improvement Society of Podunk, on the "Abnormal Truths of Social Order." He telegraphed to know what night he should send them, and Orcutt replied:—

129. "Go to thunder with your old law-books. We have not had a primary meeting nor a justice court since we have been here, and, D.V., we never will have."

Haliburton says this is as bad as the state of things in Kansas, when, because Frank Pierce would not give them any judges or laws to their mind, they lived a year or so without any. Orcutt added in his next despatch:—

130. "Have not you any new novels? Send up Scribe and the Arabian Nights and Robinson Crusoe and the Three Guardsmen, and Mrs. Whitney's books. We have Thackeray and Miss Austen."

When he read this, Haliburton felt as if they were not only light-footed, but light-headed. And he consulted me quite seriously as to telegraphing to them "Pycroft's Course on Reading." I coaxed him out of that, and he satisfied himself with a serious expostulation with George as to the way in which their young folks would grow up. George replied by telegraphing Brannan's last sermon, 1 Thessalonians iv.11. The sermon had four heads, must have occupied an hour and half in delivery, and took five nights to telegraph. I had another engagement, so that Haliburton had to sit it all out with this eye to Shubael; and he has never entered on that line of discussion again. It was as well, perhaps, that he got enough of it.

The women have never had any misunderstandings. When we had received two or three hundred despatches from B.M., Annie Haliburton came to me and said, in that pretty way of hers, that she thought they had a right to their turn again. She said this lore about the Albert Nyanza and the [220] North Pole was all very well, but, for her part, she wanted to know how they lived, what they did, and what they talked about, whether they took summer journeys, and how and what was the form of society where thirty-seven people lived in such close quarters. This about "the form of society" was merely wool pulled over my eyes. So she said she thought her husband and I had better go off to the Biennial Convention at Assumpink, as she knew we wanted to do, and she and Bridget and Polly and Cordelia would watch for the signals, and would make the replies. She thought they would get on better if we were out of the way.

So we went to the convention, as she called it, which was really not properly a convention, but the Forty-fifth Biennial General Synod, and we left the girls to their own sweet way.

Shall I confess that they kept no record of their own signals, and did not remember very accurately what they were? "I was not going to keep a string of 'says I's' and 'says she's,'" said Polly, boldly. "It shall not be written on my tomb that I have left more annals for people to file or study or bind or dust or catalogue." But they told us that they had begun by asking the "bricks" if they remembered what Maria Theresa said to her ladies-in-waiting.[2] Quicker than any signal had ever been answered, George Orcutt's party replied from the moon, "We hear, and we obey." Then the women-kind had it all to themselves. The brick-women explained at once to our girls that they had sent their men round to the other side to cut ice, and that they were manning the telescope, and running the signals for themselves, and that they could have a nice talk without any bother about the law-books or the magnetic pole. As I say, I do not know what questions Polly and Annie put; but,—to give them their due,—they had put on paper a coherent record of the results arrived at in the answers; though, what were the numbers of the despatches, or in what order they came, I do not know; for the session of the synod kept us at "Assampink for two or three weeks.

Mrs. Brannan was the spokesman. "We tried a good many experiments about day and night. It was very funny at first, not to know when it would be light and when dark, for really the names day and night do not express a great deal for us. Of course the pendulum clocks all went wrong till the men got them overhauled, and I think watches and clocks both will soon go out of fashion. But we have settled down on much the old hours, getting up, without reference to daylight, by our great gong, at your eight o'clock. But when the eclipse season comes, we vary from that for signalling.

"We still make separate families, and Alice's is the seventh. We tried hotel life, and we like it, for there has never been the first quarrel here. You can't quarrel here, where you are never sick, never tired, and need not be ever hungry. But we were satisfied that it was nicer for the children, and for all round, to live separately, and come together at parties, to church, at signal time, and so on. We had something to say then, something to teach, and something to learn.

"Since the carices developed so nicely into flax, we have had one great comfort, which we had lost before, in being able to make and use paper. We have had great fun, and we think the children have made great improvement in writing novels for the Union. The Union to the old Union for Christian work that we had in dear old No. 9. We have two serial novels going on, one called 'Diana of Carrotook,' and the other called 'Ups and Downs'; the first by Levi Ross, and the other by my Blanche. They are really very good, and I wish we could send them to you. But they would not be worth despatching.

"We get up at eight; dress, and fix [221] up at home; a sniff of air, as people choose; breakfast; and then we meet for prayers outside. Where we meet depends on the temperature; for we can choose any temperature we want, from boiling water down, which is convenient. After prayers an hour's talk, lounging, walking, and so on; no flirting, but a favorite time with the young folks.

"Then comes work. Three hours' head-work is the maximum in that line. Of women's work, as in all worlds, there are twenty-four in one of your days, but for my part I like it. Farmers and carpenters have their own laws, as the light serves and the seasons. Dinner is seven hours after breakfast began; always an hour long, as breakfast was. Then every human being sleeps for an hour. Big gong again, and we ride, walk, swim, telegraph, or what not, as the case may be. We have no horses yet, but the Shanghaes are coming up into very good dodos and ostriches, quite big enough for a trot for the children.

"Only two persons of a family take tea at home. The rest always go out to tea without invitation. At 9 P.M. big gong again, and we meet in 'Grace,' which is the prettiest hall, church, concert-room, that you ever saw. We have singing, lectures, theatre, dancing, talk,

2. Maria V's husband, Francis, Duke of Tuscany, was hanging about loose one day, and the Empress, who had got a little tired, said to the maids of honor, "Girls, whenever you marry, take care and choose a husband who has something to do outside of the house."

or what the mistress of the night determines, till the curfew sounds at ten, and then we all go home. Evening prayers are in the separate households, and every one is in bed by midnight. The only law on the statute-book is that every one shall sleep nine hours out of every twenty-four.

"Only one thing interrupts this general order. Three taps on the gong means 'telegraph,' and then, I tell you, we are all on hand."

"You cannot think how quickly the days and years go by!"

Of course, however, as I said, this could not last. We could not subdue our world, and be spending all our time in telegraphing our dear B.M. Could it be possible?—perhaps it was possible,—that they there had something else to think of and to do, besides attending to our affairs. Certainly their indifference to Grant's fourth Proclamation, and to Mr. Fish's celebrated protocol in the Tahiti business, looked that way. Could it be that little witch of a Belle Brannan really cared more for their performance of Midsummer Night's Dream, or her father's birthday, than she cared for that pleasant little account I telegraphed up to all the children, of the way we went to muster when we were boys together? Ah well! I ought not to have supposed that all worlds were like this old world. Indeed, I often say this is the queerest world I ever knew. Perhaps theirs is not so queer, and it is I who am the oddity.

Of course it could not last. We just arranged correspondence days, when we would send to them, and they to us. I was meanwhile turned out from my place at Tamworth Observatory. Not but I did my work well, and Polly hers. The observer's room was a miracle of neatness. The children were kept in the basement. Visitors were received with great courtesy; and all the fees were sent to the treasurer; he got three dollars and eleven cents one summer,—that was the year General Grant came there; and that was the largest amount that they ever received from any source but begging. I was not unfaithful to my trust. Nor was it for such infidelity that I was removed. No! But it was discovered that I was a Sandemanian; a Glassite, as in derision I was called. The annual meeting of the trustees came round. There was a large Mechanics' Fair in Tamworth at the time, and an Agricultural Convention. There was no horserace at the convention, but there were two competitive examinations in which running horses competed with each other, and trotting horses competed with each other, and five thousand dollars was given to the best runner and the best trotter. These causes drew all the trustees together. The Rev. Cephas Philpotts presided. His doctrines with [222] regard to free agency were considered much more sound than mine. He took the chair,—in that pretty observatory parlor, which Polly had made so bright with smilax and ivy. Of course I took no chair; I waited, as a janitor should, at the door. Then a brief address. Dr. Philpotts trusted that the observatory might always be administered in the interests of science, of true science; of that science which rightly distinguishes between unlicensed liberty and true freedom; between the unrestrained volition and the freedom of the will. He became eloquent, he became noisy. He sat down. Then three other men spoke, on similar subjects. Then the executive committee which had appointed me was dismissed with thanks. Then a new executive committee was chosen, with Dr. Philpotts at the head. The next day I was discharged. And the next week the Philpotts family moved into the observatory, and their second girl now takes care of the instruments.

I returned to the cure of souls and to healing the hurt of my people. On observation days somebody runs down to No. 9, and by means of Shubael communicates with B.M. We love them, and they love us all the same.

Nor do we grieve for them as we did. Coming home from Pigeon Cove in October, with those nice Wadsworth people, we fell to talking as to the why and wherefore of the summer life we had led. How was it that it was so charming? And why were we a little loath to come back to more comfortable surroundings? "I hate the school," said George Wadsworth. "I hate the making calls," said his mother. "I hate the office hour," said her poor husband; "if there were only a dozen I would not mind, but seventeen hundred thousand in sixty minutes is too many." So that led to asking how many of us there had been at

Pigeon Cove. The children counted up all the six families,—the Haliburtons, the Wadsworths, the Pontefracts, the Midges, the Hayeses, and the Inghams, and the two good-natured girls,—thirty-seven in all,—and the two babies born this summer. "Really," said Mrs. Wadsworth, "I have not spoken to a human being besides these since June; and what is more, Mrs. Ingham, I have not wanted to. We have really lived in a little world of our own."

"World of our own!" Polly fairly jumped from her seat, to Mrs. Wadsworth's wonder. So we had—lived in a world of our own. Polly reads no newspaper since the "Sandemanian" was merged. She has a letter or two tumble in sometimes, but not many; and the truth was that she had been more secluded from General Grant and Mr. Gladstone and the Khedive, and the rest of the important people, than had Brannan or Ross or any of them!

And it had been the happiest summer she had ever known.

Can it be possible that all human sympathies can thrive, and all human powers be exercised, and all human joys increase, if we live with all our might with the thirty or forty people next to us, telegraphing kindly to all other people, to be sure? Can it be possible that our passion for large cities, and large parties, and large theatres, and large churches, develops no faith nor hope nor love which would not find aliment and exercise in a little "world of our own"?

## Document I-4

**Document title: Percival Lowell, *Mars* (Boston: Houghton Mifflin Co., 1895), pp. 201-12.**

Percival Lowell, a Brahmin from Massachusetts, became interested in Mars during the latter part of the nineteenth century. Using personal funds and grants from other sources he built what became the Lowell Observatory near Flagstaff, Arizona, to study the planets. This research led him to publish *Mars and Its Canals* in 1906, which argued that Mars had once been a watery planet and that the topographical features known as canals had been built by intelligent beings. Over the course of the next forty years others used Lowell's observations of Mars as a foundation for their arguments. The idea of intelligent life on Mars stayed in the popular imagination for a long time.

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[201] To review, now, the chain of reasoning by which we have been led to regard it probable that upon the surface of Mars we see the effects of local intelligence. We find, in the first place, that the broad physical conditions of the planet are not antagonistic to some form of life; secondly, that there is an apparent dearth of water upon the planet's surface, and therefore, if beings of sufficient intelligence inhabited it, they would have to resort to irrigation to support life; thirdly, that there turns out to be a network of markings covering the disk precisely counterparting what a system of irrigation would look like; and, lastly, that there is a set of spots placed where we should expect to find the lands thus artificially fertilized, and behaving as such constructed oases should. All this, of course, may be a set of coincidences, signifying nothing; but the probability points the other way. As to details of explanation, any we may adopt will undoubtedly be found, on closer acquaintance, to vary from the actual Martian state of things; for any Martian life must differ markedly from our own.

[202] The fundamental fact in the matter is the dearth of water. If we keep this in mind we shall see that many of the objections that spontaneously arise answer themselves. The supposed herculean task of constructing such canals disappears at once for, if the canals be dug for irrigation purposes, it is evident that what we see, and call by ellipsis the canal, is not really the canal at all, but the strip of fertilized land bordering it,——the thread of water in the midst of it, the canal itself, being far too small to be perceptible. In the case of an irrigation canal seen at a distance, it is always the strip of verdure, not the canal, that is visible, as we see in looking from afar upon irrigated country on the Earth.

We may, perhaps, in conclusion, consider for a moment how different in its details existence on Mars must be from existence on the Earth. One point out of many bearing on the subject, the simplest and most certain of all, is the effect of mere size of habitat upon the size of the inhabitant; for geometrical conditions alone are most potent factors in the problem of life. Volume and mass determine the force of gravity upon the surface of a planet, and this is more far-reaching in its effects than might at first be thought. Gravity on the surface of Mars is only a little more than one third what it is on the surface of the Earth. This would work in two ways to very different conditions of existence from those to which we are accustomed. To begin with, three times as much work, as for example, in digging a canal, could be done by the same expenditure of muscular force. If we were transported to Mars, we [203] should he pleasingly surprised to find all our manual labor suddenly lightened threefold. But, indirectly, there might result a yet greater gain to our capabilities; for if Nature chose she could afford there to build her inhabitants on three times the scale she does on Earth without their ever finding it out except by interplanetary comparison. Let us see how.

As we all know, a large man is more unwieldy than a small one. An elephant refuses to hop like a flea; not because he considers the act undignified, but simply because he cannot bring it about. If we could, we should all jump straight across the street, instead of painfully paddling through the mud. Our inability to do so depends upon the size of the Earth, not upon what it at first seems to depend on, the size of the street.

To see this, let us consider the very simplest case, that of standing erect. To this every-day feat opposes itself the weight of the body simply, a thing of three dimensions, height, breadth, and thickness, while the ability to accomplish it resides in the cross-section of the [204] muscles of the knee, a thing of only two dimensions, breadth and thickness. Consequently, a person half as large again as another has about twice the supporting capacity of that other, but about three times as much to support. Standing therefore tires him out more quickly. If his size were to go on increasing, he would at last reach a stature at which he would no longer be able to stand at all, but would have to lie down. You shall see the same effect in quite inanimate objects. Take two cylinders of paraffine wax, one made into an ordinary candle, the other into a gigantic facsimile of one, and then stand both upon their bases. To the small one nothing happens. The big one, however, begins to settle, the base actually made viscous by the pressure of the weight above.

Now apply this principle to a possible inhabitant of Mars, and suppose him to be constructed three times as large as a human being in every dimension. If he were on Earth, he would weigh twenty-seven times as much, but on the surface of Mars, since gravity there is only about one third of what it is here, he would weigh but nine times as much. The cross-section of his muscles would be nine times as great. Therefore the ratio of his supporting power to the weight he must support would be the same as ours. Consequently, he would be able to stand with as little fatigue as we. Now [205] consider the work he might be able to do. His muscles, having length, breadth, and thickness, would all be twenty-seven times as effective as ours. He would prove twenty-seven times as strong as we, and could accomplish twenty-seven times as much. But he would further work upon what required, owing to decreased gravity, but one third the effort to overcome. His effective force, therefore, would be eighty-one times as great as man's, whether in digging canals or in other bodily occupation. As gravity on the surface of Mars is really a little more than one third that at the surface of the Earth, the true ratio is not eighty-one, but about fifty; that is, a Martian would be, physically, fifty-fold more efficient than man.

As the reader will observe, there is nothing problematical about this deduction whatever. It expresses an abstract ratio of physical capabilities which must exist between the two planets, quite irrespective of whether there be denizens on either, or how other conditions may further affect their forms. As the reader must also note, the deduction refers to the possibility, not to the probability, of such giants; the calculation being introduced simply to show how different from us any Martians may be, not how different they are.

It must also be remembered that the question of their size has nothing to do with the [206] question of their existence. The arguments for their presence are quite apart from any consideration of avoirdupois. No Herculean labors need to be accounted for; and, if they did, brain is far more potent to the task than brawn.

Something more we may deduce about the characteristics of possible Martians, dependent upon Mars itself, a result of the age of the world they would live in.

A planet may in a very real sense be said to have life of its own, of which what we call life may or may not be a subsequent detail. It is born, has its fiery youth, sobers into middle age, and just before this happens brings forth, if it be going to do so at all, the creatures on its surface which are, in a sense, its offspring. The speed with which it runs through its gamut of change prior to production depends upon its size; for the smaller the body the quicker it cools, and with it loss of heat means beginning of life for its offspring. It cools quicker because, as we saw in a previous chapter, it has relatively less inside for its outside, and it is through its outside that its inside cools. After it has thus become capable of bearing life, the Sun quickens that life and supports it for we know not how long. But its duration is measured at the most by the Sun's life. Now, inasmuch as time and space are not, as some philosophers have from their too mundane standpoint [207] supposed, forms of our intellect, but essential attributes of the universe, the time taken by any process affects the character of the process itself, as does also the size of the body undergoing it. The changes brought about in a large planet by its cooling are not, therefore, the same as those brought about in a small one. Physically, chemically, and, to our present end, organically, the two results are quite diverse. So different, indeed, are they that unless the planet have at least a certain size it will never produce what we call life, meaning our particular chain of changes or closely allied forms of it, at all. As we saw in the case of atmosphere, it will lack even the premise to such conclusion.

Whatever the particular planet's line of development, however, in its own line, it proceeds to greater and greater degrees of evolution, till the process stops, dependent, probably, upon the Sun. The point of development attained is, as regards its capabilities, measured by the planet's own age, since the one follows upon the other.

Now, in the special case of Mars, we have before us the spectacle of a world relatively well on in years, a world much older than the Earth. To so much about his age Mars bears evidence on his face. He shows unmistakable signs of being old. Advancing planetary years have left their mark legible there. His continents are all [208] smoothed down; his oceans have all dried up. *Teres atque rotundus*, he is a steady-going body now. If once he had a chaotic youth, it has long since passed away. Although called after the most turbulent of the gods, he is at the present time, whatever he may have been once, one of the most peaceable of the heavenly host. His name is a sad misnomer; indeed, the ancients seem to have been singularly unfortunate in their choice of planetary cognomens. With Mars so peaceful, Jupiter so young, and Venus bashfully draped in cloud, the planet's names accord but ill with their temperaments.

Mars being thus old himself, we know that evolution on his surface must be similarly advanced. This only informs us of its condition relative to the planet's capabilities. Of its actual state our data are not definite enough to furnish much deduction. But front the fact that our own development has been comparatively a recent thing, and that a long time would be needed to bring even Mars to his present geological condition, we may judge any life he may support to be not only relatively, but really older than our own.

From the little we can see, such appears to be the case. The evidence of handicraft, if such it be, points to a highly intelligent mind behind it. Irrigation, unscientifically conducted, would not give us such truly wonderful mathematical [209] fitness in the several parts to the whole as we there behold. A mind of no mean order would seem to have presided over the system we see,—a mind certainly of considerably more comprehensiveness than that which presides over the various departments of our own public works. Party politics, at all events, have had no part in them; for the system is planet wide. Quite possibly, such Martian folk are possessed of inventions of which we have not dreamed, and with them electrophones and kinetoscopes are things of a bygone past, preserved with veneration in museums as relics of the clumsy contrivances of the simple childhood of the race. Certainly what we see hints at the existence of beings who are in advance of, not behind us, in the journey of life.

Startling as the outcome of these observations may appear at first, in truth there is nothing startling about it whatever. Such possibility has been quite on the cards ever since the existence of Mars itself was recognized by the Chaldean shepherds, or whoever the still more primeval astronomers may have been. Its strangeness is a purely subjective phenomenon, arising from the instinctive reluctance of man to admit the possibility of peers. Such would be comic were it not the inevitable consequence of the constitution of the universe. To be shy of anything resembling himself is part and parcel [210] of man's own individuality. Like the savage who fears nothing so much as a strange man, like Crusoe who grows pale at the sight of footprints not his own, the civilized thinker instinctively turns from the thought of mind other than the one he himself knows. To admit into his conception of the cosmos other finite minds as factors has in it something of the weird. Any hypothesis to explain the facts, no matter how improbable or even palpably absurd it be, is better than this. Snow-caps of solid carbonic acid gas, a planet cracked in a positively mono-maniacal manner, meteors ploughing tracks across its surface with such mathematical precision that they must have been educated to the performance, and so forth and so on, in hypotheses each more astounding than its predecessor, commend themselves to man, if only by such means he may escape the admission of anything approaching his kind. Surely all this is puerile, and should as speedily as possible be outgrown. It is simply an instinct like any other, the projection of the instinct of self-preservation. We ought, therefore, to rise above it, and, where probability points to other things, boldly accept the fact provisionally, as we should the presence of oxygen, or iron, or anything else. Let us not cheat ourselves with words. Conservatism sounds finely, and covers any amount of ignorance and fear.

[211] We must be just as careful not to run to the other extreme, and draw deductions of purely local outgrowth. To talk of Martian beings is not to mean Martian men. Just as the probabilities point to the one, so do they point away from the other. Even on this Earth man is of the nature of an accident. He is the survival of by no means the highest physical organism. He is not even a high form of mammal. Mind has been his making. For aught we can see, some lizard or batrachian might just as well have popped into his place early in the race, and been now the dominant creature of this Earth. Under different physical conditions, he would have been certain to do so. Amid the surroundings that exist on Mars, surroundings so different from our own, we may be practically sure other organisms have been evolved of which we have no cognizance. What manner of beings they may be we lack the data even to conceive.

For answers to such problems we must look to the future. That Mars seems to be inhabited is not the last, but the first word on the subject More important than the mere fact of the existence of living beings there, is the question of what they may be like. Whether we ourselves shall live to learn this cannot, of course, be foretold. One thing, however, we can do, and that speedily: look at things from a standpoint raised above our local point of view; [212] free our minds at least from the shackles that of necessity tether our bodies; recognize the possibility of others in the same light that we do the certainty of ourselves. That we are the sum and substance of the capabilities of the cosmos is something so preposterous as to be exquisitely comic. We pride ourselves upon being men of the world, forgetting that this is but objectionable singularity, unless we are, in some wise, men of more worlds than one. For, after all, we are but a link in a chain. Man is merely this earth's highest production up to date. That he in any sense gauges the possibilities of the universe is humorous. He does not, as we can easily foresee, even gauge those of this planet. He has been steadily bettering from an immemorial past, and will apparently continue to improve through an incalculable future. Still less does he gauge the universe about him. He merely typifies in an imperfect way what is going on elsewhere, and what, to a mathematical certainty, is in some corners of the cosmos indefinitely excelled.

If astronomy teaches anything, it teaches that man is but a detail in the evolution of the universe, and that resemblant though diverse details are inevitably to be expected in the host of orbs around him. He learns that, though he will probably never find his double anywhere, he is destined to discover any number of cousins scattered through space.