

1 ORIGINS OF THE DREAM

Traveling to the stars is one of the greatest and grandest dreams of humanity. The prospect of leaving the Earth behind, blasting through light years of empty space, reaching another solar system, and then alighting upon a completely new and alien world, is one of the biggest, boldest, and bravest schemes ever conceived. The idea pervades popular culture, having been depicted in a long line of science fiction short stories and books, in television series such as *Star Trek* and its sequels and imitators, and in movies like *Star Wars* and *Interstellar*, plus their own train of sequels, copies, and spinoffs. As a result, it is all too easy for us to imagine that one day – maybe even one day soon – some select portion of the human race will actually be *leaving for the stars*.

And what a romantic dream it is! The whole enthralling vision is magnetically attractive and intoxicating. As Daniel Deudney said in his book *Dark Skies* (a critique of space expansionism): “It feeds off experiences of the technological and cosmic sublimines, of awesome roaring rockets and astounding gizmos, and of weirdly alien planets, incomprehensibly titanic cataclysms, and mesmerizing spacescapes. Everything about it is oversized: speeds, distances, magnitudes – and payoffs.”

For all of their appeal, however, dreams have their limitations. They are expressions of emotional states, desires, and yearnings as opposed to being cognitive structures embodying practical human interests, needs, or necessities. To say this is not to downplay or dismiss the value of dreams. Dreams have a legitimate, perhaps even a necessary, place in the overall scope of human aspiration, creativity, and achievement. Dreams motivate people to attempt, and to accomplish, great feats of construction, such as

an architect building the world's tallest skyscraper or an engineer designing a rocket that will take us to the planet Mars. History's biggest megaprojects – the Suez Canal, the Channel Tunnel, the Apollo Project – had been dreams in the minds of their respective planners and engineers long before they were ever begun.

People have even discovered literal truths in dreams. In the mid-1800s the German chemist Friedrich August Kekulé happened upon two of his most important discoveries while dreaming, and later recorded a detailed account of each dream. The first discovery was his idea of the manner in which carbon atoms combined with others to form carbon compounds. The solution occurred to him while riding an open-top bus in London:

One fine summer evening I was returning by the last omnibus, "outside," as usual through the deserted streets of the metropolis, which are at other times so full of life. I fell into a reverie, and lo, the atoms were gambolling before my eyes! . . . The cry of the conductor "Clapham Road" awakened me from my dreaming; but I spent part of the night in putting on paper at least sketches of these dream forms.

Kekulé's better-known discovery was that of the hexagonal structure of the benzene molecule, which likewise came to him in a dream:

I was sitting, writing at my text-book; but the work did not progress; my thoughts were elsewhere. I turned my chair to the fire and dozed. Again the atoms were gambolling before my eyes. This time the smaller groups kept modestly in the background. My mental eye, rendered more acute by repeated visions of the kind, could now distinguish larger structures, of manifold conformation: long rows, sometimes more closely fitted together; all twining and twisting in snake-like motion. But look! What was that? One of the snakes had seized hold of its own tail, and the form whirled mockingly before my eyes. As if by a flash of lightning, I awoke; and this time also I spent the rest of the night in working out the consequences of the hypothesis.

These experiences gave Kekulé a new respect for dreams. “Let us learn to dream,” he said, “then perhaps we shall find the truth.”

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A dream so vast, complex, and multifaceted as that of traveling to the stars has, like a river flowing from many tributaries, more than one source or origin. In addition, the sources may be of different types, originating as myths, as desires, in abstract conceptual thought, from the construction of proofs of concept, and in the results of experimental tests. As a matter of simple logic, the first and most basic prerequisite of interstellar travel was the prior notion of human flight through the air. The dream of leaving the surface of the Earth and traveling through the atmosphere is quite ancient. It originated in myth, and then had a somewhat tortuous developmental history that was littered with a number of dead ends as well as an even greater number of dead people.

The idea is reflected in many legends going back to antiquity, including the myth of Daedalus and Icarus, which is the best known among them. But there are also other myths, from earlier times and different cultures. In his book *Taking Flight*, the aviation historian Richard Hallion said:

From the dawn of time people around the globe have expressed the dream of flight, emphasizing the incredible and depicting aerial powers as an element of religion, mythology, or war. The Egyptians worshipped Horus, the sky-god falcon ... The peoples of Asia Minor venerated various flying deities, such as the winged Hurrian goddess Shaushka (Ishtar) and the sacred double-headed eagle of Hittite tradition.

And the Christians, Jews, and Muslims had their divine winged angels.

But even before people had any thought of taking to the skies, they had invented all sorts of gadgets and contrivances that flew, and their designs reflected at least a primitive, intuitive

understanding of what later became known as the principles of aerodynamics. Even a child playing games had a natural grasp of how to throw stones or branches so as to make them reach their targets. A more adult activity was to propel straight, elongated objects swiftly and accurately, whether in outdoor games or as weapons that might mean the difference between eating or starving – or even life or death, depending on the circumstances. Thus there are ancient spears and arrows that are efficiently streamlined, that do not tumble in flight, and that follow the same flight path when launched in the same manner, allowing for the development of marksmanship.

The mythical flight of Daedalus and Icarus was patterned after the flight of birds, for both fliers had feathers attached to their arms. Their flight was in fact a partial success since although Icarus lost his feathers by flying “too close to the sun,” and plunged into the sea and drowned, his father Daedalus landed safely on the shore.

The idea of using birds as templates for human flight was attractive inasmuch as birds were an obvious proof of concept that heavier than air flight was possible, and for that reason it was embraced by many who hoped to get people aloft. So great a person as Leonardo da Vinci had closely observed the flight of birds, and wrote in his notebook: “A bird is an instrument working according to mathematical law, which instrument it is within the capacity of man to reproduce with all its movements.” He also thought the same about bats: “Dissect the bat, study it carefully, and on this model construct the machine.”

This was the concept of an ornithopter, a mechanical device propelled by a person equipped with wings that could be flapped by muscle power. Da Vinci sketched a number of designs for such contrivances, all of which were essentially unworkable in practice. Birds are relatively small and light, and the members of many species have hollow bones. The largest and heaviest birds, such as ostriches and emus, are flightless. The best and most agile fliers – hummingbirds – are so small and light as to weigh almost nothing at all: the bee hummingbird, of Cuba, weighs less than half an ounce.

Human beings are far too heavy to be supported in the air by means of the lift provided by flapping wings, as several men who built ornithopters and tried to fly in them demonstrated. Between 850 and 1500, various “tower jumpers” built wings out of wood, feathers, or cloth, and then jumped off roofs, trees, and other heights, desperately flapping away, often killing themselves in the process. The bird template therefore constituted a dead end in the attempt to make human flight possible, and retarded rather than accelerated the development of flying machines.

But amid the history of failed bird-mimicking flight concepts and actual flight attempts, there appeared in the first decade of the eleventh century an instance of true winged flight that must be regarded as at least a partial success. This was the case of a young Benedictine monk named Eilmer, of Malmesbury Abbey in England. The abbey, portions of which still exist, had walls that were about 150 feet high (about as tall as a 15-story building), and is located in western Wiltshire, an area characterized by frequent gusty winds.

Brother Eilmer had been inspired by the Daedalus legend, and also perhaps by the profusion of crows that nested upon the building’s heights, and so constructed for himself a crude set of wings that could attach to his hands and feet. The wings are thought to have been made of wood covered by a light cloth. The outstretched wings did not flap, but in the air they would be pushed upward at their tips, giving them a dihedral (V-shaped) angle with respect to each other, a geometrical arrangement that acted to keep the wings laterally stable in flight.

And so one fine day, probably when the wind was gusting favorably, in an act of singular courage (and considerable recklessness), Brother Eilmer climbed to the top of the abbey wall and stood on the ledge for a moment, balancing himself. He looked down upon the tops of trees below him, as well as the river in the distance, and perhaps even saw a flock of birds. And then, no doubt murmuring a few words of prayer, launched himself off into empty space.

He did not fall downward like a stone, but, according to a later historian of British monks, William of Malmesbury, glided a fair distance away. As William described the incident:

[Eilmer] had by some contrivance fastened wings to his hands and feet, in order that, looking upon the fable as true, he might fly like Daedalus, and collecting the air, on a summit of the tower, had flown for more than a furlong; but agitated by the violence of the wind and a current of air, as well as by the consciousness of his rash attempt, he fell and broke his legs, and was lame ever after. He used to relate as the cause of his failure that he had forgotten to provide himself with a tail.

A furlong was about 600 feet, approximately the length of two football fields, and to travel through the air that far horizontally was a genuine example of gliding flight even if the landing came with a bang. His glide path was relatively steep, and the whole flight is thought to have taken between 12 and 15 seconds. But despite its painful ending, Brother Eilmer's floating descent to the ground was an early, real-life example of hang gliding.

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The first true, safe, and successful free ascent of a human being from the ground and into the air, and back, was not achieved by an ornithopter, hang glider, or anything else having to do with wings. It was made, instead, by . . . a hot-air balloon.

One might imagine that the first humans to successfully achieve the age-old dream of flight would be household names, familiar to all the world, but in fact they are complete unknowns to most people today. But the balloon by which they flew was an invention of the comparatively well-known Montgolfier brothers, Étienne and Joseph, papermakers, of Annonay, France. The idea for the craft had originated with Joseph, who in November 1782 sat gazing into a fireplace. He saw little ash particles being carried up the flue and came to the

sudden realization that this rising current of heat might be captured in some manner and be put to practical use.

He soon constructed a small test balloon out of taffeta, filled it with smoke from a fire, and lo and behold, it rose into the air. The two brothers then constructed a bigger test model, the *Martial*, which in September 1783 made an ascent witnessed by Louis XVI, Marie Antoinette, and an estimated 100,000 Parisians. In what would become the grand tradition of putting animals inside spacecraft before using human subjects, in the balloon's basket were a sheep, a duck, and a rooster.

After that success, the Montgolfier brothers created their masterpiece vehicle of flight, the *Globe Aërostatique*. Looking much like a flying Fabergé egg, it was said to be one of the most richly decorated aerial vehicles ever to exist. Its outer surface was covered with the 12 signs of the Zodiac, the King's initials, multiple radiating sunbursts, a repeating pattern of fleurs-de-lys, plus representations of draperies, bunting, and various other oddments and adornments.

The test pilot for the balloon's maiden flight would be one Jean François Pilâtre de Rozier, a 26-year-old *citoyen*-scientist and adventurer who was always ready for anything. On Friday, November 21, 1783, Rozier and his co-pilot, François Laurent, the Marquis d'Arlandes, boarded the craft in the Bois de Boulogne. With heat provided by a brazier burning straw and wool, at 1:54 in the afternoon the blue and gold balloon rose from the ground "in a most majestic fashion," according to an observer, gained height to the degree that it could be seen by all of Paris, and flew off toward the Seine. Twenty to 25 minutes later, the aeronauts landed safely in a field on the outskirts of the city. So ended the first human flight in the history of the world.

The balloon in its various incarnations proceeded to have a checkered career, carrying passengers, and often killing them, until it all came to a tragic conclusion in the *Hindenburg* disaster, in which the enormous Zeppelin crashed and burned at Lakehurst, New Jersey, on May 6, 1937. Thirty-five people out of a total of 97 souls on board perished in the flames or died in hospital later.

Lighter-than-air flight lives on today in the colorful sport of hot-air ballooning and in a collection of advertising blimps that fly over crowds at large events. As such, the balloon proved to be only a small step up the conceptual ladder that led – at last, and eventually – to the dream of flying to the stars.

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The most significant next step up the ladder was an enormous one, taken by the Wright brothers, who made their famous first flights on December 17, 1903. It was the start of a progression that culminated in the development of the modern, safe, and efficient airliner that we know today. The Wright brothers had proceeded slowly and scientifically, experimenting first with kites and then with gliders. They constructed two wind tunnels in which they tested more than 200 airfoils of different cambers and chords, establishing coefficients of lift for each. Only after years of such research and trial and error did they achieve actual flight.

Still, flying through the atmosphere of Earth, as astonishing as it was at first, constituted only one stage of many leading to the dream of traveling to the stars. A further necessary concept would require a complete change of orientation and frame of reference, for this was the notion of not only leaving the surface of Earth, but of departing from both the planet and its atmosphere, and traveling to another heavenly body, the closest of which was of course the Moon. Surprisingly, this quite radical and literally outlandish notion was nevertheless also quite ancient. When it first appeared, however, the idea was not meant to be taken seriously but was rather intended only as part of an elaborate fiction, or even as a sort of hoax or joke.

The author of this fable was one Lucian (circa 150 CE) of Samosata, a town in what is now Turkey. Lucian was a professional satirist, lampooner, and spinner of tales, most of them wholly unbelievable. He is credited with having produced more than 80 works of satire and fiction, all of which made gleeful fun of everything and everybody. In a work called *Philosophies for Sale* he depicts the Greek god Zeus as establishing a slave market in which he puts several famous

philosophers up for auction, including Pythagoras, Diogenes, Heraclitus, and Socrates. In *The Lover of Lies*, he satirizes belief in paranormal phenomena such as miracle cures for various illnesses. He also ridicules superstition, religion, and the Greek gods. Nothing and nobody was sacred to him, and his works were highly prized for their irreverence and absurdity.

Lucian's most famous work, *Vera Historia*, "The True History," begins by telling the reader that everything in the narrative is completely made-up and false, and should not be believed, despite its title conveying exactly the opposite impression. The fictional history was Lucian's attempt to out-do what he saw as some of the more fanciful elements in Homer's *Odyssey*, and in this he succeeded all too well.

"The True History," which describes a voyage to the Moon and back, is regarded by some critics as the first work of science fiction. The journey begins at sea, with Lucian and some fellow travelers sailing out beyond the Pillars of Hercules (the Strait of Gibraltar), where they come upon an island endowed with a river that flows with wine, and where the trees look like women.

The online Project Gutenberg translation by Thomas Francklin describes the course of events as the travelers prepare to leave the island:

We then took our casks, filled some of them with water, and some with wine from the river, slept one night on shore, and the next morning set sail, the wind being very moderate. About noon, the island being now out of sight, on a sudden a most violent whirlwind arose, and carried the ship above three thousand stadia, lifting it up above the water, from whence it did not let us down again into the seas but kept us suspended in mid air, in this manner we hung for seven days and nights, and on the eighth beheld a large tract of land, like an island, round, shining, and remarkably full of light; we got on shore, and found on examination that it was cultivated and full of inhabitants, though we could not then see any of them. As night came on other islands appeared, some large, others small, and of a fiery colour; there was also

below these another land with seas, woods, mountains, and cities in it, and this we took to be our native country.

They soon encounter another individual, who speaks to them in their native language:

“You are Grecians,” said he, “are you not?” We told him we were. “And how,” added he, “got ye hither through the air?” We told him everything that had happened to us; and he, in return, related to us his own history, and informed us, that he also was a man, that his name was Endymion, that he had been taken away from our earth in his sleep, and brought to this place where he reigned as sovereign. That spot, he told us, which now looked like a moon to us, was the earth.

An unknowing but prophetic word picture of the famous “Earthrise” photo taken from orbit above the Moon by Apollo 8 astronaut William Anders on December 24, 1968 (Figure 1.1).

A second fictional voyage to the Moon was of greater significance, for two reasons. One, it was written by none other than Johannes Kepler, author of the laws of planetary motion. And two, because Kepler’s narrative is much more realistic than Lucian’s, to the point that some of it rings true, almost as if it were “hard” science fiction or even plain fact. Fittingly enough in this context, the author called his story *Somnium*, “The Dream.” A new translation from the Latin of a relevant section by Tom Metcalf of The *Somnium* Project, conveys a few of the core events during this second fictitious trip to the Moon:

The whole journey, although far, is completed in a time of four hours at the most. Never are we more busy than the time determined for our departure. . . . This occasion proves so narrow [just like a space shot!] that we take few of the human race along. . . . First of all he experiences a strong pressure, not unlike an explosion of gunpowder, as he is hurled above the mountains and the seas. For this reason,

drugs and opium are consumed at the start, so that he falls asleep, and each of his limbs disentangled, so that his body is not torn from his legs [as if by g-forces], nor his head driven from his body, but so the shock will be distributed across all his limbs. Next he experiences new difficulties: it is intensely cold ... When they awake, humans usually complain of indescribable exhaustion in all their limbs, from which, much later, they recover enough to walk.

Strong pressure. G-forces. Intensely cold. Exhaustion on landing and trouble walking – similar enough to what astronauts on long-duration missions on the International Space Station experience when they arrive back on Earth. In his book *Cosmos*, Carl Sagan writes that Kepler got some other things



Figure 1.1 Earthrise. (NASA)

right as well: “Because of the length of the lunar day and night Kepler described ‘the great intemperateness of climate and the most violent alteration of extreme heat and cold on the Moon,’ which is entirely correct.”

The first Project Apollo Moon landing on July 20, 1969 was the real-world embodiment of centuries of fables, hopes, and dreams.

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Two additional conceptual leaps of the imagination were necessary before the dream of interstellar travel could emerge as a realistic possibility. The first was the idea of leaving the Earth–Moon system altogether, and traveling to another planet within the solar system. Lucian of Samosata had mentioned traveling to Venus in his “True Stories,” but only as yet another instance of his tall tales. Several other authors also wrote stories and books about traveling to Mars in the late 1800s. But the first to explore this idea at length and in detail, and in such a way as to reach a wide audience, was Edgar Rice Burroughs in his 11 novels about Mars, starting with his first, *The Princess of Mars*, of 1912.

Burroughs’s fiction had been inspired in part by the prior work of two astronomers, Giovanni Schiaparelli and Percival Lowell. In 1877 Earth and Mars reached points in their orbits when they were closest together, and therefore made Mars favorable for observation from Earth. During this time Schiaparelli made an exhaustive telescopic study of the Martian surface and decided that he saw there a series of *canali*, meaning channels. The word was mistranslated into English, however, as “canals,” implying that they had been deliberately made by intelligent living beings.

In 1894, during another close approach of the two planets, the Harvard educated astronomer Percival Lowell made an even more thorough study of Mars from his own private observatory in Flagstaff, Arizona. He took thousands of photographs of the Martian surface and claimed to have seen complex patterns of canals, which intersected at what he called “oases.” He later

wrote several works about the planet, including an essay and a book, each entitled “Mars as the Abode of Life.” Both claimed that the canals had been built by intelligent beings for purposes of irrigating the planet’s otherwise dry land areas. He clarified matters somewhat by saying that “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.”

Having promoted visions of an alien, dying, intelligent civilization, Lowell became, according to science writer (and science fiction author) Isaac Asimov, “the patron saint of the intelligent-life-on-Mars cult.” Of course no canals existed on Mars, then or now, and Lowell’s visions are possibly just wishful projections of his hopes and dreams onto an entirely canal-absent surface. The mystique of Mars nevertheless kept its hold on the general public.

Edgar Rice Burroughs, during his time one of the world’s best-selling authors, the creator of *Tarzan of the Apes* among 90 other books, wrote a popular series of novels depicting a complex, intelligent civilization on Mars. The first of them, *A Princess of Mars*, is narrated in the first person by one John Carter of Virginia. It begins strangely enough: “I am a very old man; how old I do not know. Possibly I am a hundred, possibly more; but I cannot tell because I have never aged as other men, nor do I remember any childhood.”

At the end of the Civil War he and a fellow officer go prospecting for gold in Arizona. They are quite successful at this, but his colleague ends up being killed by Apache tribesmen. Later, standing alone in an open field in the moonlight, John Carter catches a glimpse of Mars:

My attention was quickly riveted by a large red star close to the distant horizon. As I gazed upon it I felt a spell of overpowering fascination – it was Mars, the god of war . . . As I gazed at it on that far-gone night it seemed to call across that unthinkable void, to lure me to it, to draw me as the lodestone attracts a particle of iron.

My longing was beyond the power of opposition; I closed my eyes, stretched out my arms toward the god of my vocation and felt myself drawn with the suddenness of thought through the trackless immensity of space. There was an instant of extreme cold and utter darkness.

Next thing he knows, he is on the planet Mars, lying on the ground, naked. “I opened my eyes upon a strange and weird landscape. I knew that I was on Mars; not once did I question either my sanity or wakefulness.”

There follows a tale full of what has come to be known as the well-worn chestnuts of science-fictional alien worlds: little green men – “green Martians” – though in this case they were big green men, 15 feet tall. There were also BEMs, bug-eyed monsters: “Their eyes were set at the extreme sides of their heads a trifle above the center and protruded in such a manner that they could be directed either forward or back.”

And of course Lowell’s canals duly made their appearance: “Twice we crossed the famous Martian waterways, or canals, so-called by our earthly astronomers.”

The alluring visions offered by the Burroughs Mars novels – including the magical means of getting there – cast a spell over generations of impressionable young readers, among them scientist Carl Sagan, who confesses in *Cosmos* that “I can remember spending many an hour in my boyhood, arms resolutely outstretched in an empty field, imploring what I believed to be Mars to transport me there. It never worked.”

Sagan would turn out to be one of the world’s foremost proponents of colonizing Mars, and of human interstellar migrations. Meanwhile, the first successful landing on Mars occurred on July 20, 1976, when NASA’s Viking 1 lander touched down in Chryse Planitia.

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The final leap of the imagination necessary for the dream of traveling to the stars to be entertained as a serious possibility was the biggest conceptual advance of them all: the idea of

exiting our native solar system entirely, traveling through not miles but light years of space, landing on a completely new and foreign planet, and establishing a founding civilization there. Whereas the prior feats required only small, incremental progressions from one stage to the next, the act of traveling to the stars was an exponentially greater change of scale, time, and reach.

For this, something more than a dream or a tall tale was needed. What was needed was a genuine spacefaring vehicle, the rocket, as well as an understanding of the principles of space flight, and, lastly, the idea that the true home of humanity was not just the Earth, Mars, or the solar system, but the cosmos.

The first rockets, the essential prerequisites of interstellar travel, depended in turn upon the invention (or accidental discovery) of a propellant, the earliest of which was a derivative of black powder, itself a mixture of sulfur, carbon, and potassium nitrate (saltpeter). The mixture contained an inhibitor so that it would explode slowly and progressively, producing a short, controlled burn rather than a sudden blast. A form of such a chemical propellant appeared in China by the middle of the ninth century. It could be packaged into a length of bamboo that was open at one end; with a stabilizing stick at the bottom and a pointed nose cap at the top, and *voilà!* a rocket.

They were at first amusing toys, but soon were put to other uses. Rockets were used in warfare as far back in time as the year 1232, during the Mongol siege of Kaifeng, in China. The technology of black powder rocketry soon made its way to Europe, and it, along with other propellants, have been in use ever afterward.

The idea of using rockets for space flight owes much to the Russian physicist and aerospace engineer Konstantin Tsiolkovsky, who had formulated the basic principles of astronautics before the end of the nineteenth century. According to a short autobiographical sketch, Tsiolkovsky was born in a remote Russian village in 1857. At the age of 10 his hearing had been substantially impaired by a bout of scarlet fever, and he was partially deaf thereafter. "This handicap estranged me from people," he wrote, "and prompted me to read, concentrate, and dream."

One of the things he dreamt about was flight, an interest first stimulated by his mother, who gave him a toy balloon filled with hydrogen. Marvelously, it rose through the air. As he matured, Tsiolkovsky essentially recapitulated the designs of some aeronautical dream-machines that had been proposed by others, starting with the lowly ornithopter and its futile, flapping wings. He built a few examples of these, none of which worked, which brought him to “the final realization that the thing was impractical.”

His next step forward, however, was a gigantic one, into what he called “cosmic space.” In 1895 he wrote a book, *Dreams about Earth and Skies*, and in 1898 an article, “Reactive Flying Machines.” Taken together, these treatises made him one of the fathers of modern space flight. The 1898 essay established the fundamentals of orbital mechanics. It also proposed the then radical idea of using the very same rocket propellants that are still in common use today: liquid oxygen and liquid hydrogen (LOX/LH₂). “The two liquid gases are separated by a partition,” he wrote. “The place where the gases are mixed and exploded is shown [in an accompanying diagram], as is the flared outlet for the intensely rarefied and cooled vapors.”

Later in the same piece Tsiolkovsky advanced the idea of an Earth-orbiting space station: “It is possible to construct a permanent observatory that would travel for an indeterminate length of time around the Earth, like the Moon, beyond the limits of the atmosphere.”

Tsiolkovsky later wrote about space suits, satellites, and the colonization of the solar system. At one point he even hinted at the idea of traveling beyond the solar system, saying that “Not only the earth, but the whole universe is the heritage of mankind.” And: “Perhaps, a hundred years will pass before my idea will find application and people will travel not only on the surface of our globe but also on the face of the universe.” He is popularly known for the aphorism that “Earth is the cradle of humanity, but one cannot remain in the cradle forever.”

This, then, was the final culmination of a succession of dreams that had emerged progressively in 11 steps or stages

that had begun in antiquity. In logical order, the several steps were from: (1) the birth of ancient Greek and other myths of flight, to (2) proposals for machines that would make flight possible by mimicking the flapping wings of birds, to (3) actual attempts at human flight, to (4) successful human flight through the air by means of balloons, to (5) powered, controlled, sustained human flight through the atmosphere by winged vehicles, to (6) fictional accounts of flying to the Moon, to (7) the invention of rockets leading to an understanding of the principles of space flight, to (8) the Apollo Project Moon landings, to (9) fictional accounts of traveling to Mars, to (10) actual landings on Mars by rockets and robotic rovers, to (11) the idea of leaving Earth and colonizing the universe. Arguably, many of these stages of flight were the embodiments of age-old dreams.

As we have seen, truths can be found in dreams, and Kekulé was a champion of dreaming: “Let us learn to dream, gentlemen, then perhaps we shall find the truth,” he said. Still, he ended his praise of dreams with a caveat, on a decidedly cautionary note. “But let us beware of publishing our dreams before they have been put to the proof by the waking understanding.”

Can the heroic dream of interstellar flight survive critical scrutiny by the waking understanding, or is it one of those dreams that ends by going up in smoke? That is the question.