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The space age and the origin of space research

INTRODUCTION

The exploration of space is one of the greatest achievements of the twentieth century. In the ideal photo album of this century one could hardly avoid including such pictures as our blue planet seen from space and the human footprint on the Moon's surface; the close-up images of a comet's nucleus and the rough landscape of Mars; the floating of astronauts in the black vacuum around a space station and the rings of Saturn photographed from an approaching spacecraft.

Space technologies have provided us with the possibility of real-time global communications, as well as with unprecedented knowledge of cosmic phenomena. Traditional research fields like astronomy underwent dramatic changes when telescopes could be flown beyond the atmosphere; others emerged brand-new when physicists could put their sophisticated instruments onboard satellites and space-probes. Knowledge of our own planet took a big step forward when it became possible to investigate, from space, the delicate equilibrium of its various components.

This book is devoted to the great advances in scientific knowledge that space technologies have made possible. Scientific research, however, can hardly be considered to be the main driving force in space activities. Political and military considerations, in fact, played the major role in making the old dream of exploring space a technical reality. To the deliberate attempt of the Nazi regime to develop the ultimate weapon to win the war we owe the V2, the prototype of the rockets which helped the United States and the Soviet Union to start successful space programmes in the

immediate post-war period. Then the Cold War was to fuel the development of more powerful missiles, capable of delivering a nuclear weapon across the oceans.

These missiles were also capable of launching a satellite into orbit, and a new dimension was thus added to the Cold War confrontation: the demonstration of technical superiority in a field which could greatly affect the public imagination. This was seen as being particularly important in Third World countries, which were, at that epoch, emerging from the colonial era and in search of ideological principles, economic models and international patronage. Being first in space, first on the Moon, became an important political goal for both superpowers, wanting to demonstrate the superiority of their cultural values, the efficiency of their political institutions, the performance of their industrial system, and the strength of their armed forces.

Scientists on both sides of the Iron Curtain were able to take advantage of the opportunity offered by this new dimension, building instruments which could be fitted into the nose-cones of sounding rockets or the payloads of spacecraft, and designing space missions which could solve old and new problems in astronomy and geophysics. A new scientific community emerged from this experience, identified less by their disciplinary affiliation than by the technical means they used.

Space science, in fact, is not a well-defined research field. It includes, in principle, any scientific investigation conducted by the use of rockets, Earth-orbiting satellites and deep-space-probes. In terms of established scientific disciplines, it covers fields as different as atmospheric physics, geophysics, plasma physics, cosmic-ray physics and the various branches of astronomy (solar, stellar and planetary; from radio wavelengths up to the gamma-ray

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Figure 1 Astronaut's footprint on the Moon, 1969. (Source: NASA.)

region of the electromagnetic spectrum). Space sciences have also revitalized the old subdiscipline of astrometry and have helped make observational cosmology a practical and very fruitful area of research. Moreover, they have made important contributions to material sciences, biology and medicine. Each of these disciplines was dramatically reshaped by the advent of space technologies, both regarding their scientific content (such as *in situ* measurements of ionospheric phenomena, chemical and isotopic investigation of the Moon's soil, astronomical observations in new spectral bands) and with respect to their increasingly interdisciplinary nature (such as the growing importance of physicists in astronomical research).

This chapter presents an historical overview of the origin of space science within the framework of the major political and military events which shaped the early phase of the space age. Given the nature of this overview, it was decided to include a comprehensive bibliography at the end, rather than to insert specific references to the vast literature on the history of space into the body of the text.

DREAMS OF SPACE FLIGHT

A journey to the Moon and beyond has for centuries been the object of popular fantasies, philosophical speculations and poetic dreams. Space travel literature can be traced back to Lucian of Samosota's *Vera Historia* (*True History*),

written in the second century, whose heroes are taken to the Moon by a terrible whirlwind that lifts their ship into space. In Lucian's second book, entitled *Icaro-Menippus*, the trip to the Moon is carefully planned and eventually performed by Menippus, the hero, with the help of wings fastened to his shoulders.

At the height of the Italian *Rinascimento*, a voyage to the Moon was conceived in 1516 by the great Italian poet Ludovico Ariosto in his epic poem *Orlando Furioso*. Searching for the lost mind of Orlando, Astolpho is carried to the Moon by Elijah's chariot drawn by four red horses. He visits the Moon, where everything lost on Earth is stored in a valley, and eventually finds the paladin's mind in a phial.

A century later, in Germany, one of the fathers of modern astronomy, Johannes Kepler, told of a Moon flight in his *Somnium* (*Dream*), posthumously published in 1634. In Kepler's dream, conceived as an allegory for astronomy which reveals the reality of celestial bodies, supernatural demons (that is, astronomical knowledge) drive the learned traveller to the Moon along the shadow of the Earth during a lunar eclipse, and then they drive him back along the Moon's shadow during a solar eclipse.



Figure 2 Johannes Kepler. (Source: Istituto e Museo di Storia della Scienza, Florence.)

The same theme was dealt with in those years by two English bishops. Francis Godwin, Bishop of Hereford, wrote *The man in the Moon: or a discourse of a voyage thither* under the pseudonym Domingo Gonsales. The book was published in 1638 and it became very popular all over Europe. The protagonist of the book, Gonsales himself, flies to the Moon by a chair pulled by wild geese. In the same year, John Wilkins, Bishop of Chester, published *The discovery of the man in the Moon: or a discourse tending to prove that 'tis probable there may be another habitable world in that planet*. Wilkins tells nothing about the means of propulsion but he speculates that no effort would be required beyond the point where the influence of terrestrial gravity ceases, which he assumes to be some thirty kilometres above the Earth's surface.

At the court of the king of France we find the most remarkable author of Moon tales of the seventeenth century. This is Savinien de Cyrano Bergerac, dramatist and poet, philosopher and swordsman, whose enormous nose found a place in the history of French literature thanks to Edmond Rostand's famous play of 1897. Cyrano's *L'autre monde, ou les états et empires de la Lune*, posthumously published in 1657, tells of several attempts by himself to reach the Moon. First, he tied a string of vials filled with dew around himself, so that the rays of the morning sun could draw him upward when evaporating the dew, but he only arrived in Canada on that attempt.

He then tried to launch himself from the top of a hill by a special spring-loaded vehicle, but the vehicle crashed down into the valley. After curing the bruises by smearing ox marrow on his body, the hero returned to his vehicle, but he found that some soldiers had taken possession of it and were tying fireworks to it in order to make it appear as a flying fire dragon. He tried to stop the soldier who was setting fire to the fuse, only to find himself trapped in the vehicle while the latter lifted off to the clouds.

Tiers after tiers, all the rockets were rapidly exhausted, but instead of crashing down to Earth with the vehicle, Cyrano continued his ascension to the sky. The waning Moon, he explained, used to suck up the marrow of animals, and that is why his greased body was pulled upwards. A few days later he finally landed on the Moon, where he had many adventures and philosophical discussions with its inhabitants. After returning to Earth, the hero decided to visit the Sun, and the story is told in Cyrano's second book, *Histoire comique des états et empires du Soleil* (1662).

While presenting the first space travel performed by means of rocket propulsion, Cyrano's works do not deal with science, nor even science fiction. They are instead remarkable examples of philosophical novels, a literary device for the author to expound his materialistic ideas and his libertine vision of human affairs. European literature of the seventeenth and eighteenth century counts several other

works in which space travel and encounters with alien people serve as witty means for conveying the author's opinions about mundane matters.

But in the century which saw the birth of modern science, other works tried to deal with the old dream of space flight in the light of the new astronomical knowledge (sunspots, Jupiter's satellites, Saturn's rings, mountains on the Moon, and so on), and in accordance with the tenets of the new natural philosophy. A major event was the publication, in 1686, of Bernard de Fontenelle's *Entretiens sur la pluralité des mondes*, a popular astronomy book which was widely read throughout Europe for its fascinating speculations on the nature and habitability of Solar System bodies. Fontenelle claimed that each planet had its own inhabitants and discussed their likely appearance, civilization and habits.

The belief that planets are inhabited by different species of rational beings was also expressed by the great Dutch scientist Christian Huygens in his *Cosmotheoros, or conjectures concerning the planetary worlds*, first published in Latin in 1698. However, if the Moon and the planets were no longer considered as metaphorical symbols but as real worlds subject to universal physical laws, tales of space travels had to cope with the problem of escaping the Earth's gravitational pull. In David Ruesen's *Iter lunare or voyage to the Moon* (1703) a huge spring device is proposed as a means of launching a manned vehicle towards the Moon. Two years later, Daniel Defoe's *The consolidator* tells us that ancient people mastered the art of space flight and used to travel to and from the Moon. Defoe describes in particular an intriguing engine based on the use of hollow bodies filled with 'a certain spirit' which produced a continuous fire. The fire acted on a spring-and-wheel mechanism which kept two large wings in motion.

Many other tales of lunar travel can be found in eighteenth century literature, including Samuel Brunt's *A voyage to Cacklogallinia* (1727), whose heroes are propelled into space by intelligent birds, and Murtagh McDermot's *A trip to the Moon* (1728), where a whirlwind takes the hero to the Moon and gunpowder is used to return him to Earth. In Voltaire's *Micromégas* (1752) we find the first extraterrestrial visitor of literary history: an intelligent giant arriving on Earth from the star Sirius after a long journey through the Milky Way and the Solar System.

In the nineteenth century, science fiction became a well-established literary genre, nourished by the dramatic progress of astronomy and by the growing importance of science and engineering in everyday life. Romantic tales and philosophical speculations were gradually replaced by scientific and technical discussions of the various aspects of space flight. Science fiction writers, however, still lacked the most important element: a credible means to escape the Earth's gravitational field. An antigravity material called *lunarium* was devised by the University of Virginia professor George

Tucker in his novel *A voyage to the Moon with some account of the manners and customs, science and philosophy of the people of Morosofia and other Lunarians*, published in 1827 under the pseudonym of Joseph Atterley. Eight years later, Edgar Allan Poe, a former student of Tucker's, sent his hero Hans Pfaall on a lunar trip in a home-made balloon. In 1865, the Frenchman Achille Eyraud imagined a spaceship powered by a reaction engine based on the ejection of water for his *Voyage à Venus*.

The recognized father of modern science fiction is Jules Verne, whose novels *De la terre à la lune* (1865) and *Autour de la lune* (1870) became very popular all over the world. The former tells of the long and careful preparation of a voyage to the Moon, to be accomplished by three astronauts sitting inside an artillery shell fired into space by a huge cannon, called *Columbiad*. The shell was equipped with a special mechanism for absorbing the shock, a chemical system for air regeneration, and rockets for soft landing on the Moon's surface. The book ends with the successful

firing of the cannon and the story is then picked up in the second book. Here we follow the heroes during their space travel. Owing to a large meteorite passing close to their spaceship, the latter is displaced out of the planned trajectory and ends by orbiting around the Moon. An attempt to steer the vehicle towards landing by the use of the rockets fails and the voyagers are pushed towards the Earth, safely descending in the Pacific Ocean where they are rescued by an American ship.

Verne's stories took advantage of the most advanced scientific knowledge of his times, including calculations of escape velocity and flight trajectories, a sound determination of the best geographic location for the launch cannon (in Florida, not far from the present US launch facilities), and a realistic description of weightlessness in outer space. Inspired by the general scientific optimism of the late nineteenth century, Verne and his followers were less interested in writing Moon tales (his heroes, in fact, do not land on the Moon), than in discussing in literary form the possibilities for



Figure 3 Illustration from *De la terre à la lune* by Jules Verne. (Source: AKG.)



Figure 4 Illustration from *Autour de la lune* by Jules Verne. (Source: AKG.)



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