History of Rocketry and Astronautics

Proceedings of the Ninth, Tenth and Eleventh History Symposia of The International Academy of Astronautics

Lisbon, Portugal, 1975

Anaheim, California, U.S.A., 1976

Prague, Czechoslovakia, 1977

Frederick I. Ordway, III, Volume Editor

R. Cargill Hall, Series Editor

AAS History Series, Volume 9

A Supplement to Advances in the Astronautical Sciences

IAA History Symposia, Volume 4

AAS Publications Office
P.O. Box 28130
San Diego, California 92128

Affiliated with the American Association for the Advancement of Science
Member of the International Astronautical Federation

First Printing 1989

ISSN 0730-3564

ISBN 0-87703-309-9 (Hard Cover)
ISBN 0-87703-310-2 (Soft Cover)

Published for the American Astronautical Society
by Univelt, Inc., P.O. Box 28130, San Diego, California 92128

Printed and Bound in the U.S.A.

Chapter 19

KEPLER'S "THE DREAM, OR LUNAR ASTRONOMY" AS A PREDECESSOR OF SPACE RESEARCH*

Z. Horsky†

It is well known that the foundations of a scientific theory about the movement of bodies in space were laid by Isaac Newton. They are as old as the law of gravitation published in 1687 in his famous work *Philosophiae naturalis principia mathematica.* Already in this work we can read a clear and correct description of the conditions under which a body with a given imparted initial speed in a given direction would start orbiting the Earth or would leave the Earth forever [1]. In a rough simplification, it is possible to conceive of all the development of cosmonautics after Newton as a search for conditions of how to reach these speeds and how to ensure that a spaceship survives the physical conditions of passing through the atmosphere and extraterrestrial space, conditions generously ignored by Newton in his considerations.

It follows from the fact that the theory of gravitation created a scientific basis for a future active space research, that predecessors of this research have to be looked for among those scientists who, before Newton, had approached the wording of the gravitational law. And among them the most successful was precisely Johannes Kepler who worked out in Prague his "axioms of a true science about gravitation". They are contained in the introduction to his basic work *Astronomia nova* published in 1609 [2] where, as is well-known, he formulated on the basis of Tycho Brahe's and his own observations the first two laws of the movement of planets, i.e., of those laws whose application is a daily bread of the present-day space researcher. We can only regret that Kepler himself never returned at a later time to the ideas forming the content of the "axioms of the true science about gravitation" and preferred to orient his later research in a different way.

Presumably, it was not a mere chance that at a time when these "axioms" were worded, Kepler intensely examined the idea of reaching another space body, specifically the Moon. We can have an idea about the extent of his obsession with this possibility when reading his work *Dissertatio cum nuncio sidereo* from 1610. In the form of a long letter, Kepler answers Galileo and reacts to his work from the

---

* Presented at The Eleventh IAA History of Astronautics Symposium, Prague, Czechoslovakia, September 1977.

† Astronomical Institute of the Czechoslovak Academy of Sciences, Prague, Czechoslovakia.

same year *Sidereus nuncius*. Kepler writes Galileo from Prague: "Provide us with ships or veils adapted to the celestial atmosphere -- and people will be found who will not be taken aback by these distances. We might say that the brave ones to undertake this voyage are waiting already. And so, Galileo, you are going to found the astronomy of Jupiter and I myself that of the Moon [3]." Kepler calls Galileo founder of Jupiter's astronomy, because Galileo in his Stellar Messenger reports the discovery of Jupiter's four large satellites. And he considers himself -- not by mere chance -- to be a founder of lunar astronomy, since already at that time he had finished the manuscript known under the title *Somnium sive de astronomia lunari (The Dream, or Lunar Astronomy)*.

And it is exactly this work by Kepler that represents the center of interest of our paper. In this work we can perceive in the most distinct way Kepler as a precursor of space research. In recent research in the field of the history of literature, this work has not been ignored. Studies evaluating the science fiction type of literature and among them especially those dealing with imaginary voyages to the Moon had always to take into consideration this work by Kepler, which is very strong both from the point of view of strictly literary values and from the point of view of its content. Another reason why the authors of these studies have to take Kepler's work into consideration is the fact that one of the best known and most popular works of this type, *The Voyage to the Moon* by Cyrano de Bergerac, is partially and consciously influenced by Kepler's *Dream*. At the same time these studies had always to establish quite a particular position of the *Dream*, the impossibility to classify it within this or that developmental trend of this or that type of literature. But even in Kepler's life work itself the *Dream* and its nature represent a total exception [4].

What is the content and the structure of Kepler's *Dream*? Our knowledge is based on the Latin printed edition published only four years after the death of the author by his son Ludwig Kepler (1634) [5]. The original manuscript was lost, unfortunately. It appears from the published work that it was elaborated in two different stages and that, in fact, it had never been completely finished by the author. Recently, a detailed analysis of the structure of this work was carried out and the history of its origin examined by Professor Edward Rosen, who accompanied his English translation of the *Dream* with a detailed commentary [6]. Many aspects of Rosen's research will serve as a basis for what follows.

Rosen distinguishes three stages in the birth of the work. In the text of the *Dream* itself only two stages are apparent. The first one represents only about one-fourth of the total size forms the essence and the proper text of the *Dream*. It was written in Prague as early as 1608/9. The rest, originating much later, consists of long comments regarding the basic text.

The basic text itself consists again of two quite distinct parts. The first part is pure literary fiction. Kepler begins by references to his time. The dispute from 1608 between the Emperor Rudolf II and his brother the Archduke Matthias, was commented on by the Prague public and compared with examples from the history of Bohemia. Under the impact of these events Kepler also began to study Czech his-

tory and was attracted by the fate of the princess Libusha who excelled in the art of witchcraft.

Once, when reading a book, Kepler fell asleep -- and here the fiction part of the narration begins -- and saw himself playing the role of a certain Duracotus. His mother was a witch and also a healing woman named Fiolxhilda. In the figure of Duracotus we can distinguish clearly the person of Kepler himself as well as in the old healing woman his mother. Let us, however, follow only the main elements of the story.

Fiolxhilda, angry with her son, who once interrupted her witchcraft due to his unfortunate curiosity, sells him to the naval service. By accident Duracotus gets to the Danish island of Hven where Tycho Brahe lives. For several years, he studies astronomy under the master's guidance. Even this detail reveals the autobiographical details of Kepler's explanation. After five years, Duracotus returns to his mother who arranges for him a voyage to the Moon. The voyage could take place only thanks to the witchcraft of the mother, to her capacity to call the demons from Levania, a name designating the Moon. The transfer of a human body from the Earth to the Moon closes the fantastic part of the story.

We can find herein a number of rational observations: Kepler foresees the dangerous effects of the solar radiation on a human body outside the atmosphere (he believes that the atmosphere reaches only to the highest peaks of the mountains), and that is why the whole voyage had to take place during the time of the Moon's eclipse, when it is necessary to move inside the shadow of the Earth. Kepler also reckons with breathing difficulties outside the atmospheric envelope of the Earth. To a certain extent he seems to guess even the difficulties connected with overloading. Kepler also predicted, in good agreement with his axioms of the true science about gravitation, the existence of a borderline beyond which, during the movement of a body from the Earth to the Moon, the lunar gravitation will prevail over the terrestrial one. He was also aware of the fact that this borderline must be much nearer to the Moon than to the Earth, given the smaller volume of the Moon and, consequently -- assuming the same density of the Earth and of the Moon -- the smaller mass of the Moon. In the author's humorous allusions as to who is and who is not suitable for such a voyage to the Moon, some researchers are ready to see a kind of future cosmonaut.

As soon as Duracotus had landed on the Moon, he began describing the phenomena he observed there. The description is very systematic and begins, "in the way of geographers", with phenomena to be observed in the sky. After that, an exact description is given of astronomical phenomena as observed from the Moon.

Let us mention just the main facts. The Moon is divided into two hemispheres; one of them is facing us constantly. It is, therefore, possible to watch from it the Earth nearly always in the same position in the sky. The second hemisphere, which is averted from the Earth, will never allow anybody to see our planet. Quite certainly the view of the Earth is the most beautiful phenomenon to be observed from the Moon. Moreover, the observer will see the Earth constantly rotating round its axis! And, according to the gradual swiveling of its spots, he will be capable of measuring

time as by a watch. For that reason Kepler -- using the words of fictitious Moon inhabitants -- calls the Earth Volva (from the Latin verb *volvere*), because unlike the Moon seen from the Earth Volva is constantly revolving.

Further on he claims that the movement of the fixed stars has the same appearance on the Moon as on the Earth (with only a different time of the apparent turning of the celestial sphere), while the seeming motion of the planets is when much more complicated than observed from the Earth. These basic findings were very likely a matter of primary concern for Kepler; it is because of them he undertook the daring attempt to observe the sky from the Moon. The defender of the Copernican heliocentric system has thus acquired two decisive arguments:

1. An observer on the Moon will have -- just as an observer on the Earth -- a feeling that he stands on a stationary body in the centre of the Universe that is turning in its totality round him. If this feeling can be proved to be fallacious on the Moon, it must be fallacious on the Earth as well.

2. An observer on the Moon will see with his own eyes that the Earth is revolving round its axis. In the spirit of the Copernican astronomy and in agreement with the tendencies of Giordano Bruno's philosophical cosmology, Kepler tried in the first place to deepen the antianthropocentric world outlook.

In the subsequent text of the *Dream* a detailed analysis of the phenomena belonging to the field of spherical astronomy follows, conceived specially for the Moon. When he has covered this topic and when Kepler begins to assess the physical conditions on the Moon (e.g. predictions of big droughts or, on the contrary, of long rain periods due to a long-term exposure of the lunar surface to the solar rays and after that due to a long night during the long lunar day), the *Dream* comes all of a sudden to an end. Kepler has fully exhausted and covered the field that, as an astronomer, he could master with absolute certainty and accuracy; as soon as he was obliged to guessing only, the author suddenly woke up from a deep dream with his head buried under the pillows.

This is the form in which the manuscript of the *Dream* remained for more than 12 years; only later on did Kepler return to the text again and added the 223 remarks and notices, some of them never to be completed. They were created at a time when Kepler worked subsequently in Linz, Ulm and Zagan. The remarks are about three times longer than the text itself. When Kepler's son Ludwig made up his mind to publish the *Dream* in the year 1634, he commented on the remarks that his father had written noting them to have gradually been prepared between the years 1620 and 1630. But, as Rosen [7] proved convincingly, work on the remarks could have begun by the end of the year 1621; or, more likely, during 1622 at the earliest.

It is worthwhile to take into account the environment in which the basic text of the *Dream* originated, as well as the stimuli influencing its conception. Rosen believes that the oldest stage of Kepler's *Dream* is his student dissertation at Tübingen University in 1593 [8], which dealt with the topic "How would the phenomena occurring in the heavens appear to an observer stationed on the Moon." The content of this thesis, however, remains unknown. It was never exposed to public discussion as it was too Copernican to be admitted to a public judgment.

On the other hand, we can hardly accept the view that this thesis was included in the known Kepler's text the *Dream*. It seems that Kepler in Prague returned once again to his original student idea, but treated it in a new way. The influence of the Prague scientific environment is apparent in the text of the *Dream*. And not only because Kepler himself talks about this matter publicly in his introduction to the work.

The autobiographically conceived Duracotus was initiated to astronomy by Tycho Brahe and Kepler himself collaborated with Tycho in Bohemia in the years 1600 and 1601. We also know from Kepler that in his idea to work up a lunar astronomy there was participation by his Prague friend Johannes Matthaus Wackher of Wackenfels, imperial councilor to Rudolf's court. (He was born in 1550 in Constance and died in 1619 in Vienna.) This very individual thinker has up to now escaped attention in the history of the astronomy. Studies about the Prague scientific milieu around 1600 usually do not quote his name as among the foremost representatives of mathematics and astronomy such as Tadeáš Hájek z Hájku (Hagecius), Tycho Brahe, and Johannes Kepler or the outstanding designers of instruments Erasmus Habermel and Justus Bürgi (known also in mathematics as an inventor of logarithms). Next to these Prague scientific personalities Wackher seems to fade, the main reason very probably being that he never published his astronomical views and considerations and that he was regarded by his contemporaries rather as a philosopher and politician. Nevertheless, his cosmological views were very bright and independent. They are known especially, thanks to Kepler's mediation.

Wackher was a zealous and enthusiastic defender of the philosophy of Giordano Bruno. In cosmology he fully understood the meaning of Bruno's speculative completion of heliocentrism. He advocated Bruno's idea that there are also planets revolving around the fixed stars -- suns [9]. He even predicted Jupiter's rotation around its axis in the same sense as the four satellites discovered by Galileo orbit the Jupiter [10]. Wackher enabled Kepler to carry out his first observations using a telescope [11].

In speculative cosmology, Wackher was even more courageous than Kepler himself. He advocated without any objection the view that the Sun is only one of the stars, whereas Kepler for a long time refused Bruno's idea that the stars should be formations analogical to the Sun. In his *Dissertatio cum nuncio sidereo* (1610) Kepler, in agreement with Giordano Bruno, admitted at the most that the stars, unlike the planets, produce their own brightness, he denied, however, that any of the fixed stars could approach or even equal in size and brightness the Sun [12]. Only later, in his *Epitome astronomiae copernicanae Kepler*, -- did he make some concessions in his outspoken resistance against Bruno's views [13]. This likely was in part because of Wackher's influence.

Wackher also influenced Kepler in another sense: He made him give up the rest of his anthropocentric world outlook concerning the Universe. Kepler tells us that he had animated discussions with Wackher concerning the Moon and that he wrote *Lunar Astronomy* to please Wackher [14]. The conception of the dream originated, therefore, in Prague in the course of discussions with the then most

outspoken advocate of Bruno's philosophy and whose influence is obvious in the *Dream*.

Wackher's attitude to Bruno's philosophy is even more valuable and praiseworthy if we take into consideration the fact that he defended Bruno's views even after their author had been condemned and burnt. On the other hand, this fact also proves a high degree of tolerance in the Prague scientific community, before the Battle of the White Mountain, in the very community that enabled Kepler to develop his astronomical theories.

These tolerant and free conditions in the scientific life of Prague are in a sharp contrast with another important event from Kepler's life closely connected with his *Dream*. In 1617, during Kepler's stay in Linz, his mother was accused of witchcraft and risked a sentence of burning. She was lucky that Kepler had not yet decided to have his *Dream* printed. The autobiographical elements in the introduction were too obvious and very likely would have turned into dangerous aggravating circumstances in a trial against his mother. Kepler himself was worried that some hand-written copies of the *Dream* might fall into undesirable hands. In the trial against his mother, which took place in Leonberg and dragged on until 1621, Johannes Kepler actively and successfully defended her. Although she was acquitted, the poor old woman had been jailed during all the time of the trial and was perhaps even tortured before her release from prison in the autumn of 1621. But her health was broken and she died shortly later -- on April 13, 1622.

We can therefore regard as correct the view of Professor Rosen that Kepler was not writing his comments to the *Dream* as early as 1620 as claimed by his son, but very likely only after the successful end of the trial and his return to Linz in 1621; or maybe even later, after the death of his mother in 1622.

Kepler worked on the additional remarks until his death. It turns out that they develop mostly the pedagogical part of the *Dream*, whose text allows one to develop more broadly an explanation of this or that piece of astronomical knowledge. The remarks reveal for us the systematic personality of Kepler working in the same way as when he wrote his voluminous textbook *Epitome astronomiae copernicanae*, which chronologically precedes their origin.

NOTE

People who recently stood on the real Moon saw in the sky exactly the same phenomena as predicted by Kepler in his *Dream*. In the spirit of his prediction they also lived a fallacious feeling that they stood on the surface of a body stationary in the middle of the Universe. Kepler was also the first one to define the relationship of lunar gravitation as compared with that of the Earth, what is the cause of their differences, and what consequences they bring about during the motion of a body sent from the Earth to the Moon. We may admit that Kepler at least partially guessed what obstacles the human organism would have to overcome during its voyage through space. It may seem today that all this is too little when compared with the broad range of considerations required by the theory of space research. If,

however, we add to all this Kepler's laws of the movement of the planets and the mighty inspirational force of his work that was followed by Isaac Newton and his successors; and if, moreover, we remind ourselves that more than three-and-a-half centuries divide us from Kepler's discoveries, we will not hesitate in calling him one of the true precursors of scientific space research.

REFERENCES

1. Isaac Newton, *Philosophiae naturalis principia mathematica*, 1687, lib. I., def. 5.
2. Johannes Kepler, *Gesammelte Werke*, Bd. III -- *Astronomia nova*, ed. Max Caspar, München 1937, pp. 25-26.
3. Johannis Kepleri, *Dissertatio cum nuncio sidereo*, Pragae 1610, p. 26; Joannis Kepleri, *astromoni Opera omnia*, ed. Ch. Frisch, vol. II., Francofurti a.M. at Erlangae 1859, p. 502; Walter Gerlach -- Martha List, *Johannes Kepler*, München 1971, pp. 137-138.
4. Marjorie Hope Nicolson, *Voyages to the Moon*. New York, The Macmillan Company, 1948, p. 41 sqq.
5. Joh. Keppleri, *Mathematici olim Imperatorii Somnium, seu Opus posthumum de astronomia lunari. Divulgatum a M. Ludovico Kepplero filio, Medicinae Candidato*. Impressum partim Sagani Silesiorum, absolutum Francofurti, sumptibus haeredum authoris. Anno M DC XXXIV.
6. Edward Rosen, *Kepler's Somnium. The Dream, or posthumous Work on Lunar Astronomy*. Translated with a Commentary by ... The University of Wisconsin Press, Madison, Milwaukee, and London, 1967.
7. Edw. Rosen, *op. cit.*, pp. XIX, XX.
8. Edw. Rosen, *op. cit.*, pp. XVII & 207-208
9. *Diss. cum nuncio sid.*, Pragae 1610, p. 22; O. o., ed. Ch. Frisch, vol. II., Francofurti a.M. et Erlangae 1859, p. 500.
10. *ibid.*, p. 29; i.e. p. 503.
11. Edw. Rosen, *op. cit.*, p. 167.
12. *Diss. cum nuncio sid.*, Pragae 1610, p. 22; O. o., ed. Ch. Frisch, vol. II., Francofurti a.M. et Erlangae 1859, p. 500.
13. *Principiorum doctrinae sphaericae pars secunda, O. o.*, ed. Ch. Frisch, vol. VI., Francofurti a.M. et Erlangae 1866, p. 136 sqq.
14. *Diss. cum nuncio sid.*, Pragae 1610, p. 15; O. o., ed. Ch. Frisch, vol. II., Francofurti a.M. et Erlangae 1859, p. 496.