

History of Rocketry and Astronautics

**Proceedings of the Fifty-Third History Symposium of
the International Academy of Astronautics**

Washington DC, USA, 2019

Otfrid G. Liepack, Volume Editor

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AAS History Series, Volume 52

A Supplement to Advances in the Astronautical Sciences

IAA History Symposia, Volume 39

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AMERICAN ASTRONAUTICAL SOCIETY

AAS Publications Office
P.O. Box 28130
San Diego, California 92198

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

First Printing 2022

ISSN 0730-3564

ISBN 978-0-87703-681-4 (Hard Cover Plus CD ROM)
ISBN 978-0-87703-682-1 (Digital Version)

Published for the American Astronautical Society
by Univelt, Incorporated, P.O. Box 28130, San Diego, California 92198
Web Site: <http://www.univelt.com>

Printed and Bound in the U.S.A.

Chapter 1

**Otto Paul Fuchs—
A Forgotten Austrian Pioneer of Rocketry and
His Rocket Launches in Summer 1928***

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Abstract

Otto Paul Fuchs is known as one of the first authors to use the term *cosmonautics* way back in 1926. His experiments with solid propelled rockets and their launch in summer 1928 close to Vienna at Lake Neusiedl are largely unknown. This chapter tells the story of the launch of this two rockets and new biographical details of his life.

I. Introduction

We know that the engineer Otto Paul Fuchs (November 18, 1897, in Vienna [1]—May 14, 1965, in Philadelphia, Pennsylvania, USA [2], his ashes were scattered in the Atlantic) being the first one using the expression “cosmonautics” in a follow-up article “Beitrag zur Kosmonautik” (“Contribution to Cosmonautics”) to Dr. Franz (von) Hoefft’s general article “Die Eroberung des

* Presented at the Fifty-Third Symposium of the International Academy of Astronautics, October 21–25, 2019, Washington, DC, United States. Paper IAC-19-E4.1.01.

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Weltalls” [3] (“Conquest of Space”), in the Austrian journal *Flugzeug und Yacht* in May 1926.

In the chapter “Austrian Groups,” in Frank H. Winter’s book titled *Prelude to the Space Age*, the following can be found about establishment of the Austrian Scientific Society of High Altitude Research on page 31:

A “Rocket Committee” of the Society met irregularly at von Hoefft’s home at Darwingasse 34 in Vienna and was also known as the von Hoefft Committee, though, a certain Engineer O. P. Fuchs was its real leader [4].

In a further paper given at the IAC Congress 2003 at Bremen by Dr. Bruno Phillip Besser under the title “Pioneers from Other German-Speaking Countries: Austria” states:

Guido von Pirquet, as far as he could remember, wrote in March 1960 about the foundation of the society:

In autumn 1926 my attention was called to the rocket committee by engineer Fuchs at the Urania Observatory, who in those days substituted the head Dr. Klumak from time to time in the explaining talks. ... The mentioned committee met from time to time in the flat of Dr. Franz von Hoefft, Darwingasse 34, who was living there with his mother... [5].

This is the exact translation of some notes in German, which can be summarized as Pirquet’s curriculum vitae.

This chapter will prove that Frank Winter is right to connect engineer Fuchs with Otto Paul Fuchs and that he clearly had an important role during the forerun of the founding of the society. It will also introduce hints to the launch of two small solid propelled rockets at Lake Neusiedl, close to Vienna, and an exclusive news article about it.

In mid-1954 Fuchs migrated to the USA [6] to work at Burroughs Research Division, in Philadelphia, later at Temple University and he was also involved in the US space program [7].

II. Contribution to Early Astronautics

II.1. Article “Contribution to Cosmonautics”

According to statements made by his daughter Ruth (Eva) Fuchs Otto Paul Fuchs spent his childhood in Budapest until the marriage of his parents on February 28, 1904 [8,9] and his youth in Innsbruck where his father had died early on January 26, 1906 [10]. Thanks to his parents’ fortune Otto Paul and his elder brother Victor received private tuition and thus never attended public schools. These statements are also identical with the contents of the few documents found

in Otto Paul Fuchs's estate, which his daughter handed over to the Hermann-Oberth-Raumfahrt-Museum (aerospace museum) [11].

An article "Paoli Mathematical Wizard, Modest Man Despite Medal" by Alice P. Nielsen from Dec. 1954 gives some details about his family background. Otto Fuchs ... says his interest in Mathematics was not apparent until he was quite "old" 15 years old, to be exact.

The Fuchs family was originally from France where their name was Reynard, (Fox). From France they went to Germany where the succeeding generations had their name translated into the German for Fox, thus, it became Fuchs, before they finally emigrated to Austria.

After the first world war the family lost all their money. Fuchs was forced to interrupt his schooling and go to work. His first job, at the age of 21, was to figure out the erection of a cable to carry passengers in cars up the side of a mountain. This added to his determination to further his mathematical education and career.

Throughout the years of his country's turmoil, Fuchs studied hard. An acute food shortage leading to much suffering and unrest was not conducive to the health of this scientist of slight build, but his determination and a high goal won over all difficulties thrust in his path.

The family was able to retrieve some of its lost fortune, only to have Hitler take it away again. Once more there was a period of hardship, but the law of percentages, figured by a scientific mind, saved Fuchs from discouragement [12].

Although he still held the Hungarian citizenship he acquired the Austrian citizenship (*Österreichische Bundesbürgerschaft*) on August 20, 1922 [13], according to the documents found in the war archives he was mentioned in the context of the production and trial development of military vehicles at Wiener Neustadt or Fischamend [14]. From March 1, 1918, he worked as a technical design engineer in the propeller testing institute in the unit for captured airplanes with specific tasks as structural engineer and drawing control of enemy airplanes. Specific mention was made of his contributions to the airfoil theory [15]. His draft of June 14, 1918, pertaining to a 200-horsepower three-decker fighter presented an extreme streamlining of the foil and can be considered as the pioneer of the nozzle (slit) foil (k u k Flars. Test laboratory of Flugzeugmeisterei Fischamend—June 14, 1918) [16].

In March 1920 he referred to himself as "the former operational engineer of the V. W. G., design engineer in the aircraft arsenal" [17] and from 1920 onwards he promoted the recovery of the stagnating Austrian aviation industry by means of newspaper articles [18] and speeches in Innsbruck [19].

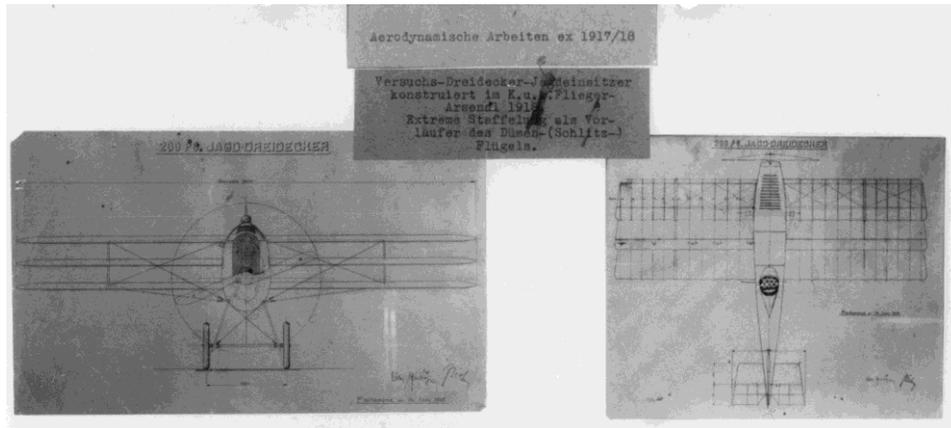


Figure 1-1: 200 HP three-decker fighter by Otto Paul Fuchs dated June 14, 1918.

In 1926 he moved over to Vienna [20] and from July onwards he published some technical articles relating to aviation issues in the renowned Austrian technical magazine *Flug*, which was published in 1926 as *Flugzeug und Yacht* [21].

Owing to the very general article “Eroberung des Weltalls” [22] (“Conquest of the Universe”) by Dr. Franz Hoefft from Vienna, which described a vertical ascend to reach the parabolic speed of 11.2 km/sec. Fuchs felt induced to add his own considerations about an ascend in an angle smaller than 90 degrees in a supplement “Beitrag zur Kosmonautik” (“Contribution to Cosmonautics”). He wrote:

At this point in time I would definitely not affirm the question as to whether opting for a launch in an optimal flight angle smaller than 90 degrees is necessarily more favorable than the vertical ascend. There is, however, the preliminary assumption that the economically fertile benefits in the atmospheric region gained from the experience made relating to aviation technology (foils) could be used, which do not make a huge difference in space, but are beneficial during launch and landing [23].

This is a clear evidence for the fact that Fuchs, as the man of aeronautics, brought the ascending and descending of a rocket-driven vehicle by means of foils into play. Therefore, he counts among a number of aviation experts who envision the continuance of aviation above the atmosphere by employing the new drive technology—the rocket motor. The most famous advocate of this method was Max Valier who promoted Oberth’s ideas and thoughts in his works but also put the aeronautic aspect up for discussion right from the beginning. He had Oberth and Hohmann create (for free) the mathematic and physical basics and as early as on September 7, 1925, he was ready for initial talks with representatives of Junkers-Werke in Berlin.

Unfortunately, this approach, and also a second one in early 1929, fell on deaf ears. Also, negotiations with Udet, Klemm, Espenlaub, and finally Hatry remained futile. Valiers ground vehicles were altogether the result of his failed ambitions to develop a rocket aircraft. All Valier types proposed by Valier were rocket aircrafts. His proposals of spaceships were Oberth spaceships of “Valierian design.”

Thus Otto Paul Fuchs, like many others, also in this respect counts among those who preferred the aeronautic way into space and whose most important representative was, of course, Eugen Sänger. From March 27, 1928, he was a member of the Gesellschaft für Höhenforschung (society for the research of heights).

With regard to content Oberth evaluates Fuchs’s article in a letter to Hoefft dated November 27, 1926, as follows:

I would not like to deem engineer Fuchs as the sole mouthpiece of the association. His article about “cosmonautics” which I received from Pittner did by far not seem to be up to the mark. Perhaps he has indulged more deeply into the matter in the meantime. Please treat this part confidentially [24].

II.2. Contribution to Early Rocket Movement

In a circular by Max Valier dated March 29, 1925, also Prof. Dr. Karl Wolf, Technische. Hochschule WIEN, IV. (Technical University of Vienna) was mentioned among the recipients.

He wrote:

At long last I succeeded in making also the other gentlemen aware of the suggestion made by Dr. Hoefft, i.e. that all researchers engaged in the spaceship challenge should cooperate more closely. It goes without saying that I will follow this suggestion. I assume that the same applies to the rest of the gentlemen, except for Prof. Dr. Wolf whose position at the technical university demands for certain considerations which might presumably prevent Prof. Wolf from obviously joining such an association of whichever form. However, eventually it is not necessary to found a club or association in whichever legal form. I would definitely object this. It is obviously sufficient if two gentlemen met by way of written correspondence, or even better, in person and if they did not consider each other as rivals but rather as joint fighters for a common cause. The less the outside world knows of the existence of such an intellectual circle, the more effective it is [25].

This is the first evidence of the existence of a cooperation between the group Oberth, Hoefft, Valier and Hohmann with Professor Wolf from Vienna.

As described in the Winter and Besser documents a loose group was formed who exchanged experience via correspondence or met in irregular intervals whereby the topic was examined in both a favorable and critical manner.

As reported in the introductory section Pirquet wrote:

In autumn 1926 my attention was called to the rocket committee by engineer Fuchs at the Urania Observatory, who has in those days from time to time substituted the head Dr. Klumak in the explaining talks ... The mentioned committee met from time to time in the flat of Dr. Franz von Hoefft, Darwingasse 34, who was living there with his mother...

Mention is made here of a certain engineer Fuchs who invited Pirquet to join a meeting of said rocket committee. Said Fuchs actually was O. P. Fuchs, which could be clearly proved at a later point by the letters with Hohmann and Oberth-Hoefft.

It is again Pirquet who reports in his later documentations about the divide between advocates and critics of the feasibility of aeronautics:

And back then [December 1926] Prof. Wolf also wrote a series of correlating formula on the blackboard ... which were in themselves entirely correct—however, without taking the stage principle into account)

He then stated as results from his examination the following:

- a) a height of 54 km will be reached (which was back then anyway the current record held by the long-range Paris Gun)
- b) as far as the exhaust velocity is concerned it was impossible to exceed the molecular velocity reached by the initial temperature, which is in figures a value between 1,500 and 2,000 m/sec.

Dr. v. Hoefft replied on that stating some theoretical reservations (he had studied physical chemistry at Prof. Nernst's chair)—while I said that “the bullet of the long-range gun must have achieved an initial speed of 1,600 m/sec.—and that bullet was anything but a cork stubble.

As a consequence the rest of the committee no longer contributed to the works and meetings whereas Hoefft, however, filed an application for the foundation of a company with the authority, with Hoefft being nominated as president and myself as secretary [26].

A letter by Valier to Hohmann dated January 1, 1927, reveals:

Dr. v. Hoefft is writing from Vienna that he was unlucky with the foundation of his company. First the others had been reluctant, and he had founded on his own initiative, thereupon the other gentlemen had reacted peeved and had let him down [27].

The course of events is comprehensively described in a letter by Hoefft to Oberth dated December 14, 1926, also with reference to Wolf and Fuchs:

... when last Thursday's [December 9, 1926] session with Wolf did not end as I had hoped, as we, i. e. you and me, were attacked from all sides. ... I would never have envisaged such a mixture of hatred, malicious envy and narrow-mindedness possible. Wolf claimed the chair for himself and delivered a speech about a register rocket which he had simply developed from my draft which he had held in his hands for eight days ...), thus stealing my intellectual property:

Wolf $m_0 = 27$ kg, $m_i = 10$ kg, $c = 1450$ m/sec, $v = 1000$ m/sec, $h = 66$ km

Hoeffft $m_0 = 29$ kg, $m_i = 7$ kg, $c = 2000$ m/sec, $v = 2400$ m/sec, $h = 100$ km,
 $g = 30$ m/sec² + 10 m/sec. against gravity.

That was what he had counted on—for a rocket which was to reach cosmic speed an incredible ratio was reached for $c = 1450$ —and thereupon announced flatly that reaching cosmic speeds was absolutely impossible, he would only join a society which would change its name “for space research” into “for research of the higher atmospheric layers.” The representative of the ministry of armed forces colonel Dr. Leitner went even further claiming that according to the kinetic theory of gases it was impossible for the exhaust speed to reach speed of sound at the smallest diameter of the nozzle, let alone a higher speed at a later point as would correspond to the temperature of the gas atoms. Then the professor of physics Thirring at the University of Vienna appeared declaring that any transport of liquid oxygen was excluded. Eventually, I was heard and stood the chance of explaining my project, however, the adverse impression created before could not be remedied. I immediately objected to Wolf claiming that he had ignored the stage principle. ... In the end, Dr. Körner demanded that the “authorities” should be gained; the name of the society be changed; and Wolf be elected for president and that the press should be silenced by publishing the statement that cosmic speeds were impossible, while sharply attacking Dr. Papp who also replied.

On general request I suspended the decision taking until the next Thursday, briefly read out the criticism and your suggestion made in your last letter, letters by engineer Schreiner, Graz who applied for membership as a consequence of the press release and provided two of his patented drawings free of charge for the tests, and by Gail who intended to promote the society in his speeches and also applied for membership. The clash had been postponed to the 16th of that month for I am not willing to give in, all the more since Dr. Papp, engineer Baron Piquet, engineer Lewinski [29] and Dr. Gauster, the latter two were two former assistants to Wolf, also had a say...

... Whoever chooses not to join under these circumstances, just like engineer Fuchs, who ostentatiously sat next to Professor Wolf, will be kicked out. Körner is supposed to have said after the meeting that it was high time to seize the issue from the hands of the amateurs (in his opinion that is you and me!) and hand it over entirely into the hands of the university! There will possibly soon exist two rocket societies in Vienna because I can hardly prevent the dissidents from uniting, even if I can spoil their success by blaming them in the press for their theft of ideas as promised by Dr [Desiderius].Papp, and they do not have any own ideas! ... [28].

Thus, the names of Prof. Dr. Thirring, Dr. Papp, Ing. Lewinski, and Dr. Gauster have been added to the circle stated in the Besser documents by Pirquet and the contents has been substantiated.

We acquire further information of the subsequent activities of that “rocket committee” from the family chronicles by Walter Hohmann, in particular, the

role and significance of Otto Paul Fuchs's contribution is concretely shown for the first time:

February 15, 1927—family chronicle by Walter Hohmann:

Engineer Otto P. Fuchs as secretary of a "*free society of scientists*," which engages into space and rocket-related issues, in order to ask him to join in to the free exchange of thoughts of the following gentlemen (there are no membership contributions nor any other features of clubby culture, although small donations to cover the correspondence costs are appreciated):

Professor – Dr. Wolf, technical university

Professor – Dr. Wagner, central institute for meteorology at the university

Assistant – Dr. Koerner, II. Institute for chemistry at the university

Lecturer – Dr. Kirsch, university

Observer – Dr. Dörr, central institute for meteorology at the university

Professor – Ing. Greger [31], technical institute, institute for material testing and research

Colonel – Dr. Leitner, ministry of war

General a. D. – Ing. Novakowsky, former chief ballistician;

Dr. Sternheimer, institute for astronomy at the university

Assistant – Ing. Lewinsky, faculty for structural mechanics, technical university;

Dr. Franz v. Hoefft, independent scholar

Although, according to the current state of the art, exhaust gas velocities of 3–4 km/s cannot be reached due to the kinetic theory of gases, ... all publications available so far have met factual acceptance ..., although reaching cosmic speeds and thus the opportunity of conducting space flights is at present out of the question—in line with the opinions of the German researchers such as privy councilor Lorenz ... It would be of my personal interest to learn which specialist area you are usually engaged in. I for myself am a lecturer of flight mechanics ...

Walter Hohmann on November 26, 1927, to engineer Fuchs is thankful for the great honor of being invited to exchanging thoughts, ... for the members' names and positions serve as a guarantee for the purely economic aims, I for myself would not be interested in economic aims. I am also by no means locked in the idea of reaching celestial bodies, I rather feel that there are far more things left between sky and earth which are worth exploring and which cannot be approached by any other means but a rocket...

I am really glad about meeting you on this occasion as the author of the review to my contribution in the magazine "Flugzeug und Yacht" ... this had been sent to me at the time ... I am a civil engineer specialized in the special fields of statics, building and bridge construction, at present, head of the statics department D of the local municipal building authority ... by the way, I started my practical work in Vienna in 1904–1906, which ... I have kept in pleasant memory ... Perhaps the lighthouse at Praterspitz is still

there, it was one of my first constructive works with the Wahlberg company.

Engineer Fuchs on March 3, 1927, to Hohmann:

He also thanks him among other things for his readiness to provide financial support. He informs Hohmann of the Vienna body's intention to ask professor Oberth to come to Vienna in order to prove his in medias res successful experiment, as rumors say, which means reaching an exhaust velocity of 2700 m/s by using liquid fuels.

, ...as already mentioned, this is nonsense in the light of the kinetic theory of gases. Still, as we are by no means narrow-minded ... we would be glad to be disabused of our notions by Mr. Oberth! ... As far as the lighthouse at Praterspitz is concerned: I will research myself. I can well understand that Vienna is still in your memories and that you wish to learn something about your unexperienced creation' ... in economic terms we are also not interested (in an egoistically motivated approach) ... in forming associations ... not in the interest of the cause.

We intend to provide precisely the basis required for that cause in the opinion of potential financiers: a scientific impeccable expertise ... Now Dr. Körner ... suggested asking Oberth whether he would travel to Vienna at our expense, ... assuring ... to allow Oberth to speak before the Chemical-physical Society, which would mean the same to Oberth ... having made a real name ... and he ... could then dedicate his life entirely to his work ... [sic] [30].

Summing up the role of engineer Otto Paul Fuchs among this “rocket committee” it can be said that in his function as secretary of this *Free Society of Scientists* he provided its organizational backbone, functioning at the same time also as its spokesman. Evidence of this is also furnished by a letter from Hoeffft to Oberth dated November 27, 1926: “I again received a letter from Fuchs informing me that the statutes of the society were already ready for submission!” [32], and the letter written by Oberth to Hoeffft dated September 19, 1926, where he said that he himself would not deem Fuchs as the mouthpiece of the society. In his article in the magazine *Flugzeug und Yacht* Fuchs had appeared as an expert in aeronautics and was introduced to that group by Hoeffft as a new combatant in the cause of “cosmonautics,” who allowed him, the freshman in Vienna, to establish best contacts into Vienna's elite of scholars. His role as secretary contributed to stabilize his role within the group. Thus, it became clear that if Fuchs did not intend to break up with this *Free Society of Scientists*, he would have to assume their positions. Consequently, it is quite understandable that he did not join the Society for the Research of Heights and that he tried to benefit from Hoeffft's and Pirquet's “resignations” from the *Free Society of Scientists* by establishing again contacts to the German advocates of the issue on a purely “scientific” basis,

which also secured his position within the *Free Society of Scientists* and the continuance of the same.

At present there is no further direct evidence available to prove any work or activities contributed by this *Free Society of Scientists*.

Yet, a letter written by Hoeffft to Oberth dated December 14, 1926, reveals that also Thirring formed part of this committee and, according to Hoeffft, stated the following: “Now came the professor of physics at the Vienna University Thirring declared that the entrainment of liquid oxygen was impossible.”

In 1934 Hans Thirring will together with Karl Menger and Hermann Mark draft the brochure *Alte Probleme—neue Lösungen in den exakten Wissenschaften; Fünf Wiener Vorträge*, Leipzig (*Old Problems—New Solutions in Exact Science; Five Vienna Lectures*), Vienna: Franz Deuticke comprising 122 pages, where he takes clear position in the essay “Kann man in den Weltraum fliegen?” (“Is Flying into Space possible?”) [33].

The contribution indicates that Thirring was well informed about the current status of the issue, he explicitly mentions the book *Raketenflug (Rocket-flight)* by Eugen Sänger which was published in 1933 as one of the “few sound special works in this field.”

Eventually Thirring believes that the rocket motor could gain a certain importance in aeronautics, “the flight into space, by contrast, will not be witnessed by the present generation.”

Also, Thirring’s considerations reflect the adverse effect of the negative results achieved by Oberth’s conical nozzle in the experiments performed on the premises of the Chemisch-Technische Reichsanstalt in summer 1930. As the conical nozzle was supplied with a meagre 1/5 of the intended fuel quantity per second which generated a maximum reaction thrust of 7 kg instead of approx. 70 kg, the calculated exhaust velocity of the gases was only 700 m/sec. instead of feasible 2,400 m/sec.

Therefore, Thirring still based his calculations on a value of just 1,000 m/sec. as realistically achievable efflux velocity.

An interesting aspect is the reference made to Eugen Sänger who started his experiments from 1933 with the support of Professor Dr. Rinagl at the technical testing institute (material testing, building material testing) in Vienna. He provided “suitable” rooms in the old public works department at Dreihufesengasse [34] next to the institute of electrical engineering. Rinagl was also a professor at Vienna Technical University [35,36].

The question as to whether the *Free Society of Scientists* played a major role in this matter requires further investigation.

Sänger, for instance, achieved an effective exhaust velocity of $c = 2,560$ m/sec in his 102nd overall experiment on June 8, 1934 [37].

It is certain that the committee of scholars did not dissolve because of the breach with Hoeffft in late 1926 but will presumably have focused on different issues.

For Otto Paul Fuchs his collaboration in the committee of scholars and, in particular, his acquaintance to Hans Thirring was to result in a joint lecture (1934) [38] and later in a joint book (1939) [39] and thus had a decisive impact on his later career in electrical engineering and early computer development.

II.3. Contribution to Rocket Engineering

Press Coverage

Although the image showing engineer Fuchs together with his rocket design was spread in a number of articles, reference is made herein to only two “serious” newspaper cuttings published in the magazine *Motor Sport Wien* of July 15, 1928, No. 5, page [40].and *Illustrierte Technik*, 1928, issue 30, page 10 [41].



Figure 1–2: Engineer Otto Paul Fuchs with his small experimental rocket type 01 which he launched above Lake Neusiedl in summer 1928.

Twilight of Rockets in Austria

Engineer Fuchs, a well-known expert in aviation circles, designed a probe made of aluminum which he employed in ascending tests at Lake Neusiedl in the presence of press representatives, which produced a satisfactory result. As the small experimental rocket is said to have reached a height of

approx. 700 meters this satisfactory experiment provided an incentive to the engineer to expand his project about refining the rocket drive for use in airplanes which he had kept secret for a long time. Hopefully, the public will soon learn that the invention made by engineer Fuchs can be deemed as a complete success and serve as proof for other foreign countries that our resourceful heads are capable of achieving the same or even more and, that in addition to the numerous globe-rocking inventions which were already developed by Austrians also a solution to the new future oriented idea of realizing a rocket drive for the fastest means of transport now might well be attributable to the inventive spirit of Austrian researchers.

Inventions from Abroad

The rocket to serve science. The Vienna aviation researcher engineer Fuchs designed a rocket which is intended to transport scientific recorders into heights of 30 to 60 kilometers. The rocket was made of steel, nickel and light alloys.

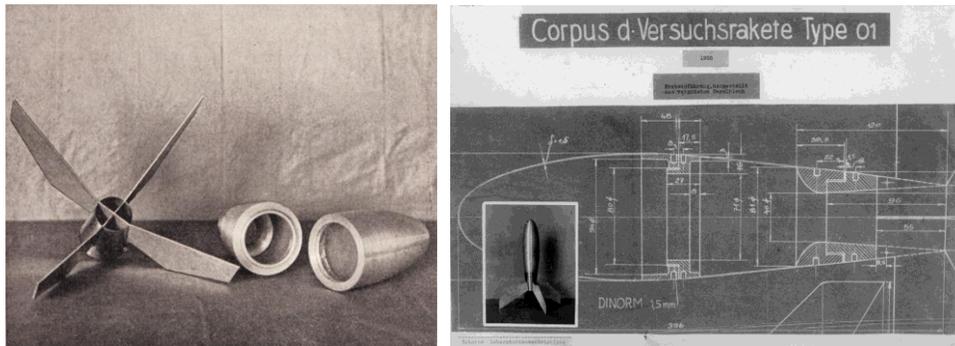


Figure 1-3 (left): Dismantled components of the rocket without propellant.

Figure 1-4 (right): Drawing of the body of the experimental rocket type 01.

The newspaper information was illustrated with the images hereinabove. However, this result did not gain more attention in view of the fact that it had to compete with the significant tests made by Fritz von Opel on the occasion of his record drive in his rocket vehicle Opel-Rak 2 on the Berlin Avus speedway on May 23, 1928.

An additional aggravating factor was that there were no further comprehensive reports on this in the daily newspapers as the *Neue Wiener Journal* of Sunday, June 24, 1928, reported exclusively by the well-known journalist Dr. Desiderius Papp on page 7:

Rocket Launch Near Vienna. Test Launch a Complete Success
by Dr. Desiderius Papp

Last night a sensational experiment was conducted near Vienna. A group of engineers and pyrotechnicians from Vienna launched two rockets. Both were splendid specimens of their kind, bigger and more powerful than those which had driven Opel's rocket vehicle in his spectacular test run on the Avus speedway near Berlin. The test launch of the first Austrian rocket which run excellently was merely witnessed by one representative of the press, the reporter of the *Neue Wiener Journal*. He writes the following:

The massive Renault vehicle is approaching Schwechat at high speed via the country road in that starry night. It is past 1 hours after midnight; we are in a hurry. Each jerk of the car is accompanied by engineer Otto Paul Fuchs's glance on the mysterious something which is wrapped in wood wool and stored inside the car. His problem children are resting there gently wrapped, two rockets. They are the problem children of all of us, just for one egoistic reason! The black powder in their metal bodies would by far be enough to blow up a tenement with all its accessories ... If it goes off here in the car? On our right, on our left motorists are darting past. We have already passed the earthquake-troubled Schwadorf, now we are approaching Burgenland. Still twenty minutes to go. In the far distance the shimmer of the surface of Lake Neusiedl appears in the bright plain. We have reached our destination.

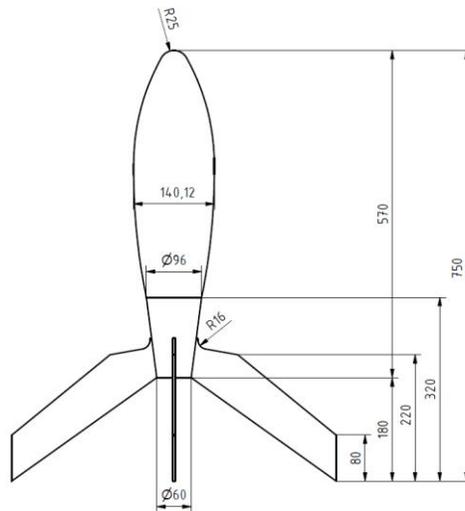


Figure 1-5: Reconstruction of Fuchs Experimental Rocket Type 01 by Martin Frauenheim. Drawing by J. Grafe.

The region is just like robber-knights in those days and rocket constructors these days would have dreamt of. Far and wide free unbuilt land surrounding the ruins of an age-old tower with wall that were several meters thick. There is a terrace where the text equipment could be installed, there are

niches to provide protection from any rocket nozzle which might accidentally fall on your head. This ruin was created by God precisely for rocket engineers.

The two protagonists of the night performance are lifted out of the vehicle. Now I have got time to take a closer look on the lads. Given the purpose they are designated for they are massive colossuses yet presenting quite a pleasant picture. The mirror-like cigar-shaped aluminum carcass, flanked by four lateral foils at the bottom, is 75 centimeters high and thus approximately three times as high as the Sanders' rockets of the famous rocket vehicle of the time. It is of course true that the pleasant appearance still conceals a tricky core. It contains about two kilos of fine gunpowder and under the dimly shining capsule, where the cigar has its tip, is an extra explosive charge designated to play any possible art after launch. The whole rocket weighs about six kilos which is a stately weight for an individual of its kind.

Frigate lieutenant Richard Landi positions the rocket with the help of two assistants into the launch rack. The stuff is firmly clamped by four angle steels to prevent it from flying off, for this first gigantic cigar made of duraluminum is only to serve as outpost for the second one. It merely serves for testing the stability of its components in order to verify how far its nozzles, which are the heart of such a rocket, would endure the infernal heat and tremendous pressure set free during its launch. The blasting fuse of several meters in length winds out of the rocket like a black exotic snake. It is time to withdraw into a safe cover. Engineer Fuchs and his assistants are holding their stopwatches in their hands. The cameras are focusing their glassy eyes on the scenery. Two small flashlights, the signal that the flame at the fuse has just started its fiery way to the rocket. In an instant the black cord has transformed into a fabulous creature. There are the fizzles of the blaze and the flame is making its way further and further up to the rocket. Forty seconds have past, seemed like an eternity. Now the flame has taken possession of the propellant. A thunder-like bang, for an instant the entire medieval landscape seems immersed by Bengal lights. Thick clouds of smoke are coming off the pile of stones where the rocket was initially positioned. After they have faded the actual rocket has disappeared. The elementary force of the explosive has ripped its carcass apart, however, its upper part, the steel nozzle, has sustained this horrible interplay of forces. It has remained intact. This was the only thing that counted and now the second experiment, the highlight of the performance, is ready to start. The second rocket has already been positioned into the launch rack, the angle steel which had hampered the first rocket during its launch and fixed to the earth are removed. Few minutes are passing, the black fuse is again transforming into a hissing, growing tongue of flames, and its blaze seizes the soul of the rocket with a thunder-like noise.

The aluminum body is soaring into the starry sky like a glowing meteor. A long blinding fire tail, like that of a phantastic comet, presents its flight for a few seconds. Then, all of a sudden, a detonation which is more massive and powerful than all the previous ones makes the air tremble. The rocket has exploded. The explosive charge in the rocket's had has exploded, indi-

cating with its roaring noise the climax of the rocket's orbit. Then the blinding fireworks extinguish.

"Seven hundred meters," declares one of the assistants with a glance onto his stopwatch.

A nice, satisfactory result for a rocket where not the height of its orbit was the decisive factor but the evidence of the fact that its power was sufficient to carry a weight of four kilos towards the sky. Indeed, a splendid result in face of the fact that the rocket was flying at a velocity of twelve hundred meters per second [42].

This marks the end of the first phase of active engagement in aerospace engineering.



Figure 1–6: Otto Paul Fuchs (right) with the sound recorder Photophon. Austrian patent No. 132981/1932, which was acquired by Klangfilm G.m.b.H. Berlin, a subsidiary of Siemens-Berlin.

Afterwards, according to his own statement, Fuchs worked as a scientific collaborator at the Institute of Experimental Acoustics (Prof. Dr. Serinture) at the University of Vienna (1930–1933) [43]. In those times (1929–1932) he designed the sound recorder *Photophon* which realized the so-called *noiseless recording method* for the first time. The corresponding basic patent Austrian patent No. 132981/1932 (including international rights) was acquired and used by Klangfilm Ges.m.b.H. Berlin, the subsidiary of Siemens-Berlin [44].

Starting in 1933 he was a scientific collaborator with Prof. Dr. Hans Thirring, University of Vienna, till 1938. From 1938 to 1939 he worked as a physicist at the Luftfahrt-Forschungsanstalt Braunschweig (aerospace research institute). He completed his military service with the German Airforce from 1939 to 1940 [45].

II.4. Contribution to Space Flight Engineering

Apart from Thirring [46] he also published some articles in technical magazines together with engineer Horst Kottas [47] and in 1939 he became a co-author in the works *Photowiderstände* by Hans Thirring, comprising 140 figures on 186 pages, published by Johann Ambrosius Barth Verlag in Leipzig [48].

He worked as a research director of the Fuchs Research Institute Vienna, (1940–1945) (which, according to his curriculum vitae, had been established by order of Reichsluftmarschall Göring of the German Airforce) [49] at the IX. Vienna district, at Währinger Strasse 12 [50], where he conducted research and instrument development works on behalf of e.g. the Austrian aircraft manufacturer Wr. Neustadt, Arado-Flugzeugwerke, Werk Stauffen, the Gesellschaft für Reproduktionsbedarf Kranich in Vienna, the ministry of aviation in Berlin and the University of Vienna [51].

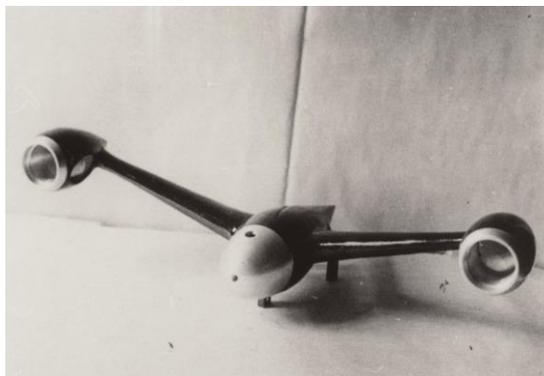
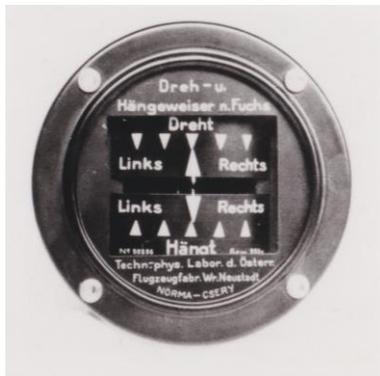


Figure 1-7: Flight altitude control instrument 1936/1937 on behalf of the Austrian aircraft manufacturer Wr. Neustadt.

Figure 1-8: Automatic track levelling *Levisier* 1941/1942 on behalf of the Reichsluftfahrtministerium (ministry of aviation in Nazi Germany) Berlin.

In 1942 he received a certificate of equivalence to the doctor's degree in physics and electrical engineering granted by Prof. Dr. Hans Thirring, institute for theoretical physics, University of Vienna, Prof. Dr. Karl Wolf, Rector Mag-

nificus and Professor for Mechanics at Technische Hochschule (Federal Inst. of Technology) of Vienna, Prof. Dr. Franz Jung, Prof. for Mechanics, Technische Hochschule (Federal Institute of Technology) of Vienna. The topic “Über Gesetzmäßigkeiten und Eigenschaftskennwerte von Widerstandszellen” was recognized as a thesis and published in collaboration with H. Kottas in *Zeitschrift für technische Physik*, Leipzig, Germany, February 1936, and *Zur Bestimmung der Wirkgrößen von veränderbaren Ohm’schen oder lichtelektrischen Widerständen*, published in collaboration with H. Kottas in *Zeitschrift für Instrumentenkunde*, Berlin, Germany, 36, 6, 1936, and *Photowiderstände*, textbook, part 2, published in collaboration with Prof. Dr. Hans Thirring, University of Vienna by Publishing House J.A. Barth, Leipzig, Germany, 1939 [52].

The above-mentioned certificate of equivalence for doctorates gives rise to a number of questions and requires further research as doctorates are exclusively awarded by universities and so-called “certificates of equivalence” do not exist. In addition, all three persons mentioned herein above were in compulsory retirement in 1942 and thus not in a position to issue any certificates [53].

The lecture “Neuere infrarotempfindliche Zellen und ihre Anwendungen” (“Newer Infrared-Sensitive Cells and Their Applications”) by H. Thirring and Otto Paul Fuchs, dated April 20, 1937 [54].

Thirring wrote on October 16, 1952, about that time:

Mr. OTTO PAUL FUCHS of Alserstrasse 26, Vienna IX, is known to me since about twenty years, and during the war I had a part time job in his laboratory. I found never the slightest indication that he was a member or candidate for membership of the NSDAP; on the contrary I know that he was an outspoken enemy of the whole Hitler System. We listened regularly together to the London Radio, we assembled small secret circles to which I read anti-Nazi literature, and above all he was concerned to help people who were persecuted by the Nazis on political or racial reasons.

Among the small staff of his laboratory consisting of 6 or 8 persons there were three girls of half-Jewish extraction and Professor Karl Wolf and myself who had been dismissed from our academic chairs on account of anti-fascist convictions.

Fuchs was bold enough to risk his position in order to help us in our distressed condition [55].

From 1945 until 1952 he worked as a consultant for applied physics and mathematics. From 1952 until 1954 he worked as a consultant for the Burroughs Corporation on Statistical Research in Vienna. At the same time, he worked on Statistical Research at the Institute of Technology and the Austrian Research Institute in collaboration with Prof. Dr. Edmund Grünsteidl in Vienna.

In 1954 he was transferred by Burroughs Corporation for Statistical Research to their Research Center in Paoli, Pennsylvania, until 1956 [56] and lived at 410 Lancaster Ave., Haverford, Pennsylvania [57].

Due to the new legislation after the end of the Second World War Otto Paul Fuchs was awarded the Staatsbürgernachweis (proof of citizenship) on March 5, 1948, in Kitzbühel, in accordance with the citizenship law of July 10, 1945, St. G.Bl. Nr. 60) [58] and from September 30, 1949, he was granted the right to bear the title engineer “ING” in accordance with the Federal law dated July 7, 1948 (B.G.BL. Nr. 171/1948) by the Federal ministry of trade and reconstruction [59].

It can be obtained from Fuchs’s data sheet that he was awarded the title “Ing.” diploma Vienna 1929 (Austrian Fed. Gvt.) [60]. This statement is not understandable as only persons who have passed the corresponding II. state exam, in this case at the technical university of Vienna or Graz, are entitled to bear the academic title of a graduate engineer “Ing.” Also, the estate did not produce such a certificate. Back then the degree or title “Dipl.-Ing.” existed only in Germany and was introduced not before 1938 under the Nazi regime in Austria and maintained also after 1945 [61].

Reference to the activities of engineer Fuchs from 1948–1951 is made in the book *Das 500jährige Jubiläum der Krakauer Studienzeit (The 500th anniversary of our studies in Krakau)* by Nicolaus Copernicus, Secesja, published in 1993, page 95:

The next step in optimizing statistical and stochastic information technology lead to the manufacture of program-controlled simulation devices by the working group for experimental statistics (Adolf Adam, Otto Paul Fuchs, Horst Kottas) at the institute for statistics at the University of Vienna during the years 1948 until 1951 [62].

With respect to the same period of time the following is reported in the obituary Prof. Ing. Dr. Adolf ADAM (February 9, 1918 – August 7, 2004) by Wilfried Grossmann and Norbert Rozsenich at the University of Vienna:

In 1948 the fertile discussions with the engineers Otto Paul Fuchs and Horst Kottas resulted in a patent application (Patent A 951-48) with the title: “Verfahren unter Heranziehung der Zufallsgesetze physikalische und mathematische Aufgaben zu lösen und Einrichtungen hie[r]zu” [= “Procedures for solving physical and mathematical problems applying the laws of chance and equipment thereto”]. It was a kind of, “Monte Carlo calculator,” which can be deemed as prototype for the later development of computer technology. This development was taking place when Metropolis and Ulam published their revolutionary works on the Monte Carlo Method in the United States which still today played a decisive role in modern applied statistics [63].

In the magazine *Elektronische Rechenanlagen (Electronic Calculators)* of 1983, issue 6, in his article “Zur Kulturgeschichte der Simulmatik” (“About the Cultural History of Simulmatics”) Adam reported comprehensively on this cooperation covering two pages:

... The cybernetic firing solutions of the time were problematic. The Austrian engineer Otto Paul Fuchs indeed realized the combination of aeronautical “necessities” and tactical “coincidences” and therefore indulged into the stochastic approach to these issues. The objectified result of his research was a Monte-Carlo calculator aiming at improving success probabilities.

At the same time the reporter was concerned with the simulation of four-terminal networks which had to be composed of a random sample of quadrupole components and thus created a method of statistical quality control with complex quality criteria. The engineer Horst Kottas joined in focusing on the technical realization of Fuchs’s ideas.

On February 28, 1948, an application for patent no. A 951-48 was lodged in Austria under the title:

“Verfahren unter Heranziehung der Zufallsgesetze physikalische und mathematische Aufgaben automatisch zu lösen, und Einrichtungen hiezu” (= “Procedures for Automatically Solving Physical and Mathematical Problems And Equipment Thereto”).

In a joint publication (A. Adam, O. P. Fuchs und H. Kottas, study group for experimental statistics, Vienna) “Elektronik und Statistik” (= “Electronics and Statistics”) in the *Mitteilungsblatt für Mathematische Statistik (Information Bulletin for Mathematical Statistics)* (Munich, 1951) Fuchs writes [7]:

Even if the method proposed by Metropolis and Ulam (the so-called Monte-Carlo-Method) still fails to understand the integration of physical random mechanisms and the automatic performance of stochastic processes to the physical signals generated by precisely those random mechanisms as such, and thus also fails to understand the problem in its most general form, which means, if necessary, going without digital computer operations to determine allocations in an automatic experimental manner, nevertheless, the proposal made by these two authors (Fuchs und Kottas) constitutes the most remarkable contribution in this field which has become known so far.

This device which was presented by the name “Stochastomat” at a later point is essentially a true simulator of statistical probability calculation by the Austrian mathematician Richard von Mises ...

... Similar solutions were rediscovered later by various authors. However, back then the time was not ripe for the introduction of the simulation technology; for the time being the experts concentrated on the opportunities of conventional computer science.

In this context the following needs to be mentioned. Persons who were concerned with the problems of digital calculators in Austria or elsewhere around 1950 were deemed among experts as utopists, to put it mildly. There were, in the first place, the physicists doing analogous calculations and the analytically minded mathematicians who tried to disqualify a digital computer science thus depriving it of any potential significance in the future. I suggest covering the slightly gloomy pioneer years of electronic data processing with the cloak of oblivion ...

... Privy councilor Prof. Dr. H.C. Wilhelm Winkler (who will celebrate his 100th anniversary in 1984) has as a supporter of mathematical statistics within the German cultural area also contributed positively to the development of electrical statistics (see Figure 7, left). The speaker (and reporter) is elaborating on the advantages of the simulation procedures for the simulation of economic processes, although he failed to produce enthusiasm among the advocates of analytical modelling.

Experiments of that kind were a bit fishy to the present mathematicians.

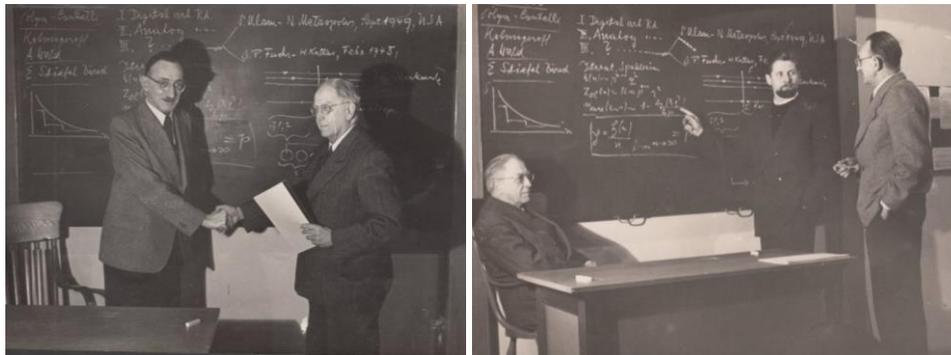


Figure 1-9 and 1-10: Prof. Winkler (sitting), Adolf Adam and Otto Paul Fuchs in 1950 during a discussion on the topic “Stochastomat.” © F. W. Scheidl, Vienna, XV.

On the right side is the skeptically observing Paul Otto Fuchs to whom the sufficiently known orthodoxy of established science did not provide a single opportunity. Eventually he suffered the typical fate of Austrian pioneers. These achievements were honored by the state by awarding him the title of “Technischer Rat” (technical councilor); funds for research were promised, however, not made available.

Fuchs migrated to the United States and was presumably overrun there by the capital-intensive research circles. Nevertheless, he may not fall into oblivion. ...

The Vienna daily newspapers reported that this Vienna electronic brain was capable of solving arithmetical problems within eleven days which up to now would have taken 210 years to be solved, although it would still take thirty days to feed them into the computer [64].

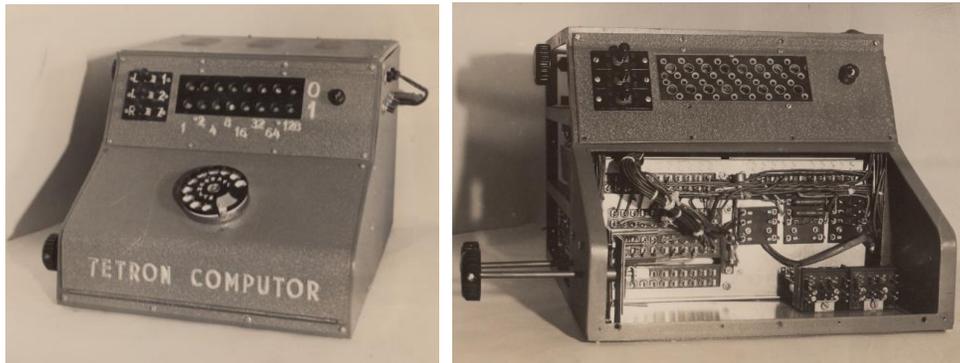


Figure 1–11 and 1–12: Vienna electronic brain—“*Stochastomat*”—*Tetron Computer*.



Figure 1–13: Otto Paul Fuchs and Horst Kottas in Vienna.

This work started already in 1946 and 1948 when the Austrian patent was applied for [65]. On April 2, 1952, Fuchs and Kottas file the application for the US patent US 2891724 (A) Automatic apparatus for transforming statistical or stochastic functions. For Kottas, Vienna has been stated as his place of residence, for Fuchs, however, Haverford, Pennsylvania. Haverford was at the time a suburb of Philadelphia in the US. June 23, 1959, has been stated as date of priority [66].

In an article published in *The Philadelphia Inquirer* of Sunday, March 20, 1955, on page 174. *On Familiar Terms With Einstein* he is referred to as mathematician and his “colleagues” are reported about as follows:

MATHEMATICIAN Otto Paul Fuchs, who recently came to Philadelphia from his native Vienna, was working diligently on a hypothetical equation when he turned to a fellow scientist and said, without cracking a smile, “I think I’ll take a ride to Princeton and discuss this with Dr. Einstein.” He wasn’t joking. For Dr. Fuchs and the world-renowned genius are old acquaintances who often had worked together solving mathematical problems [67].

He received the title “Technischer Rat” (“Technical Councilor”), awarded honoris causa by the President of the Austrian Federal Republic in 1954 for outstanding work in the fields of applied mathematics and thermodynamics [68].

The registration documents of the City of Vienna prove that Fuchs immigrated to the United States at the end of April [69].

His immigration status as of May 3, 1954, is the following: Austrian Citizen, US Registration No. A 8662555, May 3, 1954 [70].

He spoke the following foreign languages: German, Italian, and (Latin) [71].

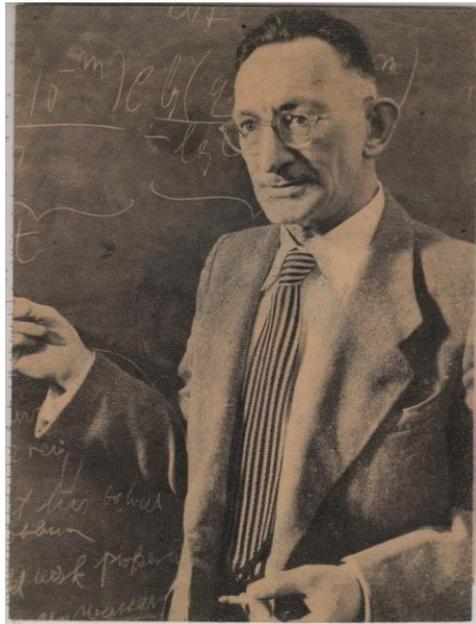


Figure 1–14: Dr. Ing. Otto Paul Fuchs in the US.

In 1956, Fuchs (Research Division Burroughs, Philadelphia, Pennsylvania) delivers a speech before the Österreichische Statistische Gesellschaft (Austrian

Statistical Society) on the topic “Collective Research Relating to Electronic Calculators” (“Kollektivforschung im Zusammenhang mit Elektronischen Rechenmaschinen”) [72]. In 1956, he makes suggestions for savings, as this was not appreciated at Burroughs, he leaves the company [73].

From summer 1956 [74], he is appointed as research professor for physics at Temple University [75]. He received his title “Doctor of Science” in 1957 by the still private [76] Golden State University with his thesis: “An Atomic Random Pulses Generator,” which will be published in 1957 or 1958 [77].

Fuchs is involved in the following experimental works:

Bohn, J. L. and Fuchs, O. P., “High velocity impact studies directed toward the determination of the spatial density, mass and velocity of micrometeorites at high altitudes,” Sci. Rept. 1, Air Force Cambridge Research Center TN-58-243, Armed Services Tech. Info. Agency, Doc. AD 152478 (January 1958).

J. Floyd Bohn, Otto P. Fuchs and Robert K. Morton, Report “Spectrophotometric determination of high temperatures,” November 1960, Temple University.

J. Lloyd Bohn, Otto P. Fuchs, E. Hewitt, and E. J. Sherwood, “Research directed towards the study of transducing meteoric impacts,” Final Rept., Air Force Cambridge Research Labs. TR-60-436.

Fuchs, O. P., Report “Interpretation of micrometeoritic data,” Temple University, Physics Dept., Philadelphia Pa., February 1961 [78,79].

Otto P. Fuchs, “Impact Phenomena,” Temple University, Philadelphia, Pa., *AIAA Journal*, Vol. 1, No. 9, pp. 2124–2126 [80].

A statement of June 12, 1963, by J. Lloyd Bohn, Chairman—Physics Department of Temple University—read:

Dr. Otto P. Fuchs was referred to me by President Gladfelter in the summer of 1956. After an interview with Dr. Fuchs, he was appointed a lecturer in the Department of Physics starting in September of that year. He immediately became interested in research and has been making outstanding contributions to Science. He would have been appointed Research Professor of Physics years ago except that this title was not established at Temple University until 1963. This is his present title, and he is continuing research in space physics, statistics, and Computers [81].

A telex dated October 26, 1964, by Goddard Space Flight Center in Greenbelt, Maryland, reports about his work for the NASA as follows:

Dr. J. L. Bohn and Dr. Otto Paul Fuchs are principal investigators on NASA RESEARCH GRANT NSG-84-60. This work concerns THE PHYSICS OF HYPERVELOCITY IMPACT. A rather extensive laboratory set up has been created in the PHYSICS DEPARTMENT OF TEMPLE UNIVERSITY for this type of work. The use of many types of accelerating techniques have been tried for various kinds of particles. The above named researchers

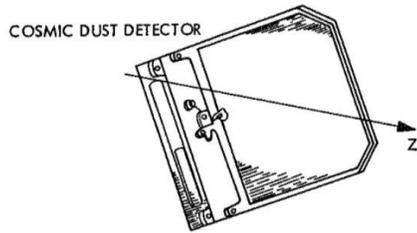


Figure 1-17: Mariner IV cosmic dust detector (drawing).

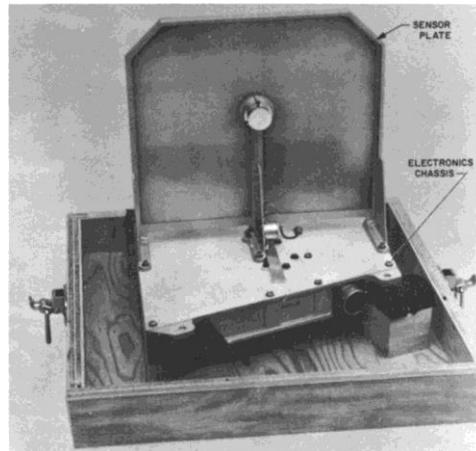


Figure 1-18: Mariner IV cosmic dust detector (picture).

Interestingly you will find in *MARINER MARS 1964 HANDBOOK* by Robert Van Bure—December 1, 1965 (page 98)—JPL Technical Memorandum 33-265—a list differs quite a bit from the others, but Bohn and Fuchs are still named [87].

He writes in an undated letter to Thirring:

I had to overcome numerous colds during the past 1 1/2 years, among other things a pneumonia and long periods of extraordinary tiredness. In spring I had to undergo medical treatment again. In the course of the treatment a series of tests revealed that I am suffering from lung cancer, a carcinoma of the size of half-a-dollar coin in my left lung.

On 2nd October I moved into Jefferson Hospital as patient to Prof. Gibbon (inventor of the heart-lung machine and # 1 surgeon for heart and lung surgeries in the US). After my physical condition had been assessed as fit enough to undergo such surgery the operation was made on 4th October; the left lung was completely removed, took samples of specific glands for histological examination, my heart was shifted to the right as it would have been deprived of his natural support by the missing lobe of the lung, and after about six hours Dr. Gibbon told Judith that the operation may be called a success. It was not only that the entire left lung had been removed as a preventive measure but also the numerous histological tests made during the operation proved that no suspicious (unspecific) cells had been found." [88].

On the evening of May 14, 1965, Dr. Ing [89] Otto Paul Fuchs dies at the age of sixty-seven years in the hospital at Temple University in Philadelphia, USA [90].

He leaves behind his wife Rosa Judith Hotter, 6323 Overbrook Ave., Philadelphia, Pennsylvania [91], born on August 5, 1926, in St. Georgen on Stiefling,

mathematician, whom he married on March 6, 1954, in Graz in his third marriage [92] and his daughter Ruth Eva Fuchs, born in 1951, from his second marriage with the architect Isolde Albine Schlerka, born on January 6, 1923 (marriage October 7, 1950, in Salzburg). This marriage was again divorced already on October 12, 1953 [93].

The following can be obtained from his obituary in the *Philadelphia Bulletin* of May 16, 1965:

Dr. Fuchs was one of six scientists, including another one from Temple, Dr. J. Lloyd Bohn, who designed the cosmic dust detectors [94,95] aboard the Mariner 4 spacecraft now bound for Mars.

He also was involved in research and design of the space platform, which will be launched into orbit around the moon in preparation for a manned U.S. flight to the moon.

He had been an old acquaintance of the late Dr. Albert Einstein and frequently worked with him on mathematical problems [96].

The *New York Times* of May 16, 1965, continues as follows:

... Dr. Fuchs was the author of many papers and several texts on semiconductors, aerodynamics, electronics, space research and statistics. His physics equations are being used at the Manned Space Flight Center in Houston [97].

He was a member of the following professional associations: Scientific Research Society of America. Österreichische Mathematische Gesellschaft [98].

III. Conclusions

Summarizing the period of the second half of the 1920s in the life of Ing. Otto Paul Fuchs with respect to the developing aeronautics movement it can be said that his first written contribution to rocketry, as Hoeffft expressed himself, revealed him as a new advocate of his idea. He was not only a follower, neither in the field of aeronautics which was his main focus at the time, but he was an active creator to serve a good cause and who assumed an active role as secretary in the pioneering association of the later Gesellschaft für Höhenforschung.

In his time he seems to have been closely linked to the scientific scholars concerned with these issues, otherwise he would not have become secretary, however, he would not have stuck to their, in part, wrongful conceptions and was, just like the scholars, not willing to join the newly founded society under Hoeffft's presidency.

No concrete evidence of the continuance of this loose association has been found so far.

Fuchs makes again an active contribution with his two solid fuel rockets which presented a very progressive design at the time. As can be obtained from the exclusive report this experiment was a preliminary experiment about employing the rocket propulsion in aeronautics. Unfortunately, nothing else beyond this remark is known.

In fact, the flight engineering association (Flugtechnische Verein) was quite aware of the

formation of a section for research on high-altitude flights which was established within the framework of the Austrian flight engineering association on June 6, 1928, whose purpose was to study and promote the further development of jet propulsion in aviation and aeronautics as well as to compile collections and deliver speeches. President Pittner took the chair of that section and it was decided to get into touch also with foreign researchers who are engaged in this field [99].

Also, the tests with small-sized model rocket aircrafts conducted by Aurelius Bisail need to be evaluated in this context.

Engineer Otto Paul Fuchs, however, was a member of the competing Österreichische Fluggesellschaft, which was founded in 1927 and where Hans Friedrich Orelli, the formerly responsible editor of the magazine *Flug* published by the Österreichische Flugtechnische Verein, played an important role.

The official organ of the Österreichische Fluggesellschaft was the magazine *Motorenwelt-Wiener-Motoren-Zeitung*. This magazine has not been made available for corresponding research by the portal ANNO run by the Austrian national library (Österreichische Nationalbibliothek).

The assessment of his achievements in the fields of electrical engineering and early computer engineer should be left to the experts in these disciplines. The fact that the Vienna technical museum still exhibits a prototype of the computer which was developed by engineer Otto Paul Fuchs and assembled by engineer Horst Kottas (Computer type Fuchs-Kottas), also called “Vienna Electronic Brain” (“Wiener Elektronengehirn”) reflects the importance of his work [100].

The question as to the precise responsibilities of Fuchs with the Burroughs Corporation in the US requires further research. The fact that the Burroughs Corporation, recruited him to their in 1951 newly-established Research Division in Paoli, a Philadelphia suburb, in 1954 serves as a proof of his abilities and performance which he must already have contributed to Burroughs in Vienna from 1945 to 1951. In addition, further research is required as to the question in how far he was involved in the military missile program by the US navy where Burroughs Corporation played a substantial part in both the Poseidon missile program and the emerging missile program of the US.

There is reliable proof of his substantial contribution to the development of the *Cosmic Dust Detector* of the US space probe Mariner 4 which was the first space probe to pass Mars at a distance of 9,844 kilometers on July 15, 1965 [101].

Likewise, his contribution to the mathematical formula by Dr. Fuchs requires further specification. The statement:

He also was involved in research and design of the space platform, which will be launched into orbit around the moon in preparation for a manned U.S. flight to the moon.

This statement might probably refer to Explorer 35 (IMP-E) as this lunar probe carried a micrometeorite detector of Temple University [102].

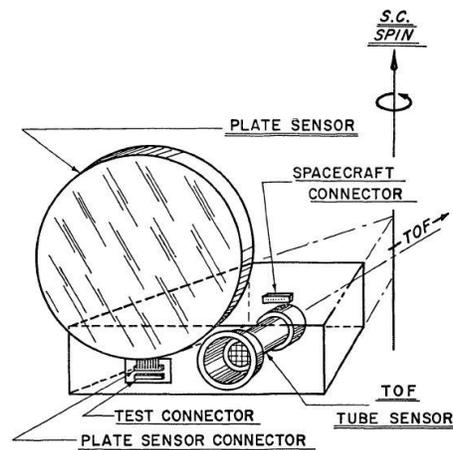


Figure 1-19: Lunar Explorer 35 (IME-E), dust particle experiment (functional sketch).

Conclusively, it must be said that Otto Paul Fuchs was one of the very few pioneers of the first hours of cosmonautics in the 1920s who made his own substantial contribution to cosmonautics. This alone will lead to a new evaluation of his person within the circles of rocketry and cosmonautics pioneers where he had played, until to date, an entirely underestimated role. Fuchs was lucky enough to make one of the few sustainable contributions to cosmonautics (*Beitrag zur Kosmonautik*).



Acknowledgments

My special thanks go to the following persons without whose cooperation or support this chapter would not have come about:

Dr. Michaela Laichmann, Prof. Dr. Susanne C. Pils, Herr Merkel and Herr Plank,
Vienna City Administration, Department 8, Municipal and Regional Archives Vienna

FOI Claudia Hauer,
Österreichisches Staatsarchiv—Kriegsarchiv/Marine und Luftfahrt

Mag. phil. Dr. phil. Juliane Mikoletzky,
Archiv Technische Hochschule Wien. freie Mitarbeiterin

Bernhard Reismann, Universitätsarchivar,
Archiv Technische Hochschule Graz.

Mag. Dr. Matthias Egger,
Landeshauptstadt Innsbruck Stadtarchiv/Stadtmuseum

Margery N. Sly, Director,
Special Collections Research Center, Temple University Libraries

Jennifer,
Reference Librarian, Haverford Township Free Library

Mag. Dr. Barbara Köller,
Stadtgemeinde Wolfsberg

Selda Ay,
Beratungs- und Servicezentrum

Yasemin Maden,
Stadtverwaltung Herzogenrath—A 35 Bürgerdienste

Kirsten Moss,
Stadtbücherei Herzogenrath

Brigitte Drießen,
Stadtarchiv Aachen (E 49/3)

Dr. Tanja Jelšina,
Kaluga

Michael Tilgner,
Wedel

Dr. Wolfgang Both,
Berlin (Nachlass Hohmann)

Martin Frauenheim,
Hagen am Teutoburger Wald

Frank H. Winter,
former curator NASM

Ursula Mock,
Proofreading

Elke Korbmann,
Translation

Very special thanks go to people without whose cooperation and support this work would not have been possible in that way: Dr. Ruth (Eva) Fuchs, daughter of Otto Paul Fuchs; Prof. Dr. Susanne Claudine Pils; Mag. phil. Dr. phil. Juliane Mikoletzky; and Frank H. Winter.

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[1] Magistrate of the City of Vienna, Magistrate Department 8, Vienna City and National Archives—MA 8—B-MEP-1032734-2018—10 December 2018.

[2] Email by Dr. Ruth Eva Fuchs to Author, dated 23 August 2019.

[3] *Flugzeug und Jacht*, May 1926, pp. 7–9, July 1926, pp. 7–9.

- [4] Frank H. Winter, *Prelude to the Space Age*, Smithsonian Institution Press, 1983, pp. 30–31.
- [5] Dr. Bruno Phillip Besser, “Pioneers from Other German-Speaking Countries: Austria,” *AAS History Series*, Volume 34, p. 543.
- [6] See [01].
- [7] HORM-Archive: Fuchs Nachlass 026 *Temple University—News release, for immediate Release 5/15/1965*.
- [8] HORM-Archive: Fuchs Nachlass 062 *Behördlich autorisiertes Übersetzung aus dem Ungarischen Auszug aus der Trauungsmatrikel vom 24 February 1954*.
- [9] This is a so-called “Transylvanian marriage”—also see: *Jahrbuch des Vereins für Geschichte der Stadt Wien*, 2018 (yearbook of the Association for history of the city of Vienna).
- [10] HORM-Archive: Fuchs Nachlass 075 Kopie: Geburts—u. Tauf—Register (copy of the register of births and baptisms, parish Fünfhaus, Vienna, 1897, p. 251, No. 1021).
- [11] HORM-Archive: Fuchs-Nachlass 191 Memos dated 7 August 2019, with Ruth Fuchs.
- [12] Newspaper clipping, December 1954.
- [13] HORM-Archive: Fuchs Nachlass 091 *Landesregierung für Tirol. IIN 865/4. Innsbruck, 3 August 1922, Aufnahms-Urkunde. Handschriftlich: Gelöbniß abgelegt am 20 August 1922*.
- [14] Österreichisches Staatsarchiv—Kriegsarchiv/ Marine und Luftfahrt—No. 20190514102139895.
- [15] HORM-Archive: Fuchs Nachlass 060 *begl. Abschr. Luftschraubenprüfanstalt, Exh. No 829., Fischamend, 1 March 1918, i.V. Koczka Oblt.*
- [16] HORM-Archive: Fuchs Nachlass 002 *Bildtafel, VI/4, Aerodynamische Arbeiten ex 1917/18, Anlage 41*.
- [17] <http://anno.onb.ac.at>—*Innsbrucker Nachrichten*, 13 March 1920, 67th year, No. 60, p. 7 [2019].
- [18] <http://anno.onb.ac.at>—*Innsbrucker Nachrichten*, 16 March 1920, 67th year, No. 62, p. 6 [2019].
- [19] <http://anno.onb.ac.at>—*Innsbrucker Nachrichten*, 29 May 1920, 67th year, No. 120, p. 9 [2019].
- [20] see [01].
- [21] *Flugzeug und Jacht*, 1926, July, p. 4–7, Aug., p. 4–5 u. Sept., p. 4–5.
- [22] *Flugzeug und Jacht*, 1926 May, p. 7–9.
- [23] *Flugzeug und Jacht*, 1926 July, p. 7–9.
- [24] HORM-Archive: letter Oberth to Hoefft, dated 27 November 1926.
- [25] Barth, Hans, Briefwechsel I, Kriterion Verlag, Bukarest, 1979, p. 39–41 [26].
- [26] Österreichische Zentralbibliothek für Physik und Fachbereichsbibliothek Chemie in Wien—Teilnachlass Guido (von) Pirquet, Signatur: W87-1.
- [27] Letter Valier to Hohmann, 1 January 1927, Archiv Familie Hohmann.
- [28] Barth, Hans, Briefwechsel I, Kriterion Verlag, Bukarest, 1979, p. 84–88 [47].
- [29] Annotation made by Mag. phil. Dr. phil. Juliane Mikoletzky, Archiv Technische Hochschule Wien, volunteer: Wolfgang Lewinsky war tatsächlich bis 1927 Assistent bei Karl Wolf, somit Ende 1926 noch nicht “ehemalig” (“Wolfgang Lewinsky was in fact assistant to Karl Wolf until 1927, thus in 1926 he was not “formerly”).

- [30] Familien-Chronik Walter Hohmann, 15 February 1927—3 March 1927, Archiv Familie Hohmann.
- [31] Annotation made by J. Mikoletzky: *Prof. Otto Greger, Leiter der Versuchsanstalt für Maschinenmechanik am Technologischen Gewerbemuseum.*
- [32] Letter Oberth to Hoeffft, dated 19 September 1926—Archiv HORM.
- [33] Thirring, Hans, Menger, Karl u. Mark, Hermann: *Alte Probleme-neue Lösungen in den exakten Wissenschaften; Fünf Wiener Vorträge*, Franz Deuticke: Leipzig, Wien 1934.
- [34] Annotation J. Mikoletzky: This is not correct: the Dreihufeisengasse is located near Getreidemarkt (today Lehargasse), the Elektrotechnische Institut including Bauhof, by contrast, is clearly at a distance at Gußhausstrasse.
- [35] Annotation J. Mikoletzky: this refers to Technische Versuchsanstalt (TVA) at the TH (technical university) in Vienna. Rinagl was at the same time also a professor at the technical university in Vienna.
- [36] Hartmut E. Sängler, *Ein Leben für die Raumfahrt—Erinnerungen an Prof. Dr.-Ing—Eugen A. Sängler*, 2006, Stedinger Verlag, Limwerden, ISBN 3-927 697-42-7, p. 38.
- [37] Dr. Eugen Sängler, *Versuchstagebuch 1933–34*, p. 183, V 103, copy archived at the library of University of Alabama in Huntsville.
- [38] Deutschen Physikalischen Gesellschaft, 1934, p. 40, 64 u. 80
<https://books.google.de/books?id=oSPOAAAAMAAJ&q=otto-paul-fuchs&dq=otto-paul-fuchs&hl=de&sa=X&ved=0ahUKEwj69P6c7bHjAhVhMewKHRwZAHQ4ChDoAQgnM AA> [2018].
- [39] Thirring, Hans, and Fuchs, Otto Paul: *Photowiderstände*, Johann Ambrosius Barth Verlag: Leipzig 1939.
- [40] *Motor Sport Wien*, 15 July 1928, No. 5, p. 15.
- [41] *Illustrierte Technik*, 1928, H. 30, p. 10.
- [42] <http://anno.onb.ac.at>—*Neues Wiener Journal*, 24 June 1928, 36th year, No. 12423, p. 7 [2019].
- [43] HORM-Archive: Fuchs Nachlass 019 Personal Data Sheet and Curriculum Vite, without date, p. 3.
- [44] HORM-Archive: Fuchs Nachlass 009 Fuchs—Auszug aus den Arbeiten, p. 3.
- [45] See [43].
- [46] <https://books.google.de/books?id=yKK2zQLNBxgC&q=otto-paul-fuchs&dq=otto-paul-fuchs&hl=de&sa=X&ved=0ahUKEwj69P6c7bHjAhVhMewKHRwZAHQ4ChDoAQg7M AU> [2019].
- [47] Horst Kottas Engineer Horst Kottas was born on 26 August 1907 in Spital on Drau [a] and last lived in Herzogenrath-Kohlscheid, Grachtstraße 51, an Aachen suburb and died in Aachen on 10 September 1987 [b].
- [a] Magistrat der Stadt Wien, Magistratsabteilung 8, Wiener Stadt—und Landesarchiv: MA 8—B-MEP—639975-2019 23.07.2019.
- [b] E-Mayl von Yasemin Maden—Stadtverwaltung Herzogenrath—A 35 Bürgerdienste vom 7 August 2019.
- [48] Archives of the author.
- [49] see [43].

- [50] Adolph Lehmann's allgemeiner Wohnungs-Anzeiger (Wien)—1942—Volume 1 u. 2—Fuchs
www.digital.wienbibliothek.at/wbrobv/periodical/structure/278153 [2019].
- [51] HORM-Archive: Fuchs Nachlass 009-010 Fuchs—Auszug aus den Arbeiten, pp. 3–4.
- [52] HORM-Archive: Fuchs Nachlass 016 Personal Data Sheet and Curriculum Vite, without date, p. 1.
- [53] Verh. d. D. Phys. Ges. (3) 18, 80. 1937. No. 3. (Vienna).
- [54] Information given by J. Mikoletzky, archives of the Technical University, Vienna.
- [55] HORM-Archive: Fuchs Nachlass 029 Copy: letter of Prof. Hans Thirring, Kitzbühel, 16 October 1952.
- [56] See [43].
- [57] HORM-Archive: Fuchs Nachlass 042 Patent: United States Patent Office 2,891,724, Patented 23 June 1959.
- [58] HORM-Archive: Fuchs Nachlass 059 Republik Österreich, Zahl 9/1948 A 2327/1, Staatsbürgerschaftsnachweis, Kitzbühel, 5 March 1948.
- [59] HORM-Archive: Fuchs Nachlass 056 Staatsgültiges Zeugnis 46122-I/1-49, Bundesministerium für Handel und Wiederaufbau, 30 September 1949.
- [60] HORM-Archive: Fuchs Nachlass 012 Personal Data Sheet and Curriculum Vite, without date, (with signature on p. 3), p. 1.
- [61] Information given by J. Mikoletzky, archives of the Technical University of Vienna, also see: Juliane Mikoletzky: (Zeit)Zeugnisse. Zeugnisse und Diplome der Technischen Universität Wien und ihrer Vorgängerinstitutionen von 1815 bis zur Gegenwart (Contemporary) certificates and diplomas of the Technical University of Vienna and its preceding institutions from 1815 until present, Vienna 1994.
- [62] <https://books.google.de/books?id=JM0fAQAIAAJ&q=otto-paul-fuchs&dq=otto-paul-fuchs&hl=de&sa=X&ved=0ahUKEwj69P6c7bHjAhVhMewKHRwZAHQ4ChDoAQg4MAQ> [2018].
- [63] *AUSTRIAN JOURNAL OF STATISTICS*—Volume 34 (2005), Number 1, 3–6.
- [64] HORM-Archive: Fuchs Nachlass 104 Zeitungsseite: Salzburger Nachrichten, 12 September 1950, p. 3.
- [65] HORM-Archive: Fuchs Nachlass 010 Fuchs—Auszug aus den Arbeiten, p. 4.
- [66] see [56].
- [67] HORM-Archive: Fuchs Nachlass 031 Newspaper clipping: *Philadelphia Inquirer*, 20 March 1955, p. 174.
- [68] HORM-Archive: Fuchs Nachlass 013 Personal Data Sheet and Curriculum Vite, without date, (with signature on p. 3), p. 2.
- [69] see [01].
- [70] see [52].
- [71] see [43].
- [72] *Bevölkerungsstatistik und Bevölkerungswissenschaft in Österreich 1938 bis 1955*, von Gudrun Exner, Peter Schimany, Seite 338 (Anhang).
- [73] HORM-Archive: Fuchs Nachlass 112 Recordings of telephone conversation between Ruth Fuchs and Judith Hotter on 19 May 2007, p. 6.

- [74] HORM-Archive: Fuchs Nachlass 023 Letter by J. Lloyd Bohn, Department of Physics, Temple University, Philadelphia 22, PA., 12 June 1963, to whom it may concern.
- [75] HORM-Archive: Fuchs Nachlass 026 News Release, Temple University, 15 May 1965.
- [76] Annotation by J. Mikoletzky.
- [77] See [60].
- [78] https://archive.org/details/NASA_NTRS_Archive_19650015410r.
- [79] <https://books.google.de/books?id=6psTNOEZeH4C&q=%22otto+P.Fuchs%22&dq=%22otto+P.Fuchs%22&hl=de&sa=X>.
- [80] HORM-Archive: Fuchs Nachlass 048-050.
- [81] See [72].
- [82] HORM-Archive: Fuchs Nachlass 024 Telex, Goddard Spaceflight Centers in Greenbelt Maryland, 26 October 1964.
- [83] NASA Press Kit, RELASE NO: 64-266, 29 October 1964, MAINER MARS 1964, p. 41.
- [84] JPL TECHNICAL MEMORANDUM NO. 33-229 p. 31.
- [85] REPORT FROM MARS: Mariner IV 1964–1965—EP39, p. 36.
- [86] JPL Technical Report 32-1427, May 1, 1970, p. 7.
- [87] Robert Van Bure, MARINER MARS 1964 HANDBOOK, 1 December 1965, p. 98 (JPL Technical Memorandum 33-265).
- [88] HORM-Archive: Fuchs Nachlass 025 Letter by O. P. Fuchs to Hans Thirring, without a date [October 1964].
- [89] Dr. Ing. is an academic degree which can only be acquired at a German university. The Dr. Ing. degree mentioned in the Press Release of Temple University has been created of “Doctor of Science” granted by the private Golden State University and the title “Ingenieur” (engineer) granted in Austria in 1948.
- [90] See [74].
- [91] HORM-Archive: Fuchs Nachlass 030 Newspaper clipping: *Philadelphia Bulletin*, 16 May 1965.
- [92] Rosa Judith Hotter died 19. October 2019 in St. Georgen on Stiefling.
- [93] Magistrate of the City of Vienna, Magistrate Department 8, Vienna City and National Archives—MA 8—B-MEP-640725-2019—6 August 2019 On 18 June 1936 marriage in Mariazell with Hermine Leopoldine Fuchs, née Schustek, born on 16 September 1910 in Vienna, Roman-Catholic. The marriage remained childless and was finally divorced on 30 July 1948.
- [94] A cosmic dust detector, consisting of a 22-by-22-cm aluminum impact plate which was coated on both sides with a nonconducting material and which had a crystal acoustical transducer bonded to one side, was used to continually monitor dust-particle flux and mass distribution from earth proximity through the Mars encounter. The impact plate and dielectric-aluminum film combination constituted a penetration detector in the form of a capacitor. The experiment was also intended to observe the degree of dust-particle concentration near earth and near Mars, the rate of change of the dust-particle flux density with respect to distance from earth, and the perturbation effects of large planetary bodies on the dynamic behavior of the dust particles. The instrument was mounted above the main spacecraft bus, with the case just inside the thermal shield to protect it from the sun. The sensor protruded through an opening in the thermal shield. The instrument memory consisted of two 8-bit bi-

nary data-analysis registers and a microphone accumulator which recorded the number of microphone events observed by the instrument. Experiment data were received concerning particle momentum, the incoming particle direction, particle impacts below the microphone threshold, and microphone event accumulations. Measurements revealed a dust concentration near earth with a mass distribution somewhat different from that of interplanetary space. In-flight calibration was performed once a day on command from the ground. No instrument degradation was detected.
<https://nssdc.gsfc.nasa.gov/nmc/experiment/display.action?id=1964-077A-07>.

- [95] Data acquisition resumed in late 1967. The cosmic dust detector registered 17 hits in a 15-minute span on September 15, part of an apparent micrometeoroid shower that temporarily changed the spacecraft attitude and probably slightly damaged its thermal shield. Later it was speculated that Mariner 4 passed through debris of D/1895 Q1 (D/Swift), and even made a flyby of that comet's possibly shattered nucleus at 20 million kilometers. On December 7 the gas supply in the attitude control system was exhausted, and between December 10 and 11, a total of 83 micrometeoroid hits were recorded which caused perturbation of the spacecraft's attitude and degradation of the signal strength. On December 21, 1967, communications with Mariner 4 were terminated. The spacecraft is now derelict in an exterior heliocentric orbit. https://en.wikipedia.org/wiki/Mariner_4.
- [96] See [46].
- [97] HORM-Archive: Fuchs Nachlass 033 Newspaper cutting: *New York Times*, 16 May 1965.
- [98] See [46].
- [99] *Flug* (Wien), 1928 June, No. 6, p. 2.
- [100] E-mail by Dr. Ruth Eva Fuchs to author, dated 23 August 2019.
- [101] <https://de.wikipedia.org/wiki/Mariner> [2019].
- [102] Linda Neuman Ezell, *Programs and Projects 1958–1968*, NASA SP-4012—NASA HISTORICAL DATA BOOK Volume II, p. 251.