# A pathline with many branching points $1954 \leq t \leq 2015$

KARL G. ROESNER

Darmstadt, Germany
http://www.kgroesner.de, e-mail: kgroesner@t-online.de

My life is full of unexpected events, more or less influenced by my own decision or by chance, which mark branching points like milestones of my life. Starting with the first and most important decision in my life, I have to describe the situation one year before I entered the university:

$$\text{First bifurcation: Archaeology} \longrightarrow \text{Physics}$$

This dates back to the year 1954. At that time I prepared for the final examination at school, which was based on modern but also ancient languages like Latin and Greek. It is apparent, that because of this classical education I was dreaming of being an archaeologist in the far future, devoted to expeditions into foreign countries like Egypt or the Holy Land to detect the ruins of old settlements or valuable burial objects in graves ...

But my interest was also attracted by mathematics and physics, which I liked, especially because of their fascinating feature to be exact and applicable to predict the results of technical processes and phenomena in nature. It was the time, when all over the world people discussed the possibility of launching rockets to build a spacelab or to realise the ambitious plan to reach the moon.

There was a crucial experience, when I had the chance to listen to a lecture of Hermann Oberth about the trip to the moon. Picture 1 is a photo of the cover of the journal, named "Weltraumfahrt" of 1957, which shows Prof. Hermann Oberth and Prof. Wernher von Braun looking at the first issue of the American journal "Space Journal". In his talk Hermann Oberth was so optimistic about the solution of all still open problems that I got enthusiastic and was more and more willing to give up my dream of becoming an archaeologist, in favor of studying physics and mathematics. I definitely decided after my examination to get enrolled at the university as a student of physics. This was the first branching point in my life of serious consequence. As student of the first year I was a member of the "Gesellschaft für Weltraumforschung" among 137 other students. At that time I was far from being involved professionally with problems of space science. But nevertheless, I was very interested in the development of space research and had a subscription for the journal mentioned above.

Dreaming of the future being a physicist designing rockets or landing modules, and studying physics from the beginning are two rather different things! Most of my courses as student at the University of Münster were devoted to mathematics, which I liked very much, although we were left alone with problems to understand mathematical proofs on the basis of our very limited knowledge. But this did not deter me from mathematics! In the contrary, up to now mathematics is still my "first love".

Speaking about love brings me to the more private part of my life: Both, Lotte and me, we went to school in the same town. We knew each other on the occasion of attending the same dancing course in the age of seventeen. During my whole time of academic education we stayed in permanent connection — without iPhone or handy — only by the exchange of letters! There could be no question of immediate connection by email via internet, words which were not yet born, leave alone that those things existed!

### Second bifurcation: Münster $\longrightarrow$ Göttingen

The second important branching point on my pathline through space and time was the decision to move to the Georg-August-University in Göttingen in 1956. Here, I felt to be at the spring of science, not least, because of the numerous research institutes of the famous Max-Planck-Gesellschaft. Its President at that time was Otto Hahn, Werner Heisenberg was head of his research Institute of Physics, and Carl Friedrich von Weizsäcker gave courses on philosophical problems arising from modern theoretical physics. Other names which accompanied my time in Göttimgen were those of famous mathematicians and physicists who lectured permanently or as guest professors for some semesters. I remember e. g. a course given by P.D. Lax in mathematics and another one in physics by P. Debye on molecular physics.

Besides my studies in many different physical and mathematical subjects I decided to take courses in Russian language due to my inherent love of languages at the Slavistic seminar. This I did with great enthusiasm and was full of admiration of Russian classical literature. Names like Dostoyewski, Pushkin, Tolstoy and Turgenyev I knew from schooltime. But now I was able to read them even though with the help of a good dictionary. My day's work was fully packed with Russian courses, mathematical seminars and physical practica. Nevertheless, I felt happy.

Concerning my professional education as physics student, I went through the hard school of theoretical physics of Friedrich Hund, who — to my opinion without good reason — was never elected to win the Nobel Prize. He had the unique talent in his lectures to let the students feel, that they have understood everything following his plausible arguments. But when we were left alone to do our exercises, we found out that we had understood nothing! It was a necessary experience for us that theoretical physics is mostly based on strong mathematics. So we learned by ourselves how to manipulate multiple integrals of complicated functions etc. Experimental physics was represented by well-known names like R.W. Pohl and R. Hilsch. So, well equipped with a huge amount of physical and mathematical knowledge, I passed my "Diplomprüfung" in physics and got the chance to join the famous Max-Planck-Institut für Strömungsforschung, which was founded by Ludwig Prandtl, the pope of modern aerodynamics in Germany. The present director was Walter Tollmien who gave selected courses at the university in Applied Mathematics and Mechanics. In this environment I felt to be at the right place to realise my dream of participating in the research of fluid dynamic problems, especially in gasdynamics.

### Third bifurcation: Bachelor $\longrightarrow$ married man

As I got a salary from the Max-Planck-Institut, we — that means Lotte and me — decided that it's time to get married. This was the third most important branching point in my life: From bachelor's life to a married man. From this moment on, a path line parallel to mine must be followed, up to now, because without Lotte's steady support I never had

come to the point which I have reached. She took care of our three children from birth, took some of my load off, that my head was free for research and I could concentrate on scientific problems.

In more detail, I will describe the situation in Göttingen after being married. At that time the Max-Planck-Institutes in Göttingen were equipped with an IBM Computer of the first generation — unbelievable that such a machine with 1000 words capacity on a magnetic drum was looked at as a computer! Nevertheless, I was attracted by this monster of machine as if by magic. Naturally, later the fastest IBM machines were installed in the computing center and I had access as single user to these computers. As a consequence, my doctoral thesis was mainly based on numerical methods, to find a method for the solution of the equations of gasdynamics in three space dimensions and time. Not knowing in what a hazardous business I got involved, I accepted the theme of my thesis from my supervisor, and was left alone with the problem, how to find the solution. That was sheer madness!

In this situation I could use my knowledge of Russian language! In the Otto-Hahn-Library of the Max-Planck-Gesellschaft I found many Russian Journals, where the major part of the articles were devoted to numerical methods for gasdynamical problems. No translation into German or English language was available, so I made every effort to understand the content of the papers and the mathematical theories behind the applied methods. Studying the results, I got in touch with the names of V.V. Rusanov an N.N. Yanenko, two scientists who influenced my further life significantly.

<center>Fourth bifurcation: East ⟶ West</center>

Politically, it was the time of the "Cold War", when it was nearly impossible to approach a scientist beyond the "Iron Curtain" by letter — or personally at all — to discuss scientific questions. The only way to communicate with scientists of Eastern countries was the attendance of international conferences. The first encounter with Russian mathematicians for me was possible in 1967, because I was invited by the Polish Academy of Sciences to take part in the IX Symposium on Advanced Problems and Methods in Fluid Mechanics in the North of Poland, in a densely wooded region full of lakes. There I met the first time V.V. Rusanov and N.N. Yanenko among a great number of other Russian scientists: Another important milestone in my life! Academician Yanenko told me about his monograph on the "Fractional Step Method" and promised to send me an exemplar of his book with the hope that I would translate it to German language and publish it by Springer-Verlag, Heidelberg. So I did, and was successful to use my knowledge in Russian language a second time to translate scientific books. Rusanov's work was also closely connected to my thesis, and I learned a lot from his numerical investigations of gasdynamical flows for my further work in computational fluid dynamics.

I remember well this meeting in the forest region of Poland — it was in September — because many of the Russian scientists took a bath in the morning in the crystal-clear water of the lake around our conference center while I preferred to take a shower with warm water! This first encounter with scientists from the East, especially Russia, had an essential influence on my further academic career.

Naturally, there was no problem for scientists in the West to contact scientists in Western countries, and a first chance for me to do so, was the participation in the Second International Conference on Numerical Methods of Fluid Dynamics at Berkeley University in 1970, where I met the second time N.N. Yanenko. He together with M. Holt of Berkeley had the plan to

strengthen in the future the scientific cooperation between East and West by invoking a bi-annual meeting on international level in different countries around the world. A committee was built, and Prof. Henri Cabannes from Paris proposed to include me into the international group of scientists for the preparation of the next conferences. This was a great honor for me to be member of this committee, and had a favourable influence for my whole academic career.

After the following conference in Paris in 1972, I was invited by Academician N.N. Yanenko to visit his Computing Center in Akademgorodok, subsequent to the International Conference on Mechanics in Moscow. I must confess, that I was very excited about his offer and agreed with pleasure to his invitation. This was the first encounter with one of his best collaborators, now Academician Y.I. Shokin, who took care of me during my stay in Akademgorodok. At that time I would describe my role as an ambassador of good will to establish a link between mathematicians in East and West.

Due to the generous support of the Deutsche Forschungsgemeinschaft I could invite colleagues from Eastern countries, especially from the USSR of that time, to spend a longer period in Germany to do cooperative work. During my stay at Freiburg University I invited Dr. Y.I. Shokin (now Academician) for a stay in Freiburg of some months at the Institut für Angewandte Mathematik. From this time on we were in close contact, and some years later I met him again in Akademgorodok when I was invited for about one month. Doubling the experience of translating the book of N.N. Yanenko I did the same with the monograph of Y.I. Shokin on The Method of Differential Approximation.

<div align="center">

Fifth bifurcation: Dr. rer. nat. $\longrightarrow$ outside lecturer (Privatdozent)

</div>

In the meanwhile, I finished my Ph. D. thesis and was promoted to "Dr. rer. nat." (doctor rerum naturalium) which gave me the chance to look for a possibility to do my second doctoral thesis, called "Habilitation". Such a scientific career was hardly possible at the Max-Planck-Institut für Strömungsforschung in Göttingen.
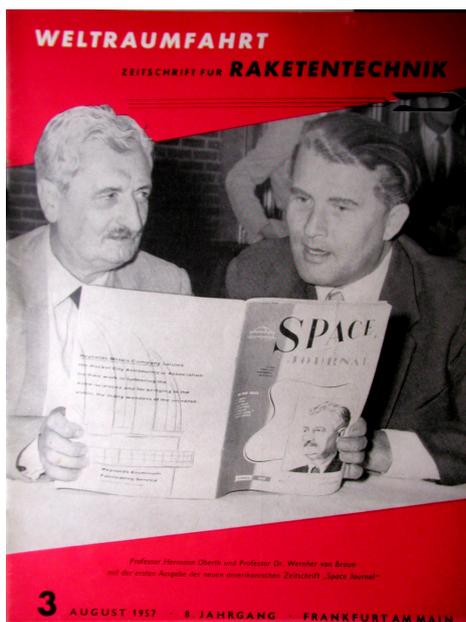


Pic. 1



Pic. 2

In this situation I got the offer to apply for the post as assistent at the "Institut für Ange-wandte Mathematik" at the Albert-Ludwigs-Universität in Freiburg. The current director of this institute was Prof. Henry Görtler, one of Prandtl's assistants in Göttingen in the thirties of the last century. He gave me the chance to concentrate on my habilitation work, and besides that he asked me to take on mathematical courses. It was this combination which I appreciated very much and which I had dreamed of, and which characterises my further activities at universities in Germany. I finished my habilitation work on a problem of gas separation of isotopes and arrived at the state of a "Privatdozent" with the right to give courses at the "Technische Hochschule (TH) Karlsruhe" (now Karlsruhe University) in the Department of Fluid Mechanics. This was indeed a branching point in my academic career. Lecturing was a great pleasure for me. I got in close contact to students, played the role of a supervisor for them with respect to diploma work or Ph. D. thesis.

Sixth bifurcation: Karlsruhe $\longrightarrow$ Darmstadt

Being a "Privatdozent" means normally to be in a transition stage to the higher level of professorship. Therefore my stay in Karlsruhe was restricted to an unknown number of years, till I could get the appointment as professor at another university. After four years teaching at TH Karlsruhe, I had to decide to follow an offer of the TH Darmstadt (now Technische Universität Darmstadt) to apply for a position as professor, or to wait for another chance to get promoted at any other university. I decided immediately for Darmstadt and started in 1980 teaching and research work in Computational Fluid Dynamics at the Institute of Mechanics, gave courses on fluid dynamics, gasdynamics and numerical methods in fluid



Pic. 3



Pic. 4

dynamics. Many of my Ph. D. students had an excellent background in Mechanics and Computational Fluid Dynamics, so that they could attack demanding problems by numerical methods on the latest generation of supercomputers. I insisted on the comparison of any numerical result with reliable experimental data. CFD which was sometimes disparagingly interpreted as "Colored Fluid Dynamics" was not convincing to me, until an experiment showed the coincidence of numerical and experimental data.

I myself went on to cooperate with scientists all over the world: The most important connection lead me to Japan, to my good friend Kunio Kuwahara at Tokyo University. He was at that time running his world-wide known own computing center, called ICFD (Institute of Computational Fluid Dynamics). We had a common interest to compare my experimental results on rotating fluid flow with his numerical results, based on his own developed numerical methods running on the latest version of Hitachi machines or Fujitsu computers. For me it was the Eldorado of computational fluid dynamics! In 1997/8 I was invited during my sabbatical year to join the Institute of Space and Astronautical Science (ISAS) in Sagamihara near Tokyo, were the launching of the solid-fuel rocket Muses-V-I was prepared to carry an antenna into space for astrophysical measurements. In picture 2 you can see me sitting in front of a terminal looking at results of my calculations on a supercomputer.

During our stay in Japan, a dream of my childhood came true: I could witness with Lotte the launching of a monster rocket at the Island of Kagoshima, 5th February 1998. It was the longest possible rocket which could be launched from an inclined ramp. Picture 3 shows the inclined rocket before launching. Because of the terrible sound noise during take-off, only within two months in the year launching was allowed, not terrifying the fishes in the Pacific! Picture 4 shows the rocket after successful lift-off entering a cloudy region in the sky. The mission was successful!



Pic. 5

The end of our stay at ISAS was celebrated in a nice environment of a typical Japanese restaurant, organised by our good friend Kunio Kuwahara. Picture 5 gives an impression about the mood at our farewell party.

Back to Darmstadt, there were only two years of teaching and research till to my retirement. Officially, in the age of 65 one has to say good bye to the University and leave the chair open for the younger generation. But this situation can be compared in some sense with the dissolution of a marriage! There are still "children" left, who should be taken care of. So, I was continuing on a private basis my activity as supervisor of Ph. D. students for about ten years after retirement. Then I decided to say definitely good bye to university life, and concentrated on problems which were left out during my employment as professor. Computer algebra attracted me already 20 years ago from the very first moment, when the IBM workstations were equipped with AXIOM, a powerful software. As I have no access to any kind of supercomputer now, I focus my interest on mathematical problems which could be solved by analytical methods using computer algebra on a laptop. A result is given in my paper on oscillating boundary layer flow.

$$\text{Next bifurcation: From here and now} \longrightarrow \ ...$$