

Autumn 1967



In the winter term of 1963 I began my studies in physics and mathematics at the University of Leipzig, I was twenty years old. Between my German High School graduation at the Gerhart-Hauptmann High School in Zwickau and the beginning of my time as a university student, I was a radio operator in the Air Force of the army. I was based in the school for pilots in the city of Kamenz near Dresden.

But the story of this book started later, in the autumn of 1967. At that time I was sick with flu and therefore could not take part in the practical work which was required for all students.

In those days all students had to spend two weeks in October helping farmers with their potato harvest. I cannot say that I was overly enthusiastic about traveling to Mecklenburg for this purpose; but those weeks fostered a closer sense of community among the students. Lifelong friendships began in those potato fields, sometimes even leading to marriages, although the campsites had not been exactly comfortable quarters.

Since my illness had not permitted me to go to the fields, I was sent by the FDJ (Federal Communist Youth) organization to the Physics Institute at Leipzig University, to do some practical work in the library. When I showed up at the library administration office, I was told, to my astonishment, that I was to go to the University Church the following day. It turned out that part of the library stocks was stored in the side wings of that church.

St Paul's University Church was called by most people Paulinerkirche; it was located on Karl-Marx Square, north of the Augusteum, the main building of the university. This was the only university church in Saxony that was not destroyed. The church even survived the Anglo-American air raid offensive on December 4, 1943 during World War II. Since the roofs were built on a steep slope, the bombs were diverted to neighboring buildings and did not damage the interior of the church. Thanks to the courageous efforts of the people of Leipzig, the church also escaped the fires which destroyed a major part of the city.

Inside St Paul's Church there was still a part of the cloisters of the Dominican Abbey, founded in 1229; at that time it was located directly inside the eastern city wall. This Abbey was dedicated in 1240, and renovated in the fifteenth century. Martin Luther changed it into a Protestant church in 1545. It has been used as the university auditorium ever since the year 1545.

In old travel guide books of Leipzig you would read: "St Paul's Church was known as one of the most splendid, well-preserved open churches of Middle Germany. It was ornate with tombs, epitaphs and other artifacts, intertwined with a tradition of Johann Sebastian Bach's music and the history of the reformation." As ordered by the Government of the DDR (Democratic Republic of Germany), travel books on Leipzig published in East Germany after 1968 did not give any references to the university church.

On the first day of my assignment to this building on Karl-Marx Square, I made my way there on a bicycle. After I rang the door bell several times, a small side door was opened by Mrs Werner, an elderly employee of the university library. She led me to a spiral staircase which we climbed to reach "her domain" — a fairly remarkable library consisting of mostly old, dust-covered volumes.

"My God" said Mrs Werner, "they sent you here? I would love to know who thought of this nonsense. I have no work for you. I have to take inventory of the books myself anyway."

“Well,” I told her, “I better go back to the main office, maybe they’ll send me somewhere else.”

“Don’t do that. You know what, why don’t you just stay here and keep me company. I’ll get you a desk and you can bring your books tomorrow and work here. This is more convenient than the German Library. At the end of your time here, I’ll sign the form telling the administration that you worked for two weeks, which is actually even true.”

“Perfect, that’s done!” I grinned. “I’ll be here tomorrow morning with my books.”

The following days at the university library were pleasant. Mrs Werner left me to do my own things without disturbing me. The only condition was that I would drink coffee with her often. I gladly did that since her coffee was excellent — almost as good as the one from my landlady in Leipzig. At times I rummaged through the old books and read Shakespeare in the original language, or Dante, and even Galileo’s *Discorsi* was there.

The library also housed history books about the university — the old Universitas Litterarum Lipsiensis, which had been founded in 1409, making it the fourth oldest university of all of the German-speaking universities of that time. In the meantime, its name had been changed to Karl-Marx University in 1953, the year of the national uprising against the regime of the SED (Sozialistische Einheitspartei Deutschlands, the former East German Party of Socialist Unity). The name change had been suggested by Chairman Ulbricht of the DDR government and it prevailed in the Party Center. There were lots of name changes, equally absurd, for example the city of Chemnitz turned into Karl-Marx City. Karl-Marx had never been in Leipzig, nor had he had any affiliation with the university. He received his doctorate at the University of Jena — without ever having studied there.

The square where the church was located, had been called Augustus Square, named after King Friedrich August of Saxony,

and had been renamed Karl-Marx Square. The older people of Leipzig, like Mrs Werner and my landlady, simply ignored the new name and continued to speak of the Augustus Square. One day, during a coffee break, Mrs Werner said mockingly, calling Chairman Ulbricht “goatee”, his nickname among the people, that the “goatee” might even have the idea of changing the name of University Church to Karl-Marx Church. She had no idea that the party leader had an even more sinister plan of what to do with the church.

Mrs Werner was an expert in the history of this university. She told me that between 1835 and 1873 the Augusteum housed the Physics Institute. The Augusteum was a beautiful classicistic building, which was completed in 1835. The entrance door was designed by the famous German architect and painter Karl Friedrich Schinkel. The main wing of the building was destroyed during World War II, with the exception of the church’s front and the long side wings. They housed individual institutes, libraries, and lecture halls.

Mrs Werner spoke enthusiastically about the Lecture Hall 40 of the Augusteum, which was, for a while, the intellectual center of East Germany. The lectures of Professor Hans Mayer in this auditorium were legendary; and the same held for those of the philosopher Ernst Bloch.

“Just imagine, Mr Fritsch, what Bloch said one day when speaking about Immanuel Kant: ‘Immanuel Kant was born, lived and died in Kaliningrad.’” We had to laugh so hard. Shortly after Bloch’s description of Kant, he received an express letter from Paul Froehlich, the party chief of the SED in Leipzig, in which he expressed that Bloch was no longer welcome at the Institute. Bloch left for Tuebingen. “What a country we live in.”

I also learned from Mrs Werner that until the 1930s, many great physics lectures were held at the Augusteum. Werner Heisenberg, already world famous in his early years, received a

chair in Theoretical Physics in 1927. Another Augusteum lecturer was Ludwig Boltzmann, the founder of the theory of modern atomic and thermodynamic theory, who had come to Leipzig in 1900.

In the fall of 1967, I started working on my doctoral thesis. The director of the Theoretical Physics Institute, Gerhard Heber had suggested that I go for my PhD without going through a time-consuming detour of a Master's thesis. My dissertation dealt with problems of gravitational theory, which interested me particularly. Professor Hans-Juergen Treder, the director of the department of theoretical physics of the Academy of Science in Berlin, had already shown interest in my project. So I worked under his guidance. Treder worked in the observatory in Potsdam-Babelsberg. Starting with the winter term of 1967, I was a PhD student, shuttling back and forth between Leipzig and Potsdam. I rented a room in a nice street in the old part of Potsdam.

While still completing my work in St Paul's Church, I read a new book by Werner Heisenberg, who was, at that time, director of the Max-Planck Institute of Physics in Munich. In his book, Heisenberg describes his ideas of a unified theory of elementary particles and therefore, of all of matter. His special interest was in the area of strong interaction between atomic nuclei. Experimentally, it had been shown, for quite some time, that very strong attractive forces act between the nucleons, the protons and neutrons inside the atomic nuclei. The origin of these forces was completely unknown at that time.

Heisenberg believed that these forces could be described with the help of a simple mathematical equation. This equation was dubbed "world formula", not by Heisenberg himself, but by the press, a highly exaggerated name as it turned out to be. I had my doubts about Heisenberg's approach to the phenomenon of nuclear forces — after all, I had, for some time, occupied myself with the writings of Murray Gell-Mann of the California Institute of

Technology in Pasadena. In his papers, Gell-Mann defended his ideas that much smaller particles exist within the atoms; particles which he had called quarks. (The name is derived from James Joyce's book *Finnegan's Wake*).

Although I initially had a hard time believing that atomic nuclei were composed of particles smaller than the nuclear particles themselves, Gell-Mann's arguments convinced me. His daring hypothesis would be able to explain a series of experimentally proven phenomena — amongst them some odd symmetry patterns of elementary particles. Only one thing remained inexplicable: the question of the forces between quarks. These forces had to be extremely strong, much stronger than the forces between nuclei. This implied that the nuclear forces were nothing but what remained after the very strong forces between the quarks had acted inside the atomic nuclear particles.

During the summer vacation in 1967, I had worked on this problem without gaining new insights other than those that I found in the papers of Gell-Mann. In Heisenberg's book I found a hint for a new way of approaching the question of how to describe the forces between elementary particles. This had first been approached by two American theoretical physicists: C.N. Yang and S. Mills. One day I surprised Mrs Werner when I arrived on my bike with a big batch of books, including a thick volume of the American journal *Physical Review*.

"Oh my God, Mr Fritzsich, what are you doing with all those books, as though I didn't have enough of them?"

"Unfortunately, they are not the right ones for me, but don't worry, I won't read all of them. I am looking for something specific."

In the following days I read everything I could find about the Yang–Mills theory at the library of the Physics Institute and at the German Library. Unfortunately I did not find much about this topic. In an article by the Nobel laureate Richard Feynman, a

colleague of Gell-Mann's in Pasadena, I read that the Yang–Mills theory is very useful for studying these unsolved problems that combine quantum physics with the theory of gravity. Indeed, there are parallels between the ideas of Yang and Mills and the theory of gravity, which Einstein had created in 1915.

I now tried to apply the ideas of Yang and Mills to the forces between quarks. During my stay at St Paul's Church I examined a series of alternatives, but stopped there since I saw no possibility of clearly differentiating the various versions. I would need new experimental insights to get ahead.

At that time I could not foresee that three years later, after my escape from the DDR, I would start at the same point that I had reached in October 1967, but this time at Stanford University in California. In the summer of 1970, I got to know Murray Gell-Mann, who received the Nobel Prize in Physics in 1969 for his contributions to particle physics, at the Aspen Center of Physics in Colorado. Our common interests in physics brought us together. We became friends, and for several years we worked together, both at the California Institute of Technology in Pasadena, and also at the European Center of Elementary Particle Physics (CERN) in Geneva, Switzerland.

Shortly before I left California in the spring of 1971, I told Gell-Mann of my studies in Leipzig in trying to describe the forces between quarks using elements of the Yang–Mills theory. Although he was initially skeptical, my remarks seemed to get him interested. When we met again in the autumn of 1971 to work at CERN for a year, we continued to work along these lines. But it was not until the summer of 1972 before we were able to find the key to understand the forces between quarks. Indeed, they proved to be forces that can be described by a Yang–Mills type theory. The forces are due to force particles which we called gluons.

In hindsight, my studies in Leipzig were quite useful. The theory itself, which we later called “Quantum Chromodynamics”,

proved to be the correct theoretical description of the forces between quarks, and also of the strong forces inside atomic nuclei. This is an important building block of today's physics. To me, it will always remind me of St Paul's Church in Leipzig.