

## Chapter 2

# Early Life in Germany

### 2.1 Childhood and Schooling

Herbert Fröhlich was born at 11.30 am on Saturday 9 December 1905 in the home of his paternal grand-parents, Abraham Jakob and Dorken (*née* Landauer) at Im Brühl, 186 (now Freudenstädter Straße 31), in Rexingen (Württemberg), a village in the Neckar valley, on the edge of the Black Forest, where an unusually high proportion of the inhabitants were Jewish. Rexingen is near Horb am Neckar, approximately midway between Freudenstadt and Tübingen. Herbert's parents (both b.1878) Jakob (known as Julius) and Frieda, *née* Schwarz (known as Fanny) came from long-established Jewish families<sup>1</sup> in Rexingen, where they were married in 1903. Herbert's birth was registered on 10 December by his father, a dealer in livestock. The family was comfortably off, but had no tradition of university education. Herbert was the first male child in the family—one year younger than his sister Betty,<sup>2</sup> and 10 years older than his brother, Albrecht<sup>3</sup> (known as Ali).

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<sup>1</sup> There are 36 Fröhlich entries in the archives of the old Jewish Cemetery in Rexingen, and 62 relating to his mother's family (Schwarz); the Fröhlich line can be traced back to at least 1744 (In Stein gehauen 1997, 2003, pp. 122–123).

<sup>2</sup> At school Betty (*b.*1904) excelled in mathematics, but having, in those days, no possibility of pursuing it professionally, became, instead, an accomplished pianist. In 1926, as an ardent Zionist, she was the first member of the family to leave Germany for Palestine, at first living on a collective farm with her husband Fritz Lichtenstein. They separated in 1938, and she later married Martin Lustig. She had a daughter and 4 sons, one of whom was killed in the Yom Kippur war of 1973.

<sup>3</sup> Albrecht (1916–2001) later became a distinguished pure mathematician, and was elected Fellow of the Royal Society of Great Britain in 1976. He married in the same year as his brother (1950), and died at the same age of 85 years, leaving a widow (Dr. Ruth Brooks), 2 adopted children and several grandchildren. Herbert and Albrecht were not the only siblings to be elected F.R.S. in the 20th century; others include Christopher and Michael Longuet-Higgins, Maurice and David Hill, Nathaniel and Miriam Rothschild, and Sidnie and Irene Manton.



**Fig. 2.1** Fröhlich as a youth on the ski slopes, c.1923

In October 1907, when Herbert was not yet 2 years old, the family moved to Munich,<sup>4</sup> and decided to become naturalised Bavarians in order to be able to enjoy rights that otherwise would have been denied them. After moving, his father continued his livestock business in partnership with Josef Bikart from premises<sup>5</sup> in Fürstenfeldbruck, a small town some 25 km west of Munich, travelling there each day by train. It was in Munich—a city for which he retained a life-long nostalgia—that Herbert grew up, developing a love of chess and classical music, and attending Primary School (*Volkschule*) from 1911 until 1915, when he entered the Municipal High School of Commerce (*Städtische Höhere Handelsschule*). He was always a very independent child, and in 1921, when his excellent mathematics teacher was replaced by a mediocre one, he left school at the age of 15 without his *Matura*, essentially as an act of defiance, to avoid fulfilling the expectation of his elders that ‘such a clever boy’ must go to university! He then apprenticed himself to a firm of textile manufacturers (quite possibly belonging to an uncle on his mother’s side), spending 6 months at the Technical College for the Textile Industry in Reutlingen, intending to make a career in commerce, which he did until 1926.

During this time, however, he became interested in radio, which in those days one had to build oneself. In a magazine for radio enthusiasts, he read that anyone who seriously intended to build radios needed higher mathematics. Accordingly, he bought what turned out to be a very good book from which he taught himself calculus, and started to do physics as a hobby; but he soon ‘caught the bug’, and decided he wanted to study it properly. In order to gain admission to university, however, he first had to take his *Abitur*. In those days, each German state had its own regulations, and, after studying these, he decided to go to Magdeburg where external candidates were examined mainly in relation to their proposed course of study later on. Since there were few posts in theoretical physics—other than school teaching, which did not appeal to him—he opted for experimental physics, intending to keep theoretical physics as a hobby. After 6 months as a private student at the *Oberrealschule* in Magdeburg, he took his *Abitur* early in 1927 at the age of 21.

During the 1920s, he was a member of the *Jungjüdische Wandervögel* (a hiking club for Jewish youths) and travelled extensively throughout Germany collecting folk songs; he was, however, never interested in any political activity. He excelled in sporting activities, particularly skiing and mountaineering, a love of which he retained throughout his life (Fig. 2.1).

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<sup>4</sup> From September 1917 until 1933, when they left Germany, they lived at Seidlstraße, 22.

<sup>5</sup> At first, they had premises at Hauptstraße 1, moving a few years later to Schöngesingerstraße 6, and finally in 1930, to Bullachstraße 3, near the centre of the town.

## 2.2 Entrance to University and Early Academic Career in Germany

Fröhlich entered the Ludwig-Maximilian University in Munich as an undergraduate in the summer of 1927, beginning 4 semesters of lectures in physics, mathematics and chemistry. On his first day, he decided that the most important thing to do was to find a subject for a thesis, and accordingly went to a lecture that he had seen advertised entitled *Current Problems in Modern Physics*, seating himself in the front row. This turned out to be rather embarrassing, since, unbeknown to him, the front row was always reserved for full professors: he should have sat at the back—indeed, as a new student, he probably should not have been there at all!

During his second year, he decided he wanted to enrol for a doctorate in experimental physics under the Nobel Laureate Wilhelm Wien, but with Wien's death later that year (1928), Fröhlich changed to his erstwhile 'hobby', theoretical physics, quite ignorant of the fact that Munich was then one of the world centres of this subject. Here, the Theoretical Physics Institute was presided over by one of the great architects of the old quantum theory, Arnold Sommerfeld, some of whose lectures Fröhlich started to attend. In an interview given in 1983 [F188], he gave the following account of those early days:

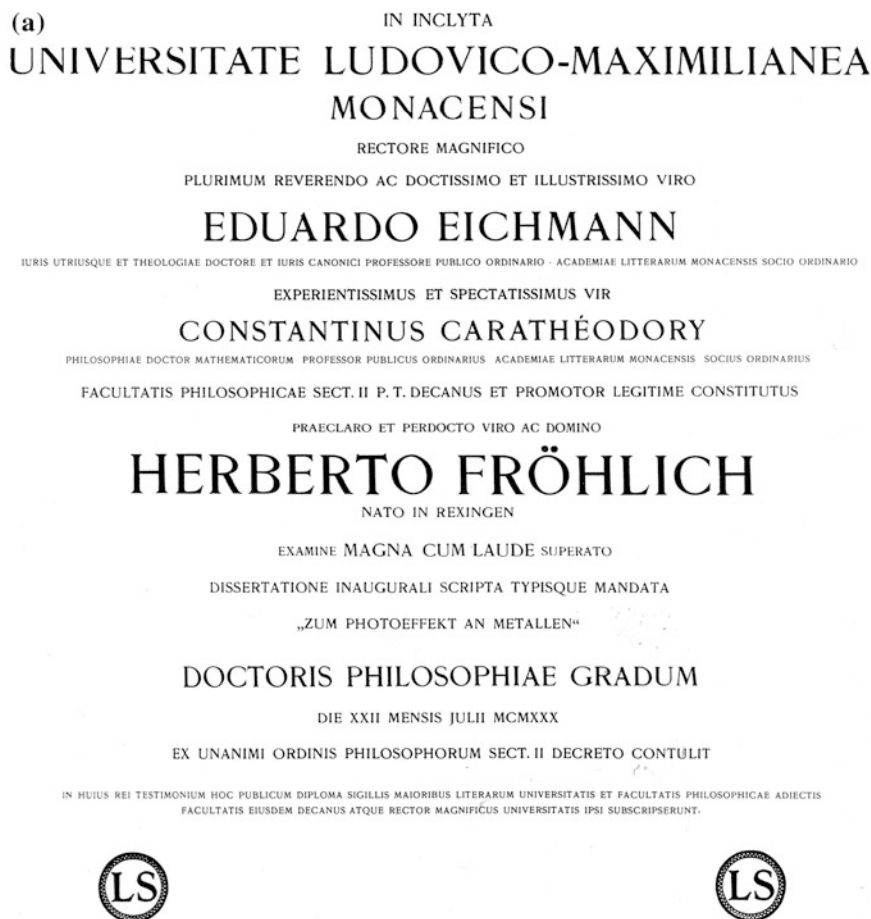
I went to one of Sommerfeld's lectures. There one learnt a great deal from the mistakes he made. He never used a manuscript; he would just start making his calculations on the blackboard, make a mistake and start looking for it. Sometimes one of the students would notice what the mistake was. One day I did that. After I had done that several times, he asked me to stay behind, and then said, 'From now on you will direct the problem class.' So I was already a theoretical physicist, and had to make up problems for the others. Then, at the end of my second undergraduate year, Sommerfeld gave me some papers to read during the vacation. I read these, then thought I could do something along those lines, and made a calculation. When I came back, I showed what I had done to Sommerfeld; he asked me to change this and that, and then said, 'Well, there's your thesis' [F188].<sup>6</sup>

Thus, in July 1930, during his third year—and without ever having taken an undergraduate degree (which would have taken 4 years!)—Fröhlich submitted his doctoral thesis on the photoelectric effect in metals, and received his D.Phil. (*Magna cum Laude*) on 22 July (Fig. 2.2).

After one year as a Research Fellow in Munich, during which time he was supported by a scholarship from the German Scientific Society's Emergency Fund, Sommerfeld came to tell him that Gustav Mie, who was then head of Physics Institute of the University of Freiburg (im Breisgau), wanted someone to introduce modern physics there. Since at that time there were very few jobs in theoretical physics, Fröhlich wasted no time in accepting Mie's offer, and in October 1931 went off to Freiburg; the alternative may well have been for him to become a skiing instructor, for he was an enthusiastic and highly competent skier!

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<sup>6</sup> This denotes reference (188) in the *Complete Bibliography of H. Fröhlich*, at the end of this book; similarly [Fx] denotes reference (x).



**Fig. 2.2** a Fröhlich's Doctoral Diploma from the University of Munich, 1930; b the cover of his Doctoral Dissertation [F1]

(b)

# Zum Photoeffekt an Metallen

## Inaugural-Dissertation

zur Erlangung der Doktorwürde

der Philosophischen Fakultät Sektion II  
der Ludwig-Maximilians-Universität  
München

Vorgelegt am 8. Juli 1930

von

### Herbert Fröhlich

aus München

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J o h a n n A m b r o s i u s B a r t h i n L e i p z i g

Fig. 2.2 (continued)

Before leaving Munich, Fröhlich published two papers, the first [F1] being his D.Phil. thesis in which he extended W. Wentzel's theoretical treatment of the photoelectric effect, based on Sommerfeld's theory, to the case of thin metallic sheets, drawing attention to the importance of surface conditions, particularly in determining the difference between the normal and selective effects; his calculations agreed in all essential aspects with experiment. The second publication [F2], which proved to be way ahead of its time, arose from the following consideration: just as the form of the thermionic Richardson equation<sup>7</sup> for the current of electrons emitted from a hot metallic surface as derived from quantum mechanics, using Fermi-Dirac statistics, differs from the that given classically on the basis of Maxwellian statistics, so one might anticipate a corresponding difference in the expressions for the fluctuations in the electric current. This was shown to be indeed the case, there being, in addition to a contribution arising from the discreteness of the electronic charge (which turned out to be identical to that given by Schottky's classical derivation—so-called 'shot noise'), a contribution allied to the finiteness of Planck's constant,  $h$ , which was proportional to  $h^3$ . Unfortunately, however, it was found that the latter lay far below the limits of detection then possible. The real significance of this publication, however, was its application of the technique of so-called 'second quantization'<sup>8</sup> (*Quantelung der Amplituden*)—only 3 years after it had been extended to fermion systems by Jordan and Wigner in 1928 (Jordan and Wigner 1928)—to the Fermi gas constituted by the conduction electrons in a metal, which were treated as the quanta of an electron field,  $\psi$ , whose Fourier coefficients,  $a_k$  and  $a_k^\dagger$ , anticommute—i.e.

$$\psi = \sum_k \frac{a_k}{\sqrt{L}} e^{ikx + i\omega t}, \quad \text{where } k = n\pi/L, \quad n = 1, 2, 3, \dots, \quad (2.2.1)$$

in the case of a one-dimensional system of length  $L$ , where, in respect of the Pauli principle,

$$a_k^\dagger a_k \equiv N_k = 0, 1, \text{ and } a_k a_k^\dagger = 1 - N_k, \quad (2.2.2)$$

the mean number of electrons (with momentum  $\hbar k$  and energy  $\hbar\omega$ ) being  $\bar{N}_k$  (Fig. 2.3).

<sup>7</sup> The quantum mechanical form of this equation permits the work function,  $W$ , of a metal to be determined from measurement of the thermionic current, which is proportional to  $T^2 \exp(-W/kT)$ ; classically, the pre-exponential factor becomes  $T^{3/2}$ , whilst the meaning of  $W$  is somewhat different.

<sup>8</sup> 'Second quantization' is a technique whereby a many-body system of identical particles is described by a quantum field in three-dimensional space and time, rather than by appropriately symmetrised many-particle Schrödinger wave-functions in multi-dimensional configuration space. The individual particles are the quanta of this field (just as photons are quanta of the electromagnetic radiation field) whose quantization rules dictate the particle statistics, bosons (fermions) being described by commuting (anti-commuting) fields. Many years later, as a spin-off of his work on the connection between micro and macrophysics, Fröhlich demonstrated the equivalence of the two approaches in a way that is very much simpler than that which is usually presented [F155].

## Der Schroteffekt nach der Quantenmechanik.

Von **Herbert Fröhlich** in München.

Mit 1 Abbildung. (Eingegangen am 23. Juli 1931.)

Der Schroteffekt wird quantenmechanisch berechnet. Man erhält zum klassischen Wert ein Zusatzglied, das aber unter normalen Verhältnissen unter der Meßgenauigkeit liegt.

Die nach der Quantenmechanik (Fermistatistik) gewonnene Gleichung für den Richardseffekt ist etwas verschieden von der klassischen (Maxwellstatistik)  $\left( A_1 T^2 e^{-\frac{W_a - \bar{W}}{kT}} \text{ bzw. } A_2 T^{1/2} e^{-\frac{W_a}{kT}} \right)$ .

Ebenso wird man auch für die Stromschwankungen nach der Quantenmechanik einen anderen Wert als den klassischen erwarten, entsprechend den verschiedenen Schwankungen eines Fermischen und eines Maxwell'schen Gases. Die von Schottky abgeleitete klassische Formel<sup>1)</sup> ist im wesentlichen durch das endliche Elementarquantum  $e$  bedingt. Dagegen wird wohl die entsprechende quantenmechanische Formel neben diesem groben Atomismus, der einfach die Existenz einzelner kleinster Teilchen darstellt, auch noch von dem feineren, durch das Wirkungsquantum  $h$  bedingten Atomismus abhängen. Es wird sich zeigen, daß die quantenmechanische Formel nur wenig von der klassischen abweicht. Es ist aber interessant zu sehen, welcher Art diese Korrektur ist.

*Durchführung der Rechnungen.* Gegeben sei ein Metall von der Temperatur  $T$ , Oberfläche senkrecht zur  $X$ -Richtung. Gesucht werden die Stromschwankungen des in der  $X$ -Richtung austretenden Stromes  $J$ .

Die Rechnung werde der Einfachheit halber zunächst eindimensional ( $X$ -Komponente) durchgeführt. Die Hinzunahme der  $Y$ - und  $Z$ -Richtungen kann nach der eigentlichen Schwankungsrechnung erfolgen, weil diese Komponenten natürlich keine Schwankungen des Stromes  $J$  ergeben.

Die Rechnungen werden mit Hilfe des quantenmechanischen Mehrkörperproblems im dreidimensionalen Raum (Quantelung der Amplituden), wie es von Dirac und Jordan entwickelt wurde, durchgeführt.

Es möge nur ein diskretes Spektrum vorhanden sein. Das kann dadurch erreicht werden, daß man sich das Metall  $Q$  (Elektronenquelle) und den Empfänger  $S$  (Senke) zwischen zwei unendlich hohe Potentialschwellen vom Abstand  $L$  gebracht denkt.

<sup>1)</sup> W. Schottky, Ann. d. Phys. **57**, 541, 1918; **68**, 157, 1922.

**Fig. 2.3** The paper [F2] in which 'second quantization' was first applied to electrons in a metal—Reproduced by permission of Springer-Verlag



What was so impressive was not only his evident awareness, already at this early stage in his research career, of such a sophisticated and highly advanced technique of quantum field theory, but also his courage to be the first to apply it to a problem in solid-state physics. It was to be almost another 20 years, however, before Fröhlich fully realised the potential and utility of this technique in the solution of non-relativistic many-body problems (vide Chap. 5).

Once in Freiburg, in addition to lecturing on the new electron theory of metals, which had been born out of applying the recently developed quantum theory of Schrödinger to solid-state physics,<sup>9</sup> Fröhlich continued his researches in metal physics, publishing 5 papers. The first was a long paper [F3] that gave the first theoretical treatment of secondary electron emission from a sheet of metal on which cathode rays are incident; this early work later became rather well-known, and was still being cited almost half a century later (Rösler and Brauer 1981). It was found that in order to produce secondary electrons (whose energies are always below 25 eV), the primary electrons had to have an energy of at least of the order of 10 eV, this lower limit being determined mainly by the Pauli principle; for a primary energy of 100 eV, it was calculated that there is about one secondary electron for each primary. Finally, in the case of thin metallic sheets, it was predicted that the majority of secondary electrons are emitted from the face opposite to that on which the primary electrons are incident.

The second paper [F4] dealt with light absorption and the selective photoelectric effect; the third [F5] was devoted to the determination of the energy levels of metallic electrons from their optical constants; the fourth [F6] concerned the position of the absorption spectra of coloured alkali halides, in which he attempted to explain—on the basis of wave mechanics and assuming weakly bound electrons—the Mollwo relation between the frequency of the absorption maximum and the lattice constant of photochemically coloured alkali halide crystals at room temperature; the final paper [F7], *On the absorption of metals in the visible and ultraviolet*, was the subject of his *Habilitationsschrift*, which was submitted for publication in the journal *Zeitschrift für Physik*, in January 1933 (Fig. 2.4).

Fröhlich became *Privatdozent* at Freiburg in December 1932, and his appointment was confirmed by the State of Baden (to which Freiburg then belonged) the day before the state administration was dissolved early in 1933. It was only in 1932, the year before Hitler became Chancellor, that Fröhlich truly realised what was going on, during an outing with other staff and students during the Christmas vacation:

It was only at this time that I realised what was going on. Nobody before took it seriously, so I don't think the people themselves took it seriously. On this outing we had a certain young man, an average student, neither good nor bad, not imaginative; and as he walked with me he said: 'When he comes to power, he will never leave again'. And then he said: 'The Jews have decided to destroy Germany'. And I said, 'How do you know this?'

<sup>9</sup> This was an activity in which even Pauli participated (Pauli 1926), although he later came to despise it: 'I don't like this solid-state physics.....though I initiated it (with his application of Fermi-Dirac statistics to calculate of the spin paramagnetism [Pauli paramagnetism] of the electron gas in a metal); one shouldn't wallow in dirt' (Hoddeson et al. 1992, p. 159).

## Über die Absorption der Metalle im Sichtbaren und Ultravioletten<sup>1)</sup>.

Von **Herbert Fröhlich** in Freiburg i. B.

Mit 4 Abbildungen. (Eingegangen am 21. Januar 1933.)

1. Es wird gezeigt, daß bei Metallen die Größe  $\sigma \nu = nk \nu^2$  ( $\sigma$  = Leitfähigkeitskoeffizient,  $n$  = Brechungsindex,  $k$  = Absorptionskoeffizient,  $\nu$  = Frequenz) den Übergangswahrscheinlichkeiten der Elektronen proportional ist. Insbesondere läßt diese Größe sehr deutlich die Energiebanden der Metalle erkennen, und es besteht prinzipiell die Möglichkeit, aus den experimentellen Daten über die Frequenzabhängigkeit von  $n$  und  $k$  Lage und Breite dieser Energiebanden bzw. der verbotenen Energiegebiete zu bestimmen. 2. Aus den bis jetzt vorliegenden Messungen kann die Breite des ersten verbotenen Gebietes bei Cu, Ag und Au bestimmt werden. 3. Aus dem Wert der Größe  $\sigma \nu$  kann man folgern, daß bei Cu, Ag und Au die Elektroneneigenfunktionen von den Eigenfunktionen freier Elektronen bedeutend stärker abweichen als bei den Alkalimetallen (ungefähr im Verhältnis 1:20).

Der Bau der Atome und Moleküle ist durch das Studium ihrer optischen Eigenschaften weitgehend geklärt worden. Es ist naheliegend, auch aus der Optik der Metalle Schlüsse auf ihren Aufbau zu ziehen. Bei oberflächlicher Betrachtung hat es allerdings den Anschein, als ob man bei den Metallen aus den optischen Konstanten nur wenig Aufschluß über die Energieniveaus bekommen könnte. Daß dies nicht zutrifft, sondern daß man sehr weitgehende Kenntnis der Energiestufen der Metalle erwarten kann, wenn es nur gelingt, die optischen Konstanten weit genug ins Ultraviolett zu verfolgen, soll in der vorliegenden Arbeit gezeigt werden.

§ 1. Nach den in den letzten Jahren entwickelten Vorstellungen über den Bau der Metalle bestehen die erlaubten Energiewerte aus Banden, deren Breite mit wachsender Energie zunimmt<sup>2)</sup>. Man kann sich diese Energiebanden aus zwei Grenzfällen entstanden denken. Entweder man geht aus von dem isolierten Metallatom: dann bedeutet die Energiebande ein unter Einwirkung der Nachbaratome verbreitertes und verschobenes Energieniveau dieses Atoms. Oder man geht aus von den vollständig freien Elektronen: dann müssen durch Interferenz der an den einzelnen Gitterpunkten des Metalls gestreuten Elektronen gewisse Energiewerte ausgeschlossen

<sup>1)</sup> Freiburger Habilitationsschrift (I. Teil); vgl. H. Fröhlich, Naturwissenschaften **20**, 906, 1932.

<sup>2)</sup> F. Bloch, ZS. f. Phys. **52**, 555, 1929; Ph. M. Morse, Phys. Rev. **35**, 1310, 1930; R. Peierls, Ann. d. Phys. **4**, 121, 1930.

**Fig. 2.4** Fröhlich's 1933 Freiburger Habilitationsschrift [F7]—Reproduced by permission of Springer-Verlag

He answered: 'I've read the *Protocols of the Elders of Zion*'.<sup>10</sup> 'Do the Jews know this?', I asked: 'Of course', he said. 'Well I'm a Jew, and I don't know it, I replied, to which he answered: 'Well you must be a very great exception'. Although he was completely average in every way, he was also completely mad. And that was an insanity that had spread right through Germany [F188].

With the rise of Nazism, the appointment was short-lived, and he was dismissed in April 1933 under new 'cleansing' laws pertaining to Jews and other undesirables, the Law for the Restoration of the Professional Civil Service (*Gesetz zur Wiederherstellung des Berufsbeamtentums*) having been passed on 7 April 1933. Had this not have happened, Fröhlich would have probably succeeded Königsberger as Professor of Theoretical Physics in Freiburg. On the back of his letter of dismissal Fröhlich made some calculations, but later threw the letter into the waste paper basket. Thinking better of it, he retrieved it, thinking that the calculation might eventually come in useful; he records that this did, in fact, turn out to be the case after the War, but he always refused to reveal to what the calculation referred. Since the Easter holidays were approaching, he decided to go on a skiing holiday.

Just before Fröhlich's dismissal, his brother, Ali, who was then about 17 years old, lent a book on Trotsky to a friend who was distributing anti-Nazi leaflets. This person was later picked up by the SS, and unfortunately had the book, which had Ali's name on it, in his possession. Fearing that this would make Ali a target for the SS, his parents appealed to a policeman who lived in the same apartment block; he said that all he could do to protect Ali would be to arrest him as an 'Enemy of the State', and have him taken to a police station that was not yet under Nazi control. After spending the night in a cell, he was brought before a judge who gave him a sympathetic hearing and released him. Upon seeing him return home, the policeman's wife's immediate reaction was to ask 'You are not still here are you?' Ali took the hint, and left immediately for Strasbourg,<sup>11</sup> where he had relatives. When the SA (*Sturmabteilung*)<sup>12</sup> learned of Ali's release, and being unable to trace him, they took reprisal on his father, arresting him on 29 March at Fürstenfeldbruck railway station, and then beating him up; the next day, he was detained under *Schutzhaft*,<sup>13</sup> but was released a few days later on 3 April.

When Herbert returned from his skiing trip, family was afraid to come down to open the front door. Fortunately, his sister, Betty, who had moved to Palestine in 1926,

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<sup>10</sup> A fraudulent document that first appeared in Russia in 1905, in which was discussed a supposed Jewish plan for world domination; it was widely cited during the 1920s and 30s in defence of anti-semitism.

<sup>11</sup> Strasbourg is the capital of the Alsace region of eastern France, which borders Germany, and is only 25 km west of Rixingen where Herbert had been born.

<sup>12</sup> The original para-military wing of the Nazi Party, which played a key role in Hitler's rise to power during the 1920s and early 1930s. It became disempowered after Hitler's blood-purge in 1934 (Night of the Long Knives), being effectively then superseded by the SS.

<sup>13</sup> *Schutzhaft* was a kind of protective custody under the guise of which political opponents of the Nazi regime, and especially Jews, were rounded up so that they could be officially 'protected' from the wrath of the German population.

was staying with them at the time, and it was decided that the remainder of the family, apart from Herbert, would join her there. In the meanwhile, for safety, his parents moved later that Spring to Strasbourg, whilst Betty returned to Palestine to make the necessary arrangements. Herbert, however, remained in Munich, and attempted to raise money from the property and land his father had in Fürstenfeldbruck.

Having made some sales, Herbert arrived at the office of the family's solicitor to sign the relevant documents, only to be told: 'I'm very sorry, but one of my men is in the SS; everything is confiscated'. In great anger, Fröhlich immediately went to the Nazi offices and demanded to see the Chief Confiscator, a man by the name of Josef Meisinger.<sup>14</sup> On being led in, Meisinger's first words were: 'I've been waiting for you'. He then continued: 'I could, of course, keep you here, but I shall not do so if you collaborate. You must tell me all your father's bank accounts; we know them already, but we just want to see whether you will collaborate'. Realising what might befall him, he told Meisinger about some accounts, but not others. After that, he saw Meisinger a number of times in attempts to get him to release items that had been confiscated. One day, he took a pile of bills, urging him to release money so that they could be paid. Meisinger laughed and said: 'Every day your father goes and sits in the Café Aubette<sup>15</sup> in Strasbourg, and you mean to tell me he has no money for his son!' Fröhlich immediately decided he must go to Strasbourg to warn his father that his movements were being watched. At the border, he was taken off the train by the SS, who told him to remove his shoes:

They thought I was so stupid as to try to take money out myself. So I took my shoes off, and said 'Do you want my socks too?' This impressed them, and they took me back again [F188].

His dealings with Meisinger continued:

I felt no fear of this man. If I had shown the least sign of fear, he would have had me taken away and killed, without doubt. At one stage, he made a basic mistake. He said to me: 'I can't see you today, for I must go to Nürnberg to see the Führer'. So I thought to myself that since I was his personal victim, nobody else would touch me, and that this was a good opportunity to get away from Munich. So that same day, I took an antique dealer and a

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<sup>14</sup> Josef Meisinger (1899–1947) was born in Munich, and joined the SS in March 1933. In 1934 he moved to Berlin with Heydrich to the office of the Gestapo. In 1940 he was appointed Commander of State Police in Warsaw, where his atrocities appalled even his superiors. He was removed to Tokyo in 1941 where he acted as Gestapo Liaison Officer until September 1945 when he surrendered himself to two American war correspondents. He was handed over to the Polish authorities in Warsaw, and executed in 1947 as a war criminal for atrocities in Poland, having become known as the 'Butcher of Warsaw'. Walter Schellenberg described Meisinger as 'one of the most evil creatures among Heydrich's bunch of thugs who carried out the vilest of his orders... He was a frightening individual, a large, coarse-faced man with a bald head and an incredibly ugly face. However, like many men of his type, he had drive and energy and an unscrupulous sort of cleverness' (Schellenberg 1956, pp. 160–161).

<sup>15</sup> An historic building on Place Kléber, built by Jacques-Françoise Blondel, 1765–1772, which still exists. Between 1926 and 1928 it was redecorated by Sophie Taeuber-Arp, Jean Arp and the De Stijl artist Theo van Doesburg.

furniture dealer round to our house,<sup>16</sup> and they agreed to let me have a cash payment the following morning in return for the key. I then took the train that went to Basel. I knew it stopped on the German side of Basel to let the *SS* men on, so I got off as they got on. I had given my money to an organisation to bring out; you had to trust them, and they got 10 % [F188].

He then made his way to Strasbourg, some 113 km from Basel, to join his parents and brother who were awaiting their visas for Palestine.<sup>17</sup> Before leaving Munich, however, he found time to write a paper [F8] with Hans Bethe, a former student of Sommerfeld, which led to Fröhlich being invited to Russia the following year (vide Chap. 3). In this paper, which dealt with superconductivity, they showed, by exact analysis, that the magnetic interaction between electrons, which Frenkel, in a recent publication (Frenkel 1933), had invoked to account for the stability of the supercurrents, has actually *no* influence in this respect, the only effect being a tiny alteration in the effective mass of the electrons, which otherwise continued to obey the usual laws of non-superconductive conduction. The paper arose from a competition between Fröhlich and Bethe to be the first to spot any error in anything new that came out on superconductivity, and on this occasion it was Fröhlich who won. It must be appreciated that at this time (and indeed for many years to come) superconductivity was *the* central problem in solid-state physics, in that it continued to defy understanding in terms of the newly forged electron theory of metals that had otherwise been so spectacularly successful.

Despite his dealings with Meisinger, Fröhlich recorded that ‘We never had any personal animosity towards each other; it was like a game of “cat-and-mouse”, in which I was the mouse. But then, in a way, I enjoyed it, because I enjoy danger!’ [F188].

One incident from this period that has hitherto never been narrated is the occasion on which Fröhlich was in a restaurant in Munich when Hitler entered. Fröhlich immediately realised that this was his opportunity kill Hitler with the steak knife he was holding. After a few moments reflection, however, he decided against it, notwithstanding the detestation with which he held Hitler, believing mistakenly that he would come to nothing, and was not worth the consequences that such an action would undoubtedly have entailed; accordingly, he continued with his meal. Even without a knife, Fröhlich, who was extremely fit, could easily have killed Hitler with his bare hands, having by then perfected his self-defence skills in order to protect himself against attacks from the Brownshirts (Fröhlich 1985).

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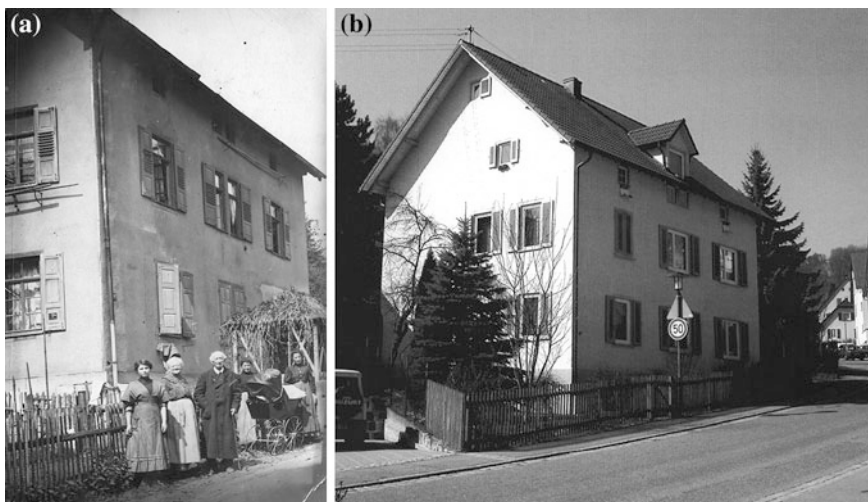
<sup>16</sup> The family home at Seidlstraße 22 contained some fine items of *art nouveau* furniture.

<sup>17</sup> With Herbert’s financial assistance (made possible by encashing an insurance policy on his father’s life and from the proceeds of the sale the family property (in both Munich and Fürstentfeldbruck), his parents and brother moved to Palestine in 1934; his father died there in 1952, and his mother in 1959.

## Photo Gallery

The numbers in round brackets at the end of each caption correspond to the section of the text to which the photograph refers.

*Unless stated otherwise, all photographs are from private collections.*



**Fig. 2.5** **a** Fröhlich's birthplace in Rexingen, in the home of his paternal grandparents (shown centre, in 1911) at Freudenstädter Straße 31 (formerly, Im Brühl 186); **b** the same in 2005 (Sect. 2.1)

**Fig. 2.6** Entry of Fröhlich's birth in the Registry Office Records in Rexingen (Sect. 2.1).

In front of the local official (who signed this form) there appeared today the person known as Jakob (Julius) Fröhlich, dealer in livestock and cattle, residing in Rexingen, of Jewish faith, and he announced that Fanny (Frida) Fröhlich, his wife, of Jewish faith, residing with him in Rexingen, gave birth on 9 December 1905 at 11.30 am to a male child, and that the child has been given the name of Herbert. Read aloud, authorised and signed: Julius Fröhlich/the Local Official: Kinkele—Reproduced by courtesy of Barbara Staudacher, Rexingen

Vor dem unterzeichneten Standesbeamten erschien heute, der Persönlichkeit nach \_\_\_\_\_ kannt,

*Jakob, genannt Julius Fröhlich,*

*Kinkele,*

wohnhaft in *Rexingen*

*unverheiratet* Religion, und zeigte an, daß von der *Fanny, genannt Frida Fröhlich,*

*geborenen Ghury, seiner*

*Lebende, unverheiratet* Religion,

wohnhaft *hier*

zu *Rexingen in seiner Wohnung*

am *neunten* ten *Dezember* des Jahres

tausend neunhundert *elf* *erst* mittags

um *elf* *zwölf* Uhr ein *Kind*

geboren worden sei und daß das Kind *Herbert* Vornamen

*Herbert*

erhalten habe.

Vorgelesen, genehmigt und *unterschieden*

*Julius Fröhlich*

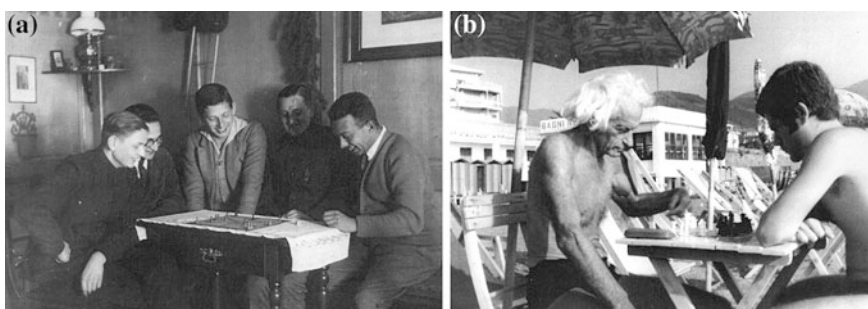
Der Standesbeamte.

*Kinkele*





**Fig. 2.7** **a** Fröhlich with his sister Betty (b.1904); **b** Betty, some years later, c.1926 (Sect. 2.1)



**Fig. 2.8** **a** Fröhlich (*centre*) enjoying a game of chess with friends in Munich; **b** another game in Levanto, Italy many years later (Sect. 2.1)





**Fig. 2.9** Fröhlich on a skiing trip with friend Eva (Sect. 2.1)



**Fig. 2.10** Possibly on a *Jungjüdische Wandervogel* outing (Sect. 2.1)



**Fig. 2.11** Fröhlich's parents, Julius and Frieda, in Marienbad, 1914, two years before their second son, Ali, was born (Sect. [2.2](#))



**Fig. 2.12** Fröhlich near his home in Seidlstraße, Munich, c.1930, aged 25 (Sect. [2.2](#))

## References

- Frenkel, J.: On a possible explanation of superconductivity. *Phys. Rev.* **43**, 907–912 (1933)
- Fröhlich, H.: Interview with the Author (1985)
- Hoddeson, L., Braun, E., Teichmann, J., Weart, S.: *Out of the Crystal Maze*. OUP, Oxford (1992)
- In Stein gehauen*: Konrad Theiss Verlag, Stuttgart (1997, 2003)
- Jordan, P., Wigner, E.P.: Über das Paulische Äquivalenzverbot. *Z. Phys.* **47**, 631–635 (1928)
- Pauli, W.: Über Gasentartung und Paramagnetismus. *Z. Phys.* **41**, 81 (1926)
- Rösler, M., Brauer, W.: Theory of secondary electron emission. *Phys. Stat. Sol. (b)* **104**, 161–175, 575–587 (1981)
- Schellenberg, W.: *The Labyrinth: Memoirs of Walter Schellenberg. Hitler's Chief of Counter-intelligence*. Da Capo Press, Cambridge (1956)

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