Gustav V.R. Born

The Born Family in Göttingen and Beyond

Georg-August-Universität Göttingen

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Revised and Extended Edition

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Gustav Born at the annual spring conference
of the German Physical Society 2012 in Göttingen.

Vorwort

Gustav Born war ein ganz besonderer Mensch. Seine Vita ist mit der Geschichte und dem Schicksal der Stadt und der Universität Göttingen untrennbar verbunden. Gustav hat seine Kindheit in Göttingen verbracht, hat auf den Schillerwiesen gespielt, ist am heutigen Felix-Klein-Gymnasium (FKG), also in direkter Nachbarschaft zur Wirkungsstätte seines Vaters Max Born im Institut für Theoretische Physik zur Schule gegangen und ist regelmäßig gemeinsam mit ihm zum Mittagessen nach Hause gegangen.

Die Machtergreifung durch die Nationalsozialisten 1933 hatte für Gustavs Vater den Entzug aller Ressourcen zur Folge. An ein akademisches und entspanntes Leben war für die Familie Born nicht mehr zu denken. Wie für so viele Wissenschaftlerinnen und Wissenschaftler folgte auch für Max Born, seinen Sohn Gustav und den Rest der Familie Born die Flucht ins United Kingdom, erst nach Cambridge, dann nach Edinburgh.

Gustav Born hat aus diesen widrigen Umständen das Beste gemacht, das Schicksal angenommen. Er war mit der britischen Armee vor Hiroshima als Soldat und Mediziner im Einsatz. Aufgrund dieser prägenden Erlebnisse hat er sich entschieden, sich in seinem Leben als Wissenschaftler der medizinisch-pharmakologischen Forschung zu widmen. Er etablierte sich schnell als wegweisender Wissenschaftler und leistete große Beiträge in seinem Fachgebiet. Gus Born war als Wissenschaftler außerordentlich erfolgreich, in seiner Community international bekannt und geschätzt, hatte einen großen Einfluss und eine ganz besondere Ausstrahlung, mit der er nicht nur seine Kolleginnen und Kollegen begeisterte, sondern auch auf Konferenzen und Tagungen den wissenschaftlichen Nachwuchs inspirierte und motivierte.

Gustav Born war insbesondere in den letzten Jahren regelmäßig mit seiner Frau Faith oder sogar mit seiner ganzen Familie in Göttingen zu Besuch, hat an Tagungen und Podiumsdiskussionen teilgenommen, Freunde besucht oder jungen Studierenden von damals berichtet. Ebenso hat er Göttinger Studierende auf den ersten Exkursionen nach Oxford begleitet und damit den Grundstein für die heutige Kooperation zwischen den beiden Universitäten Göttingen und Oxford zum Gedenken an Adam von Trott gelegt.

Bei seinem Besuch in Göttingen in 2012 anlässlich der Tagung der Deutschen Physikalischen Gesellschaft (DPG) traf Gustav Born mit Jochen Heisenberg, Hendrik Bohr und der Tochter von Carl-Friedrich von Weizsäcker, Elisabeth Raiser, zusammen. Es war ein ganz besonderes Erlebnis, seinen Vortrag zu den Erinnerungen an seine Göttinger Zeit zu hören und mit ihm und den anderen Kindern der Göttinger 18 das Theaterstück Kopenhagen anzuschauen und darüber zu diskutieren.

Mit seiner herzlichen, ehrlichen und gewinnenden Art hat Gustav Born die Menschen in seinem Umfeld sofort für sich eingenommen und begeistert. Er hatte ein erfülltes und erfolgreiches Leben. Er war und ist für uns alle ein Vorbild. Die Geschichte der gesamten Familie Born, vertrieben aus Deutschland und als Geflüchtete Europäer im UK aufgenommen und integriert, ist in vielerlei Hinsicht auch Mahnung für uns, gerade in der heutigen Zeit.

Aus Anlass des Todes von Faith und Gustav Born im Jahr 2018 und in ihrem Gedenken legen wir dieses Buch “The Born Family in Göttingen and Beyond” erneut auf. Wir sind dankbar, dass wir Euch kennenlernen durften. Ruht in Frieden.

Prof. Dr. Ulrike Beisiegel
Präsidentin der Georg-August-Universität Göttingen

Prof. Dr. Arnulf Quadt
II.Physikalisches Institut

Foreword

Gustav Born was a very special person. His vita is inextricably linked to the history and fate of the city and the University of Göttingen. Gustav spent his childhood in Göttingen, played on the Schillerwiesen, went to school at today's Felix-Klein-Gymnasium (FKG), i.e. in the immediate vicinity of the domain of his father Max Born at the Institute for Theoretical Physics, and hence went regularly home together with him for lunch.

After the seizure of power by the National Socialists in 1933 and the deprivation of all the resources of his father by the new rulers, an academic and peaceful life was unthinkable. Like so many scientists, Max Born, his son Gustav and the whole Born family fled to the United Kingdom, first to Cambridge, then to Edinburgh.

Gustav Born made the best of these circumstances, accepted his fate. He was with the British army near Hiroshima as a soldier and a physician. Due to these formative experiences, he decided to devote his life as a scientist to medical-pharmacological research. He quickly established himself as a groundbreaking scientist and made great contributions. Gus Born was considered an extraordinarily successful scientist, internationally known and highly appreciated in his community, had a great influence and a very special charisma, with which he not only impressed his colleages at conferences and workshops but particularly inspired and motivated young scientists.

In particular in recent years, Gustav Born regularly visited Göttingen with his wife Faith or even with his whole family. He participated in conferences and panel discussions, visited friends or told young students about the old times. He also accompanied Göttingen students on their first excursions to Oxford and thus layed the foundation for today's cooperation between the universities of Göttingen and Oxford to the memory of Adam von Trott.

During his visit to Göttingen in 2012 on the occasion of the conference of the German Physical Society (DPG), Gustav Born met Jochen Heisenberg, Hendrik Bohr and the daughter of Carl-Friedrich von Weizsäcker, Elisabeth Raiser. His lecture about his memories of those old times in Göttingen and to talk to him and the other children of the Göttingen 18, to watch the play Copenhagen together and to discuss it was a very special experience.

With his cordial, honest and winning manner, Gustav Born immediately captivated everyone for himself. He had a full and successful life. He was and is a role model for all of us. The history of the entire Born family, expelled from Germany and accepted as European refugees and integrated in the UK, is in several respects also a reminder for us, especially in these days.

On the occasion of the death of Faith and Gustav Born in 2018 and in memory of these two remarkable personalities, we reprint this book "The Born Family in Göttingen and Beyond". We are grateful that we were privileged to get to know you. Rest in peace.

Prof. Dr. Ulrike Beisiegel
President of the Georg-August-Universität Göttingen

Prof. Dr. Arnulf Quadt
II.Physikalisches Institut

Foreword

The first time I came across the full name "Born, Gustav Victor Rudolf" was in the early 1970s, at St. Peter's College, Oxford, of which institution Gus Born had been elected an Honorary Fellow, along with the Speaker of the American House of Representatives Carl Albert and the Shakespearian actor Richard Burton. Several members of the St. Peter's Senior Common Room also knew his famous father Max Born, Nobel Laureate in physics – from Cambridge University, they elaborated. When my subsequent academic peregrinations brought me to Göttingen, I found out that Max Born was counted there, too, among the University's Nobel laureates. Such multiple appropriations of famous people is common, but in the case of Max Born connected with the sad fact that the "golden decade" of his brilliant contributions to quantum mechanics at Göttingen had been terminated by the anti-Semitic terror of the Nazi regime; the subsequent brief hospitality Born enjoyed at Cambridge and the much longer lasting recognition at Edinburgh University justify the various claims laid to Max Born's fame.

An opportunity for clarifying and specifying the Born family's relationship to Göttingen and other places presented itself at an international meeting on "Göttingen and the development of the natural sciences", organized by the Georgia Augusta's Institut für Wissenschaftsgeschichte, 23-25 November 2000. Gustav Born agreed to present a keynote address on "The Born family in and out of Göttingen", which was held in the University's *sanctum sanctorum*, the so-called *Alte Aula*. This address was the high point of the meeting, attended by many from Göttingen's academic community and concluded with a long standing ovation. To facilitate wide circulation, the printed version has been given its very own cover and was not included in the conference proceedings (*Göttingen and the Development of the Natural Sciences*, Wallstein Verlag, 2002).

Gustav Born's lecture, just as Max Born's scientific accomplishments, is being appropriated by competing British and German interests, and a shorter version of Gus' address has already been published by London's Royal Society ("The wide-ranging family history of Max Born", *Notes and Records of the Royal Society of London*, vol. 56, 2002, pp. 219-262). We are happy to share claims to the Born family with Britain, and offer here, with more photographs and greater textual detail, the remarkable story of *The Born Family in Göttingen and Beyond*.

Nicolaas Rupke
Institut für Wissenschaftsgeschichte
Universität Göttingen

It is a singular pleasure to be invited to talk about our family in Göttingen, the town and the university with which it was deeply involved over several generations, and where I myself was born. Despite all the vicissitudes since that event in 1921, memories of my childhood here remain vivid, particularly of course during such visits as this.

I should like to begin with some words about my beloved sister Gritli (Margaret) who died in November 2000, three weeks before her 85th birthday. Gritli was a very vivid member of our family – highly intelligent and marvellously artistic, which she expressed in exquisite pottery and ceramics as well as in drawing and painting. The best likeness of Max Born in existence is a pencil drawing made by her in probably no more than fifteen minutes (figure 1). It shows not only how he looked physically with astonishing accuracy but is uncanny at reproducing his expression at work. She was very close to our father Max, who loved her dearly. I should like to dedicate this lecture about our family explicitly to the lasting memory of Gritli Born.

Figure 1. Max Born; pencil drawing
by his daughter Gritli Born.

The centrepiece of the story is our father, Max Born (1882-1970). My sister Gritli described his expression truly as a wonderful combination of intelligence, sensitivity, warmth and humour. The school of theoretical physics which he created at Göttingen in the 1920s became world famous, and so did he. Many anecdotes testify to this. On numberless occasions I have been asked whether I am the son of Max Born. Depending on whether or not the questioner is likely to have a sense of humour I reply either, "Yes, I am", or "No, I'm the father"! because my oldest son is again named Max**.** Recently we were at a wedding on the island of Ischia. It happened that I shared a taxi to the reception with the Catholic priest who had married the young couple. This man, a Jesuit, on being introduced immediately asked me, "Any relation to the physicist-philosopher?" Interesting – presumably since the time of Galileo, the Jesuits, as the intellectual arm of Catholicism, are obliged to become acquainted with their intellectual opponents. It makes the point that thirty years after his death Max Born is remembered as much for his humanism as for his science.

Figure 2. Max Born.

Max Born (figure 2) represented a tradition of substantial achievements by successive generations of European Jews. His ancestry included innovative industrialists, patrons of the arts and distinguished medical men, as well as a major social activist. His half-Jewish wife linked him to another remarkable clan. The gentile side went back to Martin Luther and beyond and included the outstanding Roman lawyer of modern times. The Jewish side contained influential theologians and philosophers, as well as prominent ancient and modern historians.

Figure 3. Hedwig Born. (Photograph Marianne Focke)

With my father Max and his wife Hedwig (Hedi) Ehrenberg (figure 3) at the centre, on the lines converging on them and spreading out from them there are people of lasting interest because they have contributed to knowledge and ideas in an extraordinary variety of ways. Almost all are academics. Sometime after World War II my mother, becoming too old for her earlier social work in Edinburgh, decided to take some courses at the University. The application form asked, amongst other things, about any associations with academics. When my mother started to write them down she found that the

form was not large enough – to do this properly she had to attach extra paper to the application form: she was immersed in academia as far as memory reached. The following members of the family were university professors: her grandfather, Rudolf von Jhering (Law); her father, Victor Ehrenberg (Jurisprudence); her brother Rudolf Ehrenberg (Theoretical Biology); her nephew Hans Ehrenberg (Philosophy); her first cousin, Richard Ehrenberg, (Economics); and his brother Victor Ehrenberg (Ancient History); both his sons Sir Geoffrey Elton né Ehrenberg (Cambridge Regius in History) and Lewis Elton (Higher Education); her nephew Rudolf or Rolli Elliott (né Ehrenberg) (English Literature); her nephew Andrew Ehrenberg (Research Professor of Marketing); and her more distant cousin Franz Rosenzweig (Philosophy of Religion); her husband Max Born (Physics); her husband's half-brother Wolfgang Born (History of Art), her husband's nephews Otto Königsberger (Architecture) and Helmut Königsberger (Modern History); her father-in-law Gustav Born (Anatomy and Developmental Biology); her son (i.e. myself) Gustav Born (Pharmacology); both her sons-in-law Brindley Newton-John (German Literature) and Maurice Pryce (Physics). I may well have left some out through ignorance.

Contemplation of Max Born's life suggests a way of linking the family lines to my parents in Göttingen. Max Born was here for three decisive periods of his life: as a student (1904-1906); as lecturer (*Privatdozent*) (1909-1915); and as professor (1921-1933). From the young student we can go back to his own childhood, parentage and beyond. As *Privatdozent* he was married, which gives us the entrée to my mother and her remarkable ancestry. And when he returned as professor in 1921 my parents already had two daughters and soon also a son, which opens a natural passage to the younger generations, all the way down to the six-month old great-granddaughter.

Paternal ancestors

Max Born's ancestry epitomises the liberalisation of German Jewry during the nineteenth century. In fact, this case history is remarkably characteristic. Before the middle of the century neither the professions nor the civil service were open to Jews, so that their abilities and energies could express themselves only in trade and business. Max Born's great-grandfathers were both businessmen – comfortably off on his father's side and extraordinarily wealthy on his mother's. The underswell of political liberalisation in the countries of Western Europe together with the wealth-creating activities of many Jews gradually enhanced their social acceptance. At the Berlin Congress of 1870, Benjamin Disraeli as Prime Minister of Britain made such

a deep impression that even Bismarck exclaimed: "That old Jew, he's my man!" (*Der alte Jude, das ist mein Mann!*)

Our family history illustrates this upward mobility, most obviously by a change of name. In earlier times poor immigrant Jews were given new names by the German authorities – the poorer the more inauspicious. Thus it was that the name of Max's paternal great-grandfather, who was born in 1790, was Meyer Schaul Buttermilch – 'buttermilk' in plain English. He was a trader, of what is not recorded; but what *is* recorded in his Polnisch-Lissa (today Leszno, Poland) community were his goodness and uprightness. His marriage with Blümche ('little flower', née Marcus) in 1816 produced eight children. The five sons were educated beyond the Jewish school in the grammar school (*Gymnasium*) in Kempen (today Kepno). One wonders how different their and their descendants' lives would have been if the name Buttermilch had been kept. But in 1842 the five sons, without the father's knowledge, applied to the King of Prussia to have their name changed to Born; and the royal document agreeing to this is still in our possession (figures 4 a & 4 b).

Three of the sons became noteworthy. The oldest, David Born, lived for a long time as a businessman in England. Around 1866 he moved to Berlin where he founded the suburbs Schöneberg and Lichterfelde. Unwilling to participate in a scam he was dismissed from his Company's board for honesty, not dishonesty!

The fourth son Stephan Born (originally named Simon) was born in 1824. His life is relevant to this day. He was a particularly bright boy. However, there was not enough money to send more than one son to the university – his older brother Marcus wanted to become a doctor. So Stephan learned the printing trade, in Berlin, at the same time reading widely and attending as many lectures as possible at the University. From early in life Stephan was profoundly conscious of social differences and of working class deprivations, and soon became involved in active socialism. In 1844 he published an article urging society to improve the workers' conditions. In 1846 he went to Paris where he was taken up by Engels. It was Stephan Born who achieved Engels' participation in the London Congress at which the Communist International was founded.

When the 1848 revolution began in Paris, Stephan was with Marx and Engels, but left them for Berlin as soon as the revolution started there. He became President of the Central Committee of the workers' organizations and published numerous pamphlets and articles promoting workers' solidarity. He led strikes in Berlin and fought on the barricades in Dresden. The workers' defeat and the death sentence upon him induced Stephan to flee to Switzerland. In Zurich he studied literature at the University and in 1878 he

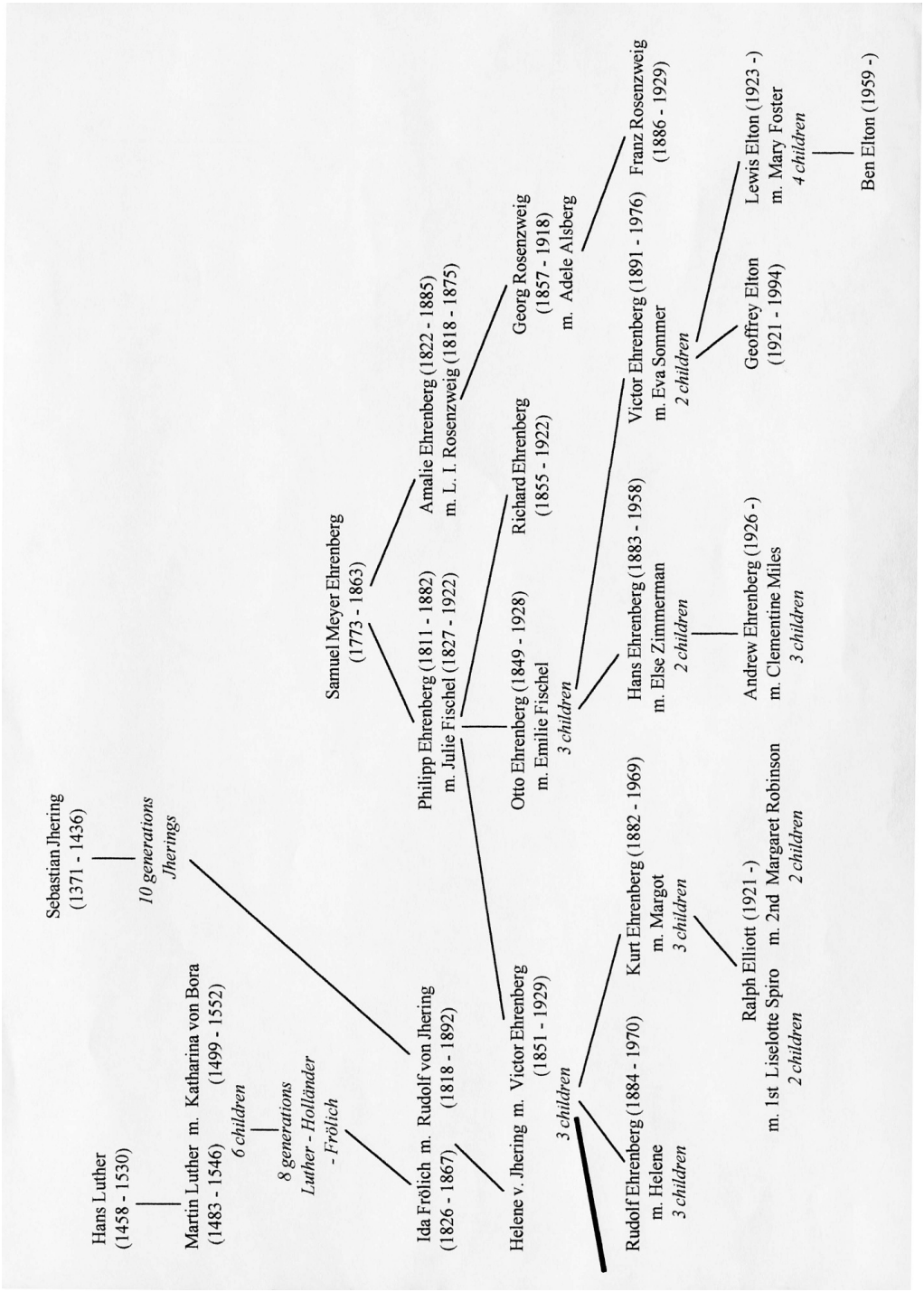


Figure 4 a. Born family tree.

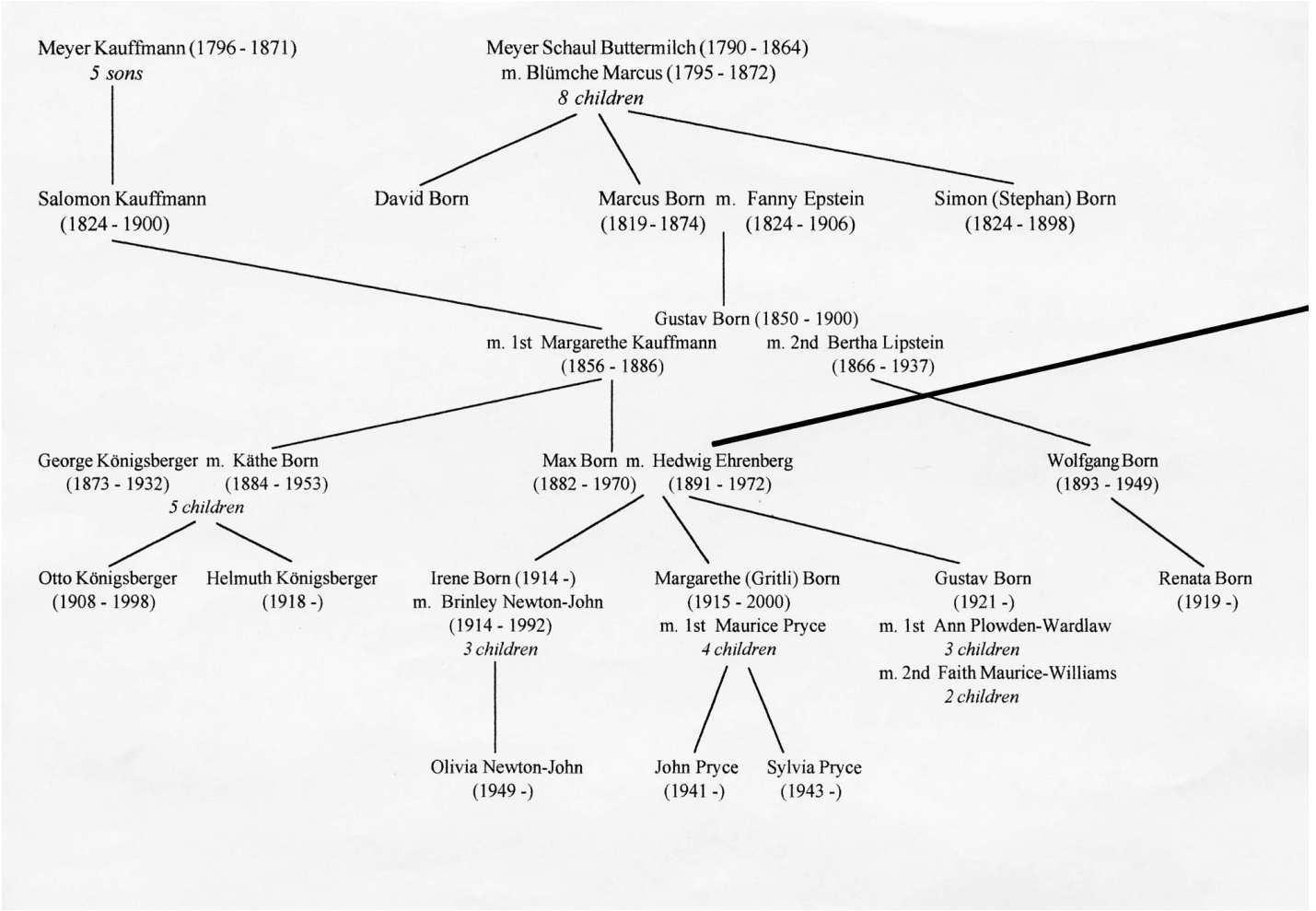


Figure 4 b. Born family tree.

became Professor for German Literature at Basle University. Most curiously he also became Editor of the daily *Basler Nachrichten*, known now, although perhaps not then, as an extremely conservative newspaper. He married the daughter of an exiled Prussian judge and had three daughters. He produced literary criticisms and, most important historically, his reminiscences of the 1848 Revolution *Erinnerungen eines Achtundvierzigers,* first published in 1898 and republished in 1978. The entire book is a fascinating document, but presumably of greatest lasting interest are Chapter 5 entitled: *Friederich Engels. Der Kommunistenbund. Heinrich Heine* (Friederich Engels. The Communist International. Heinrich Heine); Chapter 7: *Ein Winter in Brüssel. Karl Marx* (A Winter in Brussels. Karl Marx); and Chapter 21: *Zug nach Freiberg. Richard Wagner.* (March to Freiberg. Richard Wagner).

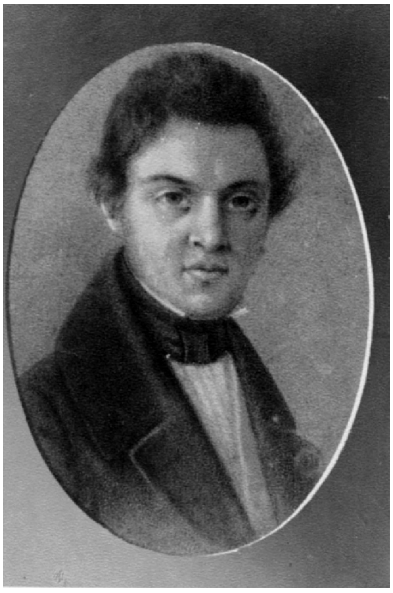


Figure 5. Marcus Born, Max Born's grandfather.

Stephan Born should be prominently remembered as an outstanding figure in the origins of the international workers' movement. But, unlike the Communists and in keeping with his humanistic family, he hated violence and was against "bloody revolution". So he was elbowed out of the history books by Marx and Engels – as we now know, to their ultimate discomfiture!

And so we come to the third remarkable son – actually the second son of Schaul and Blümche – Marcus Born, Max's grandfather (figure 5). He was

born in 1819 and became a medical student in Berlin. He was taught by Johannes Müller; the anatomist Friedrich Schlemm who discovered the canal named after him; and by Johann Lukas Schönlein, who described the purpura. He began his medical practice in Kempen on the Polish-German border, where he was soon much in demand from one and all including the Polish aristocracy. In 1849 he had himself elected to the provincial parliament as a representative of the German population. The wealthy Polish clientele withdrew from his practice, which he was unable to sustain. In 1852 he moved to Görlitz, where he became the town's most respected doctor. As the medical officer of health (*Kreisphysikus*) from 1860, Marcus was responsible for significant improvements in public health. Marcus Born died rather young, at the age of fifty-five, in 1874.

Figure 6. Gustav Born Sr.

Gustav Born Sr. (figure 6), Max's father, and the grandfather whose name I bear, was born in 1850 as the eldest and the most brilliant of Marcus's children. At the time of his father's death Gustav had completed his medical studies and accepted a position as assistant at the Anatomical Institute of Breslau (today Wroclaw) University. Soon he was promoted Principal Dissector at the Institute and University Lecturer. Max Born wrote about his father:

Though I was only 17 when he died, his picture stands most vividly before my eyes. He was a handsome man, with a most expressive face, framed by a beard as worn in those days; and with eyes of great kindness which could sparkle when he was excited as, for instance, when he read poetry to us. He loved poetry and knew much by heart, including large sections of Goethe's *Faust* and Heine's songs, and he himself wrote quite remarkably good verse of which I have a little collection. His interests extended far beyond his own field of research. One of his hobbies was botany. He was thoroughly familiar with the plants which grew in our countryside and on a walk through fields and woods he had a sharp eye for discovering small varieties which were new to him. Then out of his pocket would come a little book, a systematic botany by Wünsche, and he would teach me how to determine the species.

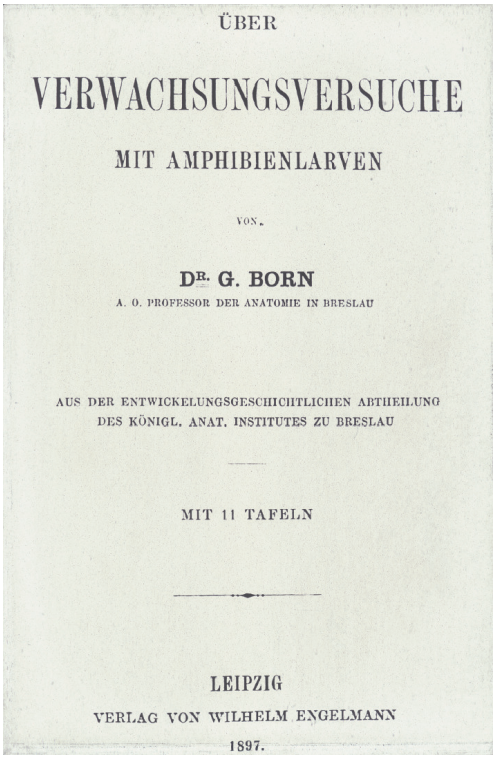
At the time the director of the anatomical school in Breslau was a Professor Hasse, a man very different from my father in every respect, personal and scientific. He kept strict discipline and did little to further research work done by his staff. My father must have suffered a great deal under this situation, and though he used to entertain us with stories about the chief it was often with a feeling of bitterness when some helpless student or young assistant was frustrated.

All his hopes of getting another appointment were in vain. Several times he was on the short list for a Chair (Tübingen, Bern) but in each case one of his friends was preferred. In 1889 he became the successor of Wilhelm Roux as Director of a Department of Embryology (*Entwicklungsgeschichte*) which was attached to the Anatomical Institute. Only during his last two or three years, after his appointment as honorary Professor Ordinarius, did he become effectively independent – but then it was too late. In the autumn of 1897 there appeared the first symptoms of coronary arteriosclerosis which slowly destroyed his strength. He continued working to his last day when a sudden death released him from his sufferings (in April 1901).

Not being a full professor he had no direct influence on the administration of the University; but when his scientific name became well established he was often asked for advice by his friends. Amongst these were many men of fame like Heidenhain and Albert Neisser, the dermatologist who discovered the gonococcus, in Breslau, and Karl Weigert and Paul Ehrlich, the inventor of

chemotherapy, in Frankfurt. The latter two, both born in Silesia, for many years used to spend the night after Christmas in our house. From Frankfurt also came the only great honour conferred on my father, the Gold Medal of the Senckenberg Institute, which he received about a year before his death. (Born, 1978)

In his short life Gustav Born's scientific originality and productivity were extraordinary. They are summarized in an article by my father Max, Walter Brandt and myself published at the half-century since Gustav Born's death (Born et al, 1950). In experimental embryology, he hybridised amphibian species and discovered new characters in the offsprings. Amphibian embryos were artificially united (figure 7).


ÜBER

VERWACHSUNGSVERSUCHE

MIT AMPHIBIENLARVEN

VON

Dr. G. BORN

A. O. PROFESSOR DER ANATOMIE IN BRESLAU

AUS DER ENTWICKELUNGSGESCHICHTLICHEN ABTHEILUNG
DES KÖNIGL. ANAT. INSTITUTES ZU BRESLAU

MIT 11 TAFELN

LEIPZIG

VERLAG VON WILHELM ENGELMANN

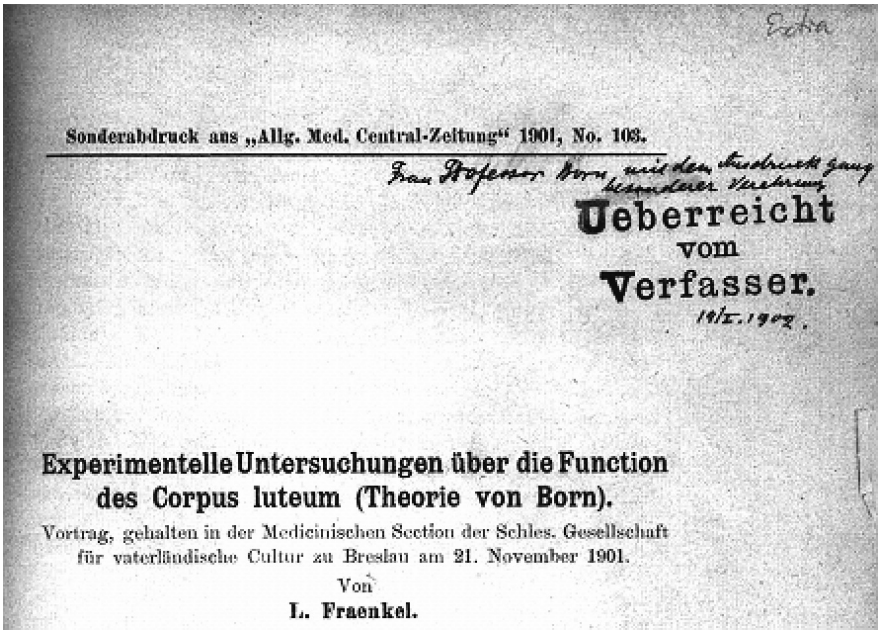
1897.

Figure 7. Title page of Gustav Born, *Verwachsungsversuche* (Hybridization experiments), 1897.

Born suggested some kind of chemotaxis to explain why corresponding organs sometimes united without having been in contact. Before the discovery of sex determination by the XY chromosomes, Gustav Born

discovered environmental factors influencing the sex ratio, particularly nutrition.

Born contributed much to knowledge of the development of the septa, ostia and valves of the mammalian heart. For this purpose he invented the wax plate reconstruction method named after him, which has since been used by morphologists everywhere (see Hopwood, 1999). I am the proud possessor of one of Gustav Born's beautiful heart models, given to me many years ago by the then director of the anatomical museum in Vienna.


Extra

Sonderabdruck aus „Allg. Med. Central-Zeitung" 1901, No. 103.

Frau Professor Born, mit dem Ausdruck ganz besonderer Verehrung

Ueberreicht
vom
Verfasser.
19/X. 1902.

Experimentelle Untersuchungen über die Function des Corpus luteum (Theorie von Born).

Vortrag, gehalten in der Medicinischen Section der Schles. Gesellschaft für vaterländische Cultur zu Breslau am 21. November 1901.

Von

L. Fraenkel.

Figure 8. Title page of L. Fraenkel's paper on the *Theorie von Born* in *Collected papers by and about Gustav Born 1879-1958* in the author's private collection; the handwritten German dedication reads: "Frau Professor Born mit dem Ausdruck ganz besonderer Verehrung".

However, the most important discovery for which Gustav Born was responsible and which has had enormous effect on human society is the function of the *corpus luteum*. Shortly before his death he proposed the hypothesis that the small yellow mass growing in the ovary where the egg had been shed is a gland for producing an internal secretion which prepares the uterus for pregnancy and maintains the ovum in its lining. Adducing diverse evidence for this he proposed experiments which provided direct support for his idea (figure 8). Arpad Csapo, Professor of Embryology at the Rockefeller Institute, told the story in the *Scientific American* in 1958:

> In 1900 a great professor of embryology at the University of Breslau, Gustav Born, called to his deathbed one of his bright former students, Ludwig Fraenkel. He presented the young man with a strange intellectual bequest: namely, an injunction to explore a mysterious yellow body in the ovaries called the *corpus luteum*. It was Born's notion that secretions by this organ would be found to play a vital part in the protection of the embryo in the womb. Thirty years later Born's legacy bore brilliant fruit in the discovery of the hormone *progesterone*. The finding of this hormone raised hopes of reducing the great toll of life taken by miscarriage. Born's deathbed intuition has carried the world a long way toward solving some of the mysteries of development and birth. In Born's day scientists had only a sketchy knowledge of the mechanisms of a mammal's gestation. Born provided the lead by calling attention to the *corpus luteum*. Born suspected that this body served as an endocrine gland – that is, an organ of secretion. Fraenkel together with Franz Cohn indeed provided the first evidence that this is so. We have reason to be grateful for Born's legacy.

The discovery was directly relevant to the development of the contraceptive pill.

Maternal ancestors

Max Born's maternal ancestry is very different but equally interesting. This story begins with Max Born's great-grandfather Meyer Kauffmann. He was born in 1796 and died in 1871 and lived, a small Jewish trader, in the Silesian town of Schweidnitz (today Swidnica). He bought textiles woven on handlooms by poor people in the lovely valleys of the Silesian hills (Sudeten); sold them at the big fairs in Breslau, Leipzig and other cities, and supplied the home industry with raw materials, wool and cotton. He was one of the first to have the idea of collecting a group of workmen in a house where the looms were driven by the power of a simple water-wheel. In this way the first textile factories came into existence. In 1841 he started his textile works in Breslau. Here he was the first to operate steam-driven looms. The quality of the hand-woven cloths from his factory were better than anything made before. He married Phillipine Wiener (figure 9) and had five sons: Salomon (Max's grandfather), Julius, Robert, Wilhelm and Adolf. The first four joined the firm and all became successful industrialists and merchants. Only Adolf went his own way; he became a physician but, as far as is known, never actually practised. He was deeply interested in music, and

it was mainly due to his initiative, and his brother's money, that the Breslau Orchestral Society was founded. He seems to have been a great friend of Max's mother who shared his musical enthusiasms.

Figure 9. Meyer Kauffmann and his wife Phillipine, née Wiener.

Meyer Kauffmann's oldest son Salomon (figure 10) greatly enlarged and modernised the factories, the products of which soon ousted cloth imported from England and France and made the family very wealthy.

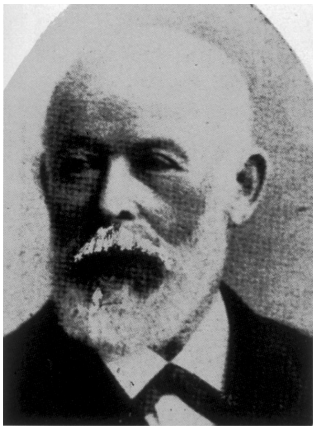


Figure 10. Salomon Kauffmann, Max Born's grandfather.

Salomon was an important figure in Breslau in both commerce and culture. As Chairman of the Orchestral Society he had as houseguests the most famous musicians including Liszt, Bruch, Clara Schumann, Sarasate, Joachim and Brahms. We possess the guest book (*Poesie-Album*) of his daughter Margarethe – Gustav Born's wife and Max's mother – which contains musical quotations and dedications from all these great artists who stayed in her parents' house. There are two entries by Brahms dated 1874 (figure 11) and 1881.

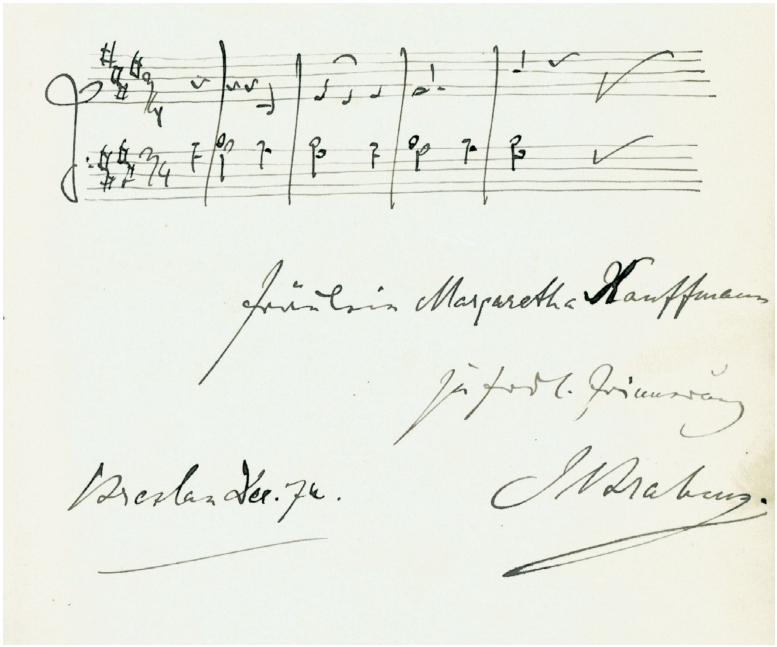


Figure 11. Entry by J. Brahms in the *Poesie-Album* of Margarethe Kauffmann; the German text reads: "Fräulein Margaretha [sic] Kauffmann zu fr[eun]dl[icher] Erinnerung. Breslau Dec. [18]74"; from the Born family archive in Edinburgh University Library.

Salomon Kauffmann had persuaded the University to give Brahms an honorary degree – his only one; and it was for this occasion that he composed the *Akademische Festouvertüre* (*Academic Festival Overture*). A few bars of it in his hand-writing are in the 1881 guest book entry.
Max Born wrote in his autobiography:

> The firm Meyer Kauffmann bought or built a considerable number of factories; at the height of their prosperity they had a spinning-mill in Breslau and five or six weaving-mills in different valleys [figure 12]. Today all this splendour has disappeared. There was only one

generation of clever, humane, energetic and prosperous men. The next generation was still clever and humane, but not energetic or prosperous. The firm was already declining when I was a young man; it became a limited liability company, later a joint-stock company. The shares were not kept in the family, which slowly became impoverished, and the end came when the Nazis confiscated all Jewish property and drove the last directors of the family firm, cousin Hans Schäfer and second cousin Otto Kauffmann (grandson of Robert), out of the firm and indeed out of the country.

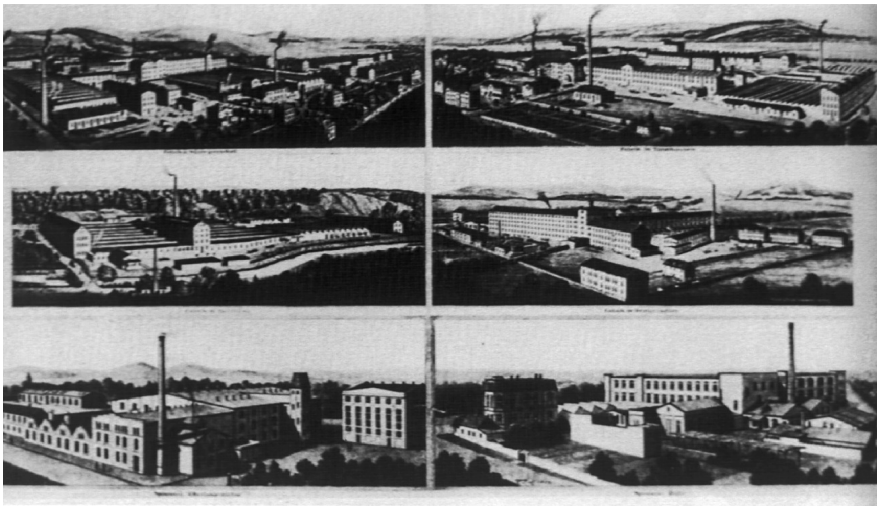


Figure 12. Meyer Kauffmann factories.

This brings us to Max Born's mother Margarethe Kauffmann (figure 13). By all accounts she was brilliant, graceful and charming, and had the gift of making people happy. She was very musical, an excellent pianist. She married Gustav Born in 1881. Their happiness was complete with the birth of Max in 1882 and of his sister Käthe in the next year. But shortly after her marriage she began to suffer from gallstones from which she died in 1886, only a few years before Theodor Kocher devised the operation that could have saved her. Little Max was only four. Her death was a terrible blow to the husband and children, the more so as their upbringing was constantly interfered with by Margarethe's wealthy parents. After some years Gustav Born married again into another wealthy family, the Lipsteins. Max remembered his step-mother Bertha Born (née Lipstein) for her kindness and honesty. She looked after them meticulously and gave her husband the

financial independence which allowed him to devote his time to research. They had one son, Wolfgang Born, who became an excellent painter of imaginative realism in strong colours and Professor of Art History at New York's City College. Wolfgang's daughter, Renate, who was a biochemist at Surrey University, is a great favourite for her humour and good sense.

Figure 13. Margarethe Kauffmann, Max Born's mother.

Home and University

So we have brought the ancestry and parentage together in Max and in his younger sister Käthe, who was strikingly like her mother (figure 14). Max describes an outwardly very fulfilled childhood and adolescence between his father's home in Breslau (figure 15) and the big Kauffmann mansions, particularly the summer house nearby in Tannhausen (today Jedlinka); always in the company of his sister and many cousins and friends. The walls of our Cotswold's cottage are adorned with charming pastel drawings of that time made by his aunt Gertrude Kauffmann-Schäfer (figure 16). His schooling in Breslau was uneventful. He studied many subjects and was good at them all, showing more interest in the humanities than in the sciences. He remembered

Figure 14. Käthe Born, Max Born's sister.

Figure 15. House of the Born familiy in Breslau; postcard with English explanation in Max Born's handwriting: "My birthplace: the house on the right, in front of the church. On the left: the King's palace."

Figure 16. Max Born at about age 10; pastel drawing by Gertrude Kauffmann-Schäfer.

his Greek to the end of his life, and from him I have my only Greek sentence – the first lines of the *Odyssey*. He also retained doggerel in his native Silesian dialect. Herewith a folk-philosophical example, together with my attempt at translation:

Zwee Knaben suchten emsiglich
am Boom nach eenem Appel
Sie fanden beede keenen nicht,
Der Boom der war ne Pappel.
Wie gut das doch die beeden Knaben

Two fellows hunted eagerly
for apples on a tree.
They found none – unsurprisingly:
Poplars are apple-free.
Praise be that this pathetic quest

Den Appel nich' gefunden haben.	Led up an alley blind
Et wurde sonst keen Ende nehmen,	Or else no tree would ever rest
Det Suchen an de Pappelbeemen!	From searches of this kind!

In his autobiography my father has let his memory play widely and vividly over his childhood. One can discern three strands identifiable throughout his life. One was a shyness combined with friendliness – the former disappeared with success, the latter turned into trusting adult friendships. Another strand was his musicality, presumably inherited from his mother. As a child he had piano lessons from an aunt – "not a very good teacher" – and as a student from a brilliant teacher Max Auerbach. Highlights from his early life were playing four hands piano with Joseph Joachim, the great violinist for whom Brahms wrote his Violin Concerto.

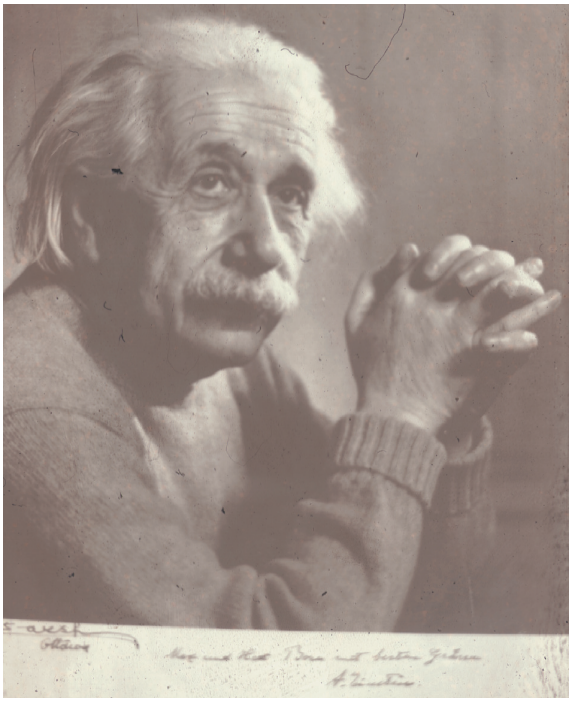
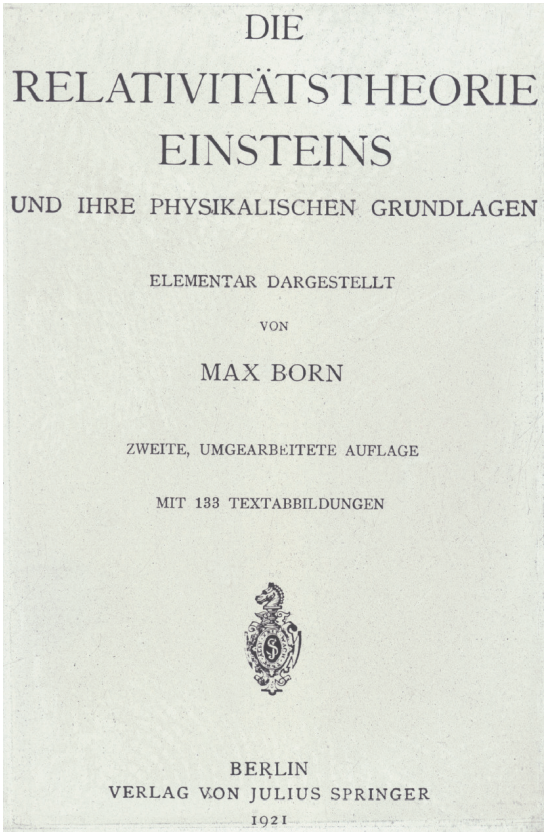


Figure 17. Albert Einstein; photograph with German dedication reading: "Max and Hedi Born mit besten Grüßen".

These two strands – his empathy with people and his musicality – came together in his closest friendships. What first attracted Albert Einstein (figure 17) to my father (it helped that they lived near each other in Berlin) was

Einstein's pleasure in finding somebody who really understood Relativity – he wrote the first book on the subject, *Die Relativitätstheorie Einsteins* (1921) (figure 18) – and also their music making. The enormous collection of bound music, now mostly with my most musical daughter Georgina, I believe still contains some violin parts with Einstein's name on them. There was his life-long friendship with the great pianist Artur Schnabel, an exact contemporary also from Silesia. After leaving Germany the two families spent some months together in the South Tyrol. Concurrent mention of Einstein and Schnabel recalls the occasion in the 1920s when they happened to be on the same ship bound for New York – Einstein by now world-famous for his mathematical physics and Schnabel for his pianistic virtuosity. To pass the time Einstein, a passable violinist, joined Schnabel at the ship-board piano in the Beethoven Sonatas. Before long, Schnabel became irritated: "Come along, Albert – one, two, three, – can't you count?"


DIE

RELATIVITÄTSTHEORIE EINSTEINS

UND IHRE PHYSIKALISCHEN GRUNDLAGEN

ELEMENTAR DARGESTELLT

VON

MAX BORN

ZWEITE, UMGEARBEITETE AUFLAGE

MIT 133 TEXTABBILDUNGEN

BERLIN
VERLAG VON JULIUS SPRINGER
1921

Figure 18. Title page of Max Born's *Die Relativitätstheorie Einsteins* (1921).

Another unexpected friendship came about when my father was trotting through deep snow past the main church in Konstanz from which came the sound of an organist playing Bach. Max sat down in the church and after listening for a few minutes said to himself: "That is either the Devil or Schweitzer!" In this way he met Albert Schweitzer whom both my parents had already admired from afar and with whom they subsequently corresponded.

During the years when Werner Heisenberg was his first assistant in Göttingen, our drawing room contained two Steinway grand pianos back-to-back; and one of my first memories is lying under the pianos and listening to our father and Heisenberg playing not only the wonderful two pianos music by Schubert but also transcriptions of symphonies, oratorios and operas – a celestial feast for a musical child. During our Edinburgh years he played sonatas with a gorgeous cellist, Peggy Sampson, daughter of the Astronomer Royal for Scotland. I am sure it is from that time that I owe my particular love for the Beethoven and Brahms cello sonatas. And every day of his life, like Pablo Casals, he played Bach for the unfathomable peace his music gives. But here is a strange thing: Max's sight reading was phenomenal – not just the two piano lines but symphony and opera scores, like a conductor; but he was unable to play by ear. With me, at a much lower level, the opposite is true: my sight-reading is poor but, within the classical idiom, I can generally reproduce what I hear, harmonies, key changes and so on: a curious difference.

A third strand was originality combined with practicality. About his cousin Franz, Max wrote that he was highly gifted but purely receptive, while he himself always had the urge to reconstruct ideas in a new shape and to find new combinations. From boyhood he always wanted to make things; so he needed a lathe for metalwork, not usually a childhood present because very expensive. As his wealthy grandfather Kauffmann's greatest concern was the Breslau Symphony Orchestra, Max built a model of the orchestra in which the arms of the players were moved by hidden strings. Turning a handle out of sight made the whole orchestra move in perfect unison. On receiving this present on his birthday – 11th December, the same as Max's – the old man was moved to tears; and two weeks later there was the lathe under the Christmas tree. One of Max's strengths as a theoretical physicist was to stay as close as possible to the experimentalists – Otto Stern in Frankfurt, James Franck in Göttingen, and so on. But his devotion to the practicalities of ordinary life – and to me – is touchingly (and comically) shown in this letter written when he was nearly seventy:

Dear Gustav,
Thank you so much for your two nice letters and the reprints.
I send you enclosed my bicycle lock, which is indeed excellent and safe. To fix it you have first with a narrow screw-driver to push the driver through the holes, then the back comes off. As soon as this is achieved the moveable part can be pushed in, and then the key can be pulled up. If you want to keep it back, you just push the key in the right direction, indicated by the little teeth. When you push the key in the bar jumps back. Now, about fixing it to the bike, it is clear that is has to be fixed at one of the two back wheel supports, in such a way that the key is upwards. For this purpose, you must push the bar into the position in which it is now. Then you can move the screws with a screw-driver and fix the ends on to the support. Then you can turn the little moveable bar to cover the holes of the screws. Then the way it works is quite clear. If the key is in, the bar is back so that the wheel can turn. When you want to lock the wheel, push the bar in, and the key can then be removed and put in your pocket. When you want to open it again, push the key in and the bar jumps back.
I have no time for more today. I am glad that you are well and happy.
With love,
Yours, Vati.

Max Born started university at 18 in his own city of Breslau. Without a burning desire to study any particular subject, and on his father's advice, Max heard lectures on a diverse range of subjects. His prosperous background obviated the need to study for a living. Soon astronomy and mathematics became his favourite subjects. Indeed it was his Breslau professor Jakob Rosanes from whom he learnt the matrix calculus which played such a crucial role in his Göttingen contributions to quantum mechanics. In accordance with student custom he spent 1902 in Heidelberg and the following year in Zurich, where he attended his first course in advanced mathematics – on elliptic functions by Adolf Hurwitz. Back in Breslau his student friends Otto Toeplitz and Ernst Hellinger told him of the great mathematicians in Göttingen – Felix Klein, David Hilbert, Carle Runge and Hermann Minkowski. Soon he was in Göttingen attending their lectures. His intelligence and diligence clearly marked him out, so that in 1905 he became Hilbert's assistant (*Vorlesungsassistent*). In that job he was charged with writing out Hilbert's lectures *in extenso*. Max did so with accuracy and elegance, producing ravishing works of calligraphic art (figure 19). They were carefully preserved in the family archives by my father. I have the firm recollection of holding them admiringly in my hands many years ago. To my great distress only one

of these unique testaments of lectures by a world famous mathematician recorded by a world famous physicist is still there; there seems no way of knowing what happened to the others.

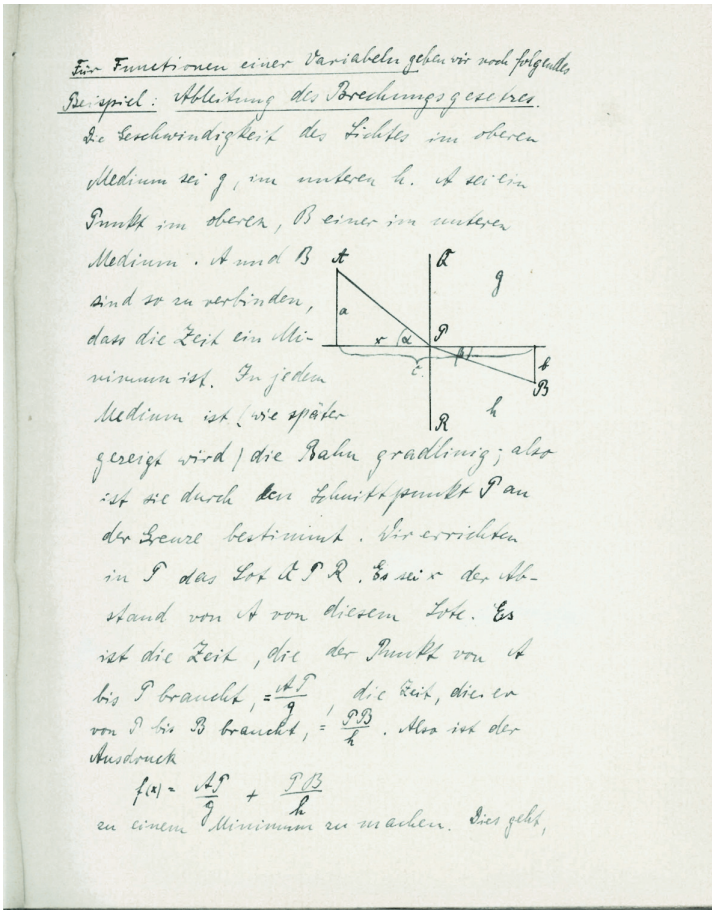
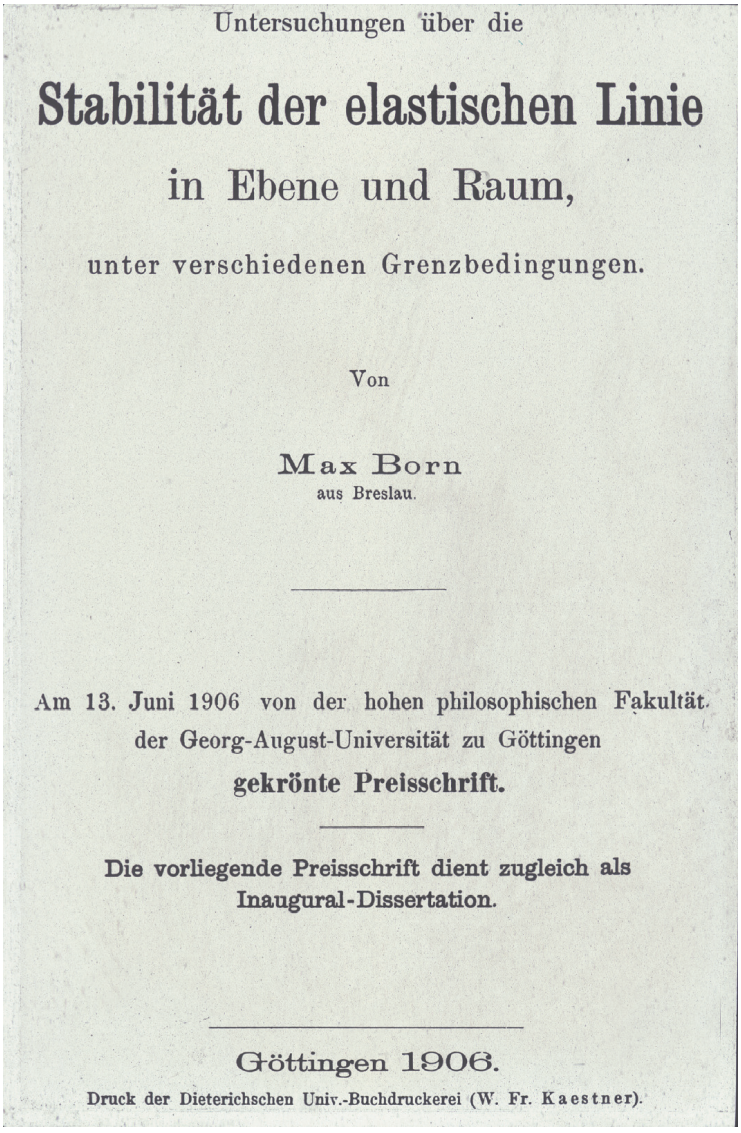


Figure 19. A page from D. Hilbert's lecture book as written by Max Born.

Felix Klein – known as "the great Felix" – became annoyed with Max, who attended his lectures only irregularly. So Max decided to substitute astronomy for geometry as one of his doctoral subjects. He attended Karl Schwarzschild's astronomy lectures and successfully obtained his doctorate in 1907 (figure 20). Max's mathematical interest brought him contacts with similarly inclined fellow students, notably Constantin Carathéodory, whom he admired, and Richard Courant, later a renowned mathematician and fellow émigré for whom an Institute was established in New York State.



Untersuchungen über die

Stabilität der elastischen Linie

in Ebene und Raum,

unter verschiedenen Grenzbedingungen.

Von

Max Born
aus Breslau.

Am 13. Juni 1906 von der hohen philosophischen Fakultät
der Georg-August-Universität zu Göttingen
gekrönte Preisschrift.

Die vorliegende Preisschrift dient zugleich als Inaugural-Dissertation.

Göttingen 1906.
Druck der Dieterichschen Univ.-Buchdruckerei (W. Fr. Kaestner).

Figure 20. Title page of Max Born's inaugural dissertation.

Max then spent two terms in Cambridge, a fateful move because it became crucial in his decision to accept Ernest Rutherford's invitation to go to Cambridge after leaving Nazi Germany in 1933. It determined our family becoming British instead of French, Russian, American, or even Turkish, all through offers of jobs he received from these countries. As it turned out, no

choice could have been better than the one my parents made in coming to England. Since our forced emigration from Germany in 1933 the Born family owes everything to Britain – our very lives when the British people first took us in and again later when Churchill's courage and steadfastness prevented a German invasion; as well as everything else – livelihood, friendship and love. No wonder that all the Borns cherish their adopted country!

From Cambridge Max returned briefly to Breslau and after an interlude in the army went back to Göttingen in December 1908. He was taken on by the great mathematician Minkowski. But within only a few weeks Minkowski died. The aftermath was a low point in Max's career. A lecture on some ideas of his own he gave to the Mathematical Society went so badly that he was preparing to leave Göttingen for good and take up engineering at a technical college; this failure seemed to him proof of inadequacy. But he was persuaded to repeat his lecture successfully, even satisfying Klein. He was accepted as Faculty lecturer (completing his *Habilitation*) in the summer of 1909.

Max moved from Kirchweg (No. 4) to Nikolausberger Weg (No. 49) where his friends included Theodor von Kármán, a clever Jewish Hungarian who later became an authority on aerodynamics. Together they published seminal work on the application of quantum theory to crystal structure. At this time also Max first met Fritz Haber, who became famous in the First World War as the inventor of ammonia production from atmospheric nitrogen which allowed Germany to continue fighting, and infamous as the originator of chemical warfare. After the war their collaboration led to the Born-Haber cycle.

Marriage

In 1912 an invitation from Albert Michelson to Chicago lead to a trip through the United States. Max was deeply impressed by the shocking contrast between rich and poor, and by the Grand Canyon. Back in Göttingen he joined von Karman and other friends in a house in the Dahlmannstrasse (No. 8). His social life flourished, with tennis and music parties. Soon he became engaged to Hedi Ehrenberg; and they married in the summer of 1913 in the house of his married sister Käthe in Grünau, a leafy suburb of Berlin on the lake called Müggelsee. It was a grand wedding attended by many members of both families. After honeymooning in Scandinavia and in Bad Pyrmont (figure 21), the small spa town to which they would be retiring forty years later, their first Göttingen address was Am Weissen Stein (No. 4).

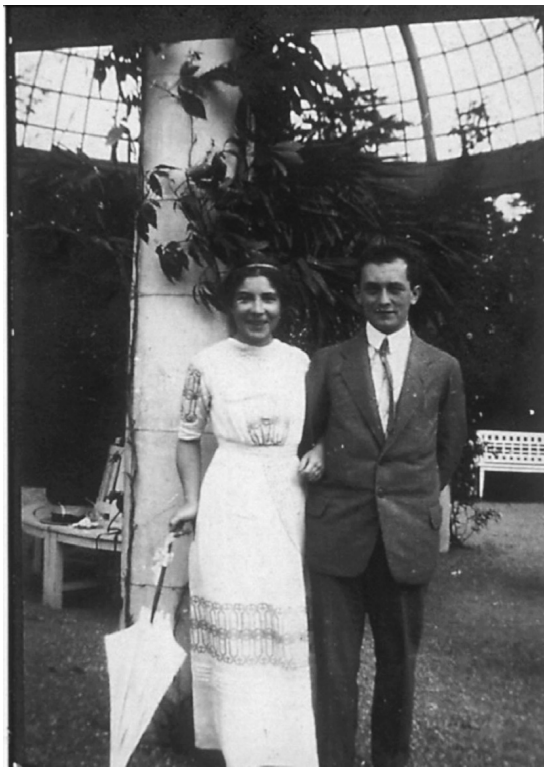


Figure 21. Hedwig and Max Born on honeymoon in Bad Pyrmont.

And so we turn to our mother's family, the Ehrenbergs. This too is a remarkable clan, records of which go back to the fourteenth century. The first noteworthy ancestor – noteworthy here being a master understatement! – is Martin Luther**,** one of the most fascinating figures in modern history (figure 22). Indeed, it could be said that Luther *started* modern history, because most of the improvements in the human condition during the last five hundred years or so may reasonably be attributed to the liberation of the human mind from the mental and physical imprisonment imposed by religious dogma, which Luther so courageously undermined. It seems to me that the Lutheran revolution was a pre-condition of the scientific revolution. It is surely no accident that natural science germinated only twice in human history: for the first time in Athenian Greece, where it did not survive; and for the second time in post-Reformation Europe, where it did. Both times it happened in societies which began to permit freedom of thought and of communication.

Figure 22. Martin Luther; painting by Lucas Cranach the Elder from 1533.

Paradoxically, Luther himself remained a man of faith, which "neither Pope nor Emperor, nor thrones, or dominions, or principalities, or powers" could shake; so he would probably be most astonished at the consequences of his courageous actions. Relevant to this memoir is Luther's action in marrying a nun, Katharina von Bora. They had three sons and three daughters. Our descent is from the oldest son, Johannes. There followed three generations of Luthers and, from 1683, four generations of Holländers, followed by four generations of Frölichs, of whom the last, Ida, married Rudolf von Jhering and thereby became our great-grandmother.

Rudolf von Jhering was born in 1818 in Aurich, a small town near the Dutch border. His ancestors were almost all lawyers, notaries and government officials going back to a Sebastian Jhering who was born in 1371. Although actually more interested in literature and writing, Rudolf too was induced to study law. His increasingly distinguished academic career was in many ways typical of that of the nineteenth century German professor, moving from place to place whenever an attractive offer came his way. He held six professorships in different Universities, the last from 1872 in Göttingen. Through teaching and writing he became the greatest Roman lawyer of modern times. Jhering's books on the law and its social implications have

remained hugely influential to this day: *Geist des römischen Rechts* (*The Spirit of Roman Law*); *Der Zweck im Recht* (*Purpose in Law*); and *Der Kampf um's Recht* (*The Struggle for Law* or *The Battle of Right*). This last book, published in 1872, was translated into eighteen languages before the end of the nineteenth century. Jhering received many honours, foremost amongst them a hereditary knighthood conferred upon him by the Austrian Emperor Franz Josef in 1872; many honorary degrees and a congratulatory letter from Bismarck on his seventieth birthday. A jotting found amongst his papers expresses our great-grandfather's view of his discipline: "The law is not merely a matter of knowledge but above all of feeling, of a sense of justice." In this he clearly anticipated the notion of natural justice which is the foundation of the human rights movement.

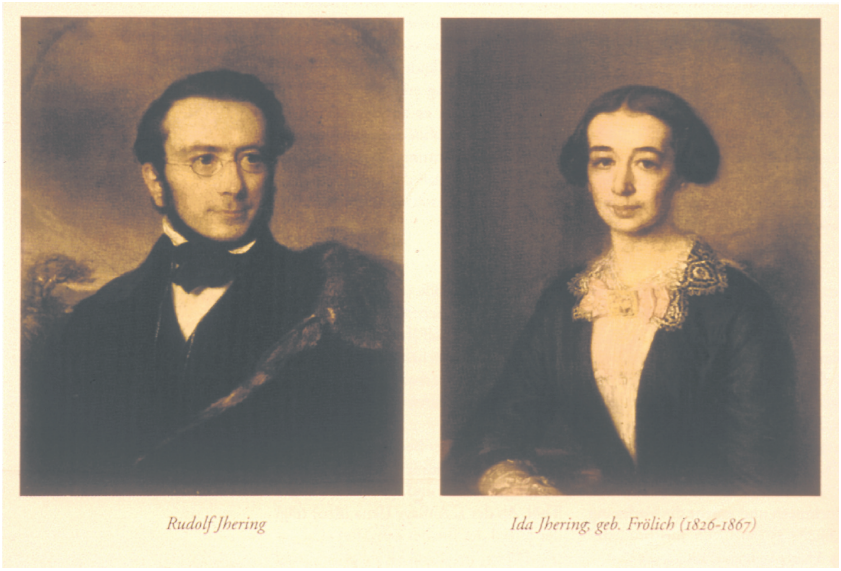


Figure 23. Rudolf von Jhering and his wife Ida (née Frölich).

Jhering was a warm-hearted, sympathetic but also temperamental man. His first wife died in 1848 after only three years of marriage. In 1849, he married Ida Frölich (figure 23). Of their four sons the eldest, Hermann, became a well known naturalist and was for twenty-three years director of the National Museum in Sao Paulo, Brazil. Their only daughter Helen von Jhering became our grandmother through marrying Victor Ehrenberg. He was born in 1851 in the picturesque little town of Wolfenbüttel where his father and grandfather were grammar school principals. In due course, Victor

became professor of Jurisprudence in Göttingen and renowned as the creator of insurance law on which he published many books and papers. He died in 1929 and so was the only grandparent I still knew – a tubby, bearded, cheerful, chortling figure carving the stuffed goose at the family Christmas lunch (figure 24). He and our grandmother lie buried in the family corner of the old cemetery in Göttingen, alongside his father-in-law and academic mentor, Rudolf von Jhering, their daughter Hedi and her husband Max Born.

Figure 24. Victor Ehrenberg with three of his grandchildren (from left to right): Rolf Ehrenberg, Gritli Born and Susi Ehrenberg in his Göttingen garden, about 1926.

One of my mother's brothers, also called Rudolf Ehrenberg, studied medicine and became a Göttingen professor in 1921. He was a jolly student. One day he sat on his balcony railing giving a drunken lecture to his poodle when he fell over backwards, fortunately only onto the balcony below, where

he slept peacefully until next morning. In books entitled *Metabiologie* (*Metabiology*) and *Ein Schicksal in Predigten* (*A Destiny in Sermons*), he attempted to relate natural science to spiritual needs. Albert Schweitzer wrote that he had read that book in one night without pause. I too began to read it many years ago; but I am afraid there has been a pause ever since. His being only half-Jewish and married to a non-Jewish Catholic wife allowed him to escape the worst of the Nazi terror. He died in Göttingen aged eighty-four. His only son, Franz, was killed on the Russian front shortly before the end of the Second World War. His older daughter, Hilda, was a physiotherapist, and his younger daughter, Maria, a professor of biology in Würzburg. My mother's other brother Kurt was in the insurance business until his emigration to England. His son, my cousin Ralph Elliott (né Rolf Ehrenberg), won distinction first as a soldier in the British Army and later as Professor of English at Flinders University and Master of University House at the Australian National University, Canberra. His interests range from ancient runes to Chaucer and to Thomas Hardy.

Another Ehrenberg line is noteworthy. Grandfather Victor's brother Richard was Professor of Political Science in Rostock. His *magnum opus*, *Das Zeitalter der Fugger* (title of the Engl. edition: *Capital and Finance in the Age of the Renaissance: A Study of the Fuggers and Their Connections*), is an exhaustive study of sixteenth-century Europe; it was first published in 1896 and was still in print in 1963. Grandfather Victor's other brother Otto had a son, Hans Ehrenberg, a Lutheran pastor and Professor of Philosophy at Heidelberg, who was rescued from a concentration camp by Bishop George Bell of Chichester. His publications include *Deutschland im Schmelzofen* (*Germany in the Melting Pot*) in pre-Nazi Germany, and later in England a deeply moving *Autobiography of a German Pastor*. Hans' son Andrew Ehrenberg was Research Professor of Marketing, a title that disguises a notable statistician. Another son, also called Victor (1891–1976), was a renowned professor of ancient history at London University. In his memoirs he wrote;

> I belong to a generation which suffered from the unresolved conflict between German heritage and Jewishness, living through two World Wars, the first on the German the second on the Allied side – times of distress, fear and hope.

Throughout those unsettling years he published learned books: *The People of Aristophanes*; *Sophocles and Pericles*; *The Greek State*; and *From Solon to Socrates*. At his honorary degree ceremony in Cambridge the public orator

said that "what was a misfortune for him proved to be an advantage for others: we owe him a considerable debt for all that he has written."

This Victor Ehrenberg and his wife Eva had two sons who changed their name to Elton and had distinguished academic careers in Britain. The younger, Lewis, became a physicist and later head of the Institute of Education at Surrey University. One of his sons, Ben Elton, has achieved fame as a stand-up comic, best-selling writer and the librettist for Lloyd-Webber's football musical *The Beautiful Game*. Lewis's older brother, Sir Geoffrey Elton, occupied the Regius Chair of History in Cambridge in the 1980s. He was an original and controversial writer on modern history, including a book called *The English*. This line also included the influential philosopher Franz Rosenzweig.

Berlin and Göttingen 1914-1933

Back to Max Born's own family. The First World War broke out in 1914. My parents moved to Berlin where Max became 'Professor Extraordinary' (*Extraordinarius*) to relieve Max Planck of some of his teaching duties. In Berlin the two daughters were born, Irene in 1914 and Gritli in 1915. Our parents' house in the Grunewald's Teplitzer Strasse is still there – I have visited it several times – and so is Einstein's house in Haberland Strasse; and there the friendship began which was to last until Einstein's death in Princeton in 1955. Much has been written about that friendship, which very much included my mother, in the many Einstein biographies and my father's autobiography; and the correspondence between them was published as a book entitled *The Born Einstein Letters.* It was in one of his letters to my father that Einstein coined the much-quoted phrase about God not throwing dice (*Gott würfelt nicht*). In a foreword Bertrand Russell wrote: "Both men were brilliant, humble and completely without fear in their public utterances. In an age of mediocrity and moral pygmies, their lives shine with an intense beauty." Of many tales in Born's autobiography, I pick out the occasion when the First World War had just ended and revolution was in the air. Max, together with Einstein and the psychologist Max Wertheimer, walked through excited crowds to talk with Friedrich Ebert, the head of the socialist government. Twenty-five years later, Einstein wrote to Max of how convinced they had been of effectively "helping to turn those people into honest democrats. How naïve we were, for all our forty years. I have to laugh when I think of it."

In 1919 the family moved to Frankfurt where Max was appointed to his first full professorship. How that came about shows up some interesting

differences between then and now. For making the most junior academic appointment nowadays the documents and correspondence needed could easily make a small book. In 1919, Max von Laue (figure 26), who later won a Nobel Prize for x-ray crystallography, was Professor *Ordinarius* in Frankfurt but keen to return to his revered mentor Max Planck in Berlin. So the two young Max's approached the older Max about an exchange of Chairs; and this was brought about by a *one-page* letter from Planck to the Minister! We still have that letter.

Figure 25. Max von Laue with Max Born and Otto Hahn in the 1960s.

In Frankfurt, my father's institute contained a promising young physicist, Otto Stern; but there was no money for apparatus. Max was told of a Jewish American who was well disposed towards Germany. This man was Henry Goldman, son of the founder of Goldman Sachs, who responded to my father's letter with a charming reply and a cheque for several hundred dollars – an immense sum at the time – with which Walter Gerlach and Stern did experiments which later gained the latter a Nobel Prize. Every year, Goldman came to Baden-Baden where my father visited him in a friendship which lasted until Goldman's death in 1937 (figure 26). We have a letter to Max

which Goldman wrote on the day before he died. About twenty-five years ago I was doing promising experiments related to coronary thrombosis – a topic, one would have thought, of anxious appeal to highly-stressed bankers! So I wrote to the senior partner of Goldman Sachs in New York, recounting my father's story of some fifty years before and expressing the hope that the Founder's super-rich successors might perhaps feel like supporting our work. No such luck: only regrets.

Figure 26. Henry Goldman (centre) with Max Born (left) and Dr. Jantzen (right) in Baden-Baden dated 10 June 1931.

We now come to Göttingen for the third time**,** because in 1921 my father returned as Professor and Director of the Institute of Theoretical Physics (figures 27 and 28); and he stayed until the Nazis drove us out in 1933. The story of his achievements and of the brilliant school he created here has been told by others, who know and understand the science. A great success was his reanimating a second Chair for James Franck (figure 29); and another the famous Bohr Festival in 1922 (figure 30).

Figure 27. Göttingen in the early 20th century; panoramic view from the Hainberg.

Figure 28. The Market Place in Göttingen in the 1920s.

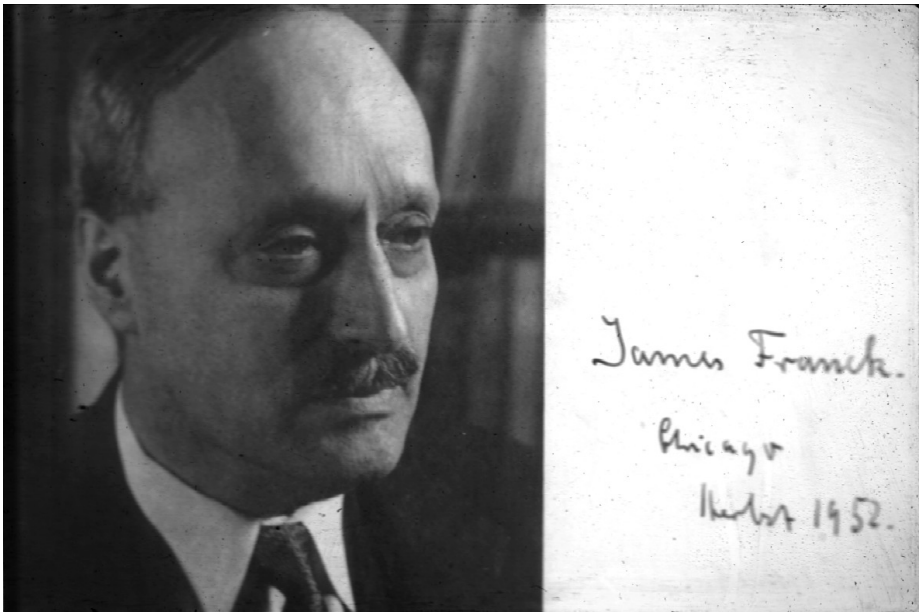


Figure 29. James Franck.

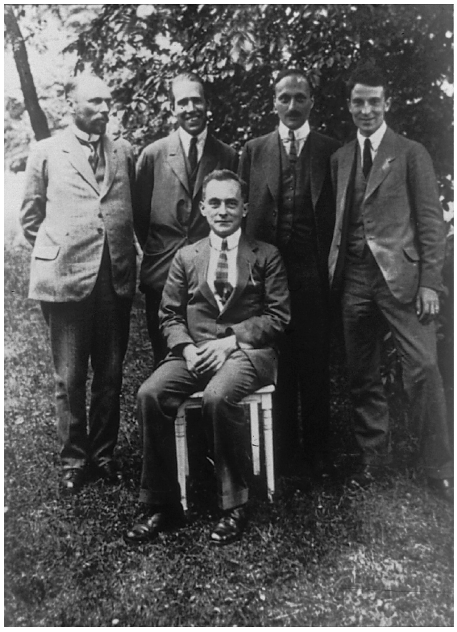


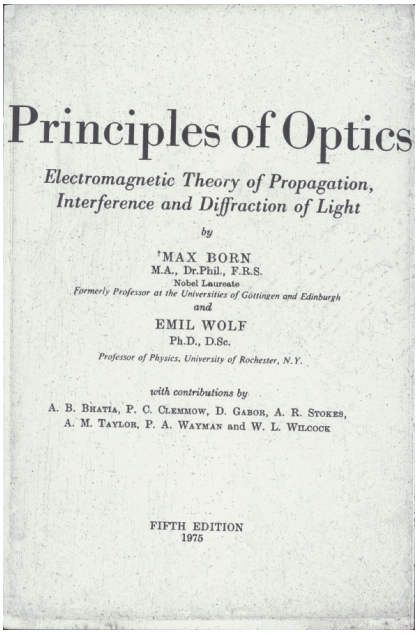
Figure 30. Max Born (sitting) with (from left to right) Carl Oseen, Niels Bohr, James Franck and Oscar Klein at the Göttingen "Bohr Festival" in June 1922.

Our family life began in Planckstrasse (No. 21); there is a commemorative plaque to Max Born on the house (figure 31). We had the downstairs apartment, spacious and bright with an enormous music room. The garden was large, the street quiet except for a shrill operatic soprano in the house opposite who practised with her window open. After several years – it might have been five or six – we moved briefly to Merkelstrasse for a year or two; and then to Wilhelm-Weber-Strasse (No. 42) for the remainder of our Göttingen time. My mother's father Victor Ehrenberg and his housekeeper were already occupying the ground floor when the Born family moved into the middle floor. The house is very much still there, more or less as it was. That brings up a comic anecdote: We left in 1933 and I first returned to Göttingen for a short visit in 1956; in between, the Nazis, the war, and the occupation had swept over the town. I thought I would like to catch a glimpse of our old home. So I rang the bell, which brought a pleasant, middle-aged lady to the door. Having introduced myself and put my request, she said: "Yes, of course you can see your old home. But tell me, how did you manage to scratch the bath so badly?" After a moment, she realised how funny this was and we both laughed for a long time.

Figure 31. House of the Born family in Göttingen, Planckstrasse 21, with commemorative plaque.

What was our family life like in Göttingen? I was born in 1921 soon after we arrived, and was only eleven when we left: so my childhood images are isolated, no doubt with much subsequent over-painting. Max was enormously busy, as Director of his Institute, with lecture courses, writing books and

overarching all with concentrated and continuous thinking about the fundamental problems in physics. His attitude to work is shown by a quotation concerning his magnificent textbook *Optik: Ein Lehrbuch der elektromagnetischen Lichttheorie*, first published by Springer, Berlin, in 1933, later continued in English under the title *Principles of Optics* with Emil Wolf, and still going strong – the seventh 1999 edition runs to 777 pages (figure 32): "I wrote a successful textbook on optics and many years afterwards another. This shows that in order to write a learned volume one need not specialise in the subject but only grasp the essentials and do some hard work." *What* hard work! Altogether he wrote 26 books and some 360 papers. He goes on: "I never liked being a specialist and have always remained a dilettante, even in what were considered my own subjects." All one can say is that he is certainly enlarging the notion of dilettantism. And then: "The philosophical background of science always interested me more than its special results".


Principles of Optics

Electromagnetic Theory of Propagation, Interference and Diffraction of Light

by

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FIFTH EDITION
1975

Figure 32. *Principles of Optics*, title page of the 1975 edition.

But he was wary about professional philosophers. As a student he listened to Edmund Husserl but found his phenomenology nonsense and Martin Heidegger's assertions repulsive nonsense. The classical philosophers he valued were the rationalists Locke and Hume; and amongst contemporaries

his Edinburgh colleague Norman Kemp Smith who lived just along the road and with whom he took frequent walks.

My mother too was very busy: running the home and the family finances, but intellectually too. She spent most mornings in bed writing poems – admired by Einstein who said they were as good as those of the young Goethe – plays, and letters – innumerable letters to friends in the arts and sciences including Einstein and his step-daughter Margot, Schweitzer, Romain Rolland, and of course her family. My sisters and I received long letters, sometimes several times a week when she wanted to chastise or to praise. Because her chastisements could be both dire and unwarranted, some letters from her remained unopened a long time! The care of her children and of the household was substantially delegated to three wonderful women: Fräulein Schütz, a housekeeper on the Prussian model of self-discipline and uprightness; and Elisabeth and Gretchen Heller, young daughters of a pipe-smoking Lutheran pastor and his jolly wife. They were people of a spontaneous goodness which sprang from a simple, unshakeable Christian belief – the only possession I have ever envied. We loved that family: their home at Kirchweg No. 2 was a place of warmth and laughter. I have often wondered how such goodness coped with the evil of the Hitler years. When in the 1960s my sister Irene and I returned to Göttingen our childhood was brought back most strongly by the Heller home: our toys and games were still in the same wardrobe drawer, and even the smells of pipe tobacco and red cabbage were the same as forty years before. When Gretchen died in her nineties not so very long ago, our grief was great.

At our house Max's co-workers went in and out. As his First Assistant (*Erster Assistent*) young Werner Heisenberg was treated like an extra family member. He was there daily for music and meals, as well as for work. Between 1923 and 1926, innumerable sheets of paper covered with their handwritten mathematics were discarded into the bottom right-hand drawer of the desk at which they sat together for hours on end. I used any blank sides of those sheets for my childish writings and for making paper aeroplanes and cut-outs. How could anyone then have known that Born and Heisenberg manuscript jottings may now fetch thousands of dollars at auction! My parents liked entertaining students and colleagues. On their return from America in 1926 I was given a marvellous electric train set. This was laid out on the floor of the living room in anticipation of a welcome home party. Came the evening with drinks and canapés but, horrors, the train did not work. Out came notebook and pencil from the pockets of this assembly of world class physicists to work out what might be wrong – the gathering certainly included Heisenberg and Viktor Weisskopf and Maria Göppert and

may well also have included Robert Oppenheimer, Enrico Fermi, Wolfgang Pauli and others at that level: no luck – the calculations did not help. Whereupon my mother took a hand, disconnected and tested the rails one at a time, found and eliminated a defective one and hey presto it worked, to my great five-year-old joy! (figure 33).

Figure 33. Max Born accompanied by Maria Göppert and Viktor Weisskopf in Göttingen; photograph reproduced by courtesy of AIP Emilio Segrè Visual Archives, a gift from Jost Lemmerich.

During the late 1920s, the Nazis impinged increasingly on town and university. By 1932, when it was Max Born's turn to be Dean of his Faculty, he and his Jewish colleagues James Franck and Richard Courant were having difficulties doing their job. One of the last normal events was Ernest Rutherford's famous guest lecture in 1932 (figure 34). The lecture with my father's introduction was recorded by Robert Pohl.

Figure 34. Ernest Rutherford (Copyright © The Royal Society).

Between that lecture and the election that brought Hitler to power in January 1933, Nazi students became increasingly disruptive. I myself can recall only one anti-semitic experience. In my class at the Oberrealschule, now the Felix-Klein-Gymnasium, some blonde brutes attacked a pleasant boy named Rosenberg. That was one of the two times in my life when rage took over. I was not big but I managed to throw one of them out of the classroom window. I believe he got hurt; but Rosenberg was left alone and I got respect and was not expelled, the Rector, Dr. Lietzmann, being a very understanding man. My class teacher was a Mr. Küchemann, an extraordinarily fine teacher in the Socratic tradition. The Nazis dismissed him from the school but apparently left him alone after that. His son, an aerodynamicist, came to England after the Second World War and helped to design Concorde in Farnborough.

Max Born's professorial period in Göttingen is vividly brought to life in his autobiography. He pays tribute to the many outstanding colleagues that made up the Science Faculty, quite extraordinary for a small university in a provincial town. Soon after his arrival Max Born joined Klein in continuing the editing of the complete works of Carl Friedrich Gauss who founded the

great mathematical tradition in Göttingen. David Hilbert lived across the road from us and is, I am told, still considered the greatest mathematician of the modern era (figure 35).

Figure 35. David Hilbert and his wife Käthe.

I remember him well as a small man with sharp features and a sharp beard (*Spitzbart*) with a strong East Prussian accent and very children-friendly. There are innumerable Hilbert stories. He was, of course, a revered participant in the famous weekly seminars where, it is said, he invariably initiated the discussion with the question: "Well, well gentleman, just what is an atom?" One day when they were talking about astronomy, the younger people asked Hilbert as a joke what he thought of astrology. The great man remained silent for five minutes, as was his custom, while his brain was working; and then he said: "Well, gentlemen if you were to assemble the ten cleverest men in the world and asked them to think of the stupidest thing in the world, they would be unable to come up with anything as stupid as

astrology." Another story tells of the occasion when Hilbert's wife had gone away on a visit and my parents invited him to dinner in our house. During the meal a tremendous rainstorm began, so that my mother invited Hilbert to stay the night in our guest room. He gracefully accepted, was provided with towel and slippers, and everyone went to bed. Half an hour later the doorbell rang: Hilbert had gone home to fetch his pyjamas!

As is well known, the Göttingen period in the 1920s was dominated by the foundation of quantum mechanics, the physical theory that underlies the electronic technologies of the modern world. The account of this momentous discovery in Born's biography begins thus:

> As I wish to make my account of this development as objective as possible, I asked Pascual Jordan who was, apart from Heisenberg, my main collaborator during this period to write down his recollections of the events. I shall record only those things in which Jordan's memories and my own agree. Quantum mechanics was, of course, not a product of our group in Göttingen alone but had many sources.

The leading *dramatis personae* were brought together at the 1927 Solvay Congress in Brussels (figure 36).

The need to be absolutely accurate about this history has become more important than ever through the great success of Michael Frayn's play *Copenhagen*. The enormous audiences in many countries see a play that is imaginatively brilliant but seems to give a wrong impression of the origin of quantum mechanics and so does injustice to Max Born. In an early scene Niels Bohr is made to say about Heisenberg: "… and in just over a year he had invented quantum mechanics." For people not in the know – almost everybody – this passage is bound to convey the impression that quantum mechanics is the one-man achievement of Heisenberg. It should be said more correctly that quantum mechanics came about through the collaboration of Heisenberg and Born, with contributions from Born's other assistant Pascual Jordan. It was Max Born, not Heisenberg, who introduced the matrix calculus and, to quote Nevill Mott:

> Born was there with his brilliant young men, particularly Heisenberg, and what he contributed is well told in this book. Perhaps the probability interpretation of the wave function was the most important of all but given Schrödinger, de Broglie and the experimental results, this must have been very quickly apparent to everyone, and in fact when I worked in Copenhagen in 1928 it was already called "The Copenhagen Interpretation" – I do not think I ever realized that Born was the first to put it forward. This is the

reason for his rather sad remark that the book I wrote with Massey in 1933 on atomic collisions did not give him credit for this, and that this did him harm.

Max Born was extraordinarily unpretentious, which makes his rare expression of sadness for not being properly acknowledged all the stronger.

Figure 36. Solway Conference, Brussels 1927; *sitting, from left to right, first row*: I. Langmuir, M. Planck, Madame M. Curie, H.A. Lorentz, A. Einstein, P. Langevin, Ch.E. Guye, C.T.R. Wilson, O.W. Richardson; *second row*: P. Debye, M. Knudsen, W.L. Bragg, H.A. Kramers, P.A.M. Dirac, A.H. Compton, L.V. de Broglie, M. Born, N. Bohr; *standing, from left to right*: A. Piccard, E. Henriot, P. Ehrenfest, Ed. Herzen, Th. de Donder, E. Schrödinger, E. Verschaffelt, W. Pauli, W. Heisenberg, R.H. Fowler, L. Brillouin**.** Photograph by Benjamin Couprie, Institute International de Physique Solvay, reproduced by courtesy of AIP Emilio Segrè Visual Archives.

Exile

The election which brought Hitler to power was in January 1933. A Nazi Rector took charge of the University. Max Born was put on indefinite leave of absence and deprived of his Institute and teaching. Friends in Switzerland advised us to leave Germany immediately. So did Einstein who was already abroad. On the 10th of May 1933 my parents and I left Göttingen by train for the Italian Dolomites, where a small flat awaited us which had been rented some time before for the summer holidays. My two sisters had for some years been pupils at the famous boarding school Salem on Lake Constance and

joined us when the summer holidays began. Our little village, Selva, was in the most gorgeous Alpine setting – great peaks covered in snow and meadows in wild flowers. Friends came to visit from near and far, including the Plancks, the Weyls, the Schrödingers and the Schnabels (figure 37). Recognised as a leader in the new physics, our father received invitations from countries all over the world. With what has happened since in mind, we can never be thankful enough that he did not accept offers from Paris and Brussels, or even Belgrade about which a knowledgeable colleague warned him that he would find "nothing of what you were promised, but if you were prepared to sit every night in a restaurant drinking wine with the Minister of Education or the Minister of Finance, and if you have a gift for telling funny stories and keep them amused, you might in due course get money, buildings, books and whatever else you want"; which did not sound promising.

Figure 37. Max Planck, Hermann Weyl, Annie Schrödinger, Hedwig and Max Born in the Dolomites, 1933.

Then came the offer of a lectureship in Cambridge mediated by Ernest Rutherford and Patrick Blackett, which he gladly accepted at the end of June, 1933. A little while later he was also visited by Frederick Lindemann (later Lord Cherwell, Winston Churchill's closest adviser during the Second World War) who offered him a position in Oxford which by then he had to decline. My mother went ahead, bought a house on the Hills Road, and transferred

much of our furniture and even some money. In October my father and I, together with our little dog, travelled by night train through France to Calais. My father remembered: "I could not sleep much but pondered on what was in store for us. That night I shall never forget. The future was not so dark as it then appeared to me."

Life in Cambridge was bound to be strange at first: everything in another country is basically the same and yet astonishingly different, from the bread you eat to the way you meet people. So it was in England. The overriding fact was the welcome and warmth with which we refugees were received by the British people. Sir Hans Krebs, speaking in 1965, gave expression to this feeling (quoted in Born, 1984):

> The social climate and the soil of this country, thanks to the spirit of generosity and tolerance that pervades it, made it easy for us to strike roots and to become firmly settled. No sum of money can adequately and appropriately express our gratefulness to the British people. Perhaps the only proper way for us to try and repay the debt is to make a continuous effort to be useful citizens, doing a job to the best of our abilities, taking an active part in the general life of the community, fully identifying ourselves with the communal life of the country, and offering our services whenever the occasion arises. If in the course of trying to serve the community we have also done well for ourselves, this is an outcome of the fairness with which we have been treated.

Every member of the Born family fully subscribes to those sentiments. My father admired Rutherford as not only the greatest of experimental physicists, but also for his wonderful character. They had clearly taken to each other from their first meeting in 1927, when they slipped out of a boring congress lecture and spent the day together driving around Lake Como, eating good meals and talking about physics, politics and people. When first invited to tea by the Rutherfords, the Borns expressed anxiety about the family dog, which had been quarantined. Soon Rutherford arranged to take them in his car to visit the dog in the kennels, even bringing books for himself and his wife to read so that the Borns might not feel hurried.

Max Born was appointed Stokes Lecturer and elected Fellow of Caius College and immersed himself in work with Leopold Infeld and other distinguished collaborators. He also wrote a popular book, *The Restless Universe*, which became a best seller. A doodle devised by my friends and myself at the Perse School gave my father the idea for the moving pictures in that book: as you flick over the pages you see gas molecules colliding,

radiation being emitted from a hot wire, an electron moving around a nucleus, and so on, in serial drawings made by my architect cousin Otto Königsberger who had escaped from Germany to join us. Both my sisters found their husbands in Cambridge, where at that time the University had far more young men than young women. Our garden had a tennis court, which augmented the attractiveness of our house.

My cousin Otto was one of many relatives my parents were able to help because my father had a job and an income, albeit a small one. They came to stay while in transit from Germany to elsewhere in the world. Many colleagues visited, including Heisenberg in 1934. Staying in our guest room he told my father of being authorised to invite him back to Germany. Rather bewildered, my father asked whether this offer included his wife and children, to which Heisenberg said no. My father refused, with great anger.

Schnabel was with us again in Cambridge. After playing the first few notes of his Town Hall recital he got up, looked into the piano and walked out. It turned out that Nazi students had cut the strings. On another Steinway from a nearby College he played magnificently and had an ovation without end.

Edinburgh

In 1935 Sir Chandrasekhara Venkata Raman, then the only Indian Nobel Laureate, invited Max Born to Bangalore where my parents stayed for six months, my father involved in physics and my mother in mysticism. They returned to uncertainty because the Cambridge appointment was coming to an end. Just then, in early 1936, two new prospects appeared: an invitation to Moscow from the physicist Peter Kapitza who had worked with Rutherford; and another to Edinburgh where the Tait Chair of Natural Philosophy was becoming vacant on the previous occupant Sir Charles Darwin, grandson of the great biologist, accepting the Mastership of Christ's College in Cambridge. Again my parents had the prescience to make the right choice – imagine becoming Russian under Stalin and during the war! Perhaps my father, ever the scientist-philosopher, was even attracted by the designation Natural Philosophy by which the Scots simply mean physics. At all events, that autumn my parents settled in Edinburgh, at 84 Grange Loan, a traditional Scottish two-storey house built of strong grey stone in a small garden with trees and flowers. For a long time I wondered how anything at all can grow in such a dour climate until later biological studies taught me about the growth of living things under far worse conditions (see also Frances Ashcroft, 2000).

Schnabel was with us again in 1947 as the pianist of a unique quartet at the first Edinburgh International Festival, the other members being the violinist Joseph Szigeti, the viola player William Primrose and the cellist Pierre Fournier, all of course top international stars (figure 38). They rehearsed in our home and I turned the pages for Schnabel at the concert in the Usher Hall. He was a man of serious aphorisms and absurd wordplay – back from the dentist, he told me he had paid fifty shillings for some shifty fillings. That evening's marvellous music, particularly the Brahms A-Major Quartet, is still playing inside me. The Edinburgh musical scene was dominated by the musicologist Sir Donald Tovey, whose droll concert commentaries were the joy of musical Edinburgh. His department's library was a musician's dream and I have never forgotten the impression made by the complete Bach Gesellschaft edition.

Figure 38. The Schnabel quartet rehearsing at the Edinburgh festival (1947). From left to right: Joseph Szigeti, William Primrose, Artur Schnabel and Pierre Fournier. Photograph: Gerti Deutsch, reproduced by courtesy of Colin Smythe Ltd. Careful efforts have been made to seek permission to reproduce this photograph. If there remain omissions in this respect, the copyright holder is invited to contact the Royal Society.

Our parents were very happy in Edinburgh. They liked the Scots, and the Scots liked them. Edinburgh University was friendly and made Max Born very welcome. It contained, then as now, highly distinguished people in all

faculties; and he became close to the Principal Sir Edward Appleton, and the mathematician Edmund Whittaker. Speaking of mathematicians, there was also Alexander Aitken, one of those rare, amazing people who know the value of π as far as it had been calculated – at that time it was to well over seven hundred places; who can multiply two, five or six figure numbers in their head within a few seconds; who are impelled to take the square roots of every casually seen number; and so on. Aitken was shy and demonstrated this ability only rarely and privately. Sadly but perhaps not surprisingly, his mind gave way in the end and he spent his last years in an institution. Max Born's department was in High School Yard – nothing 'high' about it but down a backstreet behind Thin's University Bookshop. It consisted of a small lecture theatre; a lavatory; and a large, rather sombre room in which my father had his desk and all his research students had theirs. He grafted a flourishing research school onto the undergraduate courses (figure 39).

Figure 39. Edinburgh Conference on Elementary Particles 1949; note (in the second row, on chairs) Klaus Fuchs (forth from the left) Max Born and Charles G. Darwin (ninth and tenth from the left), Rudolf Peierls (fifth from the right).

Most of his research students came from abroad – from America, Australia, India, Egypt, France; and Peng and Huang from China, both later

big noises there; Reinhold Fürth from Prague, and Herbert Green who became prominent in Australia – their joint work is described in my father's autobiography – but only two from Scotland. One of them, Helen Smith who graduated about the time that the atom bombs were dropped on Japanese cities, decided she would have nothing more to do with physics, and became a flourishing lawyer in Aberdeen. Max Born held her in high esteem wishing that all scientists should refuse all work connected with mass destruction: he himself certainly did. He had become aware of the possibility of an atom bomb quite early in the war after meeting Leo Szilard who had drafted Einstein's fateful letter to President Roosevelt. The end of the war brought about by the annihilation of two Japanese cities with atom bombs was a major reason for our parents' return to Germany – more about that later.

Max Born made the round of his students in the morning, asking about progress and giving advice, sometimes with sheets of elaborate calculations he had done the day before. The ease with which he could switch from one subject to another was apparently amazing. Being himself an incredibly fast worker he occasionally became impatient on finding that a student had not managed to complete calculations suggested only the previous day. The rest of the morning was given over to lecturing, departmental business, and his own research which he carried on at home in the afternoons and evenings. His main collaborators there were Herbert Sydney Green, Emil Wolf and Klaus Fuchs, later notoriously convicted as a Soviet spy. My sisters and I came to know Fuchs well as a charming, reticent, helpful man. He made no secret of his political convictions; but that he would become a master spy during the war was in no way foreseeable.

My mother, as may have been gathered already, combined entirely rational behaviour in all practical matters with a proclivity for the non-rational strivings of the mind in religions and mysticism. In Edinburgh she finally came to rest as a Quaker, partly no doubt through her friendship with Mary Hodgkin, a member of an old Quaker family which included the definer of Hodgkin's disease and her son Alan Hodgkin, of the Hodgkin-Huxley equations of nerve conduction who was President of the Royal Society. The Quakers being noted for good works, when the war came it was natural for our mother to help look after Edinburgh's poorest inhabitants in Niddrie Mains; and she did this devotedly for many years.

By 1938 my parents were sure that war was imminent. Having resided in Britain for the required five years, we became British citizens. This prevented our being interned as so-called 'enemy aliens' on the outbreak of war in September 1939, a fate that befell many relations and colleagues who were

sent to Australia or Canada for at least several months. During the war my sisters and their families remained safely in England.

Changes of country, language and culture did not extinguish the family's traditions. Both sons of Max Born's sister Käthe Königsberger became distinguished academics. Otto Königsberger, an architect, had won the coveted Schinkel Prize while still in Germany. Later, in India, as architect to the Maharaja of Mysore, he designed public and private buildings; and after Independence Jawaharlal Nehru appointed him Director of Housing for India, with special remit to house the refugees after Partition. On return to London he became head of the Tropical Architecture School and a professor at University College. His teaching and publications continue to influence development policies worldwide. The younger son, Helmut Königsberger, an authority on comparative parliamentary institutions, particularly in Spain, Italy and The Netherlands, has been Professor of Modern History, most recently at Cornell and King's College London. At 83 his latest book, *Monarchs, States General and Parliaments*, has just been published.

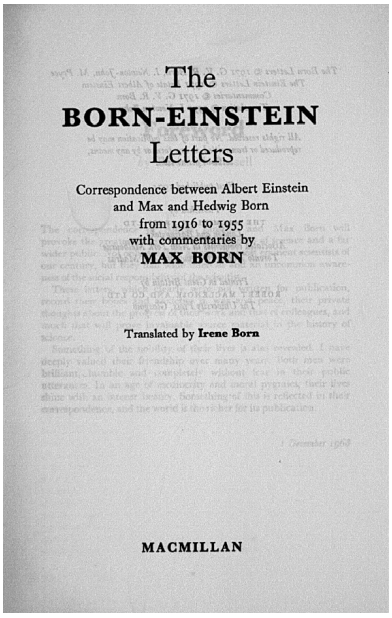


Figure 40. Title page of *The Born-Einstein Letters* (1971), translated by Irene Born.

Academic and artistic work has continued also amongst the children and grandchildren of Max and Hedi Born; but there have also been some surprisingly different occupations. Both daughters married academics. The

older, Irene**,** was an independent spirit from infancy. Our mother claimed her to be unmanageable and she was sent to the famous boarding school Salem, a very unusual thing to do in Germany. The Headmaster was the idiosyncratic Kurt Hahn, whose creed of character-building through sport on the British public school model he was able to express again later at Gordonstoun in Scotland. Not obviously academic although she now claims differently, Irene learnt dressmaking and fashion at which she excelled. Irene's writing style in both English and German is equally elegant. She did an accurate and sensitive translation of the correspondence between Max Born and Albert Einstein from German into English (figure 40).

Figure 41. Brinley, Hugh, Irene, Rona
and Olivia Newton-John.

Irene's husband Brinley Newton-John was a brilliant Welshman who achieved a Double First in Cambridge, in German and in French. Both had beautiful voices, and their *Reich mir die Hand, mein Leben* from *Don Giovanni* has also remained in my ears over seven decades. Brin's German was so good that the Royal Air Force put him amongst the Germans in

Prisoner-of-War camps to gather intelligence: clearly a dangerous job, but fortunately he was never found out. From the Headmastership of a Cambridge school he was elected Master of Ormond College in Melbourne in the late 1950s, which brought the family to Australia (figure 41). Brin later became Professor of German Literature in the Australian Newcastle. Irene still lives in Melbourne. Their younger daughter, Olivia Newton-John, needs no introduction to the younger generations worldwide. She began as a folk singer in Australia; was brought to England by her mother where they stayed with us while making contacts; and the rest is pop-music history with Olivia's spectacular career in Britain and the United States. She recently sang at the opening of the Sydney Olympic Games (figure 42). Olivia's beauty and talent go with bright intelligence and great generosity.

Figure 42. Olivia Newton-John at the opening of the Sydney Olympic Games, September 2000; photograph by Palani Mohan, courtesy of *The Age*.

Our sister Gritli was quieter and more serious (figure 43). I see her now in earnest conversation with her friends walking home from the Girls' High School along the Göttingen Düstere Eichenweg (Street of the Sombre Oaks). In pursuit of inter-sibling fairness she was then also sent to Salem. Gritli went to art school, first in Vienna and after the *Anschluss* to the Central School in London. She was an amazingly intuitive artist in several media – the most beautiful objects in our home are by her (figure 44) – and would have become widely recognised as such if her output had not remained small because of

marriage and motherhood. Gritli married Maurice Pryce, a physicist student of our father's. After secret War Service Maurice took his family to Liverpool, Oxford and then as Wills Professor of Physics to Bristol. Their son Johnny Pryce is a mathematician. The oldest daughter, Sylvia, has made a success of a self-made career in New York, from technician at the Sloane-Kettering Memorial Cancer Institute to her present position as the Director of Safety and Health at Work for the entire colossal City of New York.

Figure 43. Gritli Born.

Figure 44. Ceramic figurine by Gritli Born.

I left school – the Edinburgh Academy, where the illustrious pupils included Clerk Maxwell – in 1938 and knew by then that I was no good at mathematics and physics but certainly interested in biology, like my grandfather Gustav. With his usual foresight my father suggested my studying Medicine because as a doctor I would not have to kill people in the coming war and was moreover less likely to be killed myself, both thoughts that appealed to me. To save family money needed for refugee relatives I lived at home, which had the advantage of frequent walks with my father over the nearby parks of Blackford Hill and Arthur's Seat. I wish I had kept notes of our conversations, but I was tired from the concentrated learning and emotional exposure of the medical curriculum. What I am certain about is his enormous influence on my outlook on the world – his hatred of arrogance, rigidity and mental and physical tyrannies, and the objectivity and generosity with which he approached uncertainties in life as well as in science. I want to illustrate this with recollections which should not be lost.

One of the first books on the atomic bomb was Robert Jungk's *Heller als tausend Sonnen* (*Brighter than a Thousand Suns*). *The Listener*, a one time journal of the BBC, had a review saying: "Of all the brilliant men mentioned in these pages only one, Max Born, refused from the beginning to have anything to do with this 'devilish invention'". I suspect that it was this refusal that my father wanted to convey in a confidential message I brought to Niels Bohr shortly after he had been flown in a Mosquito bomber from Sweden to London, where he stayed under an assumed name in – I seem to remember – Buckingham Gate before joining the atom bomb project in Los Alamos.

My mother wrote in her diary almost daily for most of her life. For 5th July 1948 the entry reads: "Courant [told us] about old Max Planck, who had made a petition for his son when he was to be hanged for being involved in an anti-Hitler plot: Himmler said to Planck: 'We all – Göring, Goebbels and myself have signed a petition – your son is as good as saved. Now you sign this too.' But Planck hesitated to sign and asked for time. When Hitler heard of this he was infuriated beyond measure and shouted with a foaming mouth that the son Planck was to be hanged at once. Which was carried out. This horrible story kept me awake for long. Can there be a more cruel choice than old Planck's." My father assured me on many occasions that he would have signed without hesitation if the life or well-being of his son or indeed of any one precious to him were at stake. And my father would cite his hero Galileo who publicly renounced his scientific conclusions rather than suffer for them, knowing full well that the facts could not fail to come out. Bigots and despots come and go, Max Born would say, but precious lives must not be sacrificed for the inevitable triumph of truth.

In the war I joined the Royal Army Medical Corps for active service in the Far East (This short sentence, as may be imagined, hides more than four long years of intense and varied experiences). Since then, my working life has been in academic research, mainly on haemostasis, thrombosis and atherosclerosis, but also following up some interesting ideas in other directions. One of these brought evidence for an enabling role of electrostatic repulsion in microvascular blood flow. Observing blood cell behaviour in the smallest vessels under the microscope, Howard Florey said: "Once seen, never forgotten." I remained intrigued by the ability of red blood cells to flow through capillaries smaller than the cells in the blood. This puzzling question had been considered theoretically by Sir James Lighthill. Our experiments suggested that this flow is made possible by electrostatic repulsion between the negative charges on endothelial and red cell surfaces.

I can understand why none of my children have taken up science, because the psychological and social preconditions have changed greatly since their

childhood. But intellectual independence persists; and so does the musical inheritance.

Retirement

Max Born wrote his recollections at various times before and after his retirement from the Edinburgh Chair in 1953. Although my parents had been happy in Scotland there was no question of staying on there, mainly because they found the climate too harsh. At first they considered moving to the South of England to be near children and grandchildren. However, as my father had worked in Britain for a comparatively short period his service-linked British pension was far too small to live on, whereas under the German restitution laws he was now receiving his full professorial salary from the University of Göttingen. That money was not transferable to Britain at the time. This financial situation was one reason for their return to Germany. Another reason, to my parents more important, was their wish to contribute what they could to a democratic rehabilitation of Germany. Nevertheless, my parents' return to Germany understandably offended many other refugees, particularly those whose families had suffered more than ours, and who saw this move as too conciliatory.

Figure 45. Max Born's house at Bad Pyrmont.

My parents had a house built in Bad Pyrmont (figure 45), a gracious little spa town embedded in rolling fields and forests not far from Hameln on the Weser river. The reasons for going there were partly sentimental, partly practical: sentimental because they had spent part of their honeymoon there (figure 46); practical because the town was near Göttingen but not so near as to have their envisaged existence of writing, reading, music and walking made impossible by too many visitors. Pyrmont is also the centre for North Germany of the Society of Friends which made it attractive to my Quaker mother.

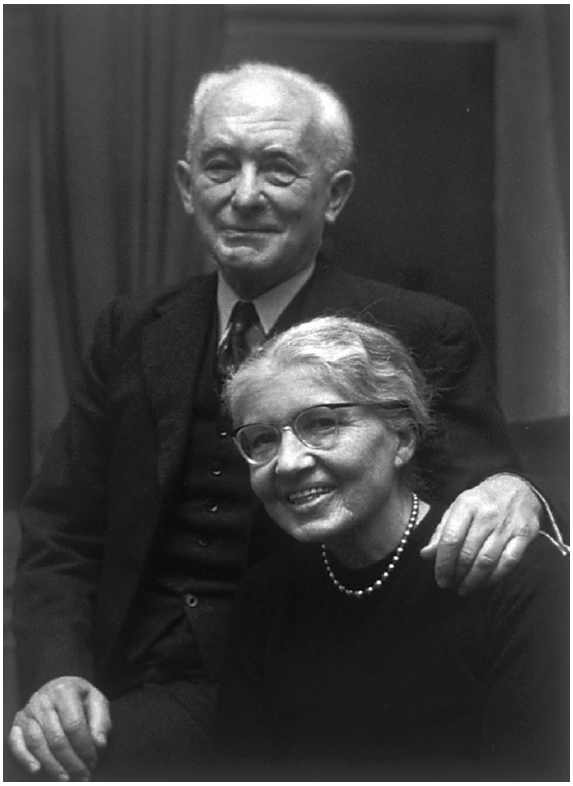


Figure 46. Hedwig and Max Born after moving to Bad Pyrmont.

My father did not give up physics entirely and continued to work on its philosophical implications. He derived great satisfaction from showing that determinism is no more tenable in classical than in quantum physics: even if the assumptions of classical mechanics are accepted, the impossibility of determining an initial state with absolute precision leads with time to limitlessly increasing imprecision.

Towards the end of their first year (1954) in Pyrmont came the award of the Nobel Prize to my father (jointly with Walther Bothe) (figure 47). This was at just the right time to add weight to his main retirement occupation, which was to educate thinking people in Germany and elsewhere on the social, economic and political consequences of science.

Figure 47. Max Born at a gathering of Nobel laureates in Lindau; from left to right: J. Cockcroft, H. Yukawa, P.M.S. Blackett (only his hair is visible), G. Hertz, R. Kuhn, F. Zernike, M. Born, A. Butenandt, O. Hahn, W. Pauli, C.V. Raman, G. de Hevesy, W. Heisenberg and I.I. Rabi (Copyright © Franz Thronbecke).

He was, of course, principally concerned with the implications of nuclear physics for war and peace but also with other, what he called pathological features of our scientific age such as rocketry and space travel. He and like-minded friends, notably Otto Hahn inside Germany and Albert Einstein, Bertrand Russell, James Franck (figure 48) and others elsewhere began to challenge public opinion with the revolutionary implications of scientific discoveries and their technological exploitation. In the *Göttinger Manifest* (1957), eighteen leading atomic physicists including Born and Hahn declared that they would never take part in work that could lead to the possession of atomic weapons by Germany.

Figure 48. James Franck and Max Born in Göttingen
at the Town Hall in May 1964.

Max Born was also an early member of the Pugwash movement, and remained indefatigable in promoting his views through lectures, broadcasts and newspaper articles, and in conversations with people at all levels from his postman to Government Ministers. The clarity and sincerity of his urgings made a profound and lasting impression on many people throughout the world and particularly so on the younger generations in Germany. These writings and speeches have been published in several collections, e.g. *My life and my views* (Born 1968). They remain well worth reading for prophetic insights and for original conclusions so well reasoned that they seem self-evident. It says much for the regeneration of Germany as a liberal democracy that, although his public utterances were often opposed to the policies of the Federal Government, there was never any question about his freedom to say what he liked, despite remaining a British citizen. On the contrary, he received from the Government the highest distinction in its gift, the *Grosse Verdienstkreuz*, which is the German equivalent of the Order of Merit. The

purposefulness and fearlessness of his public utterances were appreciated not only by like-minded politicians but even by opponents such as Franz-Josef Strauss. My father shared an abiding interest in the impact of science, particularly of theoretical physics, on philosophy with Bertrand Russell. Unlike most professional philosophers, Russell was also a trained mathematician. It was to this that my father attributed the logical and critical clarity of Russell's writings. That Russell returned the admiration is clear from his foreword to the published correspondence between Born and Einstein (see quote on page 36). About a week before my father died I read aloud to him a letter just received from Russell. He laughed about something Russell had written and said: "That clever old rascal will outlive me by many years." This particular prophecy was not fulfilled: Russell died only a few weeks later.

Farewell

My father retained to the end his wonderful clarity of mind. His 80th birthday called forth a large celebration in Göttingen with a lecture by Heisenberg and attended by many friends (figure 49).

Figure 49. Max Born's 80th birthday celebration in Göttingen; from left to right: Otto Hahn, Friedrich Hund, Hedwig and Max Born, Werner Heisenberg.

But in his eighties he began to weaken physically. He was a fastidious man and detested the bodily failures which accompanied his last illness. It was probably these that made him say to me repeatedly and dispassionately that he had had enough. My father appeared to have little interest in biology and medicine, even in their scientific aspects, which was strange in view of his curiosity about almost everything else. This made him rather naïve about his own condition and as my mother was similar in this respect, it was no surprise that their bed-side drawers were stocked with a large assortment of drugs, many of them useless or inappropriate. He was not religious and regarded beliefs in individual survival as absurd, apart from the very limited continuity achieved through one's genes and the consequences of one's work. He certainly appeared unafraid during his last days, although somewhat quizzically thoughtful, as if he were trying to come to terms with the biological events that were dominating him and which he did not understand in the same way as he understood so much else.

Figure 50. Max Born with his grandsons Max and Sebastian.

My father's recollections give away little about his inner life. He was not in the least secretive in the ordinary sense, but his deepest feelings were hidden from everyone until he began to open up a little towards the end of his life, mainly to his children. Out of the hundreds of letters I had from him, I treasure one above all in which he calls me his closest friend and rather diffidently begins to say something about emotional relationships. The wealth of feelings inside him found outlet in the varieties of classical music he loved,

from Bach to Brahms; but his emotions remained largely inaccessible through verbal expression. Why that was so I have, of course, asked myself innumerable times without finding a convincing answer. It may be that the loss of his mother when he was still so young made a naturally shy child even more so; but this begs all the important questions. It is interesting that my mother was exactly the opposite in her ability to show her emotions to others, both verbally and in an untold number of letters which were often so frank as to be disturbing to the recipients. The sometimes stormy relationship of my father and his wife settled down in their later years to a symbiotic situation in which they came to depend completely on each other. After his death she deteriorated rapidly and died two years later. Her papers include a collection of poems which he composed annually for her birthday. They express a loving appreciation of their long life together which makes one glad that any difficulties between them had faded from his mind.

He obtained great enjoyment from poetry of all kinds, profound, profane or playful. What moved or amused him he rapidly learnt by heart. He clearly derived comfort from the wonderful Goethe poem which ends:

Und solang du dies nicht hast
Dieses: Stirb and werde!
Bist du nur ein trüber Gast
Auf der dunklen Erde.

(And until you grasp this – 'die and be transformed!' – you are nothing more than a dim guest on the dark Earth.)

because he recalled it so often. During retirement he indulged his poetical whimsy by translating Wilhelm Busch into English. As his first attempt he chose a stanza most appropriate for a physicist:

Hier strotzt die Backe voller Saft.	Here blooms the cheek like rosy flower.
Dort hängt die Hand, gefüllt mit Kraft.	There hangs the hand swelled up with power.
Die Kraft, infolge der Erregung,	The power stirred by irritation
Verwandelt sich in Schwungbewegung.	Develops fast acceleration
Bewegung die in schnellem Blitze	Against the cheek, with heat
Zur Backe eilt, wird dort zu Hitze.	production.
Die Hitze aber durch Entzündung	The heat however through a chain
Der Nerven brennt als Schmerzempfindung	Of nerve reactions burns as pain
Bis in den tiefsten Seelenkern,	Down to the soul's deepest recess:
	There's nothing which you

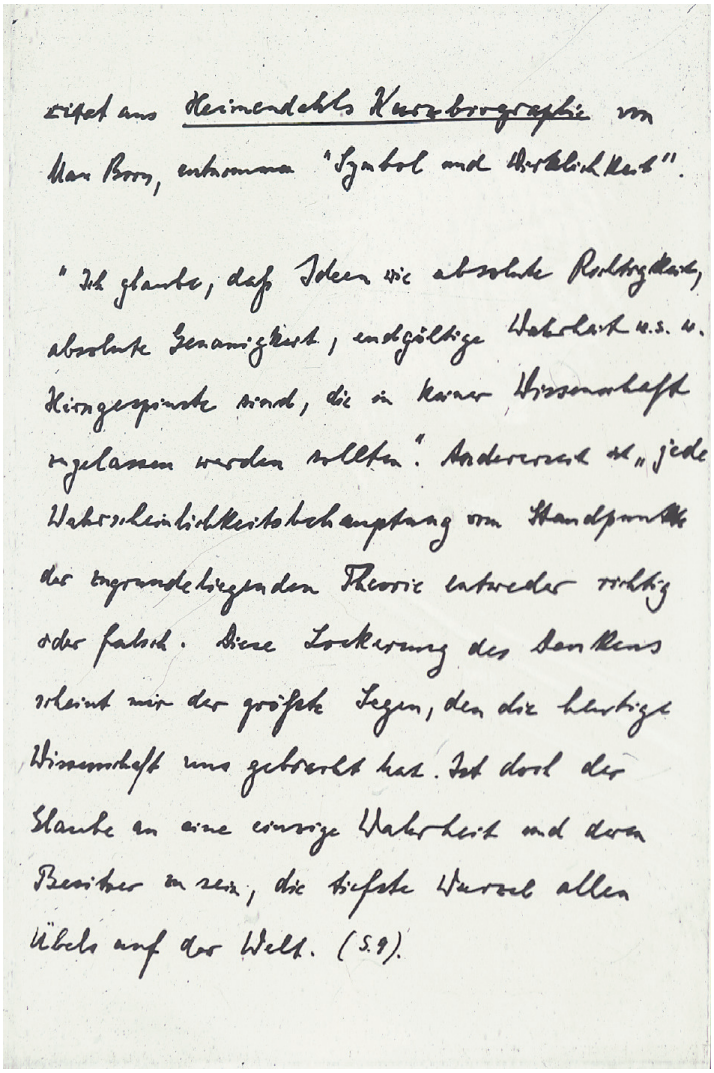
Und dies Gefühl hat keiner gern.	would like less.
Ohrfeige nennt man diese Handlung.	We call this action: box on ear –
Der Forscher nennt es	Power transformed: the engineer.
Kraftverwandlung.	

His later translation *Klecksel the painter* of Busch's *Maler Klecksel* became a successful publication in the United States. He was also very fond of *Alice in Wonderland* which he used as a quarry of quotations for lectures. The playfulness that appeared in his own poems also came out in other ways: in the funny faces he pulled whenever anyone wanted to photograph him, and in a gentle teasing of his grandchildren (figure 50).

Figure 51. Hedwig and Max Born's tombstone in the Göttingen *Stadtfriedhof*, close to the western entrance (Abt. 7) near the Ehrenberg/Jhering familiy graves.

My parent's tombstone in the cemetery in Göttingen bears the strange equation which he clearly considered his main single contribution to science, viz. $pq - qp = h/2\pi\, i$ (figure 51). But that Max Born was aware of far wider

implications of his scientific achievements is shown by a quotation from his lecture at the 1964 gatherings of Nobel Laureates at Lindau on Lake Constance, entitled *Symbol und Wirklichkeit* (*Symbol and reality*), which seems to me so profound and important that it stands, framed in his handwriting (figure 52) on my desk and makes a fitting end:


zitiert aus Heimendahls Kurzbiographie von
Max Born, entnommen "Symbol und Wirklichkeit".

"Ich glaube, daß Ideen wie absolute Richtigkeit,
absolute Genauigkeit, endgültige Wahrheit u.s.w.
Hirngespinste sind, die in keiner Wissenschaft
zugelassen werden sollten." Andererseits ist „jede
Wahrscheinlichkeitsbehauptung vom Standpunkte
der zugrundeliegenden Theorie entweder richtig
oder falsch. Diese Lockerung des Denkens
scheint mir der größte Segen, den die heutige
Wissenschaft uns gebracht hat. Ich denke der
Glaube an eine einzige Wahrheit und deren
Besitzer zu sein, die tiefste Wurzel allen
Übels auf der Welt. (S.9).

Figure 52. Extract from Lindau conference lecture, quoted from Heimendahl (1968), handwritten by Max Born.

Ich glaube, daß Ideen wie absolute Richtigkeit, absolute Genauigkeit, endgültige Wahrheit usw. Hirngespinste sind, die in keiner Wissenschaft zugelassen werden sollten. Andererseits ist jede Wahrscheinlichkeitsbehauptung vom Standpunkte der zugrunde liegenden Theorie entweder richtig oder falsch. Diese Lockerung des Denkens scheint mir der größte Segen, den die heutige Wissenschaft uns gebracht hat. Ist doch der Glaube an eine einzige Wahrheit und deren Besitzer zu sein, die tiefste Wurzel allen Übels auf der Welt.

I believe that ideas such as absolute certitude, absolute exactness, final truth, etc. are figments of the imagination which should not be admissible in any field of science. On the other hand, any assertion of probability is either right or wrong from the standpoint of the theory on which it is based. This loosening of thinking seems to me to be the greatest blessing which modern science has given to us. For the belief in a single truth and in being the possessor thereof is the root cause of all evil in the world.

Acknowledgements

For this lecture invitation I wish to express my gratitude to Professor Nicolaas Rupke, Director of the Institute for the History of Science at Göttingen University; and to Ms Elisabeth Eck and Wolfgang Böker of that Institute for essential help with preparation of the manuscript for publication. The lecture could not have been written and illustrated without the help of several family members. For that help I am deeply grateful to my daughter Carey Heath and my sons Sebastian and Matthew Born. For information and stimulation I wish to thank my sister Irene Newton-John; my cousin Ralph Elliott; Elisabeth Eck in Göttingen; and my father's biographer Nancy Greenspan.

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A Meetings of Gustav Born with Georg-August-Universität Göttingen

In the last few years, Faith and Gustav Born came to visit Göttingen regularly at various occasions. Over the years, the contact grew closer. Gustav Born gave us a video interview in Lyneham about his life as a child in Göttingen, participated in a history workshop with highschool students at the 70 year anniversary of the Stauffenberg plot against Hitler at 20th July 1944, gave the keynote speach at the inauguration of memorial plates for Carl Friedrich von Weizsäcker and Victor Weisskopf and participated in a discussion about the responsibility of scientist at the 2012 spring conference of the German Physical Society in Göttingen. In the following, you can see the resulting pictures and videos.

1.) Göttingen and the World of Physics. An Evening with Gustav Born
https://www.youtube.com/watch?v=HSc2Lz7vwFk

2.) Geschichtswerkstatt zum 20. Juli 1944 - Gustav Born
https://www.youtube.com/watch?v=UzsKGeNMgIc

3.) Gustav Born über Victor Weisskopf
https://www.youtube.com/watch?v=SpOuPWJx-oo

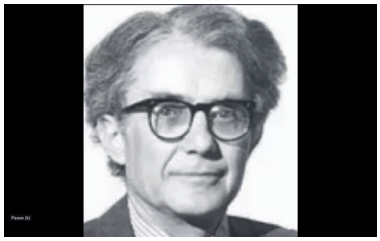
4.) Geschichten und Glückwünsche
https://www.youtube.com/watch?v=uOGKtB7bo9g

5.) Mit Bohr, Born und Heisenberg in Göttingen
https://youtu.be/8psQVSS61ZA

6.) Professor Gus Born: Life and Work
https://www.youtube.com/watch?v=1At6lyPeFfw

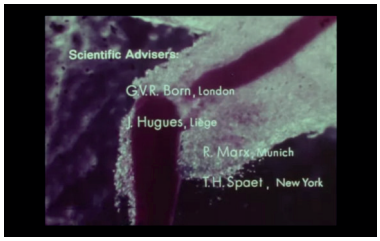
7.) From the archive: Interview with Professor Gus Born (shortened)
https://www.youtube.com/watch?v=kxLdkoxL_DU

8.) German born British pharmacologist Gustav Victor Rudolf Born Died at 96
https://www.youtube.com/watch?v=-AATtNIZO4Y



9.) From the Gustav Born archive: Prostacyclin and the prevention of heart attacks
https://www.youtube.com/watch?v=KD-r5rvxclg

10.) From the Gustav Born archive: Platelets (1972)
https://www.youtube.com/watch?v=5HOLGLL7lJ4



11.) Max Born's grave at Göttingen, Germany
https://www.youtube.com/watch?v=mIDwEoz5l64

At the annual spring conference of the German Physical Society (DPG) 2012 in Göttingen. Top: Gustav Born during podium discussion with Ulrich Schnabel, science journalist of ZEIT magazine. Bottom from left to right: Prof. Dr. Gustav Born, Prof. Dr. Michael Turner (University of Chicago and president elect of the American Physical Society), Prof. Dr. Ulrike Beisiegel (president of Georg-August-Universität Göttingen), Prof. Dr. Henrik Bohr (Technical University of Denmark), Prof. Dr. Jochen Heisenberg (University of New Hampshire), Ulrich Schnabel. Photos by Jan Vetter.

At the annual spring conference of the German Physical Society 2012 in Göttingen. Top and bottom from left to right: Prof. Dr. Jochen Heisenberg, Prof. Dr. Michael Turner, Prof. Dr. Gustav Born, Prof. Dr. Wolfgang Sandner (president of German Physical Society - DPG). Photos by Jan Vetter.

Top: Gustav Born at the annual spring conference of the German Physical Society 2012 in Göttingen. Bottom from left to right: Prof. Dr. Henrik Bohr, Prof. Dr. Arnulf Quadt, Prof. Dr. Jochen Heisenberg, Prof. Dr. Michael Turner, Prof. Dr. Gustav Born, Prof. Dr. Wolfgang Sandner. Photos by Jan Vetter.

Gustav Born at the annual spring conference of the German Physical Society 2012 in Göttingen. Photos by Jan Vetter.

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Invitation to the memorial service and concert in honour of Gustav Born at St Peters' College Chapel, Oxford, on Saturday 17th November 2018.

Gustav Victor Rudolf Born was born in Göttingen in 1921 as one of the three children of Hedwig Born and the already famous physicist Max Born who became Nobel laureate in Physics in 1954. On the grounds of the Born's Jewish origins and the open pacifism of Max Born, the National Socialists forced the Born family to leave Germany in 1933, soon after the National Socialist Party seized power. The family immigrated to Great Britain, first to Cambridge, later to Edinburgh. The Born children spent the rest of their childhood and youth in Britain, and Gustav Born obtained his medical degree from Edinburgh University, his doctoral degree from the University of Oxford. During his long and distinguished academic career, Born has held chairs of pharmacology at the Royal College of Surgeons, at Cambridge University, and at King's College in London. At the end of his outstanding career and his invaluable contributions to knowledge of the pathophysiology of the circulation, haemosthasis, thrombosis and atherogenesis, he was Research Professor at the William Harvey Research Institute.

In this book he reflects on the life journey the Born family was forced to take. The text stems from the conference "Göttingen and the development of the Natural Sciences", organized by the Georgia Augusta's Institut für Wissenschaftsgeschichte in November 2000. Gustav Born agreed to attend and follow the invitation to present a keynote address on "The Born family in and out of Göttingen", which was held in the University's sanctum sanctorum, the so-called Alte Aula. His address was the highlight of the conference, attended by many from Göttingen's academic community and concluded with a long standing ovation.

In a personal conversation with Arnulf Quadt (professor for particle physics at Göttingen University), briefly before his sad passing in April 2018, Gustav Born encouraged to make the book on the story of his family available again. The University of Göttingen is deeply honoured to follow Gustav Born's suggestion and present a commented reprint of the original keynote in 2002.

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