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THE COLLECTED PAPERS OF ALBERT EINSTEIN

Volume 1

The Early Years: 1879 - 1902

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ALBERT EINSTEIN --
A BIOGRAPHICAL SKETCH
by
MAJA WINTELER-EINSTEIN
(**EXCERPT**)

THE FAMILY

Albert Einstein was born of German Israelite parents, and was thus originally a German citizen, as were all of his known ancestors.

The Einstein family is fairly widespread in southern Germany, especially in Württemberg and Bavaria, and since, as is well known, Israelites often marry more **or** less distant relatives, the Einsteins are related to most other Israelite families in southern Germany. Nothing more specific is known about Albert Einstein's more distant ancestors. Abraham Einstein, Albert's paternal grandfather, died in the prime of his life, and his grandson never knew him. He lived in Buchau on the Federsee, and is said to have enjoyed a great and widespread reputation as an intelligent and upright man. His wife Hindel, Albert's paternal grandmother, died during her grandson's early childhood. Her intellectual powers, it seems, were not particularly outstanding. His grandfather on his mother's side was Julius Derzbacher, who took the family name Koch. He was from Jebenhausen, where he practiced his trade as a baker, at first in modest circumstances. Later he lived together with his brother in Cannstatt, and together they managed to build a considerable fortune in the grain trade. The brothers and their families shared a single household under the same roof. Their wives shared the cooking, each taking charge of and responsibility for it in weekly turns. If such an arrangement is rather rare, and not only in Germany, theirs was all the more remarkable because it lasted for decades without the least friction. As his commercial abilities showed, Julius Koch possessed a distinctly practical intelligence and great energy. Theorizing was completely foreign to him. With wealth came a desire to be a patron **of** the arts, which he undertook, however, in a petty manner, and in accord with the principles of his trade, that is, spending as little as possible on it. As a result, he often ended up bying copies rather than authentic paintings. He once took in a poor artist he happened to meet on one **of** his walks for the purpose of laying the foundation of a future ancestral portrait gallery. This was the origin of a childhood portrait of Albert Einstein, still in the possession of the author. It is doubtful that the poor painter ever earned more than a free room and board under this arrangement. On the other hand, it was quite all right with grandfather Koch if technical skill, in this case a "likeness," took the place **of** genuine art. His wife, Albert's maternal grandmother, was Jette Bernheim. She had a quiet and solicitous nature, and was also clearheaded and methodical, as is apparent from surviving school essays. She handled the difficulties sometimes produced by grandfather Koch's choleric disposition with disarming humor. She was truly the soul of that odd household of the two brothers and their families.

Albert Einstein's father, Hermann, was born in **1847** in Buchau.

He entered the *Realschule* in Stuttgart at the age of fourteen and left with the so-called One-Year-Volunteer Certificate, the possession of which released the young German intelligentzia from the compulsory three years of military ervice. In reality, this arrangement gave preferential treatment to the "better classes" which could afford better schooling for their sons, and so keep them from rubbing shoulders with the sons of the common people. - Hermann Einstein, it seems, showed a marked inclination for mathematics, and would have liked to pursue studies in this or some related field. His father's means, however, with a large family to maintain and two daughters to provide for, were too limited to allow Hermann to pursue his inclination. As a result, he decided to become a merchant. Perhaps this very potential, left fallow in the father, developed all the more strongly in his son Albert. Hermann Einstein served an apprenticeship in Stuttgart and then became a partner in a cousin's business in Ulm.

The financial means brought to the marriage by his wife, and the progress of the business, might have allowed his young family not just a carefree but a very prosperous life. The future seemed secure, and there was such complete harmony of character between Hermann and his wife that the marriage would not only remain untroubled throughout their lives, but would also prove to be, at each turn of fate, the one thing that was firm and reliable. Had Hermann remained in Ulm, his son Albert would also have been granted a more carefree youth. But the family's external circumstances were to change in the course of time.

A younger brother of Hermann Einstein, named Jakob, who later exerted a certain intellectual influence on Albert while he was growing up, finished his studies in engineering and wanted to start a plumbing and electrical business in Munich. Since his own means were insufficient, he prevailed upon his brother Hermann to join in the venture, both personally as business manager and with a large investment. And so the family moved to Munich at the beginning of 1882, when Albert was barely two years old. Begun modestly, at a time when all the world was beginning to install electric lighting, the enterprise had good prospects. But Jakob Einstein's plans were more ambitious. His fertile and manifold ideas led him, among other things, to construct a dynamo of his own invention, which he wanted to produce on a large scale. That required a larger plant, and substantial funds to start operating it. The entire family, and especially Hermann's father-in-law Julius Koch, participated financially and made the new enterprise possible. It is hard to say just why it never really flourished. Whether because the highly imaginative Jakob Einstein dissipated his energies, or because, as an impetuous optimist he never understood how to deal with realities - in short, business affairs grew progressively worse. The fault may also have lain with Hermann Einstein, Albert's father, who, owing to his more contemplative nature, may have lacked the qualities required of a businessman on a grand scale. Hermann Einstein had a particularly pronounced way of trying to get to the bottom of something, by examining it from every side, before he could reach a decision. And since everything could always be looked at from a new point of view, that particularly enterpreneurial trait of being decisive at the right moment about the right matters was impaired. In addition, he was endowed with an unfailing goodness of heart, a well-meaning nature that could refuse nothing to anyone. So even though Jakob Einstein, constantly seeking novelty and change and unable to learn from any failure, was an over-eager and even stubborn optimist, his brother

Hermann gave in to him out of sheer good nature before he was himself able to reach decisions in his business deliberations.

This was demonstrated during a further change in the sphere of activity of these two very different brothers.

Business sales were insignificant in Germany, while showing great promise in Italy. The Italian representative of the firm then proposed moving the plant to Italy. Jakob Einstein was at once so taken with the idea that he was able to persuade Hermann Einstein to make the change, literally sweeping him along. The firm in Munich was liquidated. The lovely estate with the villa in which Albert Einstein had spent a happy childhood was sold to a building contractor, who immediately turned the handsome grounds into a construction site, cutting down the magnificent old trees and erecting an entire row of ugly apartment houses. Until the time of their move the children had to watch from the house as these witnesses to their most cherished memories were destroyed.

The plant was then transferred to Pavia; the family moved to Milan in 1894 and a year later to Pavia. The success of the enterprise was so meager, however, that by 1896 it had to be liquidated. Not only were the assets of Albert Einstein's mother lost at this time, but significant contributions from relatives as well. The family had hardly anything left. Their excessive confidence in the firm's Italian representative, who had been brought in as a partner, apparently contributed to this unfortunate turn of events.

At this point the two brothers, so dissimilar in nature, went their separate ways. Without prejudice, Jakob took a step which Hermann could not decide upon: he accepted a position as an engineer with a large company, and soon won trust and respect. In contrast, Albert Einstein's father could not bring himself to take the same step and relinquish his professional independence. In particular, he did not want to bring suffering on his wife, who would have had great difficulty accommodating herself to any lower standing in the social scale. Against the perceptive advice of his still quite young son, he founded a third electrical factory, in Milan. His cousin and brother-in-law from Hechingen, mentioned earlier, was persuaded to finance the enterprise, even though he had lost money in the earlier ventures. A capable former master mechanic, who had accompanied the two bothers from Munich, was made technical manager of this small factory. But at this time, there already existed larger, more financially powerful enterprises of this type in Italy, against which a small factory in rented space could not compete, particularly since constant financial problems limited the range of its activities. The firm being doomed to failure from the start, another crisis occurred within a few years, liquidation was necessary, and most of the invested capital was lost.

With money provided by relatives, Hermann Einstein then turned to installing power stations, supplying whole villages with lighting. This time, success seemed to be his. But the many worries, the constant feeling of personal dependence on someone else's money (how much more difficult this is to bear than the merely occupational dependence on one's employer!), all of these burdens had undermined his health, which until then had been robust. He quickly succumbed to a serious heart ailment and died in October 1902. His sad fate did not permit him even to suspect that two years later his son would lay the foundation of his future greatness and fame by solving an urgent problem in physics.

But Albert Einstein's mother was still able to enjoy her son's importance. A tall woman, in radiant health, her gray eyes gazed out at the world, often with a waggish twinkle. She possessed a sound native wit. Her feelings were seldom given free rein and, although accustomed to an opulent household, she adjusted - with difficulty, but with understanding - to her altered circumstances. Married at **17,** she learned early about the realities of life and always maintained a certain practical sense, though basically she had a warm and caring nature. She was very fond **of** music and played the piano splendidly. Perseverance and patience were characteristic **of** her, as evidenced, for example, in her complicated and time-consuming needlework.

YOUTH

Albert Einstein was born in Ulm on **14** March ***1819.*** At his birth his mother was shocked at the sight of the back of his head, which was extremely large and angular, and she feared she had given birth to a deformed child. But the doctor reassured her, and after **a** few weeks the shape of the skull was normal. The child, very heavy from the outset, was always quiet and required little care. He would play by himself for hours. His grandma, on first seeing him some time later, threw up her hands in surprise, and repeated over and over again: "Much too fat! Much too fat!". Otherwise, he developed slowly in childhood, and he had such difficulty with language that those around him feared he would never learn to speak. But this fear also proved unfounded. When the 2.5-year-old was told of the arrival of a little sister with whom he could play, he imagined a kind ***of*** toy, for at the sight of this new creature he asked, with great disappointment, "Yes, but where are its wheels?" The children of family and relatives often got together in his parents' garden in Munich. Albert refrained from joining their boisterous games, however, and occupied himself with quieter things. When he occasionally did take part, he was regarded as the obvious arbiter in all disputes. Since children usually retain a very keen and unspoiled instinct for the exercise of justice, the general recognition of his authority indicates that his ability to think objectively had developed early.

His early thoroughness in thinking was also reflected in a characteristic, if strange, habit. Every sentence he uttered, no matter how routine, he repeated to himself softly, moving his lips. 'Thisodd habit persisted until his seventh year.

At the age of five he received his first instruction at home from a woman teacher. Music lessons on the violin began at the same time. The usually calm small boy had inherited from grandfather Koch a tendency toward violent temper tantrums. At such moments his face would turn completely yellow, the tip of his nose snow-white, and he was no longer in control of himself. On one such occasion he grabbed a chair and struck at his teacher, who was ***so*** frightened that she ran away terrified and was never seen again. Another time he threw a large bowling ball at his little sister's head; a third time he used a child's hoe to knock a hole in her head. This should suffice to show that it takes a sound skull to be the sister of an intellectual. This violent temper disappeared during his early school years.

As is well known, in Germany one uses the polite form "Sie" for adults and for people who are not members of one's family, while "Du"

is used only within the family, among children, and between close friends. There was thus something impertinent, but also something naive and humorous in little Albert's way of addresing his music teacher with "Du, Herr Schmied...."

Music was played often and well at home. Even though the fundamentals of the art were often difficult for the children and threatened to spoil it for the boy, because of his natural ability he soon developed a liking for music, which even led to artistic accomplishment. His musical ability seems to have come from the Koch branch of the family, the mathematical and logical from the Einstein side. Incidentally, it is not that uncommon, far apart as these two fields seem to lie, for mathematical and musical talent to be joined in one person.

The boy was trained early in self-reliance, in contrast to the customary European child-rearing method which consists of over-anxious tutelage. The **3- or** 4-year-old was sent through the busiest streets **of** Munich; the first time he was shown the way, the second, unobtrusively observed. At intersections he conscientiously looked right, then left, and then crossed the road without any apprehension. Self-reliance was already ingrained in his character and manifested itself prominently on various occasions in his later life.

The boy entered the public primary school *(Volksschule)* at the age **of** seven. There he had a rather strict teacher whose methods included teaching children arithmetic, and especially the multiplication tables, with the help of whacks on the hands, so-caled "Tatzen" (knuckle raps); a style of teaching that was not unusual at the time, and that prepared the children early for their future role as citizens. His thinking process unerratic and thorough, the boy was considered only moderately talented precisely because he needed time to mull things over and didn't respond immediately with the reflex answer desired by the teacher. Nothing of his special aptitude for mathematics was noticeable at the time; he wasn't even good at arithmetic in the sense of being quick and accurate, though he was reliable and persevering. Also, he always confidently found the way to solve difficult word problems, even though he easily made errors in calculation.

At home, the rule that schoolwork must be finished before play could begin was strictly observed, and his parents accepted no excuses for breaking this commandment. Very typical of young Albert's abilities were the games he chose to play. He filled his leisure time by working on puzzles, doing fretsaw work, and erecting complicated structures with the well-known "Anker" building set, but his favorite was building many-storied houses of cards. Anyone who knows how much patience and precision is required to build card houses three or four stories high will be amazed that a boy not yet ten years old was able to build them as high as fourteen stories. Persistence and tenacity were obviously already part of his character and would become more and more prominent later on. The same trait that helped **to** keep his mother from tiring of the most tedious and complicated needlework manifested itself in her son first in his play and later in his scientific work. Many have brilliant insights in the course **of** life, original thoughts which nonetheless lead nowhere. Only persistence that does not rest until all that is unclear is eliminated and all difficulties are overcome allows an idea to take shape and be recognized as truly one of genius.

When Albert entered public school, his religious instruction,

then compulsory in Bavaria, also had to begin. A liberal spirit, undogmatic in matters of religion, brought by both parents from their respective homes, prevailed within the family. There was no discussion of religious matters or rules. But since Albert was legally obliged to receive religious instruction, he was taught at home by a distant relative; as a result, a deep religious feeling was awakened in him. He heard about divine will and works pleasing to God, about a way of life pleasing to God - without these teachings having been integrated into a specific dogma. Nevertheless, he was so fervent in his religious feelings that, on his own, he observed religious prescriptions in every detail. For example, he ate no pork. This he did for reasons of conscience, not because his family has set such an example. He remained true to his self-chosen way of life for years. Later religious feeling gave way to philosophical thought, but absolutely strict loyalty to conscience remained a guiding principle. His later advocacy of Zionism and his activities on its behalf came from this impulse: less in accordance with and on the basis of Jewish teachings than from an inner sense of obligation toward those of his race for whom an independent working place for scholarly activity in the sciences should be created, where they would not be discriminated against as Jews.

Young Albert entered *Gymnasium* at the age of 8.5. In accord with the school's humanistic orientation, primary emphasis was placed on classical languages, Latin and later Greek, while mathematics and the natural sciences received less emphasis. The clear, rigorous logical structure of Latin suited his talents, but Greek and modern foreign languages were never his forte. His Greek professor, to whom he once submitted an especially poor paper, went so far in his anger to declare that nothing would ever become of him. And in fact Albert Einstein never did attain a professorship of Greek grammar.

In Gymnasium, the boy was supposed to begin the study of algebra and geometry at the age of 13. But by that time he already had a predilection for solving complicated problems in applied arithmetic, although the computational errors he made kept him from appearing particularly talented in the eyes of his teachers. Now he wanted to see what he could learn about these subjects in advance, during his vacation, and asked his parents to obtain the textbooks for him. Play and playmates were forgotten. He set to work on the theorems, not by taking their proofs from books, but rather by attempting to prove them for himself. For days on end he sat alone, immersed in the search for solution, not giving up before he found it. He often found proofs by ways that were different from those found in the books. Thus, during this one vacation of a few months, he independently worked his way through the entire prospective Gymnasium syllabus. Uncle Jakob, who as an engineer had a comprehensive mathematical education, reinforced Albert's zeal by posing difficult problems, not without good-natured expressions of doubt about his ability to solve them. Albert invariably found a correct proof; he even found an entirely original one for the Pythagorean theorem. When he got such results, the boy was overcome with great happiness, and was already then aware of the direction in which his talents were leading him.

At the same time the philosophical spirit began to stir in him. A poor Jewish medical student of Polish nationality, for whom the Jewish community had obtained free meals with the Einstein family, provided the impetus and thus repaid richly with intellectual stimulation what he received in material benefit. It was he who

initiated the youth into the world of philosophical thought. He discussed with him all of the questions raised by the youth thirsting for knowledge and recommended the reading of books on natural philosophy (*Kraft* und Stoff [Force and *Matter*] by Büchner, *Kosmos* by Humboldt, the *Naturwissenschaftliche* Volksbücher [Popular *Books on Natural* Sciences] by Bernstein, among others). Moreover, despite the difference in their ages, he treated the boy as an equal and friend. Whereas Uncle Jakob's style of teasing skepticism about his abilities always spurred him on anew, and the teachers at the Gymnasium pedantically looked more for ready answers than for the ability to probe and reflect, the more insightful medical student offered young Albert far more. For he invested his whole person in examining everything that engaged the boy's interest. This occurred at that very crucial age when the child matures into a thinking person. His scientific interests were broadened as a result; he was no longer engrossed solely in mathematics, but had already begun to concern himself with the fundamental problems of the natural sciences in general. Music served as hi5 only distraction. He could already play Mozart and Beethoven sonatas on the violin, accompanied by his mother on the piano. He would also sit down at the piano and, mainly in arpeggios full of tender feeling, constantly search for new harmonies and transitions of his own invention. And yet it is really incorrect to say that these musical reveries served as a distraction. Rather, they put him in a peaceful state of mind, which facilitated his reflection. For later on, when great problems preoccupied him, he often suddenly stood up and declared: "There, now I've got it." A solution had suddenly appeared to him.

When the family moved to Italy in 1894, the decision was made to leave Albert in Munich to finish gymnasium. This was done to ensure an uninterrupted course of studies, as well as because of the Italian language, which was foreign to the boy. He boarded with a family in Munich, while relatives and acquaintances made sure that he did not lack family contacts. In this period he sent only laconically phrased letters to Milan from which little could be ascertained about his life, yet this did not attract particular notice.

Actually, he was very uncomfortable in school. The style of teaching in most subjects was repugnant to him; moreover, his home room teacher did not seem very well disposed toward him. The military tone of the school, the systematic training in the worship of authority that was supposed to accustom pupils at an early age to military discipline, was also particularly unpleasant for the boy. He contemplated with dread that not-too-distant moment when he will have to don a soldier's uniform in order to fulfil his military obligations. Depressed and nervous, he searched for a way out. Hence, when the professor in charge of his class (the same one who had predicted that nothing good will ever come of him) scolded him on some occasion, he obtained a certificate from the family doctor, presented it to the school principal and abruptly left to join his parents in Milan. They were alarmed by his high-handed behavior, but he most adamantly declared that he would not return to Munich, and reassured them about his future by promising them most definitely that he would independently prepare himself for the entrance examination to the Zurich Polytechnical School (ETH) in autumn. This was a bold decision for a 16-year-old, and he actually carried it out. His parents resigned themselves to the new situation with grave misgivings, but were persuaded to do all they could to further the plan.

According to the German citizenship laws, a male citizen must not emigrate after his completed sixteenth year: otherwise, if he fails *to* report for military service, he is declared a deserter. For this reason the steps necessary for emigration were taken as quickly as possible, and young Albert was to be stateless until he was later naturalized in Switzerland. He diligently resumed his mathematical and scientific studies, and worked already then through nearly all of Violle's large textbook: in addition, he gained some practical experience in the family factory. His work habits were rather odd: even in a large, quite noisy group, he could withdraw to the sofa, take pen and paper in hand, set the inkstand precariously on the armrest, and lose himself *so* completely in a problem that the conversation of many voices stimulated rather than disturbed him. An indication of remarkable power **of** concentration.

A freer life and independent work made of the quiet, dreamy boy **a** happy, outgoing, universally liked young man. He also began *to* familiarize himself with classical German literature.

Though at first he was acquainted only with Milan and Pavia, Italy made a great impression on him even with this limitation. The way of life, the landscape, the art - everything attracted him, and later, from afar, became an object of longing. The hot summer of 1895 was spent in Ariolo on the Gotthard, where young Albert gained a fatherly friend in the Italian minister Luzzatti, who happened to be staying there.

He did *so* well at his autodidactic preparations that at the beginning of October 1895, at the age of only 16½, he passed the entrance examination to the Federal Polytechnical School in Zurich with the best outcome in mathematical and scientific subjects but inadequate results in linguistic and historical ones. Because **of** these gaps in his education and because of his youth, his parents were advised to have their son attend the final year of a Swiss secondary school, but with the prospect of certain admission the following year, despite the fact that he would still be fully six months below the presribed age (18 years).

So it was that Albert came to the Cantonal School (*Kantonsschule*) in Aarau, a small Swiss town whose schools had a deservedly high reputation and as a result were often attended by foreigners, even by some from overseas. He found welcome and understanding, and thus right away felt very much at home in the family of a teacher at the school, a scholar of literary and historical subjects. If the Munich Gymnasium had left him with a bias against secondary schools, this was thoroughly dispelled by the ways of the Aarau school. **No** traces of either a commanding tone **or** the cultivation **of** authority worship were to be found. Pupils were treated individually, more emphasis was placed on independent, sound thought than on punditry, and young people saw in the teacher not a figure of authority, but, alongside the scholar, a man of distinct personality. His time in Aarau was thus very instructive for him in many ways and one of the best periods of his life. His general education was enriched and, with the graduation certificate (Maturitätszeugniss)in his pocket, he was able to enter the Zurich Polytechnical School in the autumn of 1896.

that can be approximated as closely as desired by the lateral surfaces by increasing the number of planes from which they are formed, the same holds for the surface of the cylinder.

[Note in margin:] * The proof is pointless because as well as we can assume that the prismatic space can be unrolled, the same could be said about the cylinder!

4. TWO PHILOSOPHICAL COMMENTS

[1891–1895]

> *Leibnitz* applied this ad-infinitum continuing division of a finite quantity also to matter, in order to arrive in this way at its true components, and *Herbart* rightly says about this: "Even before one has done the first cut through the clump under consideration, there is apparent the infinite possibility that this same cut could be carried out in an infinite number of *different* ways. Herewith, actually, the whole infinite division is accomplished all at once; and one has arrived at the ultimate elements, to wit in thought, which has been the only thing that mattered. These ultimate elements cannot be matter" (because in that case one would have to repeat anew these countless divisions a *countless* number of times, which is nonsensical). "From this one ought to conclude at once, as Leibnitz has already done: It is not true that matter ultimately consists of other matter; its true components are simple (simple essences, substances, monads). And this is in conformity with truth." (Herbart's Metaphysik).

It is wrong to infer from the imperfection of our thinking that objects are imperfect.

[....]

> Whether one, along with *Leibnitz, Poisson, Herbart,* et al., seriously wants to take the infinitesimally small for a truly indivisible element, or one wants, along with others, to take it only for a useful fiction, so as thereby supposedly to eliminate all metaphysical difficulties, and conveniently and quickly introduce the calculus, is irrelevant for the calculus, for the one as much as the other leads to the goal.

[Note in left margin:] Sense? [Note in right margin:] ?!?

5. ON THE INVESTIGATION OF THE STATE OF THE ETHER IN A MAGNETIC FIELD

[Summer? 1895]

On the Investigation of the State of the Ether in a Magnetic Field.

The following note is the first modest expression of a few simple thoughts on this difficult topic. It is with reluctance that I am

compressing them into an essay that resembles more a program than a treatise. As I was completely lacking in materials that would have enabled me to delve into the subject more deeply than by merely meditating about it, I beg you not to interpret this circumstance as a mark of superficiality. May the indulgence *of* the sympathetic reader match the humble feelings with which I present these lines.

At its inception, an electric current sets the surrounding ether in a kind of momentary motion whose nature it has not yet been possible to determine with certainty. Despite the continuance of the cause of this motion, i.e., the electric current, the ether remains in a potential state and forms a magnetic field. That the magnetic field is a potential state is proved by the permanent magnet, for the law of conservation of energy precludes here the possibility of a state of motion. The motion of the ether produced by an electric current lasts until the acting motor forces have been compensated by equivalent passive forces originating from the deformation produced by the motion of the ether.

The marvelous experiments of Hertz most ingeniously elucidated the dynamic nature of these phenomena, the propagation in space, as well as the qualitative identity of these motions with light and heat. I believe that it would be of great importance for the understanding of the electromagnetic phenomena also to undertake a comprehensive experimental investigation of the potential states of the ether in magnetic fields of all kinds, or, in other words, to measure the elastic deformations and the acting deforming forces.

Any elastic change of the ether at any (free) point in some direction has to be ascertainable from the change undergone by the velocity of an ether wave at this point and in this direction. The wave velocity is proportional to the square root of the elastic forces serving the propagation and inversely proportional to the ether masses to be moved by these forces. Since the density changes produced by elastic deformations are usually insignificant, they probably might be neglected in this case too. One might therefore state with very good approximation that the square root of the ratio of the change in propagation velocity (wave length) is equal to the ratio of the change in the elastic force.

I would not dare to decide what kind of ether waves -- light, or else electrodynamic waves -- and what method of measuring the wave length would be most suitable for the examination of the magnetic field; basically, this would not matter anyway.

Provided a change of the wave length in the magnetic field is ascertainable in any direction, the first question to be solved experimentally could be whether it is only the component of the elastic state in the direction of wave propagation that exerts an effect on the propagation velocity, or whether such an effect is also exer'ted by the component perpendicular to the direction, since it is a priori clear that in a regular magnetic field, be it shaped like a cylinder or a pyramid, the elastic states are at any point completely homogeneous perpendicular to the direction of the lines of force and different in the direction of the lines of force. Hence, if polarized waves are allowed to penetrate perpendicularly to the direction of the lines of force, the direction of the plane of vibration would be of significance for the propagation velocity -- provided the elastic force component perpendicular to the propagation of a wave would indeed have an effect on the propagation velocity. This is probably not the case, even though the phenomenon of double refraction does

seem to point to it.

Once the question of how the three components of elasticity affect the velocity of an ether wave has been solved, one could proceed with the investigation of the magnetic field. To properly understand the state of the ether in the magnetic field, one would have to distinguish three cases:

1. Lines of force that unite at the north pole in a pyramid-like fashion

2. Lines of force that unite at the south pole in a pyramid-like fashion.

3. Parallel lines of force.

In these cases one should investigate the propagation velocity of a wave in the direction of the lines of force and perpendicular to them. This will undoubtedly yield the elastic deformations along with the cause of their formation once sufficiently accurate instruments for the measurement of the wave length have been constructed.

The most interesting, and also most subtle, case would be the direct experimental investigation of the magnetic field formed around an electric current, because the exploration of the elastic state of the ether in this case would permit us a look into the enigmatic nature of electric current. The analogy would also permit us to draw sure conclusions about the state of the ether in the magnetic field surrounding the electric current, provided the previously mentioned investigations attain their ends.

Quantitative investigations on the absolute magnitudes of the density and the elastic force of the ether cannot begin, in my opinion, until there are available qualitative results bound to firm conceptions; I believe that I must say only one more thing. Should it turn out that the wave length is not proportional to $\sqrt{A + k}$, where A denotes the elastic ether forces a priori and hence is a constant that has to be found empirically, and k denotes the (variable) intensity of 'the magnetic field, which is, of course, proportional to the relevant elastic forces produced, then the reason for it should be sought in the 'density changes of the moving ether produced by the elastic deformation.

First of all, however, it has to be possible to prove that there does exist a passive resistance against the production of the magnetic field by the electric current, and that this [resistance] is proportional to the length of the current circuit and independent of the cross section and material of the conductor.

6. TO CAESAR KOCH

[Pavia, Summer 1895]

My dear uncle!

I am realy very glad that you are still interested in my humble doings despite the fact that we could not see each other for such a long time and that I am such a terribly lazy letter writer. All the same, I hesitated to send you this writing, because it deals with a very special topic; besides, it is rather naive and imperfect, as might be expected from such a young fellow like myself. I shall not be the least offended if you do not read the stuff at all; however, I hope that you will appreciate it as a timid attempt of mine to

overcome my laziness regarding letter writing, which I inherited from both of my dear parents.

As you already know, I should now enter the Polytechnikum in Zurich. This matter encounters considerable difficulties because I should be at least two years older for it. We shall write you in the next letter about the outcome.

Give my love to the dear aunt and your cute little children. Your

Albert

7. ALBIN HERZOG TO GUSTAV MAIER

[Zurich] 25.1X.1895.

Mr. Gustav Maier, Zurich V.

In response to your inquiry of the 24th of this month, I wish to advise you as follows: According to my experience it is not advisable to withdraw a student from the institution in which he had begun his studies even if he is a so-called "child prodigy." In the case with which we are dealing my advice is to persuade the person in question to complete his entire course of studies in his present institution and pass the matura examinations. If you, or the relatives of the young man in question, do not share my opinion, I shall permit -- under exceptional dispensation of the age stipulation -- that he undergo an entrance examination in our institution. In this I proceed from the assumption that the rector of the educational establishment in question is going to confirm in writing and to the fullest extent your information regarding the talents and intellectual maturity of the candidate.

The director of the Federal Polytechnikum:

Herzog

Encl. Program.

8. ENTRANCE REPORT OF THE GEWERBESCHULE, AARGAU KANTONSSCHULE

[ca. 26 October 1895]

[...]
Entered in autumn:
[...]

Grade 3:

Einstein, Albert 14/III 1879 Gym. Munich

G[erman]	3 - 2	Ph[ysics]	2
I[talian]	3	Ch[emistry]	Must do catch-up work
F[rench]	has gr. gaps	[History]	*3 - 4*
G[eometry]	*3*	[Natural history]	3
d[escriptive]			
M[athematics]	2	[provisionally accepted]	