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Physics in Perspective

The Physical Tourist

Peripatetic Highlights in Bern

Ann M. Hentschel*

This tour of significant scientific sites in Bern uses the local legacy of its most illustrious scientists, Albert Einstein (1879–1955) and Fritz Houtermans (1903–1966), as its guiding thread through the old town and the university district.

Key words: Albert Einstein; Fritz Houtermans; Aimé Forster; Paul Gruner; Heinrich Greinacher; University of Bern; Naturforschende Gesellschaft in Bern; Swiss science; meteorology; metrology; relativity theory.

Inroduction

The capital city of the Swiss Canton of Bern and of the Swiss Confederation is nestled in a narrow loop of the Aare river, at the foot of the Alps. The old town, founded around 1191, is well preserved despite a devastating fire in 1405.** Major industries of the region developed under the constraints of modest domestic markets, high transportation costs, and protectionist legislation across national borders. Switzerland thus found its niche in higher-end markets, such as chocolate making, engine building, instruments, fine textiles, and chemicals or pharmaceuticals. My tour past historically significant scientific sites in Bern will use the local legacy of its most illustrious residents, Albert Einstein (1879–1955), who lived there from 1902–1909, and Fritz Houtermans (1903–1966), who lived there from 1952–1966, as its guiding thread through the old town and the university district. Place names in italics mark stops along the tour.

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** The fire destroyed some 650 half-timber houses between the prison tower and the cathedral in the middle of the old town. For a map, click on "sightseeing" at the website <www.berne.ch>.

Fig. 1. The Telephone Exchange (center, directly across from the *Brasserie Bollwerk* at the corner of Aarbergergasse) next to the Old Cavalry Barracks on Äusseres Bollwerk around 1900. The Patent Office was located there between 1907 and 1921. The three large portals of the old train station are just visible in the distance. *Source*: *Anzeiger Region Bern*, March 31, 2004, p. 1.

A Junction in Space and Time

There is nothing left of the train station where Albert Einstein arrived in Bern in early February 1902. From the main entrance of the modern station that replaced it you can still see the eastern face of the Burgerspital to your right and the tower of one of Switzerland's finest baroque places of worship directly ahead of you. The Church of the Holy Ghost, dating from 1729, was the site of some of the first democratic meetings of the Helvetic Republic. Take a left along the thoroughfare Bollwerk for two blocks, up to the corner of Aarbergergasse, and you'll be at Einstein's old haunt, the *Café Bollwerk*, formerly the *Brasserie Bollwerk*, which was just across the street from his workplace in the Telephone Exchange (figure 1), where the Patent Office relocated in 1907 (the Telephone Exchange building no longer exists).

The young theoretical physicist met his private students here for a quick lunchtime study session in philosophy or mathematical physics and occasionally joined his friends in the Patent Office for a mug of beer after hours. A few meetings of his private study group, the Olympia Academy (figure 2), probably also took place here. The original

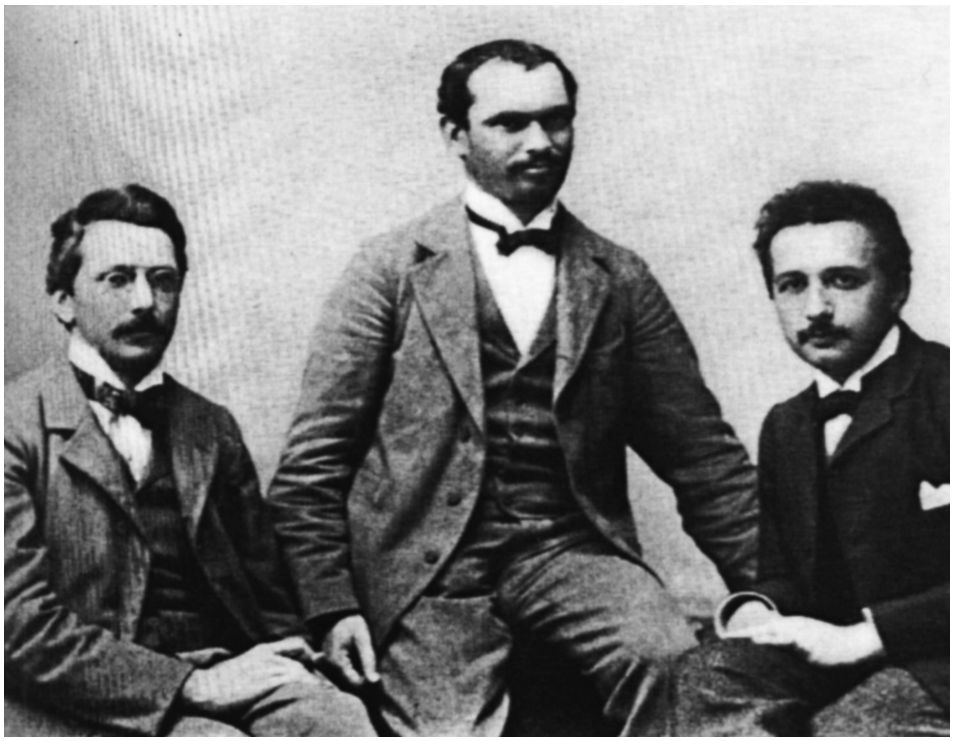

Fig. 2. The Olympia Academy *ca*. 1903. *Left to right*: Conrad Habicht (1876–1958), Maurice Solovine (1875–1958), Albert Einstein (1979–1955). *Source*: Carl Seelig, *Albert Einstein und die Schweiz* (Zurich: Europa-Verlag, 1952), p. 65.

idea of reading major works by the masters of physics and philosophy came from one of Einstein's first private pupils, the Rumanian philosophy student Maurice Solovine (1875–1958). When the doctoral candidate in mathematics, Conrad Habicht (1876–1958), joined these convivial dinners, he brought with him a strong element of humor. One day when Einstein was out, Habicht affixed an embossed sign to his apartment door that read: "Albert Ritter von Steißbein [Sir Backside], Präsident der Akademie Olympia." According to Solovine, it had Albert and his Serbian bride and university girlfriend Mileva Marić (1875–1948) in stitches in the hallway.[1] The Academy's reading list ranged from natural philosophy to literature. The epistemological issues they often ardently debated were instrumental in forming Einstein's thinking about such fundamental physical concepts as space and time.

Just next door to the Telephone Exchange was the Old Cavalry Barracks. This large and functional building, which was demolished along with the entire block in 1958 to make way for the current railway station, contained the cantonal chemistry laboratories as well as the university institutes for mineralogy, geology, zoology, and pharmaceutics. Since many of the meetings of the local Naturforschende Gesellschaft (Society

of Natural Scientists) were held there, the young graduate of the Zurich Polytechnic was soon mingling with Bernese Gymnasium (high-school) teachers, naturalists, engineers, apothecaries, chemists, medical doctors, and professors, who made up its diverse membership. Thus, in a way, the *Café Bollwerk* was the professional crossroads of Einstein as a young man, where he made the transition from technology to theoretical physics and from private tutoring to academia. Here in Bern the young civil servant became a part-time university teacher as he was developing the new conceptions of space, time, and matter that were to change the face of theoretical physics in the 20th century.

One block down Aarbergergasse takes you to Genfergasse (formerly called Anatomiegasse after the university's anatomy institute at the northern end of the street, which was torn down in 1899). Taking a left you walk past the former site of the Jewish synagogue, a somewhat dilapitated half-timber construction with the characteristic separately accessible upper gallery for women. It was owned by the local Jewish community from 1856 to 1906. Einstein's first workplace at the next corner thus was not far away from the Bernese heart of his own cultural heritage until the synagogue moved away from downtown to a fine new temple in Mattenhof. On his way to a talk by a member of the Naturforschende Gesellschaft at the Old Cavalry Barracks, Einstein walked past the synagogue often enough, but not being a practising Jew, he probably never went inside.

The Patent Office

The imposing Telegraph Building at Speichergasse 6 (figure 3), built at the turn of the last century in the French renaissance style, also accommodated the *Federal Office of Intellectual Property* from 1901 to 1907. Commonly abbreviated as the Patent Office, its purpose was to enforce the federal laws pertaining to patents on inventions, copyrights in the literary and fine arts, and pattern and product trademarks. Its founding Director, Friedrich Haller (1844–1936), was being particularly open-minded when he employed Einstein in June 1902 to fill the post of Technical Expert, Third Class. Qualified engineers were usually taken, while Einstein only had a teacher's diploma in mathematics and physics from the Zurich Polytechnic (Eidgenössische Technische Hochschule, ETH).[2]

At the turn of the last century, however, machine technology and the transportation and communications industries were in the middle of a boom, so the technical department at the Patent Office needed new examiners to process the increasing number of patent applications. The Swiss railway was being nationalized and the horse-drawn and steam-driven streetcar system had just recently been converted to electricity; telephone communication was at the forefront of the technology of the day.* Although it took Einstein longer than his officemate, the engineer Heinrich Schenk (1872–1938), to advance to Second Class, he eventually became specialized in what Haller said were particularly challenging patent applications in the field of electrotechnology. Einstein's

* The Telecommunications Museum is located at Helvetiastrasse 16; see the website <www.mfk.ch>.

Fig. 3. The Federal Office of Intellectual Property was housed in the Telegraph Building from 1901 to 1907. The office Einstein shared with Heinrich Schenk was at the left on the third floor. *Source*: H.J. Wolf, *Erinnerungen an Albert Einstein* (Bern: Amt für geistiges Eigentum, 1965), p. 11a.

work was not very intellectually demanding for him and soon became tedious, so he began to look around for better opportunities. Besides teaching positions at various Gymnasia and technical colleges, he inquired at the Telegraph Office in the same building, where the pupil he was tutoring in electrotechnology, Lucien Chavan (1868–1942), was working. This time Einstein's lack of engineering credentials evidently worked against him. He remained at the Patent Office throughout his Bernese period and surrepticiously grappled with his own theoretical problems after he had speedily dealt with the day's workload. Einstein's "civil servant's formula for success" evidently came from personal experience: "Success (A) equals work (x) plus play (y) plus keep-your-mouth-shut (z): $A = x + y + z$."[3]

Gymnasium Science

Turning right on Speichergasse, the next major building on the same side of the street is the *Städtisches Gymnasium* (municipal high school), with its eastern wing at Waisenhausplatz 30. Einstein was an occasional visitor here as well as at the nearby private parochial school, the *Freies Gymnasium*, at Nägeligasse 2 (one block farther eastward at the corner of Predigergasse, now headquarters of the police medical corps). With his

fellow members of the Society of Natural Scientists, Einstein attended talks with demonstrations in the laboratories of these Gymnasia, frequently delivered by members of their teaching staffs. Einstein also met a few of these secondary-school teachers privately after work at the Städtisches Gymnasium to tinker in the physics laboratory on the second floor of its eastern wing. Towards the end of his stay in Bern, Einstein began to develop a small electrostatic meter, which he referred to as his "Maschinchen." His main collaborator on it was Conrad Habicht's brother Paul (1884–1948), an engineering student, who later placed it on the market. It was unusual for a theoretician of Einstein's caliber to have such an active interest in technical practice.

A characteristic of Swiss society even as late as the turn of the last century was that its civil service – which includes university faculty – was so poorly paid that it was taken as a matter of course that the majority of untenured university teachers would have full-time jobs elsewhere, mainly as secondary-school teachers.* Thus, for lack of fee-paying students in the nascent field of theoretical physics, Paul Gruner (1869–1957), the lecturer of mathematical physics, earned his livelihood at the Freies Gymnasium as a full-time teacher of mathematics, technical drawing, and descriptive geometry for more than a decade, from 1893 to 1904. Even Emil König (1871–1948), Director of the Office of Weights and Measures, taught physics full time at the Stätisches Gymnasium, as had his predecessor. In this environment, it was hardly exceptional for Einstein later to offer courses at the university in the early hours of the morning so that he could hurry down the hill to the Patent Office in time for a full day's work as a technical expert examining patent applications.[4]

Einstein's Old-Town Neighborhood

The first right off Nägeligasse takes you past the apartments of Heinrich Schenk at *Predigergasse 6 and 10*, which he occupied successively in 1903–1904. Schenk, who was hired at the Patent Office at the same time as Einstein, was Einstein's permanent officemate. Another right on Zeughausgasse takes you to *Zeughausgasse 41*, the apartment of Einstein's other coworker and close friend, Michele Besso (1873–1955). Besso lived there with his wife and eight-year-old son in 1905, during the crucial period when his neighbor was working on the final touches of his theory of relativity. Besso is explicitly acknowledged in Einstein's famous paper, "On the Electrodynamics of Moving Bodies," for his constructive comments during their daily homeward discussions after work.

Our tour continues left from Waisenhausplatz through the Käfigturm, which marks the second of three former city walls. Until 1897 it was the city's prison tower, confining such troublemakers as rampaging students or Socialist strikemongers. Following Marktgasse to Kornhausplatz, turn right and take the next left to Münstergasse 61. This is the *Stadtbibliothek* (municipal library), where Einstein did what research he could

* This had unfortunate repercussions on the faculty. The university had difficulty attracting high-caliber researchers, particularly in sparsely attended subjects.

after work during its limited opening hours. It is housed in a former granary built in 1760 that was renovated to serve as a library by the burgher commune of Bern. In 1905–1906 the university library was incorporated into the collection of the Stadtbibliothek and housed in two newly built wings of the building. The small garden in the courtyard is the last reminant of the old botanical gardens planted by the Society of Natural Scientists in 1804 on the original university grounds, a medieval cloister of the Order of Discalced Friars (Barfüsserkloster).

Continuing to Münsterplatz 12, you arrive at the building where the *Civil Registry* used to be. We can picture Mileva, who had studied physics with Albert at the Zurich Polytechnic, coming out of the building with Albert on January 6, 1903, with their jovial Olympian marriage witnesses Conrad Habicht and Maurice Solovine, immediately in front of the cathedral's elaborate portal designed by the architect of its famous sister cathedral in Strasbourg. Passing to the right of the cathedral onto the promenade with a view of the river, you will find a *meteorological pillar* dating from 1873. At the end of the 19th century, meteorological stations were being set up in all major European cities as a public weather service.* This marble pillar, which was designed by the Bernese architect of the Städtisches Gymnasium, Eugen Stettler (1840–1913), was financed by the city on the initiative of the Society of Natural Scientists in 1865. The society donated the original instruments for it: a vessel barometer, a thermometer with Celsius and Réaumur scales, and a hair hygrometer.[5] It was mainly the brainchild of the society's president in 1872–1873, the meteorologist Aimé Forster (1843–1926), who had recently been appointed director of the university's Physical Institute. Forster was a gifted popularizer of meteorology, organizing public lectures at the close of the 19th century that attracted large audiences filling up to 270 seats.

A short walk northward on Kreuzgasse past the Rathaus (city hall) takes you to the former studio of the successful turn-of-the-century portrait photographer Emil Vollenweider at Postgasse 68. The Einstein couple had their engagement and wedding photographs taken there, and on another occasion the three Olympians also sat there for their group portrait. The building was sold to the city in 1918 but it is still known as the *Vollenweider Haus* after its former private owner. Taking the next connecting alleyway back to Gerechtigkeitsgasse we turn left to *Gerechtigkeitsgasse 32*, Einstein's first bachelor's lodgings in Bern in the spring of 1902. There in his furnished room he made the acquaintance of Maurice Solovine, who was one of the first respondants to his advertisement as a tutor in mathematics and physics. That summer Einstein moved to cheaper quarters south of the old town at Thunstrasse 43a (which is no longer in its original state), moving again in the autumn to an attic room at Archivstrasse 8 in the more pleasant neighborhood of Kirchenfeld. The first apartment he officially shared with Mileva, in January 1903, was in a family house at Tillierstrasse 18, just a few blocks away, but that October they decided to move back into town.

For this fifth address of Einstein's we have to go back down Gerechtigkeitsgasse, which becomes Kramgasse, one of the major arcaded shopping streets of the old town

* Another one was farther upstream by the Federal Houses of Parliament. Color photographs of all four historic Bernese weather stations can be found at the website <www.wettersaeulen-in-europa.de>.

and dotted with ornate fountains from the 16th century. In those days they were in constant use as watering places for workhorses and dogs – Bernese mountain dogs and Saint Bernards in harness – as well as being a regular stop for housemaids and laundresses. Until May 1905 Albert and Mileva and their eldest son Hans-Albert, who was born in May 1904, lived in a three-room apartment on the third floor at *Kramgasse 49*, above a restaurant then called the Brasserie zum Gurten. It is now a museum.* Einstein published two major papers while living here: "On a Heuristic Point of View Concerning the Production and Transformation of Light," in which he proposed his light-quantum hypothesis, and "On a New Determination of Molecular Dimensions," from which he calculated Avogadro's number, thus offering the first tangible evidence for the atomic theory. A plaque on this building reads: "In this house Albert Einstein in the years 1903–1905 created his fundamental papers on relativity theory"—although he actually published his famous paper after he and Mileva and son Hans-Albert moved to their next residence (which no longer exists) on Besenscheuer Weg, southwest of the fluvial peninsula.

Bernese Metrology

Just one block away from the Einsteins' Kramgasse apartment is Bern's historic clocktower. The *Zytgloggenturm* (figure 4) was built around 1218 and marks the first boundary of the original old town. After it was seriously damaged in the big fire of 1405, it was no longer used as a prison. The astronomical clock on its eastern face was built by Caspar Brunner from Nürnberg in 1527–1530. The allegorical figures on the tower's eastern face represent the four stages of life, those on the western face the four seasons. During the second half of the 19th century, the clocktower had the important task of indicating the local Bernese time. The clockworks, including puppets that revolve on the hour, were renovated in 1904. As early as 1874, the Society of Natural Scientists had recommended that the city modernize its timekeeping system and change over to a dozen public electrically driven clocks. The new telegraph and railway networks had made the introduction of a standard time indispensable. Clocks in Zurich, for example, diverged from Bernese clocks by as much as four and a half minutes.

You can still see a collection of local standard lengths dating from 1877 attached to the wall in one of the archways of the clocktower.** These were for the convenience of local merchants and their customers and go back to the middle of the 17th century. Standardization of the myriad local Swiss measures first began in earnest during the short-lived Helvetic Republic when a law was passed in 1801 requiring the introduction of the French metric system. Three decades had to elapse, however, before twelve cantons voluntarily signed a concordat in 1835 to institute a uniform Swiss system, which then gradually began to gain general acceptance.

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* See the website of *Das Einstein-Haus*: <www.einstein-bern.ch>.

** Aside from two original meter measures, they are replicas of various Swiss and Bernese foot and cord measures made between 1640 and 1769. The originals are on display at the national Historical Museum, just across the Kirchenfeld bridge at Helvetiaplatz 5; see the website <www.bhm.ch>.

Fig. 4. Bernese clocktower, originally the watchtower at the western edge of the old town. *Source*: Arnold H. Schwengler, *Liebes altes Bern. Stadtbilder 1850–1925* (Bern: Buchverlag Verbandsdruckerei, 1975), p. 39.

The Swiss Federal Constitution of 1848 laid down the jurisdiction for the establishment of the Federal Verification Office (Eidgenössische Eichstätte), which eventually came into existence in 1864 in the old treasury building formerly situated a block westward from today's Casinoplatz. If we take Amthausgasse to the Federal Houses of Parliament, we will have gone past two subsequent locations of the renamed *Federal Office of Weights and Measures*. Between 1897 and 1907 it was at Amthausgasse 17, then until 1914 it was in the basement of *Parliament* at Bundesplatz 3. At the turn of the twentieth century, it was still preoccupied with making the transition from local scales to the Parisian metric system in accordance with an international convention signed by Switzerland in 1875. Emil König (1871–1948), Director of the Federal Office of Weights and Measures from 1909 to 1932, moved it away from routine verification and enforcement, which duties were transferred to private testing stations. The incorporation of electro-technology into its program necessitated another move, in 1914, into a new building in Kirchenfeld at Wildstrasse 3, a street named after its first director, the Pro-

fessor of Physics Heinrich Wild (1833–1902).[6] This building currently houses Einstein's former employer, the Swiss Federal Institute of Intellectual Property (Eidgenössisches Institut für geistiges Eigentum). A modern extension of the building, completed in 1958, is now the main entrance at Einsteinstrasse 2.

Emil König's son Hans (b. 1904), who was appointed as Extraordinary Professor of Technical Physics in 1939 and founded the university's Institute of Applied Physics in 1961, succeeded his father as Director of the Federal Office of Weights and Measures from 1951 to 1969. During his directorship its focus turned to fundamental research on units of measurement and natural constants, which had hitherto been left in the hands of the Physikalisch-Technische Reichsanstalt in Berlin-Charlottenburg, the National Physical Laboratory in Teddington, England, and the National Bureau of Standards in Washington, D.C. In introducing the measurement of light wavelengths, Hans König laid the foundation for later developments in Swiss high-precision metrology. Between 1910 and 1955, the Office's personnel increased from 3 to 19, and in the following 40 years to over 100. In the mid-1960s the Office was moved to a better-equipped and isolated new building complex in Wabern, south of Kirchenfeld. Renamed as the Federal Office of Metrology in 1977, it expanded its functions in subsequent decades to comply with European organizations for calibration and accreditation and, since 2001, has been called the Federal Office of Metrology and Accreditation (Metrologie und Akkreditierung Schweiz, *metas*). Einstein knew both of the Königs, especially the father Emil, who had given a number of talks of particular interest to engineers at the Society of Natural Scientists. That will be our next stop.

The Naturforschende Gesellschaft

Crossing Bärenplatz we take a left into Spitalgasse to look at the former regular meeting place of the *Naturforschende Gesellschaft in Bern* at Spitalgasse 21. This Society of Natural Scientists was founded in 1786 by Jakob Samuel Wyttenbach (1648–1830), the Vicar of the Church of the Holy Ghost. Its aim was to promote and preserve knowledge about Switzerland's natural resources. Two decades later it affiliated itself with the newly established national association (now the Swiss Academy of Science). By the time Einstein attended his first meeting of the society in 1902, its membership had risen from its original 7 to 144, coming from such disparate professions as publishing, medicine, engineering, and teaching. Yet, they all shared a common interest in the natural sciences in the broad sense of the term.

Since the society had no premises of its own at the beginning of the last century, it rented the conference hall on the second floor of the former Hotel Storchen at Spitalgasse 21 for its regular fortnightly meetings (this building is currently occupied by the department store Globus). Scientific and technical demonstrations were held either in a laboratory of one of the Gymnasia or in an available auditorium at the University of Bern. Emil König, for instance, conducted experiments on electric current and resonance in the chemistry laboratory of the Städtisches Gymnasium in November 1902 and delivered a demonstration lecture on electroacoustical and optical-resonance devices, current-frequency meters, and remote-transmission towers in its physics laboratory in December 1903. Einstein was introduced into the society by his colleague and

fellow graduate of the Zurich Polytechnic, Joseph Sauter (1871–1961), whose expertise at the Patent Office lay in evaluating applications for devices claiming to exploit perpetual motion. Einstein was welcomed as a new member of the society at its meeting on May 2, 1903, as "mathematician at the Patent Office." At that meeting he heard a talk on atmospheric electricity by the lecturer of theoretical physics Paul Gruner (1869–1957), who later became his mentor at the University of Bern.

In December 1903 Einstein presented the only talk at the society of that fiscal year on physics proper. His talk, on "The Theory of Electromagnetic Waves," probably touched on wireless telegraphy and Maxwell's electromagnetic theory of light, which had been the topic of discussion at an earlier meeting on November 7. Theoretical physics was still in its infancy but was nurtured substantially by Einstein's contributions at this time. He delivered a second talk in March 1907, "On the Nature of Motions of Microscopically Small Particles Suspended in a Liquid," which reiterated his new method of determining molecular dimensions that he had published in 1905, the same year as his special theory of relativity. The society had to wait until 1911 for Einstein to deliver a talk on relativity theory, however, and then it was before its affiliate in Zurich. In 1914 he also gave a preview of his new theory of gravitation in Zurich. The Bernese society finally found a permanent meeting place in 1934 in the conference facilities in the then-new building of the Natural History Museum in Kirchenfeld.*

The Bernese society benefited from the researches and resources of the local academic institutes and medical clinics. The physiologist Theodor Kocher (1841–1917), for instance, was awarded the Nobel Prize in Medicine for1909 for his research on the thyroid gland. The society, in turn, served teachers both as a publishing organ and as a point of convergence for theoreticians, experimentalists, and technicians. Physics had a decidedly subordinate role in the Naturforschende Gesellschaft at the beginning of the 20th century. Nevertheless, it was an ideal forum for the exchange of ideas dating back to the time of the university's star mathematician, Ludwig Schläfli (1814–1895), the founder of multidimensional geometry. His importance began to be appreciated only after the posthumous publication of his major work on the theory of continuous manifolds in 1901. The physicist-historian Viktor Gorgé (b. 1931) has given a frank assessment of the climate for the exact sciences in Bern during the first half of the twentieth century:

> But neither this society nor the university kept pace with the professionization process, which was particularly conspicuous in the exact sciences. So the university just as the society sank to mere provincial importance with regard to this discipline for various reasons. One of the reasons was not least the notable circumstance that the chair for physics was filled for more than 50 years, precisely in the critical period between 1870 to 1920, by a scholar who – as far as we can judge – was more a natural scientist of the old school than a physicist according to new standards of the profession characteristic of the exact sciences.[7]

* This museum at Bernastrasse 15 has a fine collection of alpine minerals; see the website <www.nmbe.unibe.ch>.

Fig. 5. The Tellurian Observatory around 1900, which was demolished in 1958 to make way for the new science building. *Source*: Arnold H. Schwengler, *Liebes altes Bern. Stadtbilder 1850–1925* (Bern: Buchverlag Verbandsdruckerei, 1975), p. 96.

University Physics

The scholar alluded to above was Aimé Forster (1843–1926), Director of the Physical Institute and Observatory, who chose to develop the field of meteorology that his predecessor, Heinrich Wild (1833–1902), had established.[8] As Professor of Physics and Astronomy from 1858 to 1868, Wild had embarked on this field partly for lack of proper astronomical equipment at the former wooden observatory, which was built in 1822 under the direction of the Professor of Mathematics and Physics Johann Friedrich Trechsel (1776–1849). Forster essentially eliminated practical astronomy from the curriculum on the persuasive justification that Wild's meteorological program was unique among Swiss university observatories.

The building that housed the physics department where Einstein submitted his postdoctoral Habilitation thesis in theoretical physics in June 1907 was Forster's so-called Tellurian Observatory (figure 5), which was built in 1877. It was situated on top of the formerly fortified city redoubt, the *Grosse Schanze*, prompting the now obsolete street name of Sternwartstrasse. It was right next to where the palacial main building of the *University of Bern*, completed in 1903, commands a fabulous view over the rooftops of the old town and of the snowcapped Bernese alpine range. Continue down Spitalgasse past the railway station and the Church of the Holy Ghost and take the next major right across the bridge to the university district, called Länggasse.

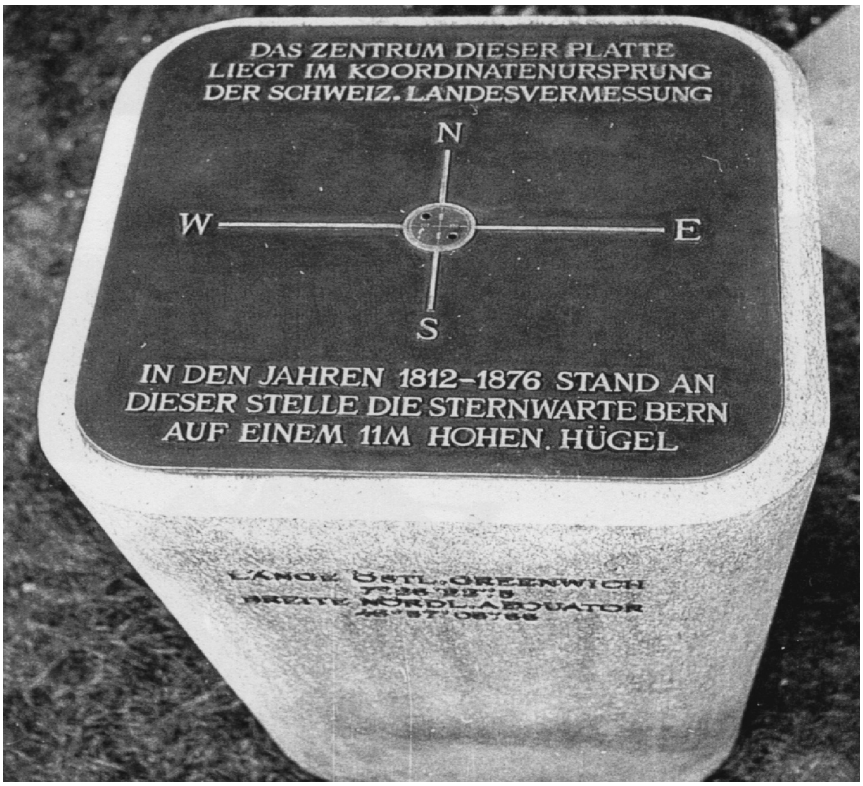

Fig. 6. The memorial stone of the original Swiss triangulation zero point. *Source*: Verdun, "Zwei Jahrhunderte" (ref. 9), p. 11 (Archiv swisstopo, Bern-Wabern).

The Tellurian Observatory was built on the foundations of the wooden barracks of 1812 on the highest point of the "great redoubt," then called the Hohliebi Bastion. Thus, all subsequent official astronomical and geodesic measurements were able to continue using the triangulation origin established at that time. A memorial stone (figure 6) set into the floor of its "meridian room" was transferred to the corresponding spot in the building that replaced the observatory in 1963. It is now a few meters lower than its original site,* in an inaccessible courtyard of the Institute of Exact Sciences at Sidlerstrasse 5 (figure 7).[9]

Besides functioning as a meteorological and seismological station (since 1878 Forster was also a member of the Swiss Seismological Commission), the Tellurian Observatory housed the director's residence on its *bel étage* and had laboratories, lecturing facilities,

* Satellite technology has obviated the need for triangulation points in the line of sight. The national origin was redesignated in 1995, for the sake of convenience, to Zimmerwald, 10 kilometers south of Bern, where the university's research observatory is currently located.

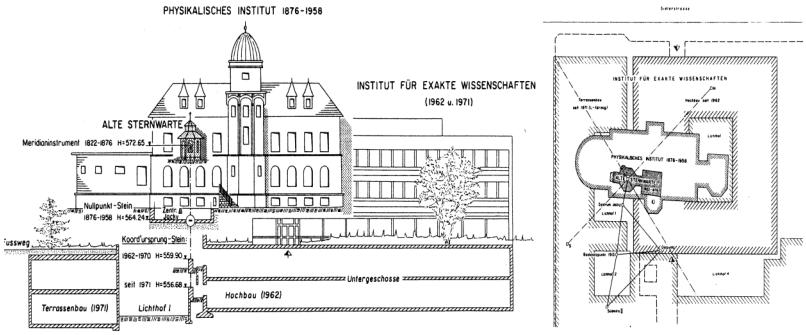

Fig. 7. Sketch of the Physical Institute and Institute of Exact Sciences, 1822–1971, and top view of the latter indicating the historic national triangulation zero point on the *Grosse Schanze*, now Sidlerstrasse 5. *Source*: Verdun, "Zwei Jahrhunderte" (ref. 9), p. 9.

and an instrument collection – a Physical Cabinet. The physics department finally got an auditorium of its own here. At its former location on the old campus (next to the library in the old town, where the Kultur-Casino now stands), the Physical Institute was housed directly above the chemistry laboratory. The young Professor Forster used to complain bitterly about having to shut all of the windows in the cramped, permanently damp old rooms in an effort to limit damage to his precision instruments caused by noxious fumes from the chemistry laboratory below. Ironically, it turned out that Forster's Tellurian Observatory was ill-suited to his agenda of seismographic and geomagnetic measurements, owing to disturbing vibrations from the passing traffic.

As far as the physics curriculum was concerned, Forster's lectures reportedly were clearly structured but firmly rooted in the classical tradition. Among the registered students, few sought a true education in physics; most were majors in medicine or were in the teacher-training program, of which Forster was the longtime head of the national board. Before 1910 the annual output of doctorates in all of the exact sciences at the University of Bern never reached ten. Physics was in a state of transition, shaking off its shackles to the mathematics department. Thus, Einstein's submission of his papers on relativity and light quanta in 1907 in lieu of a Habilitation thesis was a risky move. In those days it was more the exception than the rule for any European physics department to welcome his ideas. Einstein therefore was lucky to have the support of a dynamic and upcoming member of the university faculty, Paul Gruner (1869–1957, figure 8).* Among the dozen physicists at Swiss universities at the time, Gruner was the only one actively pursuing theoretical research.[10]

* Gruner had just been appointed Extraordinary Professor of Theoretical and Mathematical Physics in 1906, so he was only a junior member of the jury deciding on Einstein's application for permission to teach (Habilitation) at the University of Bern. Nonetheless, he managed to pull Einstein's application through, even though Einstein's theories were still considered highly controversial. The intercession of Einstein's doctoral supervisor in Zurich, Professor Alfred Kleiner, probably played a decisive role. See Schulmann, "Einstein" (ref. 10), p. 22.

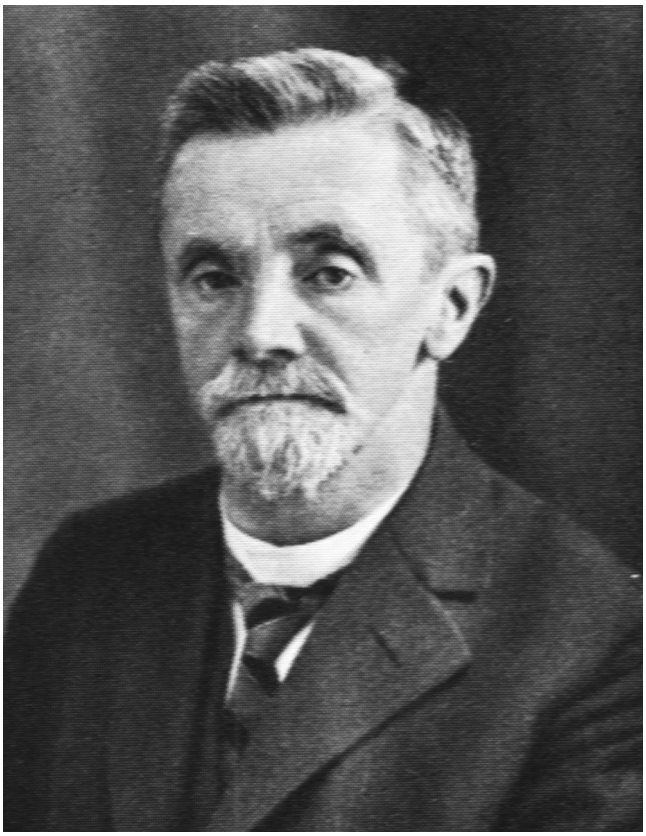

Fig. 8. Franz Rudolf Paul Gruner (1869–1957) taught courses in theoretical physics at the Univerity of Bern from 1894 until his retirement in 1939. *Source*: Flückiger, *Albert Einstein* (ref. 3), p. 101.

Although Gruner initially followed the meteorological tradition of the physics department in his choice of dissertation topic, he introduced fresh impetus into its curriculum. Throughout his career, his courses on theoretical physics reflected the latest findings of the day, lecturing on radioactivity in 1904, relativity theory as early as 1908, and quantum theory in 1927. Gruner, in fact, was the driving force behind the institutionalization of theoretical physics in Bern after 1911. He was also an able popularizer. In 1910 he published an elementary exposition of the theory of relativity in the *Mitteilungen* of the Naturforschende Gesellschaft and in 1922 a textbook on the subject. He thus acted as an effective counterweight to the anatomist Hans Strasser (1852–1927), who as president of the society had welcomed Einstein as a new member in 1903, but who became a vociferous antirelativist after 1916.

Einstein's Habilitation thesis at the University of Bern was accepted in 1908; it was on the "Consequences for the Constitution of Radiation of the Energy Distribution Law of Blackbody Radiation," and probably elaborated on his light-quantum hypoth-

Fig. 9. At the end of the 19th century there used to be a stairway to the university's main building at the top of the *Grosse Schanze*. *Source*: A. Etter and F. Rogger, ed., *100 Jahre Hauptgebäude Universität Bern* (Bern: University of Bern, 2003), p. 30.

esis of 1905. His inaugural lecture on February 27, 1908, was "On the Limit of the Validity of Classical Thermodynamics." The next two academic terms he offered lectures on "The Molecular Theory of Heat" and on "Radiation Theory" (the latter in the main building of the university at Hochschulstrasse 4, figure 9) to a couple of auditors – who with but a single exception were his personal friends and colleagues in the Patent Office.

Experimental Resurrection

Forster's successor as Director of the Physical Institute in 1924 was the experimental physicist and trained concert pianist Heinrich Greinacher (1880–1974, figure 10), who had a knack for inventing ingenious devices and instruments with the limited resources that were available to him. He constructed an early ionization chamber, and his voltage multiplier of 1926 became an important component in particle accelerators.[11] His original instrument is part of the Physical Institute's collection, some of which is on display by the main staircase of the science building at Sidlerstrasse 5. There also is a bust of Einstein in its central hallway.

After the Second World War, the Bernese government, swept up in the global wave of enthusiasm for nuclear energy, finally began to consider physics as a worthwhile investment, and the fortunes of the exact sciences in Bern finally turned around. Thus, in 1952 a physicist of the first order, Friedrich (Fritz) Georg Houtermans (1903–1966, figure 11),[12] was attracted to Bern from Göttingen with the prospect of heading a mod-

Fig. 10. Heinrich Greinacher (1880–1974) was Professor of Physics at the University of Bern from 1924 to 1954. *Source*: Scandola, *et al*., *Hochschulgeschichte Berns* (ref. 7) p. 335.

ern department of experimental physics in a state-of-the-art science building.* Houtermans had completed his Ph.D. degree in 1927 at the University of Göttingen and during the next decade had made fundamental contributions to theoretical nuclear physics, the theory of stellar reactions, the development of electron microscopy, and other fields of research. In 1941 he proposed a means of producing element 94 (plutonium).** After the end of the war, he returned to Göttingen, working on neutron physics and on methods to determine the age of rocks.

* Eduardo Amaldi notes about Houtermans's choice of Bern over one or two alternatives: "Perhaps his remark that his decision was biased towards Bern because this was the town where Albert Einstein did his famous work at the beginning of this century, was meant only half jokingly." See Amaldi, "The adventurous life," (ref. 12), p. 665.

** Between 1927 and 1937, Houtermans worked in Göttingen, Berlin, London, and Kharkov, and in December 1937, although he had been a member of the German Communist Party since the 1920s, he was arrested in Moscow by the NKVD (the People's Commissariat of Internal Affairs), imprisoned, and tortured. His wife Charlotte neé Riefenstahl , who also received her Ph.D. degree

Fig. 11. The founder of the "Berner Schule," Friedrich (Fritz) Georg Houtermans (1903–1966). *Source*: Landrock, "Houtermans" (ref. 12), p. 187.

In 1952 Houtermans wrote to the Dutch physicist Hendrick Casimir (1909–2000) from Bern: "If you want to see an authentic early-twentieth-century laboratory, come and visit me. But you have to come soon, for I am going to change all that."[13] He founded the internationally renowned Berner Schule whose focus was on applications of radioactivity to the geosciences, astrophysics, and cosmochemistry. Judging from the number of his publications and students he had in Bern, this was his most productive period, despite incurring a disability following a fall in 1962. A few of his coauthored publications were on such topics as cosmic radiation, solar neutrinos, the maser condition in molecular spectra, and health hazards of radioactivity. In 1953, based on his earlier research on the age of uranium, Houtermans estimated the age of the Earth to be $(4.5 \pm 0.3) \times 10^9$ years.

in physics at the University of Göttingen in 1927 and whom he had married in 1930, managed to get away to England with their two children, Giovanna and Jan, from where she made extraordinary efforts to get him released, but to no avail. He was not released until April 1940 – and then into the hands of the Gestapo. Only the courageous efforts of Max von Laue (1879–1960) secured his release from the Gestapo prison in Berlin and, in January 1941, obtained a position for him in a private laboratory in Lichterfelde near Berlin where he worked during the war.

One of Houtermans's former students, Hans Oeschger (1927–1998), described Houtermans's lectures in general physics as difficult to follow and error-prone but filled with brilliant comparisons to illuminate the underlying physical mechanisms.[14] Oeschger and Houtermans developed a sensitive particle counter that became the centerpiece of their carbon-dating laboratory, the first one in Switzerland. In 1963 Oeschger became head of a new department of climatology and environmental physics at Bern.

Houtermans's boisterous and risqué sense of humor was legendary. Friedrich Begemann (b. 1927), one of his graduate students, tells the story that when the Physical Institute was still housed in the Tellurian Observatory Houtermans occasionally led his "boys" down into the stairwell to wobble the sandstone pillar that was used as the Earth's axis in practical exercises, shouting, "Let's go and shake Switzerland a little!" In 1957 the cosmochemist Begemann was the first to determine the age of a meteorite by exposure to cosmic rays; he later became Director of the Max Planck Institute for Chemistry in Mainz. Another of Houtermans's mischievous pranks was to "borrow" the fire hoses for a dousing after an evening at the pub, which brought down the wrath of the building supervisor. His saving excuse was that he was carrying out an emergency drill against radioactive contamination.

Life in Länggasse

Our next stop is the former guesthouse *Pension Berna* in which Houtermans stayed in the university district of Länggasse when he first arrived in Bern in 1952. Follow Sidlerstrasse back down through Falkenplatz to Schanzeneckstrasse 17. The Pension Berna was run by the widow Emma Knuchel-Beyeler and her married sister Luise Vogt.* Coincidentally, it also is the building in which one of Einstein's senior colleagues at the Patent Office, Friedrich Blau, lived until 1904. In the chicken coop at the Blaus's subsequent residence in Muri, Einstein set up one of Bern's first homemade antennas for receiving Morse signals from Paris. The Eiffel Tower, constructed for the World Fair of 1889, had just been turned into a transmission station at the instigation of Henri Poincaré (1854–1912).[15]

Returning to Länggassstrasse, turn left and go to the *Simplex* building at Länggassstrasse 7.** When the Tellurian Observatory was demolished in 1958, Houtermans's Physical Institute was moved there temporarily. Physicists and applied mathematicians shared this former factory until 1961 when the new science building was completed (figure 12). Take the next right at Hallerstrasse, and then take a left at Gesellschaftsstrasse and go to the end to *Gesellschaftsstrasse 81*. At the beginning of

* Friedrich Begemann remembered one of the first evenings at the Pension Berna at supper time. Serving the hot soup, the motherly matron cautioned in good Bernese: "'s isch heiss" (to an out-of-towner, the colloquial slurring together of the words sounds like a rude German word). To which Houtermans quipped to his fellow boarders, "The Bernese have a peculiar way of saying 'bon appetit'." See Von Buttlar, *Leonium* (ref. 14), p. 32.

** The stationers Schreibbücherfabrik Simplex AG Bern is now located in Zollikofen.

Fig. 12. The Institute of Exact Sciences on Sidlerstrasse was inaugurated in 1963 under Houtermans's directorship. *Source*: Scandola, *et al.*, *Hochschulgeschichte Berns* (ref. 7), p. 333.

the 1950s, Houtermans occupied an apartment in this ten-unit building with his second wife, Ilse neé Bartz, and their three children, Pieter, Elsa, and Cornelia. She had worked as a chemical engineer with him in Lichterfelde near Berlin during the war, and they had married in 1944. One evening near midnight, after another long study session, Houtermans stealthily invited his hungry students in through the window of their mezzanine apartment to pillage the refrigerator.

Turn left onto Neufeldstrasse and you'll see the *Uni-Tobler* building at the next corner at Länggassstrasse 49a. This was the original manufacturing plant, from 1899 to 1984, of the famous prism-shaped Toblerone chocolate bars. In 1910 the Tobler Company was Bern's largest industrial employer.[16] Since 1992, the building houses various university departments in the humanities and social sciences, including the Institute for Philosophy with its working group in the History and Philosophy of Science. Inside you can see how the original factory-floor atmosphere has been carefully preserved. A branch of the university library is in its high atrium.

Continue down Muesmattstrasse to the *University Observatory* at Muesmattstrasse 25. Forster's focus on geophysics had come at the expense of practical astronomy: Under his directorship astronomy was taught by mathematicians and physicists strictly as a theoretical discipline. A revival occurred a dozen years after the retirement of the astronomer Georg Sidler (1831–1907) when Sigmund Mauderli (1876–1962) successfully lobbied the government in 1919 to invest in a small research

observatory so that students could again finally get some practical training. The 15-centimeter classical Merz refractor in the 6-meter dome, inaugurated in 1922, was replaced three years later by the current instrument measuring 17.5 centimeters.* Three decades later the astronomy department relieved the physicists of routine meteorological tasks, and in 1978 an automated meteorological station began operation in Liebefeld.

Like Einstein, Houtermans also had occasion to visit the Bernese Civil Registry (then located in the police headquarters at Predigergasse 5 in the center of town). Thus, in August 1953, after divorcing his second wife Ilse, Houtermans remarried his first wife Charlotte neé Riefenstahl (no relation to the notorious German filmmaker Leni), with whom he had had two children, Giovanna and Jan. The nuclear physicist Walter Winkler (b. 1927) remembered his former teacher debating about whom to ask as witnesses for the civil ceremony. On the two previous occasions Wolfgang Pauli had been one of them, but now Houtermans was hesitant to ask him once again: "I really can't take Pauli again, because the odd numbers always go wrong with him. It's sort of like a 'Pauli exclusion principle'." There apparently was something to it: Pauli actually came to Bern and served in this honorable capacity along with Giovanna and Jan, but this third bond of marriage lasted only a few months. Houtermans was back at the registry again the following year with his step-sister-in-law Lore Müller and her four-year old daugher Sabine.** Houtermans made light of his private life. When a student missed a lecture to attend his own wedding, his teacher reprimanded him in front of the entire class with the words: "But Mr. Lang, if I had skipped a lecture every time I was married, where *would* we be now?!"

Forster's vision of the University of Bern as a center of geophysical research finally materialized at the end of the 20th century. Houtermans's interdisciplinary approach led to a fruitful collaboration in nuclear geology with the University of Pisa and the Université Libre in Brussels. Martin Teucher (1921–1978), who had taken his doctorate in nuclear physics under Houtermans at Göttingen, was placed in charge of building up a high-energy physics group using the emulsion method for detecting charged particles. Johannes Geiss (b. 1926) introduced mass spectroscopy into the program, and later, as Houtermans's successor, space research. The exact sciences in Bern have managed to stay on a par with its European sister institutions ever since, thanks to substantial funding from industry and participation in international collaborative projects. Today there is a laboratory for high-energy physics at the University of Bern, and research divisions for climatology and environmental physics, and space research and planetary science.*** Einstein would have been pleased to see unified field theory on the current theoretical agenda.

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* The observatory is open to the public every Thursday at dusk; other visits can be arranged by appointment. See the website <www.aiub.unibe.ch/stw/Muesmatt>.

** Their address in 1960 was Friedeckweg 24 (which no longer exists), bordering on Monbijou Park. The Houtermans later moved into a two-family house a few streets farther south at Sulgenauweg 32. Their son Heinrich was born in 1956.

*** For current research being conducted at the various physics institutes, see the University of Bern's website <www.unibe.ch>.

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Titles on Toilets

H.B.G. Casimir told the following story about Houterman's propensity for teasing:

> He also pointed out that before World War I a coachman in Vienna would address a fare from whom he expected a generous tip as "Herr Baron." In the twenties and early thirties intellectuals were appreciated, and passengers became "Herr Doctor." But since World War II we live in an executive age, and consequently cabdrivers now use "Herr Direktor" as the preferred form of address. I wonder whether he was in league with Pauli to pull my leg? Anyway, he continued: "Words originally designating members of the aristocracy, like *Messieurs* in French or *Gentlemen* in English, in the long run find their way to lavatory doors. How pleasant it would be to live in a world where every loo is inscribed *Directors*!"

Hendrik B.G. Casimir, *Haphazard Reality: Half a Century of Science* (New York: Harper & Row, 1983), p. 221.