# ASTROPHYSICS IN POTSDAM

## Reports and memories 1874 - 1991

**Günther Rüdiger**

# I How astrophysics came to Potsdam

## 1 Carrington: "What is a Sun?"

The binary star researcher William Herschel in Slough was also an enthusiastic sunspot observer. In 1801, twenty years after his discovering of the new planet Uranus, he presented careful observations of the sun's surface in a detailed study because "it becomes almost a duty for us to study ... the solar surface."[1] With precise drawings of the "openings", he documented his particular interest in the occurrence of sunspots, even over longer periods of time, convinced of their influence on the global weather and food production. Due to a lack of climate data, he used the grain prices compiled by Adam Smith and, as suspected, found high prices when the sun was spotless - and the sun was spotless more often, at least in the past: "The historical material contains 5 irregularly spaced and unequally long periods without sunspots. The first lasted from 1650 to 1670. The next ... lasts until 1684 ... One spot in 1710, none in 1711 and 1712 and another in 1713 ... Remarkably, after this time there were never again no spots." Herschel would certainly have found the 11-year sunspot cycle if the sun had not happened to be in a grand minimum of its magnetic activity during his inspections. To him, the spots were randomly appearing openings in the sun's atmosphere - revealing the dark solar body below - and a periodic variation in their occurrence would have seemed without sense. After all, he had been observing the surface of the sun for 40 years, just as Samuel Heinrich Schwabe later did.[2]

Rudolf Wolf in a "Lecture to a mixed audience", found Herschel's opening model appealing, especially as the dark core of the spot, the umbra, really did appear to lie below the surface of the sun, but destroyed with statistics the idea of a correlation between spot frequency and weather. Around 1861, his compiled sunspot collection included observations "for 2143 days from the 17th century, 5490 days from the 18th century and for 14,860 from the current century." Wolf must have been very fair and the postal deliveries must have been very fast and reliable. Just a few months after its publication, he circulated the latest spectacular results from the private astronomer Richard Carrington in Redhill near London. Carrington had determined and calculated thousands of positions and proper motions of the spots in longitude and latitude with his telescope of only 12 cm aperture since 1853, for which he first had to determine the position of the sun's axis of rotation. He found the differential solar rotation as in his plots the daily rotational motion clearly depended on the solar latitude. Before his publications "there was still not

[1] Herschel (1801).
[2] For details of data collection and rating of the solar observers see Arlt & Vaquero (2020).

the smallest suspicion that the differences of period observed … depended in any way on the latitude of the particular spot."[3] He also realised that sunspots were never visible at the equator or the poles. They only appeared in belts between 6° and 35° north and south latitude, which themselves slowly moved towards the equator and eventually disappeared there. "Whether this is what occurs at each period of increase and decrease of the frequency of the Spots must be left to observers who may follow me to show. At present it is only probable that such is the case, and another contribution made to the facts … will ultimately elucidate the origin of this phenomenon and instruct us on the question, 'What is a Sun?'"[4]

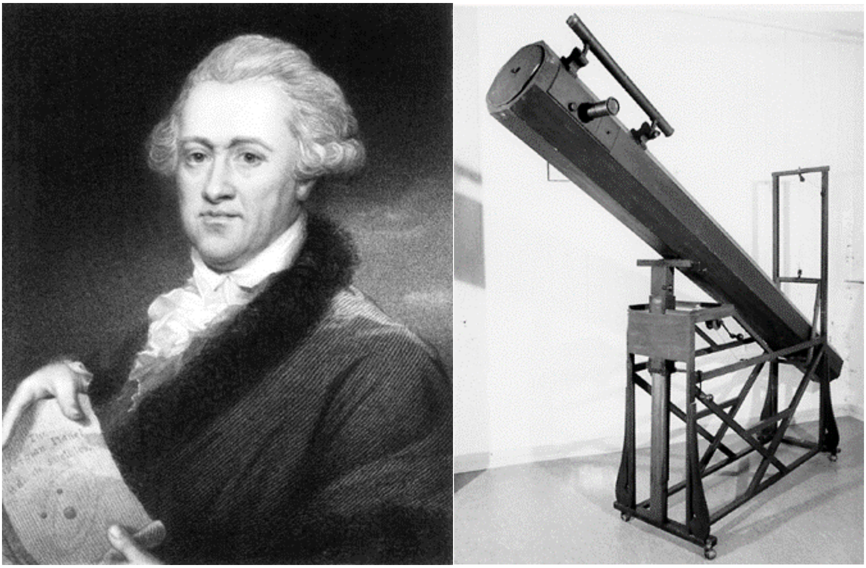

Fig. 1 left to right: Friedrich Wilhelm Herschel (1738-1822); Herschel's 10-foot telescope (22-cm metal mirror); the sunspot observations published in 1801 were made with such an instrument. Photo Universitätssternwarte Göttingen.

[3] Carrington (1863).
[4] ibid.

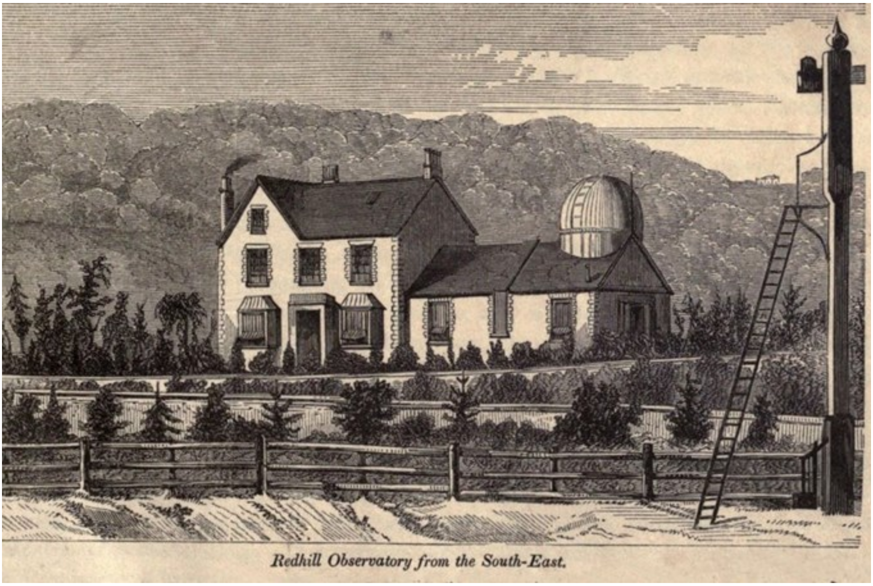


Fig. 2 Redhill observatory of Richard Christopher Carrington (1826-1875), of whom neither a photograph nor a portrait seems to exist.[5] Even the obligatory painting from the Royal Society's collection is said to have disappeared at some point.

Carrington was highly interested in the sun's variable surface: "The observation of the stars requires the hours of the night and afforded little matter of speculation; the observation of the Sun was a day-task, and presented more variety and interest."[6] He made two fundamental discoveries in the early solar physics in just seven years of work: the non-uniform ("differential") rotation of the solar surface and the latitudinal migration of the spot zones. The fact that the sun does not rotate like a rigid body but that the equator regularly overtakes the polar regions, is said to have changed the image of the sun more drastically than the discovery of the Fraunhofer lines.[7] A giant pensum, as if it had been too much: four years later, he fell ill and died at the age of 49, just a few days after his wife in the same year as the aged Schwabe[8] to whom Carrington had brought the medal to Dessau in 1857,

[5] Cliver (2005).
[6] See "Richard Christopher Carrington (obituary)", Monthly Notices of the Roy. Astron. Soc. 36, 137 (1876).
[7] Clerke (1887).
[8] Schwabe died in 1875 at the age of 86.

which the Royal Society had awarded to him. Despite his immense successes, he was never granted a position as a professional astronomer - probably for personal reasons - even though there were vacancies in Oxford in 1859 and Cambridge in 1861.[9]


Fig. 3 left to right: Samuel Heinrich Schwabe (1789-1875). Dessau, Johannisstraße 18, roof astronomy with unexpected consequences.

The unhappy pharmacist Samuel Heinrich Schwabe in Dessau had already achieved his masterpiece in the 1840s. The young Schwabe, during his school days, "assisted his father with operations and to glue bags for his grandfather".[10] Wolf about his faded colleagues: "While Schwabe's predecessors ... *either* neglected to draw a complete picture of the sun day by day, and mostl*y* proceeded from the opinion that it was only strange if the sun showed many spots, he did not let a day go by for 35 years[11] without making sure whether the sun showed spots or not ..."[12] Schwabe's preference for annual accounts had snatched a well-hidden law from the heaven which many observers could have found it.

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[9] Cliver & Keer (2012).
[10] Wolf (1877), Schwabe's father Johann Gottlob was a doctor, from his grandfather Joachim Heinrich Häseler Schwabe took over the pharmacy in 1812.
[11] First observation on 5 November 1825.
[12] Wolf (1861), p. 15.

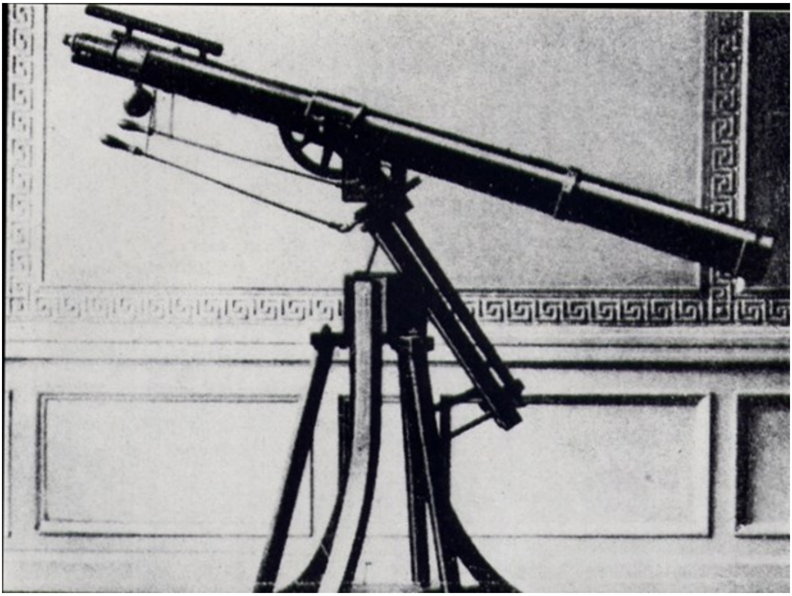

Fig. 4 The larger of Schwabe's two instruments (magnification 64) from Lohrmann, Dresden. Schwabe used filters from Fraunhofer, no projection (information from R. Arlt). Photo from about 1925.

At the beginning of his records, in 1828, Schwabe had seen sunspots on every observation day, then less and less frequently, five years later only every second day, but in 1837 again daily. After another five years, in 1843, there were only a few again. He always wrote everything down in extensive annual diaries, even if he saw nothing. Should a particularly large number of spots cover the sun every ten years? He had only really seen one single maximum, that of 1837. The rise was missing to the 1826 maximum, Schwabe was careful, he couldn't be wrong, otherwise the palace administration, from which he lived, might abandon the salary. On the other hand, it would be a huge task to find a real law of nature, it was too tempting and as a trial he wrote that the sunspots "have a period of about 10 years." His talents had ever been his sense of order; would anyone believe that he had found a clock in the sun? Just a few sentences for the Astronomische Nachrichten in Hamburg-Altona: "If one now compares the number of groups and the number of spot-free days, one finds that the sunspots had a period of about 10 years ... The future must teach us whether this period shows some consistency."[13]

[13] Schwabe (1844). The cycle lengths varies from 9 to 14 years, with a numerical average of 11 years.

Cautiously to Humboldt: "I have not had an opportunity to become acquainted with older observations in a continuous series, but I readily agree with the opinion that this period itself may again be variable."[14] While the original communication in the Astronomische Nachrichten was mainly ignored,[15] Humboldt's assistance - he presented Schwabe's countings in his "Cosmos" in 1850 - brought the desired acceptance. It was at the end of 1868,[16] when he was no longer able to climb his rooftop observatory, that he had to cease his observations, after more than 40 years of "Keplerian faith in the laws and order of Nature." [17]

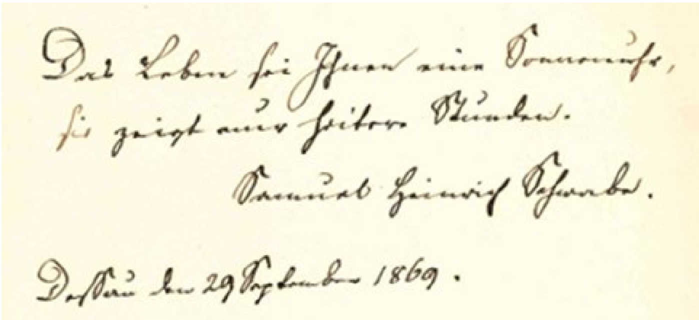

Fig. 5 Manuscript from Schwabe's 80th year after the end of his observations: "*Life be to you a sundial, it shows only cheerful hours. Samuel Heinrich Schwabe. Dessau 29 September 1869.*" Source: Dessau-Roßlau Stadtarchiv.

# 2 Maunder´s Minimum is from Spörer

## Escape north

In the fall of 1864 during the German-Danish war a 16-year-old boy received a provisional certificate from the reform grammar school in Anklam because his widowed mother could no longer pay the school fees. The certificate was mediocre: "from maths he had geometry up to the theory of similarity, arithmetic up to simple equations", but "for drawing he always showed a lot of participation and skill." Later, the school will be proud to carry the name of this student, and a

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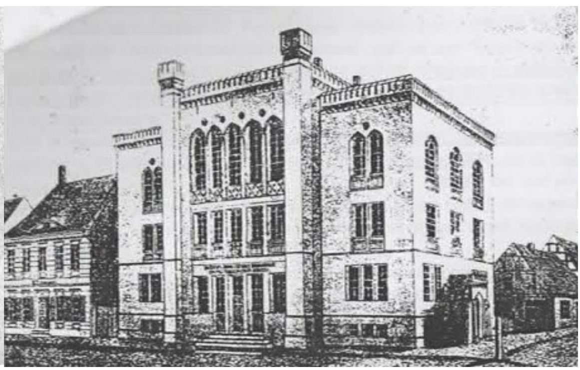
[14] Humboldt (2004), volume III, p. 543.
[15] The first citation of this paper in the Astrophysics Data System (ADS) dates from 1948.
[16] More precisely: on 15 December 1868 (information from Rainer Arlt).
[17] Clerke (1887).

personal museum in Anklam will exhibit glorious proofs of his genius. The student, Otto Lilienthal, travelled to Potsdam to the much cheaper, more craft-oriented Provinzial-Gewerbeschule,[18] which he graduated from after two years, before going on home back to start flight experiments that would later, in his 48th year, costs his life.

The Hanseatic town Anklam had only been connected to Berlin and Potsdam by the Stralsund railway the previous year. The King came from Potsdam to the inauguration of the new railway station in March 1863, the whole town was on its feet, the younger pupils sang and the grammar school students threw their caps in the air, and the largest ship ever built in Anklam was launched in the shipyard. Lilienthal's maths teacher Dr Spörer[19] from Berlin, who did not always understand the idiom of his student, had been awarded the title of professor in the same year, fifteen years after he had become a substitute teacher at this gymnasium at 1849. It was only the previous year that the school, which had started teaching with five particularly ambitious teachers and 300 students, had been granted the full rights for high-schools.

Spörer had received his permanent position at the school in November 1853 as a widower. At the age of thirty, he had married a daughter of a medical officer from Magdeburg, Louise Auguste, who died immediately after the birth of her daughter Marina Luise – Spörer´s first marriage had only lasted the nine months of pregnancy.



[18] Today Humboldt-Gymnasium Potsdam.
[19] In numerous documents from the 19th century, including private ones, the spelling is "Spoerer" instead of the "Spörer" used today.

Fig. 6 Gustav Spörer as a teacher; gymnasium in Anklam, built in 1850/1851 (right). Archive W. Hornburg.

In addition to the 13 lessons a week for maths and 6 lessons for physics, Spörer still found time to write a treatise on his teaching concept, which he presented to the school management in January 1855.[20] "Mathematics is not learnt so that one can solve equations ... which relate to practical conditions…. By introducing the student to maths, he is ruled to move in abstractions." This was followed by a detailed description of his personal curriculum from the Quarta to the Prima. "At some gymnasiums, differential calculus is also taught in the Oberprima: I doubt whether it is to the benefit of the students, … I started with it once in the primary, ... but after only six lessons I was fully convinced that too many were unable to follow." The diplomatically formulated letter seems to have been liked in Anklam and Berlin. In Spörer's 34th year, students and parents were informed that on 31 May 1855 "the mathematician Dr Spörer in recognition of the pleasing success of his activities received by the Minister von Raumer the title of Oberlehrer."[21]

"Tests that I have to correct at home will only be delivered from secondary school onwards," is announced in his instructions for maths teachers. With almost no class work to correct and only 19 lessons a week on 6 school days, he must not have been working too hard. Without differential and integral calculus, all that remained was geometry, simple algebra and trigonometry, all of which he had learnt from Professor Encke at the observatory in Berlin as the necessary tools of the astronomers[22] he certainly had not to prepare for his lessons. After three years of study, he graduated in 1843 at the age of just 21 with a numerical dissertation on a comet's orbit. "Until the autumn of 1845, Spörer was assisting at the Sternwarte Berlin, but as there was no hope of being employed in Berlin or at another observatory, he took the examination pro facultate docendi,"[23] the teaching licence. The disappointment of not being able to work as an astronomer must have shaken the high-talented graduate to the core; he decided to get away from universities and academies, at least far away from Berlin. In order to find a job as a gymnasium teacher, he turned northwards – maths teachers were always in demand – and settled in Bromberg and Prenzlau, but in 1849 he found a job even further north, initially a temporary one in Anklam. This escape, however, will bring him back to the Prussian capital decades later with his then extended family in triumph.

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[20] Spörer (1855).
[21] Sommerbrodt (1856) p. 23.
[22] Later compiled in a printed booklet, Spörer (1870).
[23] Lohse (1895).

Even during Spörer's first student year of astronomy, K. H. Schellbach became a professor of mathematics at his former Friedrich-Wilhelm-Gymnasium in Berlin, one of the leading secondary schools in Prussia. Schellbach founded – if he had read Spörer's tractate – a (short-lived) pedagogical seminar in 1855 to train young mathematicians for school teaching in order to raise mathematical and scientific education to the level of language teaching. Higher ambitions in education, such as those of the Fröbel reforms in Thuringia, were still a long way off in Prussia. Schellbach later led the crown prince Friedrich[24] privately in the natural sciences – often in the presence of the interested mother.[25] Astronomy was also part of the programme "since the discovery of spectral analysis by Kirchhoff and Bunsen in 1861 ... the study of the sun's surface has provided more and more results. Professor Spörer in Anklam was mainly concerned with the study of sunspots and prominences. But his optical apparatus was not powerful enough to work quickly and successfully. As a result, our crown prince decided to give Professor Spörer a larger telescope."[26] Already in 1863 there had been activities to give Spörer a *"7-foot Fraunhofer telescope"* from the *"physics collection of the local university."* The administration, however, had a bouquet of its timeless concerns against this plan: does a teacher have enough time to use the telescope regularly, is there a suitable building in Anklam with a diameter of at least 12 feet, who will pay for the metal tripod? The argument still often used today, that somebody "*who has so much scientific success will hardly stay in Anclam for long, as it must be his ambition to move to a larger town*",[27] was possibly invented on this occasion.

## Anklam is a sunny place

The gymnasium – probably at Spörer's suggestion – had already applied for a grant from the Anklam town for a high-quality school telescope from Steinheil in 1860 and received the full amount, so that a tripod could be financed separately.[28] It was a 3½-foot refractor[29] with a circular micrometer, just right for determining the exact location of sunspots. Spörer as a teacher only had time in the afternoons, and he had heard about the Schwabe-cycle and also about Carrington's existential problems who had to stop working and sell the observatory. Solar observations

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[24] Often also called Friedrich Wilhelm, later Kaiser Friedrich III.

[25] Queen Augusta of Sachsen-Weimar-Eisenach, educated in Weimar.

[26] Schellbach (1890), p. 19. The donation consisted of the balance of the costs.

[27] GStAPK File I. HA Rep. 76, Va Sekt. 2 Tit. VII No. 14 Vol. 2. Texts from archival documents are italicised throughout.

[28] Gymnasium zu Anclam 1861 "Invitation to the public examination of all classes", Anklam: W. Dietze, 1861.

[29] More precisely: 42″ = 106 cm focal length, just under 3″ = 7.6 cm aperture (33 lines). A letter reports that he also privately owned a 2½-foot refractor.

were thus Spörer's only realistic way of staying in astronomy; it was also obvious to perfect the measurements of the sunspot coordinates in order to "make a contribution to determining the rotation of the sun", Carrington's discovery[30] of the migration of the two spot zones to the equator and to determine the still unknown proper motions of the sunspots. He wanted to do this after class, when the majority of his fellow teachers had gone to bed after lunch. All he had to do was to cross the empty market square,[31] which was a hectare in size, to the old Anklam hunger tower, which had been given a new staircase and on which a glazed round building with an easy-to-open south-west side had been built around a massive tripod. This was his observation station for a decade and a half, which had to withstand many storms. The telescope only began to shake in strong southerly winds, while the tower walls were thick enough to absorb the vibrations caused by road traffics. The city, "*guided by its interest in science*", had the half-ruined tower carefully restored "*for unlimited use*" at its own expense. The observation pavilion, which was firmly connected to the new ceiling construction, had been built at ground level as an enclosure for the school telescope. Soon Spörer noticed that Anklam with the nearby island Usedom was one of the sunniest areas of Germany and thus quite suitable for solar studies.

[30] Carrington (1859a).
[31] The famous Gothic town hall together with surrounding buildings were demolished in 1842 on the decision of revolutionary young delegates without any idea of a successor building.

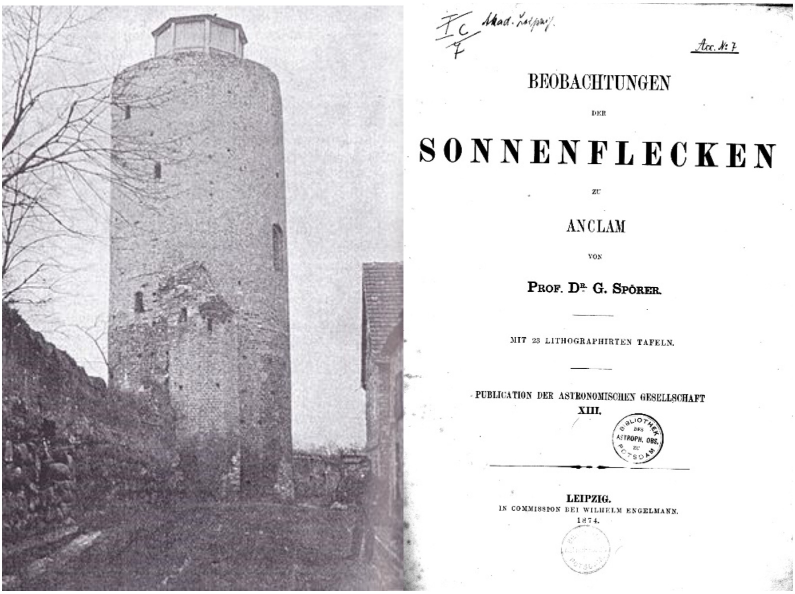


Fig. 7 Hunger tower in Anklam with self-made professional solar observatory; publication no 13 of the Astronomische Gesellschaft with Spörer's results (right).

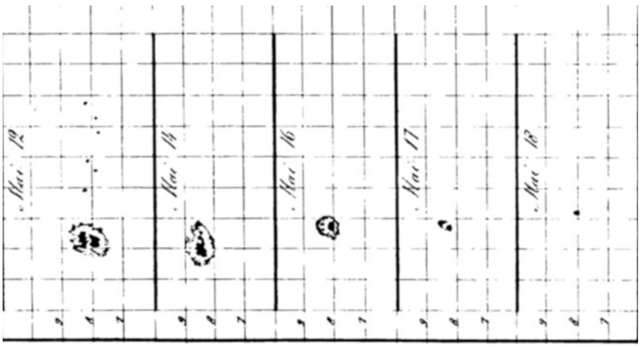


Fig. 8 Decay of sunspots (from left between 12 and 18 May 1877) ignored by Spörer and his successors. Publ. Astro. Obs. 5, Vol. II, plate 22 (1880).

Spörer´s observations in December 1860 coincided with a spot maximum, so that the rich yield of the observation campaign must have facilitated the support of the school management and the help of students. He published very detailed observation results in the annual programmes of his gymnasium[32] – certainly not against the will of his rector. At the beginning there were many spots to be seen, almost all of which appeared about 16° north or south of the equator. Five years later, there were only a few spots left, and they all appeared very close to the equator. Carrington's law of equatorial spot zone migration was thus confirmed for the southern and northern solar hemispheres of the new solar cycle.[33] Both observers had noticed almost simultaneously that the spots near the equator rotate faster than those further away from the equator. Just six months after beginning of his campaign, Spörer wrote: "Of the spots listed above, those belonging to an equatorial zone therefore have a smaller rotation time than the others"[34] and this is also what it says in his very first astronomical publication.[35] A furious start of the new part-time astronomer, who was 40 years old and found the fundamental law of star surfaces to rotate differently from a rigid body. Spörer also tried out the simplest trigonometric expressions for the newly discovered rotation law, but could not decide between cos(*b*) or cos(*2b*) for the angular velocity of rotation.[36] He described equatorial westerly storms and easterly storms at higher latitudes, which may drive the cloudy patches, and also their individual latitudinal and longitudinal motions of both signs did not remain hidden from him. It was probably because of these random velocities that Spörer had not been able to explicitly write down the sun's law of rotation in its later valid form, despite his enormous archive of data.[37]

Schellbach continued to inform the crown prince about Spörer's discoveries. Whether the information from Anklam to Potsdam went directly or via Wilhelm Förster[38] has remained unknown. In a surviving draft of a letter dated 15 December 1863 to a "*High Ministry*", Spörer complained that a "*telescope such as I now have at my disposal, namely a 3½-foot telescope belonging to the gymnasium, is far from sufficient for the faint edge of the sun*." With regard to sunspots, "*it should* be *noted that their observation and description* have *been undertaken many times, but always too little* has *been measured.*" The most careful measurements would

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[32] Spörer (1862).
[33] Was often called "Spörer's law", today rather "butterfly diagram".
[34] Spörer (1861).
[35] Spörer (1862).
[36] *b* is the heliographic latitude. The difference can hardly be seen in the data from 1860 to 1866 due to the proximity of the spots to the equator. Later Spörer stated that he had seen the maximum latitude of a spot as 40° in 1869. The data provided by Carrington and Spörer from the spot's proper motion are almost identical, although they were derived in different decades (Kempf, 1916).
[37] R. Carrington gave the expression $\cos^{7/4} b$ for the variation of the solar rotation with latitude in a short communication in 1862 (MNRAS 22, 300) close to today's formulations with $\cos^2 b$ and $\cos^4 b$. In an earlier statement he wrote, "there is an equatorial current causing spots to move in the direction of solar rotation", without talking about latitude-dependent rotation (Carrington, 1859b).
[38] Herrmann (1975). Often one finds "Foerster" instead of Förster.

be necessary in order to be able to judge the nature of the sun. The advertising was successful: in the second paragraph of the summary of the Anklam results[39] it is said that "in 1865 I received a 7-foot telescope,"[40] with which "now the locations of the more important spots ... could be measured with sufficient accuracy."[41] The prince had paid for an instrument from the famous factory of Steinheil & Sons in Schwabing. Spörer will transport it to India for the solar eclipse in the summer of 1868 and later took it to Potsdam, where it would remain in service for decades.[42] Because of the solar eclipse, it had received a new, "excellently crafted tripod with clockwork" at royal expense.[43]

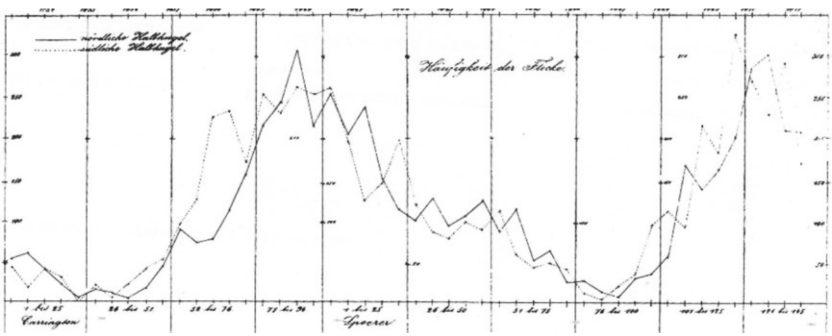

Fig. 9 Anklam sunspot statistics for 1854 - 1871 with the northern and southern hemispheres separated. Spörer (1874).

## Rainfall eclipse

Immediately after receiving the new telescope, Spörer wrote a letter to the director of the Sternwarte Berlin, Wilhelm Julius Förster, the successor of his doctoral supervisor Encke. Förster was then the secretary of the Astronomische Gesellschaft founded 1863 in Heidelberg on his initiative and that of his former student Carl

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[39] Spörer (1874). The publication contains 140 pages of figures in several columns, typical of Spörer and the later publications at the AOP.
[40] Focal length 213 cm, one often finds the wrong year 1868 for the donation. In the following year (1866) Prince Friedrich will be militarily successful as commander of the 2nd Prussian Army at Königgrätz.
[41] Aperture 13 cm, focal length 210 cm.
[42] In the east dome of the main building of the AOP, together with a large spectroscope for prominence observations. From 1908, the so-called Zeiss-triplet (15 cm refractor) for photographic-photometric tasks.
[43] Spörer (1863).

Bruhns, now in Leipzig, in accordance with Saxon association law.[44] 26 astronomers had gathered in Heidelberg for the founding, and membership grew to 149 men in the same year,[45] including Spörer who, however, was only rarely able to attend external meetings due to teaching commitments. At the first meeting in Leipzig at the end of August 1865, Förster informed the audience of a "letter addressed to him from our member Prof. Spoerer in Anklam."[46] The letter concerned a proposal following from his sunspot asseverations to set up a special institute to study the nature of the sun. Prof Spörer asked the society to declare itself in favour of the necessity of such a "solar observatory", where photometric and spectral observations should be systematically carried out in addition to measurements and recordings of the spots.[47] The assembly "agreed, expressing the wish that Prof. Spoerer may soon be put in a position to continue his work under even more favourable conditions." Not a very promising result, except that from now on his name was known to all German astronomers.

Nevertheless, an angel had guided Spörer's hand. In May 1868, following a petition from a member of the Astronomische Gesellschaft to the Reichstag of the newly founded, short-lived and Prussian-dominated North German Confederation based in Berlin, the Reichstag decided to finance a North German astronomical expedition to distant regions to view the total solar eclipse on 18 August of the same (!) year with federal money. Professor Spörer from Anklam was to lead the eight participants nominated by the board, half of whom were to travel to Aden in Yemen and half to Mulvad in the Middle East due to the weather risks. The majority of the teams were from Berlin, supplemented by one participant each from Anklam, Leipzig and Bonn. The Reichstag had commissioned Professor Förster to submit a concept and a cost estimate. It would be necessary to "set up the finest measuring equipment for spectral analysis and the use of photography" and this equipment would have to be purchased. He entitled the costs "for the entire photographic apparatus, for the spectral apparatus and for the new mounting" of the existing telescopes to 5200 Thlr, 9700 Thlr were the travel expenses and 1000 Thlr needed for the preparations, total costs are 15900 Thlr. The chancellor of the North German Confederation immediately replied: "I am pleased to inform the board of the Astronomische Gesellschaft ... that the governments of the North German Confederation have decided to grant the project ... ... in the total amount of 16,000 Thlr." [48]

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[44] Headquarter in Leipzig.
[45] The "constituent members", see Schielicke (2013).
[46] The original letter could not be found to date.
[47] Vierteljahrsschrift d. Astron. Ges. 1, 4 (1866).
[48] Vierteljahrsschrift d. Astron. Ges. 3, 186 (1868); one of the first grants for a scientific project in Prussia. The first and last Chancellor of the North German Confederation was Otto von Bismarck.

However, there were only 4 (!) weeks left until departure, and some board members refused to support this adventure. In fact, the spectral equipment had arrived too late, so that the necessary adjustment of the devices and training of the observers was hardly possible. The expected eclipse times at the expeditions' destinations were only 3 or 5 min[49] minus the excitement of all participants, which, as experience had shown, always occurs.

Spörer's absence from his gymnasium "because of leading a scientific expedition" lasted from 4 July to 12 October 1868. The journey began on the evening of 8 July in Berlin by train to Trieste, from Trieste by ship to Alexandria, by train with a stop in Cairo to Suez - the Suez Canal was not opened until the following year - and by steamship to Mumbai, arriving on 30 July. The expedition reached its destination by train, camel and ox cart more than four weeks after the start of the journey.[50] The jungle tour with heavy luggage was an organisational challenge that could only be overcome with the help of numerous local staff. It permanently rained until the day before the expected eclipse, but the pillars still had to be built, the observation huts for the instruments erected and the tents set up for the people. The morning of the eclipse day was initially cloud-free, but 10 min before first contact the sky closed in again and at 7.50 a.m. the eclipse began unnoticed. But in "a gap in the clouds, the corona suddenly appeared in the sky, surrounding the lunar disc as a dimly shining radiant wreath. ... In a very short time, I had firmly memorised the image of the corona." Spörer saw a large eastern prominence through his eyepiece and, as his personal main result, could measure its height; his colleague Tietjen saw prominences on both the eastern and western edges of the sun; spectral images were completely omitted in the rush. According to Spörer it was now certain that the prominences belonged to the sun and were not phenomena of the earth's atmosphere. Not a single photo from this expedition exists; all expedition photographers had been sent together to the parallel event in Aden.

Other observers had more success. A thousand kilometres of the German base camp, on the east coast of India, the French expedition had caused the sensation of the 1868 eclipse campaign. Their spectral apparatus showed a yellow line near the wavelength of sodium for the prominence at the edge of the sun, which was all the more extended the more radially the slit was orientated. In contrast, the line was only very short when the slit was directed tangentially to the solar limb; the prominence apparently had the shape of long radial fingers of unknown temperature. Janssen repeated the observation the next day and saw the prominence again in the light of the yellow spectral line, even without eclipse. The line, as it later turned out, belonged to an element still unknown on Earth and was named

[49] It was a particularly long eclipse with maximum of 6 min because the moon was close to the Earth.
[50] Spörer (1869).

"helium".[51] "Hence, the total solar eclipse of 18 August 1868 produced far more important results than any of the former expeditions."[52] The German Astronomical Society summarised that "the overall success of the North German expeditions cannot be considered satisfactory." Nevertheless, "the spectral apparatuses brought along were such that under more favourable weather conditions the important discovery of the typical character of the prominence spectra could not have escaped our observers." After his return to Anklam "on 12 October, colleagues and students greeted him with joy"; in his school speech the previous year, the director only had to remember the four former pupils felt at Königgrätz and otherwise the victims of measles and cholera.[53] At the end of the 1868/69 school year, Professor Spörer was elected to the vacant position of the prorector. From then on, he had to accompany the students of the upper classes on their annual trips to the islands of Usedom and Rügen, probably secretly hoping for rain so that he would not lose any worth observation time.

## What is astrophysics?

In the course of formation of the Deutsches Reich at the beginning of 1871 almost 2 billion marks had flushed to the former North German Confederation, Prussia's Wilhelminian time began and prince Friedrich could start to realise his cultural and scientific projects. At Schloss Babelsberg, people remembered the restless solar observer in Anklam, his unhappy Indian expedition, but even more his idea of founding a new solar observatory near Berlin. Wilhelm Förster[54] had originally envisioned a newly founded observatory "near Potsdam" as a spin-off of his own observatory, because in Berlin "cloudiness from smoke and dust", vibrations due to the poor paving and rising air currents "have made the conditions under which the Berlin observatory has to work in the city centre increasingly unfavourable."[55] In October 1871, Friedrich had unambiguously written to the responsible minister that he would personally pursue the "*speedy realisation*" of such plans.

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[51] Norman Lockyer also found the unknown solar line without an eclipse in 1868 and suggested the name "helium'.
[52] Klein (1869).
[53] Gymnasium zu Anclam, "Invitation to the public examination of all classes", Anklam: W. Dietze, 1867.
[54] Wilhelm Förster was a restless founder of institutions and associations: International Commission for Astronomical Telegram Traffic (1882), Physikalisch-Technische Reichsanstalt (1886), Gesellschaft Urania (1888), Verein zur Abwehr des Antisemitismus (1890), Deutsche Gesellschaft für ethische Kultur (1892 (selection). At the same time, he was the Director of the European Standardisation Commission of the Deutsches Reich since 1871 and President of the International Committee for Weights and dimensions since 1891. It is said that his Silesian dialect (Grünberg) could still be heard in his late years.
[55] Förster (1875).

Fig. 10 Wilhelm Julius Förster (1832 - 1921), visionary supporter of solar-telluric physics, in 1880. Source: Wimmer (2004).

Förster had designed a facility[56] for direct, spectroscopic and photographic monitoring of the sun, which would "function simultaneously as a main magnetic and meteorological station."[57] Behind this was his idea that the central – and for a long time the only – object of the newly developing astrophysics was the sun. On the other hand, he early emphasised the importance of solar-terrestrial relationships on when he wrote "that through the changes in the solar body itself, by means of a certain electrical effect, the phenomena of geomagnetism, air electricity and earth currents ... are modified in a considerable way, while the influence of the changing sun on temperatures has so far proved to be small, but should nevertheless provide an important object of research for the future."[58] Förster suggests Spörer who in truth is completely unfamiliar with weather observations, as the director and himself as a member of a supervisory board.[59] Finally, he warned that "England already has something similar established for solar and magnetic observations at Kew near London." Förster later indulgently about the rejection of his concept, "this was indeed a scope of observational tasks that went far beyond

[56] Förster's memorandum only mentions "proximity to Berlin" and "a somewhat isolated hill", which is said to have been a hill south of Berlin close to the Spree River.
[57] Scheiner (1890).
[58] Herrmann (1975) gave the complete memorandum.
[59] At that time, the Berlin observatory was mainly concerned with orbit calculations of minor planets and comets.

astronomy, in that it simultaneously defined the solar observatory as a meteorological and magnetic-electrical central observatory ..."[60] No wonder the Academy "shook its head at the whole project, especially since it was a speciality of the older meteorologists that they did not want to know anything about the intervention of the sunspot and flares in the earth weather conditions ..." He also admitted that the effects he was looking for could be minor and well hidden – so well hidden that such ideas were not taken up again until the next century: in the militarily motivated ionospheric research during the years of the WW II,[61] the establishing of an Institute for Solar-Terrestrial Physics at the Akademie der Wissenschaften zu Berlin and even later in the extensive studies on the influence of cycle-dependent solar radiation on the earth's climate.[62] Nevertheless, almost excessive meteorological measurements were carried out three times a day at 8 different depths during the founding period of the Potsdam Observatory in accordance with the memorandum; they were only stopped (after 17 years) when the newly formed Meteorological Observatory had begun to produce its own data. The printouts of the final 6-year measurement campaign of the AOP contain more than 100,000 three-digit figures on wind, clouds, humidity and above- and below-ground temperatures.[63] It is completely unimaginable that, without electronics, Paul Kempf might find the finest effects such as the influence of sunspot frequency on the ground temperature at a depth of up to 40 m on the Telegraphenberg. He needed own "Publications of the Astrophysical Observatory in Potsdam" to archive the enormous amount of data.

The commission of the Academy of Sciences, which had to comment on Förster's proposals argued in a different direction. For them, solar research was only the beginning of the new astrophysics. In their letter of 29 April 1872, they supported the solar physics part of the Förster memorandum, but saw it only as part of stellar astrophysics, which had recently begun to develop. A second, independent institute was to be dedicated to "telluric" physics, "in order to meet the needs in the field of astronomy and cosmic physics, ... one for astrophysics and the other for meteorology and geomagnetism."

As the two concepts were far apart in magnetism but not in solar research, Förster soon found the solution to finish the debate – which he considered hopeless – on 27 May 1873 by naming Spörer for solar research, and in the spirit of the Academy the most outstanding German observer in the field of spectral analysis, Hermann Carl Vogel, astronomer at the private observatory at Bothkamp near

[60] Förster (1911), p. 138.
[61] Seiler (2007).
[62] Solanki & Fligge (1998).
[63] Kempf (1895). The temperature measurements in the deep well were stopped as early as 1888 due to "thermal disturbances", which is why data are only available for a single solar cycle.

Kiel. Everything now happened very quickly. The Ministry appointed a founding commission[64] chaired by the Academy president, who soon appointed the Bauinspektor Spieker as a trained architect for public building[65]. As early as June 1873, the concept for an "Astrophysikalisches Observatorium" on the Telegraphenberg in Potsdam was ready, of which solar physics is only a part. After the parliament had approved the financing plan[66] in the winter of the same (!) year, Vogel and Spörer as Observators and a little later Vogel's former assistant Lohse as First Assistant were employed – and the road to the Observatory from Potsdam was initially laid out. "Spörer moved with his whole family to Potsdam in the same year[67] and continued observing sunspots with his own instruments on a tower in the city until the observatory was completed."[68] Förster describes the turbulent founding year of 1874, full of activity at his Berlin observatory and on the Telegraphenberg: "Dr Vogel and Dr Lohse are currently at Berlin observatory, where they have also been given rooms for the time being, doing preparations on the large spectroscope by H. Schröder and at the same time, in conjunction with Professor Spörer the care of the facilities of the new observatory."[69]

The Brauhausberg (Telegraphenberg) was just one of several telegraph mountains near Berlin and Potsdam, which carried optical telegraph systems that could transmit messages in a westerly direction from the Sternwarte Berlin to the Koblenz Castle for military purposes. The church in Dahlem was station no. 2, followed by the Schäferberg in Wannsee, the Brauhausberg in Potsdam and the Fuchsberg in Glindow, the latter two of which have been called 'Telegraphenberg' since then. The messages were transmitted from station to station using a kind of flag alphabet, shortened to the actual information, and it was only in the last station that the actual verbose dispatch text 'His Majesty the King rests...' was formulated. The system operated from 1834 to 1850 with an average frequency of 2

[64] Bois-Reymond (Chairman), Auwers, Foerster, Helmholtz, Neumayer, Schellbach, later Kirchhoff, Siemens and Spieker, see Spieker (1879), p. III.
[65] Eggers (1995). For architecture, see Pedde (2023).
[66] Costs without instruments 860,000 M, equivalent to the costs for the entire Technische Hochschule Charlottenburg (Bollé, 1993).
[67] 3 sons, 5 daughters. According to Wilfried Hornburg (Anklam), all of Spörer's sons (Paul *1855, Richard *1860 and Max *1865) attended grammar school in Anklam just until 1874, so that the Spörer family moved to Potsdam at the beginning of July 1874. The first-born Marina Luise Spörer married the assistant and later AOP director Gustav Müller in 1880. The destinies of the other daughters (Clara Charlotte, Anna Marie, Emma Margaretha, Gertrud Adele) are unknown. Spörer's observations in Anklam ended in June 1874. School chronicle: "On 1 July, following a call from the astrophysical observatory to be set up in Potsdam, the prorector of the institute resigned ...".
[68] Vogel (1895).
[69] Förster (1875).

transmissions per day.[70] The invention and rapid development[71] of electric telegraphy made this elaborateed Prussian communication project an episode, and only a name for the location of the Royal Observatories remained.

Gustav Kirchhoff in Heidelberg had declined the directorship in Potsdam, stating that he preferred to develop "mathematical physics". He had founded spectral analysis with Bunsen in 1861 and was the first choice of the commission. The two observers were thus placed under the supervision of a technical and administrative directorate[72] until 1881, either because there was disagreement or because there were initially doubts about the newly appointed staff. In fact, the imposing Direktorhaus belonging to the observatory was only built later, after Vogel's final appointment as director on 1 April 1882 - in a different location to the one intended.[73] Vogel lived there from around 1885 with two housekeepers and three dogs replacing the missing family. The house had been built according to the specifications for a Preußischen Rat erster Klasse, so it had a representative room with a floor area of 48 $m^2$, a ceiling height of 4.20 m and a huge double door,[74] in which possibly only a handful official receptions ever took place, e.g., that of the Kaiser Wilhelm for the inauguration of the Great Refractor.

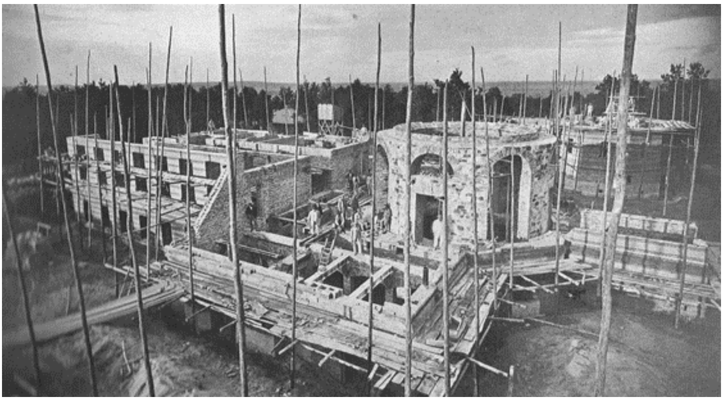

Fig. 11 Main building in construction, 1876. From Eggers (1995).

[70] Arlt (2007).
[71] England was connected to the continental telegraph network as early as 1851.
[72] Auwers (managing director), Förster, Kirchhoff (from 1875 as professor of theoretical physics in Berlin).
[73] Spieker (1894), construction drawings from 1887 under https://architekturmuseum.ub.tu-berlin.de/index.php?p=79&POS=15.
[74] Information B. Eggers.

Fig. 12 Main building of the Astrophysical Observatory from south. The bricks came from regional factories, the foundation walls and stairs (sandstone) from Wefensleben and the clinker from Siegersdorf/Bunzlau. Middle dome 10 m, original status with heliograph in the centre. Photo AIP.

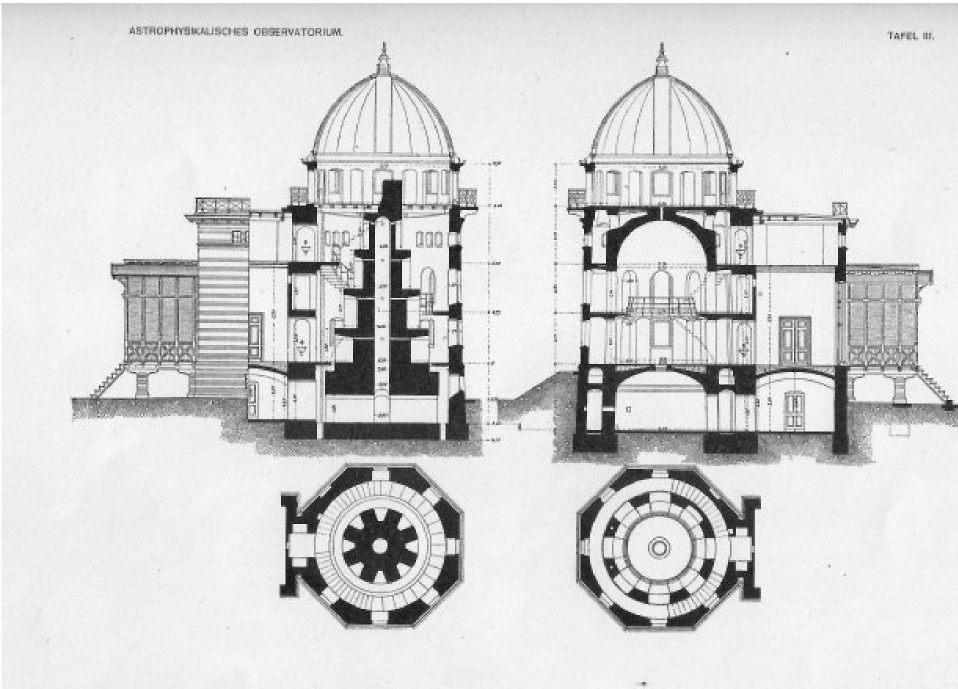


Fig. 13 West dome (own telescope fundament) and east dome (right, no telescope fundament), both 7-m-domes were initially used for solar observation. In the lowest round room under the east dome (due to the particular rigid masonry) , A. Michelson after consultation between Helmholtz and Vogel in 1881 operated his famous experiment which ruled out the existence of a stationary ether.[75] Michelson was enrolled at Berlin University at the time, and the interferometer was built by Schmidt & Haensch in Berlin.[76] Source: Scheiner (1890).

The buildings of the Schinkel school of long-living construction by the architect Paul Spieker are easy to find out. They have almost always yellow brick structures with red stripes and arched windows, occasionally with pillars. He also built the Plötzensee prison, a laboratory on the site of the Universitätssternwarte Berlin, the university library and two institute buildings, the latter almost parallel to the complex on Telegraphenberg. His plan for the Potsdam observatory ground was as simple as it was ingenious. Naturally, the telescope domes for the instruments

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[75] Shankland (1982), originally the experiment has been considered as failed.
[76] Bleyer et al. (1979), Auth (1982).

were to be located at the highest points of the hill[77] and the necessary deep well[78] – an almost invisible masterpiece – including the gas station at the lowest point. The observatory had its own electricity generator and its own water. The residential buildings for the director, observers and assistants were located halfway up, with separate access and exit roads. The concept also included a fence with dense hedge planting as far away as possible from all the buildings to hamper possible disturbances. The three large domes, which stand in an exact east-west direction, were to be located at some distance from each other, were to be accessible from one another on several levels, on the lower level through walkways with open round arches. They form the south wing of the main building, for the construction of which a massive earth wall of a forgotten defence line from 1813 had to be removed first. The north wing is centred along the meridian and contains three huge offices on the main floor, connected to a modern air heating system. The north entrance is crowned by an imposing water tower with an internal iron spiral staircase, visible from afar, which is accompanied by a similarly designed, slightly minor tower of the Direktorhaus.

## Arrival of the observers

The water supply and the residential buildings for the observators, the assistant, the institute's servants and the machinists were completed at the end of 1878. First Spörer then Vogel, Lohse, the servant Doll and the machinist Meier had moved in. The construction of the main building was behind schedule, but "individual parts of the building complex had already been in use since October of that year",[79] the entire building was only completed and handed over in the spring of 1879. The three scientists appointed Vogel as their speaker and Spörer as the person responsible for the instruments and books, certainly a preliminary decision on the future structure. Spörer "endured all the mutations of life with an indestructible calmness, and always soon returned to business as usual, i.e., to his studies of the sun",[80] is how Lohse describes the atmosphere on Telegraphenberg. From the summer of 1877, Vogel had Gustav Müller[81] as his personal assistant, with whom he had

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[77] 64 m above the Havel and 91 m above sea level.
[78] Several lockable copper tubes for holding thermometers lead from the 48 m deep well with its surrounding spiral staircase; at a depth of 24 m the shaft leads into an 8 m long test chamber. The well house above ground allowed for pendulum tests.
[79] Spieker (1879).
[80] Lohse (1895).
[81] Born in Schweidnitz, director of the observatory 1917-1921, married to Marina Luise née Spörer (1853-1885); their daughter Gertrud becomes the wife of Gustav Eberhard, his niece Käthe Müller marries the observator Hans Ludendorff in 1907.

previously worked at the Sternwarte Berlin, and after a further year, Paul Kempf, also from Berlin.

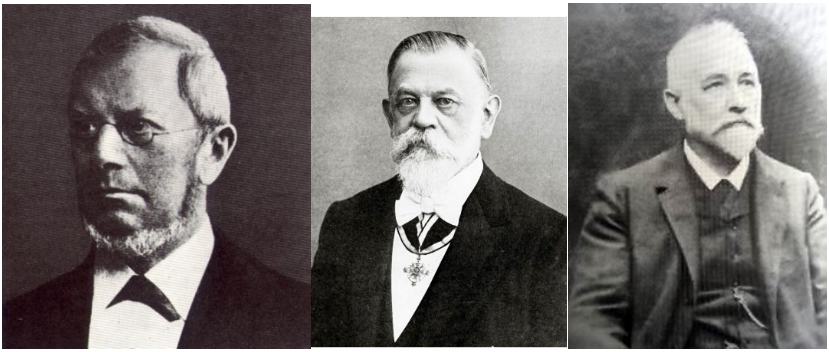

Fig. 14 The first residents of the Telegraphenberg near Potsdam, left to right: G. Spörer (1822-1895); H. C. Vogel (1841-1907); O. Lohse (1845-1915).

"For the work of Professor Spörer an assistant has not yet been employed in the past year," wrote the directorate in the 1877 annual report to the Minister of Education. In the half-completed institute, he continued to do what he had already done in Anklam, still using his own instruments.[82] Already in November 1870 he had received a spectral apparatus in order to be able to see the solar prominences in the light of their yellow line, but "only made a few observations in winter," although the sun was at its spot maximum. For the first time his own prominence observations happened during autumn 1871: "Flaming prominences followed Sept. 6 southeast of the location of the minor spot ... and reached as far as the area of the following group."[83] He observed the sun on 229 days in this year, whereby it remained spotless on 103 days, was reported to the Ministry for 1877. The heliographic coordinates were calculated and averaged for the spots registered in projection. The spot zone had always slowly moved equatorward over the course of the 11-year cycle. The year 1877 was probably unfavourable for the observation of prominences. A single "prominence, observed in June 17 to June 20" was reported in detail,[84] later hundreds of prominences were registered annually in the eastern dome, but hardly ever analysed.[85] Still from Anklam, Spörer had published his algorithms for determining the heliographic coordinates, in order to enable

[82] Set up in the east dome after a few intermediate steps.
[83] Spörer (1873).
[84] Astron. Nachr. 90, 63 (1877).
[85] Jahresbericht Potsdam für 1881, Vierteljahrsschrift d. Astron. Ges. 17, 225 (1882), last annual report before Vogel's appointment as AOP director.

observers to make a comparison with his observational results.[86] For demonstration, the positions of some prominence observations by Tietjen and by Zöllner in Leipzig were calculated. Spörer was actually only interested in the feature of prominences occurring also at much higher heliographic latitudes than the sunspots; with sunspots, the law of rotation could only be determined for lower heliographic latitudes.

Since 1881, the southern stem of the middle dome had housed a huge heliograph, the largest of its time with an aperture of 16 cm and a focal length of 4 m, in order to be able to image the solar disc with exposure times of thousandths (!) of a second. "The idea that a fixed installation of the heliograph parallel to the Earth's axis would offer great advantages, tempted Prof. Vogel and myself to work out a project for a heliograph in 1874, which later formed the basis for the realisation of the Potsdam instrument."[87] The sunlight was reflected into the optical system from below and finally reached the very heavy camera at the top. Vogel was convinced – probably in contrast to Spörer – that the traditional projection method was only sufficient for simpler questions of spot statistics, but that more precise findings, e.g., about the proper motions of sunspots, could only be achieved photographically.[88]

On his trip to England, Scotland and Ireland[89] in the summer of 1875, Vogel had seen a "photoheliograph" in Greenwich, the existence of which may have confirmed or even generated his thinking. Vogel had been guided by the "photographic assistant Mr Maunder" through the observatory and had certainly noticed that he had only recently been employed to monitor the sun daily with the heliograph. The solar images had a diameter of 10 cm, the plates were developed wet, but their quality left much to be desired: "The detail, even in the spot groups [of 1869 and 1870] was only slight." In Potsdam, Lohse began taking regular photographs of the sun already in July 1882. He also experimented at this time with perforated photo plates and special emulsions in order to be able to image the chromosphere and corona without the central sunlight, which outshines everything else. At times, the observatory on the Telegraphenberg must have depicted a

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[86] Spörer (1871).
[87] Lohse (1889). The Potsdam heliograph is also similar in details to the apparatus of de la Rue and J. N. Lockyer which Vogel had seen in England in 1875 and described in detail in his travel report. It is possible that the year 1874 in Lohse's description of 1889 may not be entirely correct.
[88] Vogel (1883). For stellar spectroscopy Vogel favoured the photographic plate only later (Lohse, 1907).
[89] Gußmann & Dick (2000). On this busyness trip Vogel saw the giant telescope (refractor of 63 cm aperture and 9.14 m focal length) of the private observatory of R. S. Newall near Newcastle and the "Leviathan of Parsons town" (mirror with a diameter of 183 cm and a focal length of 16 m) in Birr near Dublin.

research centre for photography with several, according to Vogel's command, extremely clean darkrooms. However, Vogel later realised that "the optical performance of the new Potsdam instrument did not match the expectations, and the observer had decided to use only a minor central part of the objective." The south exit of the main building, which emerged from the dismantling of the old heliograph and serves as a convenient connection to the southern institute buildings was only installed in 1960.[90]

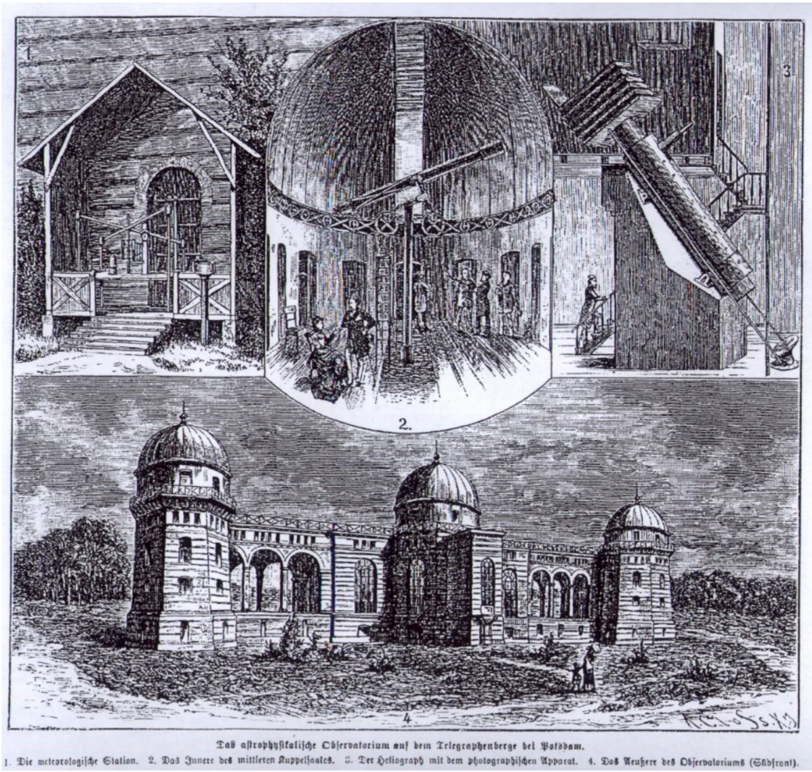



Fig. 15 Top middle: The (Schröder) 30-cm-refractor for spectroscopy, Vogel's main instrument. Top right: The heliograph installed in the southern porch of the main building. The heliostat, which is fixed to the outside ground, reflects the sunlight from below into the 4-m-tube and has a rigid camera in a separate darkroom.

[90] Vitrification of the arcades: 1961.

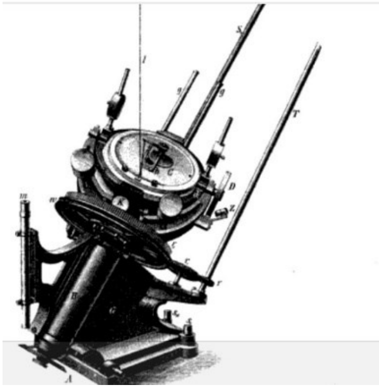


Fig. 16 Heliostat by Vogel and Lohse as part of the flagship of the observatory. Optics by Steinheil (Munich), mechanics by Repsold (Hamburg). With a device made by the same manufacturers in 1890, Schwarzschild attempted to measure the gravitational redshift of the nitrogen line 3883 Å on the roof of the Beamtenwohnhaus in 1913. Lohse (1889).

Fig. 17 Beamtenwohnhaus (= library building from 1959), built in 1898/99 for the observer and the machinist of the Great Refractor. Roof structure right: clock room (lost), roof

structure left: Spectrograph room with extra insulated walls.[91] The heliostat was located on the southern outer wall of the clock room. Source: Hall (1901).

In 1899, a 16 m long spectroheliograph was established on the roof of the Beamtenwohnhaus, which was built at the same time as the Great Refractor building and contained a spectrograph in the southern tower. The actual heliostat in front of the southern outer wall of the northern clock room reflected the sunlight from the north into the optical system. This meant that the sun could be observed in monochromatic light with a grating spectrograph, first visually and later photographically. Vogel had originally intended to have the facility built at ground level west of the main building and had already ordered the heliostat mirror in 1890, but when the construction[92] of the Great refractor and the associated offices actually came about, he simply placed it on the roof.[93] The connection between the Great Refractor "and the buildings of the astrophysical observatory is established by a wide gravel path, which is bordered by a conifer hedge."[94]

Vogel had also visited the mechanic H. Grubb in Dublin 1875 to discuss the instrument he had ordered for Potsdam. He "found the opportunity here to gain a wealth of experience and learn a lot from the intelligent young man." The vibration-free West dome will later house this Grubb refractor with an aperture of 20 cm[95] and a focal length of 340 cm for observing the sun and stars, which Spörer used from 1879 onwards producing spot drawings of highest quality every clear afternoon with projection. How quickly the spots disappear after their appearance had not interested him and many of his successors, although Vogel had seen with his own eyes that in London "the area that the sunspots occupy on the solar surface was also deduced from the ... photographs". The rotational behaviour of the bright chromosphere flares has also rarely been considered. The bright faculae visible on the Potsdam plates have only been measured in exceptional cases. Unexpectedly, the law of rotation of the flares calculated by J. Wilsing proved to be much flatter than that of the sunspots,[96] which, however, did not remained unquestioned.[97] Even the poleward meridional flow and the correlation of the latitudinal and longitudinal proper motions of the larger groups of spots will have certainly been

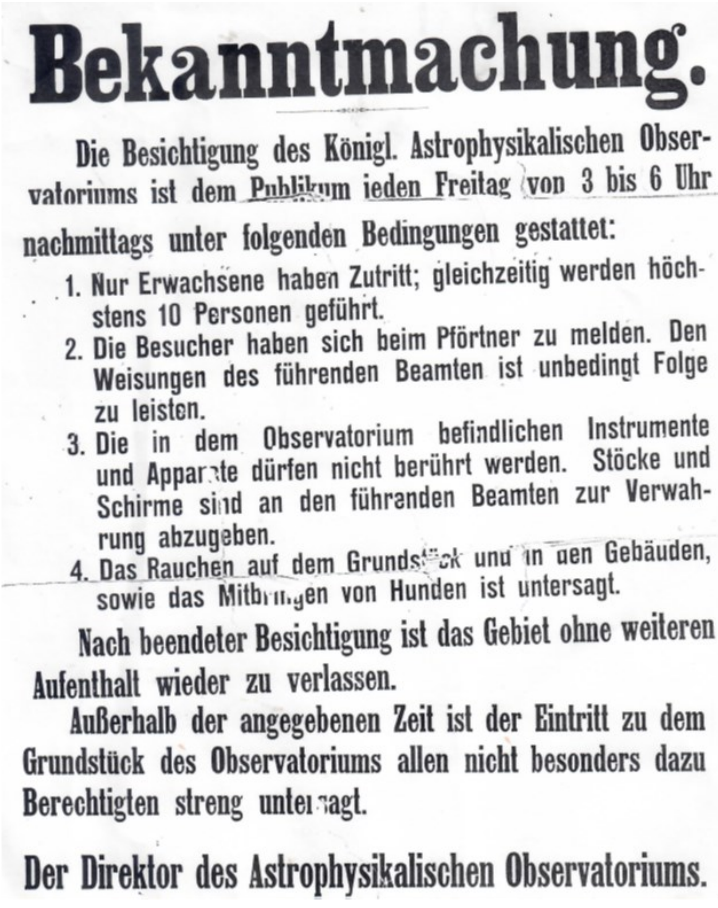
[90] Hall (1901).
[92] Architects: Paul Spieker (1826-1896) and Eduard Saal (1860-1918).
[93] Due to the roof covering, the heliostat track was distorted by air turbulence and heat development despite various actions.
[94] Hall (1901).
[95] Since 1908 new lens with 30 cm aperture by Steinheil.
[96] Wilsing (1888).
[97] Belopolsky (1893), later Kempf (1916).

included in Spörer's data but were only discovered almost one hundred years later.[98]

From 1889 to 1945, a very special double refractor with a 32 cm photographic lens and a visual guide tube with an aperture of 24 cm stood in the "photo dome" erected in the west of the main building on the Telegraphenberg. It served the first international astronomy project of a complete photographic sky map with 40 million stars up to the 14th magnitude and a general catalogue up to the 11th magnitude with about 2 million stars (Carte du Ciel, CdC), whereby the strip between 32° and 39° northern latitude was assigned to the Potsdam observatory. No other German institute had participated in this originally French program, which was developed at an astrophotography congress[99] in Paris in April 1887, and also American institutions did not show interest. Because of Lohse's good experience with solar photography, Vogel had gladly accepted the invitation to the congress and even waived the approval of ministerial travel funds. The AOP, as the best-equipped German institute, turned down the sky map because of the excessive exposure times but wanted to work intensively on the Astrographic Catalogue (AC). Immediately after returning from Paris, Vogel applied for the necessary 52,000 marks to build the facility and also for the funds for an additional observer.[100] Just ten years after the photo dome went into operation, Scheiner – who was still best friends with Vogel – published "apparent orthogonal coordinates of stars up to 11th magnitude" for the Potsdam zone.[101] The 2002 images, obtained from 1889 to 1923 by Eberhard and Ludendorff under Scheiner's direction – later by Münch and Birck – were stored in the building of the Great Refractor, but only 977 of the 16 x 16 cm plates survived the WWII and its consequences as well as improper handling,[102] including all the plates of the second series from 1913 - 1924, which had been initiated by Karl Schwarzschild for the derivation of stellar proper motions in identical star fields.[103] The astrometric work, however, was completely stopped at the end of 1924 because the interest in catalogue work coordinated by Paris was extinguished. The observator Otto Birck was retired in mid-1924 at the age of only 45 by the newly appointed director Ludendorff. Vogel had already noted that "more and more the view [was] prevailing that the double refractor was a completely perfect instrument in terms of its mechanical design and

[98] Ward (1965).
[99] 56 astronomers from 19 countries; participants from Berlin/Potsdam: Auwers, Lohse, Vogel. Förster had cancelled due to other commitments and his lack of expertise (Lamy, 2008).
[100] Bigg (2008).
[101] Scheiner (1899) – the first publication of the overall astrometric project.
[102] Letter from J. Wempe dated 9 September 1974 to the ZIAP administration. Most of the photographic plates from the first series 1893-1900 have been lost. The instrument was removed in 1945.
[103] Dick (1987,1988).

optical performance", which he had increasingly preferred to use for spectroscopic investigations rather than for astrometric tasks.[104] The production of the sky map was "only remotely related to the actual field of activity of the institute" and should therefore "stand in the background of the other work of the institute."[105]



# Bekanntmachung.

Die Besichtigung des Königl. Astrophysikalischen Observatoriums ist dem Publikum jeden Freitag von 3 bis 6 Uhr nachmittags unter folgenden Bedingungen gestattet:

1. Nur Erwachsene haben Zutritt; gleichzeitig werden höchstens 10 Personen geführt.
2. Die Besucher haben sich beim Pförtner zu melden. Den Weisungen des führenden Beamten ist unbedingt Folge zu leisten.
3. Die in dem Observatorium befindlichen Instrumente und Apparate dürfen nicht berührt werden. Stöcke und Schirme sind an den führenden Beamten zur Verwahrung abzugeben.
4. Das Rauchen auf dem Grundstück und in den Gebäuden, sowie das Mitbringen von Hunden ist untersagt.

Nach beendeter Besichtigung ist das Gebiet ohne weiteren Aufenthalt wieder zu verlassen.

Außerhalb der angegebenen Zeit ist der Eintritt zu dem Grundstück des Observatoriums allen nicht besonders dazu Berechtigten streng untersagt.

Der Direktor des Astrophysikalischen Observatoriums.

Fig. 18 Invitation to the public all Fridays from 3 pm. Regular PR work was expected of state scientific institutions (Förster, 1911).

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[104] See Vogel & Wilsing (1899), Scholz (2000).
[105] Bigg (2008).

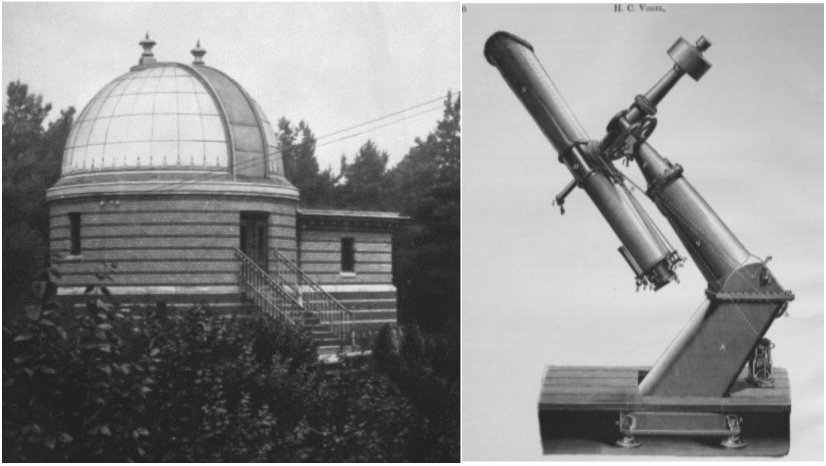

Fig. 19 “Photo dome” with darkroom, completed in 1889 for the "Photographic Sky Map" initiated by the Paris Observatory. Vacant since 1945 (left). Astrograph by Repsold (mechanics) and Steinheil (optics) for the international project Carte du Ciel (CdC). The special mounting of the double refractor allowed convenient handling for observations close to the zenith (right). Source: Vogel (1907).

In 1908, G. E. Hale from the Californian Mount Wilson Observatory concluded from comparing the spectral lines of sunspots and their surroundings with his spectroheliograph that sunspots are a magnetic phenomenon.[106] Surprisingly, this pioneering work did not trigger any demonstrable reactions on Telegraphenberg – perhaps because it was the period between the finished Vogel- and the coming Schwarzschild era after the old director and successful science manager[107] had died the previous year. The heliograph in the main building had continued to operate routinely in white light (but without visible results), the new roof instrument was equipped in the same year with the instrument by Kempf[108] which had been probed in the west dome. Polarimetry – the magnetically-induced (Zeeman) line splitting is circularly polarised – was not mentioned in the AOP reports for a long time; this deficit was only overcome 33 years later by Harald v. Klüber in the Einstein Tower in 1941.

[106] Hale (1908).
[107] The history of the Great Refractor and its building began in 1890 with Vogel's memorandum "On large telescopes and their importance in science" and a trip to England. Construction cost estimate 600,000 marks in total. Real cost of the completed Great Refractor: 706,250 marks, including 270,000 marks for instruments (Vogel, 1907).
[108] Kempf (1905).

Karl Schwarzschild had used the roof heliograph in 1913 for his search for Einstein's gravitational shift of light wavelengths; earlier publications with data from this instrument have not appeared, the study by Kempf on the rotation of the calcium network – with material from a 6-month observation campaign in 1906 with the Grubb refractor in the west dome – was only published in 1916.[109] Kempf's results do not provide any proof that "calcium, flares and spots provide different rotation laws." Unfortunately, “it was not possible to work on the rich material obtained so far, as there was a lack of a suitable assistance," complained Director Vogel typically and regularly in his annual reports from 1904 and later.[110]

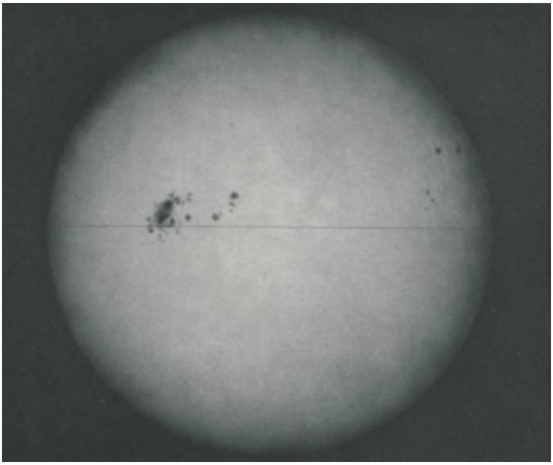

Fig. 20 Heliograph plate taken on 13 February 1892 as an example of the daily registrations by O. Lohse. Note the limb darkening independent of the latitude. "The heliograph has so far only been used for small recordings" Scheiner (1897).

[109] Kempf (1916). The daily monitoring of the solar chromosphere in the light of the calcium K-line by the Mt. Wilson Observatory started on 10 Aug 1915 and ended 7 Jul 1985.
[110] Vogel (1904).

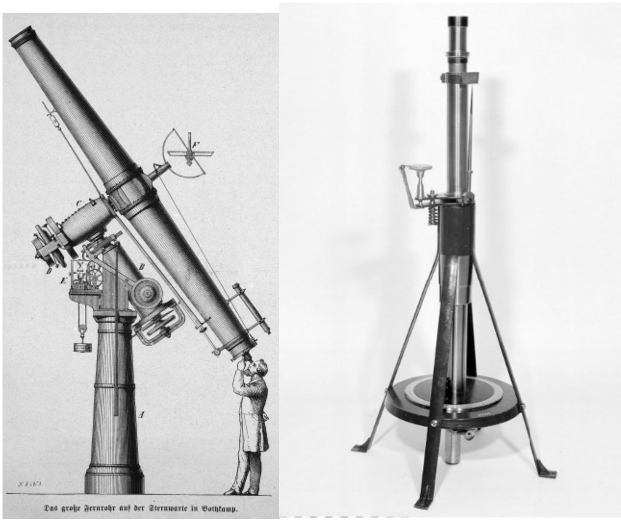


Fig. 21 Vogel's instruments in Bothkamp where he probed the Doppler line shift due to the solar rotation. Telescope and spectroscope by Schröder (1871). Sources: internet, Deutsches Museum München.

The grand instrument with an aperture of 30 cm and a focal length of 540 cm for Vogel's spectroscopic work, called the "large refractor" (until 1899), was part of the middle dome and also stood on its own footing separate from the building shell. Even before his time in Potsdam,[111] Vogel had shown that the different rotation of the edges of the sun could be detected using visual spectroscopy,[112] hence the Doppler effect also works with light.[113] This was no minor discovery. It is striking, he wrote, "that the observations always give a greater velocity than that deduced from the known rotation time of the sun, but it would be risky to draw any conclusions from this .... but it emerges from all observations, that a displacement of the lines, caused by the rotation of the sun, can be regarded as proven."[114] He was, however, sceptical about applying this concept to stars, arguing that there were simply no stars whose lines were all measurably broadened. However, if the frequently encountered broadening of the hydrogen lines were interpreted as a Doppler effect, Vega, for example, would rotate at more than a hundred times the

[111] Private observatory Bothkamp (Schleswig) 1870-1874.
[112] With the Bothkamp view spectroscope by H. Schröder.
[113] Also by spectral studies of comets and planets.
[114] Vogel (1872/1873).

surface speed of the sun. The use of photography, he assumed at this time, is not expected to be significant either, because visual observations would be far superior to these. However, the spectral lines of stars are so weak in visual observations that valuable results could only be expected for the Doppler shifts due to "the movement of stars in the radius of vision" using "powerful instruments in this field."[115]

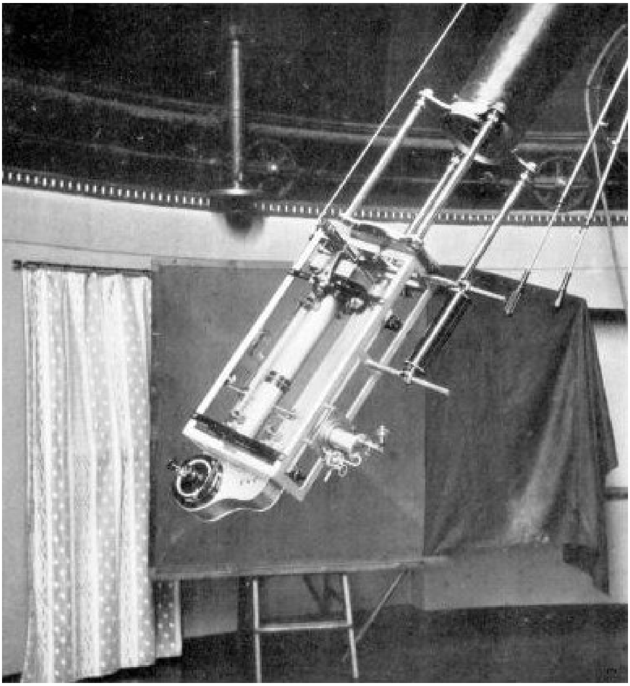

Fig. 22 Kempf-spectroheliograph on the Grubb refractor, part of the instrument on the roof of the Beamtenwohnhaus since 1908.[116] Source: Kempf (1905).

Vogel had then attended the first astrophotography congress in Paris 1887 and drastically changed his mind there about the application of photography to spectroscopic investigations.[117] In the following year he was already able to increase the absolute accuracy of his results with photographic methods to around 7 km/s

115 Vogel (1892).
116 Hassenstein (1941).
117 Lohse (1907).

and demonstrated the radial movements of Sirius, Procyon, Rigel and Arcturus.[118] The limit of a Doppler shift of 7 km/s results from the restricted ability to measure 0.01 mm on a photo plate by means of a microscope. In his publication of 1892 about a "List of proper motions in the line of sight of Fifty-one stars" one finds today only 6% wrong signs compared with the modern results.[119] His method worked, but of course with limited accuracy only.

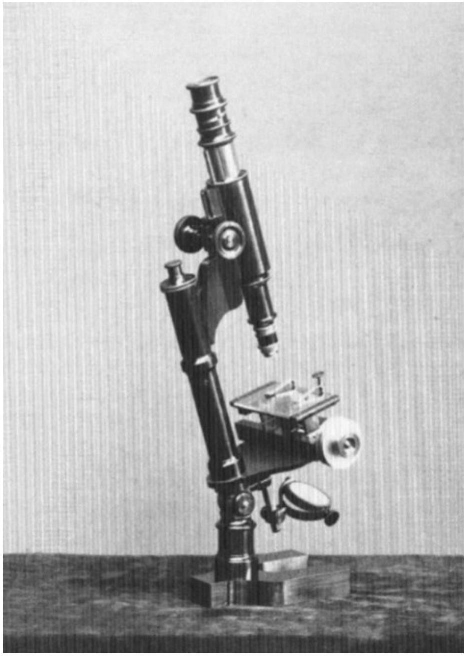

Fig. 23 Vogel´s microscope to measure Doppler line shifts on photographic plates. Source: archive AIP.[120]

The next year provided an unexpected sensation. The hydrogen lines[121] of the bright star Spica were shifted differently on different days. Spica was now observed almost daily. The radial velocities showed a sinusoidal curve with an only 4-day period and maximum values of 20 km/s. Vogel assumed to see two stars with solar mass and only one (!) solar radius apart and visionary predicted "that

[118] Vogel (1888).
[119] Vogel (1892).
[120] See Scholz (2000).
[121] Hydrogen lines were generated with Geissler tubes inside the telescope.

there will be a large number of close binary star systems; the world of orbital periods will range from many centuries down to a few days and of tiny distance until the atmospheres touch each other."[122] Spica was the first known binary whose individual stars could not be resolved even with the largest telescopes of the time. The following winter, spectral images of Algol were obtained, which showed "that Algol moves away from the sun before a minimum, and approaches it after the minimum, as must be the case when a dark body moves in front of Algol."[123] In the past, visual observations of this binary had remained inconclusive. Spectroscopy had "celebrated one of its greatest triumphs"[124] – to attend the photographic congress in Paris was the decision of his life. Vogel now wanted more. In a memorandum addressed to the ministry in 1890 entitled "On large telescopes and their significance for science", it was stated that "for the further training of astrophysics – the main task of the Astrophysical Observatory in Potsdam – it will be necessary to provide the institute with a larger instrument, which alone would enable us to maintain the highly respected position it had acquired over the 16 years of its existence, especially abroad."[125]

Vogel was the appointed director of the observatory from the beginning of 1882, Spörer was the First Observer and the Board of Directors ended its activities. Now the "Sonnen-Warthe" quickly developed into the "Kgl. Astrophysikalisches Observatorium zu Potsdam" (AOP) and the annual reports were primarily devoted to the results of spectral analyses of various celestial bodies, with the sun only being reported in the last sentences. In December of the first year under Vogel Spörer wrote an alarming letter to von Helmholtz in his role as president of the Physikalische Gesellschaft zu Berlin that he, Spörer, had wanted to come to the regular meeting of the society in Berlin "*last Tuesday*" to present his observation of the Venus transient, but Vogel had forbidden him to do so and declared his result to be "*physically misleading*". Every lecture and every publication would now have to be authorised. Spörer described his problem to Helmholtz in great detail because he feared "*that the ban would also extend to my solar investigations and that I would be prevented from publishing anything that did not completely agree with the director's views*.[126] The collegial relationship between the two astronomers survived Vogel's promotion only by a few months; the new director (and newly appointed professor) found the right to issue instructions to the employees too tempting. Nevertheless, a second assistant position was budgeted from

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[122] Vogel (1890b), Rigel is also mentioned in this publication.
[123] Vogel (1890a).
[124] G. Müller (1907).
[125] Vogel (1907).
[126] Spörer's letter to Hermann von Helmholtz dated 21 Dec 1882, GStAPK.

1886, which was given to the former assistant Paul Kempf[127] so that there were now four regular posts in addition to the director.[128]

In the end, as is often the case, things got uncomfortable. In a detailed status report of all scientific institutions on the Telegraphenberg[129] from 1890 for the public, it was stated about "Das Kgl. Astrophysikalische Observatorium zu Potsdam", signed J. S., that "the systematic observations of sunspots, which have continued for more than 100 years ... had not opened up significantly new perspectives in recent decades" and that "interest in sunspot statistics had reduced more and more", as the spectral analysis was the observatory's main field. Was this just a professional misunderstanding or was it coolly aimed at the future retirement of the 68-year-old Spörer? It is unimaginable that Vogel would not have seen this affront of his First Observer before it went to press - he may have ordered it personally or even pre-formulated parts of it. Vogel had often described himself as the First Observer of his institute, although after his appointment as director he only occasionally stood at the telescopes himself. The rest of J. S.'s description of the institute is written in a well-informed, detailed and directorial manner – certainly not the level of a newcomer to the observatory. It was only at the beginning of 1887 that Julius Scheiner, who had come to Potsdam from Bonn through intervention of Vogel's sister,[130] had quickly become Vogel's favourite student and often had to represent him – mostly for health reasons – at conferences and other official events. At the ceremonial inauguration of the Great Refractor on 26 August 1899, after the director's speech, Scheiner was allowed to explain the imposing instrument and dome to Kaiser Wilhelm, who was present. The friendship between Vogel and Scheiner broke up soon afterwards due to both of them despairing over the poor optical quality of the instrument and diverging opinions on the cause of the disaster,[131] possibly due to the suspicion that they had jointly overtaxed the technology. The announced revolution in stellar physics based on powerful lenses would not happen, at least not in Potsdam, and to get new lenses was not possible. In 1903, the director explained that "the principal observator at the Astrophysical Observatory in Potsdam, Prof. Scheiner has published a communication ... which he failed to submit to me before sending it to the editors of Astronomische Nachrichten."[132] Scheiner had, perhaps wrongly, criticised his

[127] His determination of Jupiter's mass as 1:1047.7 of solar mass is still valid today.
[128] Status 1890: First observator: Spörer; Observators: Lohse, Müller; Assistant: Kempf, assistants: Wilsing, Scheiner. Kempf became Observator in 1894, Scheiner assistant at the same time and principal observator in 1898, Wilsing did not receive a full assistant position until 1895.
[129] Scheiner (1890). The other two chapters (meteorology and geodesy) were written by the directors v. Bezold and Helmert.
[130] Elise Polko (1823-1899), poet and singer.
[131] Wilsing (1914).
[132] Astron. Nachr. 162, 159 (1903).

colleagues Hartmann and Eberhard of not having been aware of published observations of arc spectra, but the background was that the ex-friend had omitted "to submit to me". The later director Gustav Müller reported that Vogel "liked to avoid close contact with the scientific staff at the observatory. There were no joint meetings and consultations on important matters concerning the institute, and it was only on very rare occasions that the entire staff gathered around him. He preferred to negotiate with everyone alone, and for a long time he only communicated with some of them in writing."[133]

The single Professor Vogel had regarded the construction of the Great Refractor "mainly for the continuation of spectral-analytical research and here especially for the performance of velocity determinations of the stars in the radius of vision" as his life work; he survived its realisation by only a few unhappy years. Everything there – the rotating giant dome, the super-precise tracking, the functions of the guide tube, the ingenious mechanics of the observer's position, the gas-powered dynamo – depended on the quality of the large lens. It was the greatest catastrophe imaginable, Vogel hardly ever entered the dome, working – if at all – with his old refractor in the middle dome whose lack of light intensity he had complained about in his memorandum. "A good unification of the light rays can only be achieved with all larger lenses by means of retouching due to the inhomogeneities of the glass,"[134] he took heart himself. The lenses showed spherical aberration, i.e., their circular zones produced separate focal points.[135] Wilsing and Scheiner had roughly criticised even after the optical improvements "that the objective ... is now considerably inferior to what it was before, and that in its present condition it is not suitable for finer observations." Vogel replied that there will be nevertheless "an almost inexhaustible field of work in which the 80-cm-refractor in its present condition will prove its worth in the hands of skilful and clever observers."[136]

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[133] G. Müller (1907).
[134] Vogel (1904).
[135] Up to 6 mm difference by the 80-cm-objective.
[136] Vogel (1907). The comment is aimed at future investigations of visual binaries. In this publication, the author also describes in detail the development of Hartmann's optical procedures, which later became famous, for testing large lenses (Hartmann, 1908).

Fig. 24 Great refractor from 1899, dome 21 m, astrograph 80 cm, visual guide tube 50 cm, focal lengths slightly more than 12 m, mechanics by Repsold. electrics (gas-powered dynamo) by Siemens & Halske. Unlike other designs, the floor is rigid, but the observation chair is rigidly attached to the dome. "The optical 50-cm-lense proved to be quite excellent during the examination with the exclusion of a narrow edge zone."[137] The astrograph was the problem: Steinheil had tried to save the 300 kg lens in Potsdam in May 1900 and in Munich in January 1904 without success.[138]

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[137] Vogel (1901).

[138] Larger lenses hardly achieved any improvements in luminous efficacy due to the increasing glass mass (Vogel, 1907).

## The aged Spörer finds the Maunder Minimum

At the end of the 1880s, the old Spörer found the today well-known Maunder minimum of solar activity, the significance of which was not only unknown to his close colleagues. Spörer had, in addition to his own extensive archive of sunspot registrations, obtained all the documented observations from Rudolf Wolf in Zurich in order to trace his passion – each solar cycle begins with spots that appear at high heliographic latitudes and ends with new spots close to the equator – back to the beginning of the records in 1618. To his surprise, this only worked until the minimum in 1713, because there were no spots before at all in the northern solar hemisphere for decades, and the few southern examples only ever appeared close to the equator. More normal conditions were only found again in the records of Christoph Scheiner for which Spörer for 1621 found latitudes of 27°, for 1622 of 19° and for 1626/1627 latitudes of 10° – according to his expectation – but all the spots were located in the southern solar hemisphere. In August 1887, Spörer announced at the annual meeting of the Astronomische Gesellschaft his finding "that since the middle of the 17th century, over a very long period of time, conditions on the sun have been substantially different from those in more recent times."[139]

Edward Maunder from the Royal Greenwich Observatory had presented in detail the fundamental theorems of Spörer's statement of 1887 – that from the middle of the 17th century until 1713 i) there were no sunspots far from the equator, ii) that only one hemisphere was spotted and iii) spots were very rare – to the readers of the Monthly Notices in 1890.[140] Three years later, in an illustrated science magazine, Maunder himself placed a short and entertaining story of historical spot records from a large number of solar observers and – since he already knew the facts from Spörer – very quickly came to the conclusion that there had been a "prolonged sunspot minimum" before 1715.[141] Spörers name appeared only once in the references but not as the discoverer of the grand minimum. Almost a hundred years later, when it had become a focus of the dynamo theory of stellar magnetic fields, it was suddenly called the "Maunder Minimum".[142]

Spörer devoted the rest of his years to the visible differences in activity on the two solar hemispheres with growing astonishment. "In addition to the photographs taken by Dr Lohse, my own photographs are also used to calculate the heliographic

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[139] Spörer (1887) and Nova Acta der Ksl. Akademie der Naturforscher Leopoldina, vol. LIII. No. 2, Halle (1889).
[140] Maunder (1890).
[141] Maunder (1894).
[142] Eddy (1976), he named Spörer's discovery "Maunder-Minimum", allegedly because of the alliteration.

positions. ... The measurement of the plates ... was carried out by Dr Wilsing until May 1891." Spörer only returned to his most puzzling and now famous result at the very end – possibly because of the insults of J. S. & Co. "Various reports agree that from 1645 to 1670 there were only a few spots. The number of spots then increased, but there was definitely no significant maximum until 1716." He concluded "that in the period of 70 years in the northern hemisphere there was absolutely no periodicity of the spots,"[143] hence the Schwabe cycle had been stopped. In their obituaries for Spörer his colleagues Lohse and Vogel completely ignored his main discovery; they probably did not take the matter too seriously. Also, the obituaries of Maunder do not contain references to a minimum discovered by him. And so, it came about that Carrington's spot zone migration was named after Spörer and Spörer's long minimum were named after Maunder – a wrong but well-balanced German-English discovery statistics.

Maunder had complained in his report that no magnetic data exist from the reign of the Sonnenkönig Louis XIV from 1643 to 1715. Indeed, the answer to the underlying question of whether the cyclical magnetic influence on the earth had also disappeared with the sunspots would have allowed speculation about the possible magnetic nature of the sunspots. The next question, whether the magnetic clock in the sun had continued to run with reduced amplitude during the long minimum or had come to a temporary standstill,[144] could have been asked even then, but interest in this discovery quickly died out because it was more convenient to assume that there were too few active observers at the time to register all the existing sunspots. Prof Spörer had "completed the long series of his work on sunspots" and had "retired from my staff on 1 October 1894 at the age of 72", finally reported the Director Vogel.[145] He had entrusted the observator Kempf with the continuation of the sunspot statistics but observations in the style of Spörer no longer took place.[146] Julius Scheiner received a permanent position and the appointment of associate professor at Berlin University on the same day.[147] In the annual report for 1903, Vogel reports only 38 regular entries for spot statistics. The original "Sonnen-Warthe" had finally become a famous institute for stellar physics. Whether Spörer was still allowed to use his study for some time, we do not know. But the "*well-deserved retirement*" that had been announced did not

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[143] Spörer (1894).
[144] Wittmann (1978).
[145] Vogel (1894).
[146] Among the numerous publications by P. Kempf there are none on sunspots, apart from a report from 1910 on "rotating sunspots", which, however, is based on Lohse's photographs up to 1893. No favouring of a sense of rotation on either hemisphere was found. "Solar vortices and magnetic fields" were Hale's favourite topics, too.
[147] Salaries 1897: Vogel 10500 RM, observers: Lohse 6500 RM, Müller 6000 RM, Kempf 5100 RM; assistants: Wilsing 4260 RM, Scheiner 3260 RM. Source: K.-D. Herbst.

appear: after just nine months, on a Sunday trip to Giessen, the "true Berliner", who had always been healthy, died of cardiac arrest. His then 35-year-old son Richard had just taken over the management of Georgshütte Burgsolms, part of the Buderus company. The old father had probably wanted to witness the ceremonial inauguration.

# 3 Einstein' Tower and Miethe's Dome

## From rooftop observatory to rooftop observatory

The ingenious Potsdam pioneer of colour photography and successful travel author Adolf Miethe was appointed to the Chair of Photochemistry and Spectral Analysis at the Kgl. Technische Hochschule Charlottenburg on 1 October 1899. To develop 3-colour astrophotography, he had built a photographic observatory on the roof of the institute building "although the installation caused unusual difficulties." Finally, he was able "to return to the old love of my life: astronomy. A favourable opportunity provided me with this new possibility." The opportunity was a "magnificent telescope with an aperture of 30 cm" made by Gustav Heyde in Dresden which was for sale under good conditions. His minister gave permission, "in order to promote photographic astronomy at my chair ... and after brief negotiations, the transfer of the instrument and its [6 m rotating] dome to Charlottenburg was done. My joy was indescribable."[148]

Initially Miethe made his own astronomical experiences on the Telegraphenberg observatory: "The Astronomy Congress in Paris 1887 at which the great importance of photography for this science was emphasised for the first time ... and at which the plan to create a large photographic map of the heaven was adopted also had an impact on me. Lohse had intended to present the open clusters he had photographed with the Potsdam refractor. However, some illness delayed his work and he asked me to come to the Observatory and, as an assistant, to carry out a series of measurements and drawings based on his photograms. Nevertheless, I carried out this simple work with great enthusiasm and to his satisfaction, while at the same time using the Observatory's resources to complete my doctoral thesis. On his advice, I chose to work on the so-called basic photochemical law, which ... essentially stated that the photochemical power was proportional to a product of exposure time and light intensity."[149] However, the observatory had not impressed

[148] Miethe (2012), p. 236.
[149] Miethe (2012), p. 121f.

Miethe too much, imagine that Spörer could not name a lunar crater! In the winter semester of 1887, he went to Göttingen, "where I mainly intended to perfect myself further in theoretical physics, especially in optics, and in astronomy."

Fig. 25 First colour photograph of the moon, fully mechanical two-colour print, 30-cm-mirror telescope. Source: Miethe (1911, 2012).

On the anniversary of his own observatory in Charlottenburg, he produced his first colour photographs of the moon using the new instrument. Miethe had met the optician Bernhard Schmidt[150] from Mittweida shortly after observing Halley's comet with his refractor. "I was sitting in my study when a tiny ... one-armed young man introduced himself and asked for demonstration of a reflecting telescope he had made. ... He had the telescope ... with him in a minor box, from which, looking around next to the 30 cm diameter mirror, a very simple construction of a few wires and wooden rafters developed, which he set up in our dome." Miethe, in the night: "One look through the slatted frame convinced me that I was

[150] Schorr (1936).

standing in front of a miracle of optical art that considerably dominated my large telescope in terms of real performance."[151]

Fig. 26 Adolf Miethe (1862-1927). Source: Miethe (2012), p. 6.

Later, he had mounted Schmidt's mirror to his telescope. "With the unbelievable performance of the new mirror, my large instrument only became the guide telescope." Now colourful images of the moon were possible.[152] In front of the focus were the absorbing cuvettes, one of which only let through light with a wavelength of 360-330 nm, the other only light with a wavelength of 700-600 nm. Miethe enthusiastically reported in April 1911 to his ministerial director: "We have actually discovered the possibility of geological observations on the lunar surface."

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[151] Miethe (2012), p. 238f.
[152] Miethe & Seegert (1911); Miethe (2012), p. 320.

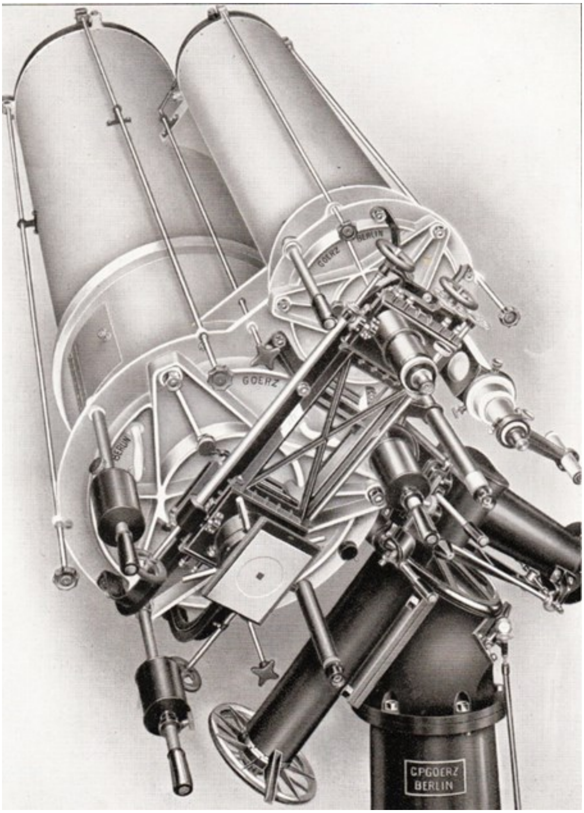


Fig. 27 Goerz-Schmidt-Heyde-double reflector (30 cm plus 50 cm mirrors), until 1945 the key instrument in the Miethe dome on the Telegraphenberg (today A23). Source: G. Kühn.

Adolf Miethe was not yet satisfied with this. In order to deepen the results, a much larger reflector telescope was constructed, the optical parts of which were supplied by Bernhard Schmidt and the mechanical parts were manufactured by Goerz. It "is still one of the most perfect instruments of its kind."[153] It was the first astronomical instrument that the Optische Anstalt Goerz AG (later Zeiss Ikon) produced in Berlin-Zehlendorf. Adolf Miethe was a member of its supervisory board. Also, a 40-cm reflector telescope was built in 1913 especially for the joint solar eclipse expedition of the Technische Hochschule Charlottenburg and the

[153] Miethe (2012), p. 324.

Goerz AG to northern Norway.[154] Miethe had indeed achieved the first co-operation between his institute and a commercial company. As a result, the expedition had a brilliant set of equipment packed in 58 boxes. The main aim was to take corona images using the 30 cm mirror from the guide tube of the Goerz-Schmidt-Heyde-reflector, whose focal length was enlarged from 7 m to 20 m with horizontal storage, which enabled a solar image with a diameter of 20 cm.[155] The fate of this and the other expeditions - Miethe was the only one who refused to go to Russia[156] - was not disturbed by the weather this time, but by the outbreak of the WW I. All the younger German members of the expedition were ordered back leaving Miethe. He experienced the solar eclipse together with his overflowing luggage in the most beautiful weather – but almost alone. Apart from the three boxes he had brought with him, his instruments only arrived back in Berlin many years later. The activities of all the other expeditions to Russia were completely prevented by the war. "Contrary to the Russian hospitality first offered, the members of the expeditions who were required to serve in the German army were taken prisoner and could only be exchanged after a long time," wrote the Frankfurter Zeitung in June 1916.

The Miethe reflector consisted of two high-quality Schmidt mirrors of 50 cm and 30 cm aperture with 300 cm and 180 cm focal length, with the mechanics made by Heyde. Special mirrors allowed the focal lengths to be extended to 11 and 21 m, respectively; the ocular of the minor mirror and the cassette of the other were mounted together. However, the instrument was used only seldom; Miethe's last communication from March 1920[157] explains that he had noticed the unusual structure of a crater in Mare Serenitatis the previous evening with his main instrument while preparing to take pictures of the moon: "It seems as if the depression in the centre of Linné had increased considerably in size and depth."

In 1921 Miethe directed the film "Im Flugzeug zum Mond" and organised a much-noticed press conference, founded and managed a central "Testing and Research Institute for Cinema Technology". He died in 1927 at the age of only 65 as a result of a railway accident,[158] his rooftop observatory became isolated until it is moved to Potsdam in 1932 thanks to the activity of Erwin Freundlich, the principle observator of the Einstein institute for solar physics.

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[154] Today Deutsches Museum München.
[155] Miethe et al. (1916).
[156] In preparation for the 1887 eclipse expedition of the AOP to southern Russia, Miethe had learnt the Russian language "with absurd effort at the request of the Potsdam gentlemen in half a year. … When one day I was told with a cold smile that they had decided otherwise, I thought I had the right to be terribly angry" (Miethe, 2012, p. 80).
[157] Miethe (1920).
[158] Seegert (1927).

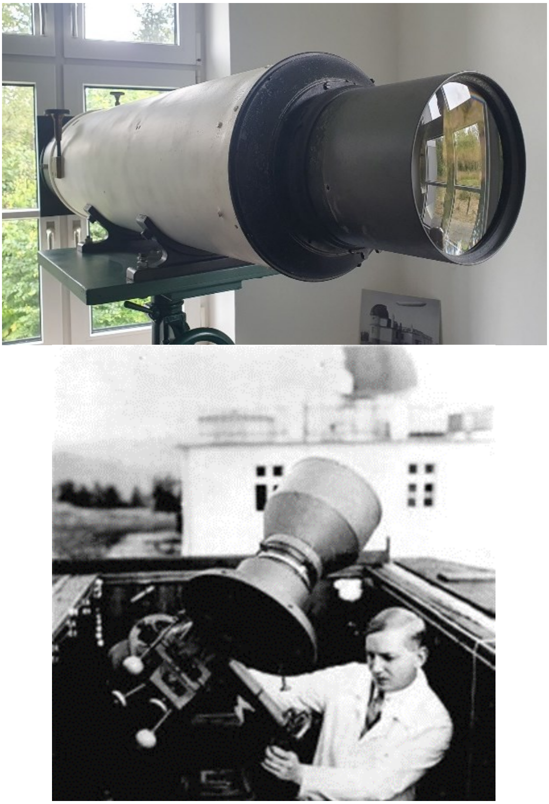

Fig. 28 Top: Miethe's 170/1200-mm-camera with Zeiss-triplet from 1913 given 1924 to Sonneberg by the Notgemeinschaft der Deutschen Wissenschaft, now existing in the museum Sternwarte Sonneberg. Photo P. Kroll. Bottom: first 135/240-mm sky observation camera with R. Brandt, 1929. Source: Freunde der Sternwarte Sonneberg e.V., internet.

Cuno Hoffmeister from the Sternwarte Sonneberg reported in a foreword written in 1967 that he had already received a Zeiss triplet 170/1200 mm "from Miethe's holdings in Charlottenburg" through the Notgemeinschaft der Deutschen Wissenschaft in 1922, which enabled him to discover new variable stars. In July 1923 – still in the roof observatory at his parent-house in Sonneberg's lower city – he received a new mount from Zeiss Jena that could carry his entire current telescope arsenal. "The objective of the telescope is a three-part apochromat from Zeiss with 135 mm aperture and 2020 mm focal length, from my private collection. The axis system also carries a large photographic camera with a Zeiss triplet of 170 mm aperture and 1200 mm focal length. Devices for mounting small cameras are also available," he wrote in the 1923 annual report. In 1925, the observatory "moved into its own building, which was to be erected by the administration of Sonneberg with the support of the state of Thuringia and the Carl Zeiss Foundation. In early summer, the site was surveyed and purchased, a 13,000 m$^2$ piece of wasteland near the village of Neufang, 635 m above sea level. ... In November, the 4.5 m diameter dome supplied by Carl Zeiss was installed and in December the main instrument was brought up from the old observatory to the new one, for which the Carl Zeiss Foundation had kindly provided a Zeiss mechanic, too. The building was handed over on 28 December." Right at the beginning of the New Year, he began observations, "which in the following years developed into the Sonneberg field plan"[159] which should basically allow statistics of variable stars including their spatial distribution. "On selected fields, partly in the Milky Way, partly at its edge, partly far away from it, all variable stars of any kind up to about the 15th magnitude should be searched for as far as possible." To this end, "all discoverers, including those not involved in the systematic work, should observe the variables they have found until at least the type and the raw elements of the light change are known. The discovery of new variables without providing lightcurves is almost worthless if this rule is not followed."[160]

Now Hoffmeister was the director of an almost professionally equipped one-man municipal observatory but without personnel. The city and state were unable to pay their chief astronomer a salary, no matter how small. During the economic crisis, the Notgemeinschaft temporarily helped with a performance grant of 250 RM per month, formally for his dissertation. The income from journal articles, the thunderstorm service and the sunshine registrations for the Prussian Meteorological Institute (from 1922) or the observation of the instruments of the Institute for Earthquake Research to determine the speed of sound in the earth's mantle will hardly have covered the postage costs for the exchange of literature. The answer to the problem came from Babelsberg. Director Guthnick of the Berlin Universitätssternwarte in Babelsberg wanted to set up photographic monitoring of the northern night sky in co-operation with the observatories in Sonneberg and Bamberg. Using wide-angle lenses, the entire northern sky was to be photographed zone by zone "at least twice a month" to locate novae and derive light curves of the brighter variable stars. Hoffmeister took up the challenge and in September 1928 the first "ernostar" camera came from Babelsberg – but soon all the four existing cameras were in Sonneberg, although the spatial distance between the observation sites had actually been part of the original concept due to different cloudiness. From January 1929, Hoffmeister's first permanent employee, the optician

[159] Richter & Wenzel (1984). The Zeiss triplet (objective with three lenses), a refracting mount with 2 astrographs of 135 mm and 170 mm aperture, was used in Sonneberg until 1971.
[160] Hoffmeister (1929).

Rudolf Brandt from Jena, supervised this Babelsberg project. What's more, from 1930, the city of Sonneberg handed over the Sternwarte – which was now generously equipped with gas heating, several buildings and ground – to the Prussian state, which attached it to the observatory in Babelsberg as „Abteilung Sonneberg". It was not until 1937/1938 that the property finally went to Prussia.[161]

## Finlay-Freundlich and Friends

On 28 May 1932, it is stated that "*on the basis of the decree of the Prussian Minister for Science, Art and Education of 16 Nov. the reflector telescope, which had become dispensable at the photochemical laboratory of the Technische Hochschule Berlin, was transferred to the Einstein Institute of the Observatory in Potsdam.*" The file lists Prof Dr Freundlich and Dr v. Klüber as being present but not Director Hans Ludendorff.[162] Ludendorff's precursor Gustav Müller had hired shortly before his retirement – under considerable pressure from Einstein – Erwin Freundlich as an observator on the Telegraphenberg and allocated the newly established foundation a good building site for the planned "Einstein Institute for the Experimental Development of the Theory of Relativity". Einstein had written already in the summer of 1913 to the young Freundlich in Babelsberg,[163] "the astronomers can render an invaluable service to theoretical physics in the next [solar eclipse] year". After Einstein's calculation of the deflection of light at the sun had apparently been confirmed by British eclipse expeditions in 1919, everything now depended on the measurement of the predicted redshift – only about $2 \cdot 10^{-6}$ of the wavelength – of the solar spectral lines or, as Karl Schwarzschild formulates, a Doppler effect of the light source of only 635 m/s.[164] "If this shift cannot be proven, as it has been so far, the whole theory collapses," warned an English physicist. Schwarzschild had already set up the spectroheliograph for precise wavelength measurement of the nitrogen line 3883 Å on the roof of the Beamtenhaus near the later Einstein Tower in 1913, shortly after his arrival as director in Potsdam.[165] A heliostat reflected the light onto a lens with an aperture of 20 cm and a focal length of 3 m.[166]

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[161] Richter (1992).
[162] Hans Ludendorff (1873-1941), Director of the AOP 1921-1938 at the suggestion of G. Müller. Einstein and Nernst had favoured Max v. Laue without success.
[163] Erwin Freundlich began to work at the then Kgl. Sternwarte Berlin-Babelsberg on 1 July 1910.
[164] Note that Vogel gives his radial velocity measurements from 1888 for Arcturus as 7600 ± 600 m/s.
[165] November 1909, against the opposition of Auwers (Dick, 2000), annual salary 11,500 M with free accommodation.
[166] Possily parts of the old heliograph from Vogel and Lohse were reused. Schwarzschild speaks of a camera lens with 16 cm and a focal length of 4 m, exactly the data of the original heliograph.

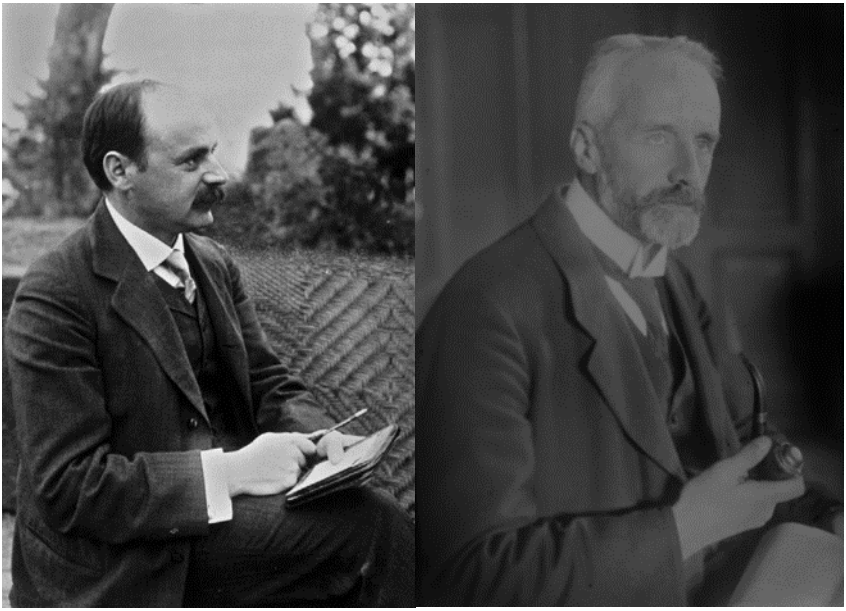

Fig. 29 left to right: Karl Schwarzschild (1873 - 1916) on the terrace of the director house, Gustav Eberhard (1867 - 1940). Information by M.-L. Strohbusch, Archive Förderverein Großer Refraktor.

Schwarzschild had found too low redshifts of around 200 m/s on average, lower values for weaker lines and higher values for stronger lines, which even decreased outside the centre of the sun. In 1906 he had introduced his Göttingen paper with "The solar surface shows us changing states and stormy changes in granulation, sunspots and prominences".[167] After the inclusion of the Doppler effect for the "descending molecules of the solar gases" of around 200 m/s, he concludes: "The smallness of these remnants would prove that the Einstein effect does not exist."[168] He also considered the difference between the radial velocity components of the edge and centre leading to Doppler effects of varying strength. Einstein had no problem recognising Schwarzschild's negative result on 5 November 1914 at the meeting of the Academy personally and without resentment. He was probably pleased that the director of the famous Observatory – who was on the way to the Russian front – had taken his ideas seriously.

[167] Schwarzschild (1906).
[168] Schwarzschild (1914).

With Schwarzschild also began a new round of optical improvements to the Great Refractor lenses. "During Schwarzschild's short directorship at Potsdam the most notable instrumental improvement was the regrinding of the two objectives of the Great Refractor."[169] Schwarzschild had commissioned in the autumn of 1912 the famous optician Bernhard Schmidt to correct the 50-cm lens in his studio in Mittweida within three months with the motto "lenses are artwork" against the objections of the Steinheil company. "The undersigned is convinced," Schwarzschild wrote to his minister, "that Mr Schmidt is the greater artist." The minister supported Schwarzschild and wrote in May 1912 in response to a protesting petition from Professor Steinheil, "I am unable to comply with the request to give you the 50-cm objective of the Great Refractor of the Astrophysical Observatory in Potsdam for further correction, as it is planned to hand over the correction of this objective ... to the optician Schmidt in Mittweida. I am prepared, however, to reserve the decision on the subsequent correction of the 80-cm lens until the correction of the 50- cm objective." Schwarzschild's verdict in July 1913 was that the lens "has been transformed from a poor lens into a good one, and after stopping down a 5 cm wide edge zone into an excellent one." A similar treatment of the 80-cm lens failed due to the desperate resistance not only of the Steinheil company.[170]

The Stockholm Nobel Prize Committee had postponed honouring Einstein for his relativity theory from year to year due to a lack of empirical confirmation, despite of the most prominent nominations.[171] In July 1918, Arnold Sommerfeld warned a friend: "I would like to draw your attention ... to the redshift of the spectral lines. So far there has been no hint of it. Schwarzschild has not found it, nor have the most careful new American measurements on Mt. Wilson."[172] Einstein hastily wrote to Minister of Culture at the beginning of December 1919 that "Dr E. Freundlich at the Astrophysical Institute in Potsdam was the only German astronomer (apart from Schwarzschild) who has rendered outstanding services to the field. It would be a great support if this astronomer was soon given an observator position at the Potsdam Institute with the task of working on testing the general theory of relativity."[173] The long road that Einstein walked to fulfil his Nobel Prize plans[174] had ultimately led to a comeback of solar research at the Telegraphenberg,

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169 Hertzsprung (1917).
170 Müürsepp (1982).
171 Pais (1986), pp. 503ff.
172 Hentschel (1992), p. 49.
173 Marginal note on this letter: "The suggestion to support Dr Freundlich by the Astrophys[ical] Obs[ervatory] came from me after the negative behaviour of G[eheim] R[at] Struve made it impossible for him to remain at the Babelsberg Observatory. ... Kr[üss]", in Kirsten & Treder (1979).
174 Einstein had dedicated the expected prize money to his wife Mileva. Draft of the divorce agreement (1918, divorce Feb 1919): "You may freely dispose of the interests. The capital would be deposited in

including the spectacular new building, despite Schwarzschild's negative results which Einstein was aware of and which did not really speak of the success of a new experiment.

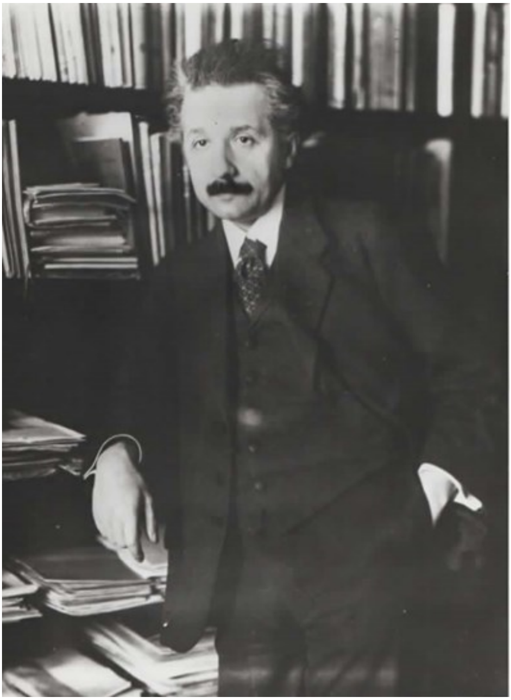

Fig. 30 Albert Einstein (1879-1955), currently awarded by the Nobel Prize (November 1922), during the construction of the Einstein Tower. Archive U. Hoffmann.

The appeal for the "Albert Einstein donation", which was to finance the construction of a tower spectrograph[175] to measure the relativistic line shift, was most probably written in December 1919 by Freundlich himself: "Albert Einstein's research on the theory of general relativity signalled a turning point in the development of the natural sciences. ... The experimental testing of its observable conclusions must go hand in hand with the further development of the theory. For the time being, only astronomy seems to be able to probe this work. ... The academies

Switzerland and kept safe for the children."

[175] The vertical construction was intended to reduce the disturbing air turbulence that occurred with the horizontal construction on the roof of the Beamtenhaus and to enable an increased focal length (Finlay-Freundlich, 1969).

of England, America and France, with the exclusion of Germany, have recently appointed a commission for the realisation of the experimental equipment to probe the theory of general relativity. ... These funds are intended to provide the Astrophysikalisches Observatorium in Potsdam the instruments needed to work successfully on this problem. Approximately 500,000 M are required."[176] The letter bears the handwritten note, "please have my signature at your disposal. The timing is certainly favourable for the campaign! Yours sincerely, W. Nernst."[177] Freundlich later named as 1.19 Mio marks as the result of his action. The erection of the tower had been going on since the summer of 1920 – without official construction permission – partly because of the actual money inflation. Einstein gave Freundlich on 24 April full procuration "for all matters relating to the construction of the tower spectrograph to be built on the site of the Astrophysical Institute in Potsdam."[178] Among the numerous donors, the director of the Badische Anilin- und Sodafabrik and later Nobel Prize winner Carl Bosch stood out whose commitment to the Telegraphenberg and the theory of relativity seems to have been inexhaustible.

The tower building was almost complete in August 1921. In Potsdam's Stadtschloss, Freundlich showed the construction plans of his project and details of the spectral apparatus to the 140 members of the Astronomical Society during the first conference since 1914. Einstein was present to clarify his predictions about the gravitational redshift in the solar spectrum. The confirmation of his calculations of light deflection at the sun by the English expeditions had been published by the Berliner Illustrirte Zeitung on 14 December 1919. Nevertheless, a newly appointed commission[179] was planned to prepare another solar eclipse expedition to India for September 1922 and – even more remarkable – Einstein, Freundlich and Nernst argued in favour of a "perihelion commission" in order to use the meanwhile more numerous and more precise orbital data of the inner planets "for a tighter control of the theory, possibly also on the perihelion motion of other planets." More than a hundred new applicants were accepted as members of the Astronomical Society including Einstein and Nernst, 33 foreigners and two women. The closing party with 200 participants took place in the dome hall of the Great Refractor after a visit to the nearby, already famous construction site of the tower.[180] On 9 November of the following year, Einstein, who was almost overactive at the Potsdam conference, learned that he had been awarded the Nobel Prize in 1921 and was

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[176] Kirsten & Treder (1979), p. 177, list of donations excerpted by Eggers (1995).
[177] Nobel Prize winner for chemistry in 1920.
[178] Hentschel (1995), p. 45. Instrument developed and built by Carl Zeiss Jena on favourable terms (including a donation of 300,000 M). During the construction period, the young Kienle was in Potsdam on a scholarship from the Bavarian Academy of Sciences.
[179] Einstein, Freundlich, Kapteyn, Ludendorff, Schorr, Voute.
[180] Birck & v.d. Pahlen (1921).

only rarely seen later on the Telegraphenberg. His name does no longer appear in the lists of participants at the next conferences of the Astronomische Gesellschaft in Leipzig (1924), Copenhagen (1926), Heidelberg (1928) and Budapest (1930).

In June 1932, the "*reflector telescope building on the grounds of the Observatory in Potsdam* is officially taken over *by the director of the Einstein Tower*". The 6,000 M for the transfer from Berlin to Potsdam were paid again by Bosch. The transfer of the night-astronomy telescope from Charlottenburg to the Telegraphenberg as part of the Einstein Tower took place in the middle of a bitter debate between Ludendorff and Freundlich over the future status of the Einstein Institute as an independent or a dependent part of the AOP. According to the official schedule, the institute should have become property of the Prussian state on 1 January 1932, which would then of course have added it to the Observatory. But shortly before this, the members of the Board of the Einstein Foundation[181] received a note from the Ministry that one of the founders had expressed the wish to "leave the Institute independent as a state institute in honour of its history and not, as would be obvious, to incorporate it into the Astrophysical Observatory. In view of the further development of the tower, I am considering accommodating this wish." An arbitrary decision, the real Einstein Institute is only a modern solar spectrograph without an own building with offices and laboratories. Hence, through the intervention of his supporters such as Albert Einstein and Max v. Laue, Erwin Freundlich had won the battle. In April 1931, Freundlich thanked Einstein who had "operated so intensively to safe my institute", despite the serious differences between the two. Einstein as the Chairman for life had invited Laue to a meeting in Potsdam by "it's going to heat up. One can't live on logic alone; one needs something for the black heart."[182] Freundlich continues "it wouldn't be easy for me to leave what I've built up here and which would probability be ruined if I left. However, I have not yet cancelled Oxford."[183] He mentioned a possible appointment from the Oxford observatory to strengthen his position in Potsdam. At this time, it was no longer clear whether Freundlich actually wanted to confirm or reject Einstein's theory. The installation of the Miethe telescope also indicated a planned departure from the original programme of the Einstein institute. Einstein was certainly prepared for anything, as he had already labelled Freundlich a "greyhound" in a letter to Sommerfeld in February 1916, saying that he would "not choose him as an intimate friend" and that one of his earlier papers had been written in a "greyhound-like" style. "But he has something to show that is worth its weight in gold, i.e., an enthusiastic dedication to the work; that is a rare quality

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[181] Bosch, Einstein (Chairman), Franck, Freundlich, Ludendorff, Müller, Paschen.
[182] Hentschel (1992), p. 138; Hermann (1996), p 62.
[183] Hentschel (1992), p. 142. He had applied for a professorship in Istanbul from 1 November 1933.

that he does not share with very many."[184] Much later, Einstein mocked Freundlich's anti-relativistic criticisms[185] by "Freundlich doesn't move me a bit. If no light deflection, no perihelion motion and no line displacement were known at all, the gravitational equations would be convincing because they avoid the inertial system."[186] In response to a corresponding enquiry from the Academy in Berlin: "The influence of the Michelson-Morley-experiment on my own ideas was quite indirect."[187] Michelson and his interferometer for measuring the speed of light in Potsdam are not even mentioned in Einstein's original work.

In July 1928 Freundlich had to suffer a hurtful comment on his application for a new building to the Einstein Institute again designed by Erich Mendelsohn. "*The whole matter still has to be discussed with Professor Ludendorff who, according to reports, has not yet been heard .... In addition, the project has been worked on by a* private architect *without any involvement of the Bauamt. It is the same architect who designed the Einstein Tower and controlled its construction. Given this experience, does it make sense to entrust this architect with further public buildings?*[188] Mendelsohn was already a seasoned architect. The following year, the final rejection came: "*The application for the inclusion of funds for an extension to the Einstein Institute at the Astrophysical Observatory in Potsdam in the draft for the next year's state budget has again not been approved.*" The activity of the institute, as long as it can maintain its independent status, depends on workspaces for the increasing number of its employees. This shortcoming of the Einstein Tower building – which itself only contains one or two offices – is not removed until 1933 with the construction of the so-called Bosch barrack ("*made of wood with a cardboard roof, without double windows*") from foundation funds with the approval of the Minister of Science. Freundlich, the networked free spirit and art lover, was, in contrast to Director Ludendorff, very successful in raising funds for instruments and assistants; all of his numerous applications for financial support to the Notgemeinschaft der Deutschen Wissenschaft were approved. "The intellectual liberalism that prevailed in his circle in countless discussions in the Einstein Tower at that time and which was determined by Freundlich and included the entire scientific as well as the human-personal sphere, was one of the best schools that a young scientist could enjoy."[189]

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[184] A. Einstein, Gesammelte Schriften 8, 255.

[185] Born to Einstein 4 May 1952: "Yesterday Freundlich was here [...] It really looks as if your formula is not quite right" (Hentschel, 1992, p. 158).

[186] Einstein to Born 12 May 1952, ibid.

[187] Pais (1986), p. 112.

[188] In fact, there are shocking reports about the condition of the Einstein tower after just a few years. An architect commissioned with one of the latest renovations - without a microphone - did not shy away from the judgement "actually a construction sin".

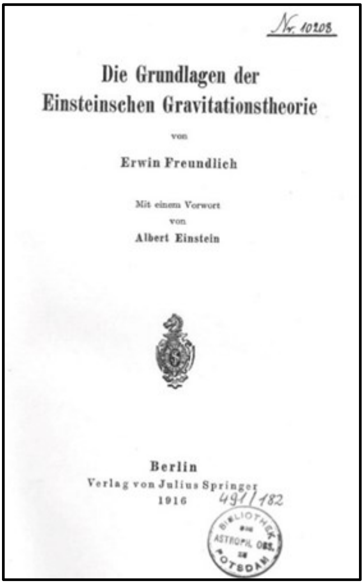
[189] Klüber (1965).

Fig. 31 Einstein Tower with Bosch barrack (foreground) and shelter (righthand) for expedition material. Source: ABBAW.

Freundlich never suffered from a lack of ideas. On 29 June 1931 he applied via Ludendorff to the Prussian Minister Adolf Grimme to obtain a second-hand telescope from the Photochemical Institute of the Berlin-Charlottenburg Technical University at a reduced price. "*In the possession of the Photo technical Laboratory in Charlottenburg is a mirror telescope with an aperture of 50 cm, which the late Prof. Miethe had acquired who was interested in many questions of astrophotography. This telescope could be used today for many tasks in astrophysics, but has been unused for years.*"[190] He also puts this strong argument alongside allegedly planned investigations into a new silvering process for mirrors, *"which one of these gentlemen from IG Farben has found in Ludwigshafen, which will make it possible to take pictures of the sky right into the ultraviolet*." The mirrors in the Einstein Tower would have to be silver-plated twice a year. "*It is also important that we ... have the opportunity to familiarise ourselves with the work with a mirror telescope.*" A strange plan for a solar institute; Ludendorff promptly rejected the

[190] Board: Einstein, v. Laue, Pahlen, Schrödinger. Klüber had used this instrument to obtain the data for his dissertation. See appendix 3.

project: "*The investigations planned by Prof. Freundlich ... can be carried out with much smaller means in the laboratory and there is a great deal of experience with the methodology of observation with a reflecting telescope ... In particular, the Einstein Institute section of the observatory has a modern instrument in the tower telescope, but very few results have been obtained with it so far*."[191] The last comment was aimed at a "Communication from the Einstein Institute" from 1930, in which Freundlich & Friends reported a "puzzling edge effect", according to which the desired redshift of the Fraunhofer lines occurs at most at the edge of the sun but never in its centre.[192] At the time, the two opponents lived next door to each other,[193] and certainly met almost daily on the sparsely populated Telegraphenberg.


Die Grundlagen der
Einsteinschen Gravitationstheorie
von
Erwin Freundlich
Mit einem Vorwort
von
Albert Einstein

Berlin
Verlag von Julius Springer
1916

Fig. 32 Erwin Freundlich (1885 -1964) completed his doctorate in Göttingen in 1910 under Felix Klein on "Analytic functions with an arbitrarily prescribed infinite domain" and wrote a textbook on the new theory of gravitation as early as 1916. Einstein to Sommerfeld: "He was the first astronomer to realise the significance of the general theory of relativity."

Minister Grimme from the "League of Decisive School Reformers" approved the application despite such reservations because it was reasonable to convert a powerful telescope into an active observatory, but perhaps also because of its history,

[191] Archiv der Berlin-Brandenburgischen Akademie der Wissenschaften (ABBAW), AOP, No. 149; cf. Hentschel (1992), p. 131.
[192] Freundlich et al. (1930).
[193] Ludendorff lived in one of the observer houses, Freundlich in the brick building erected for him in 1926, now also Freundlich-Haus A34. The Grotrian and Hassenstein families lived in the director house, also Eberhard and v.d. Pahlen lived on the Telegraphenberg (Brück, 2000).

which dated back to the early days of the Weimar Republic. However, the reflector telescope could not contribute anything to the solar-research profile of the Einstein Institute. Freundlich had the new building (the "Miethe-dome") with a dome larger than that of the tower erected at the greatest possible distance from the main building of the observatory, as if it were a lifeboat for the Einstein Tower – or as a visible sign of his growing distance from solar physics and/or Einstein. Ludendorff had submitted the building application for the Miethe dome himself on 13 November 1931 ("*For the attention of Professor Freundlich, Einstein Tower*") and the permit came the next day.

## A campaign

"Then came the year 1933, in which a large number of the best scientists that Germany had produced left their country forever, among them Einstein himself, while the majority of those who stayed behind hastened to assure the new regime of their devotion."[194] From 30 January on, the successful scientific landscape of the Weimar Republic was permanently destroyed, Minister Grimme had already lost his position in July 1932 when v. Papen became Reichskanzler. In April the Einstein Institute was given the new name "Institute for Solar Physics", after which it was formally incorporated into the Astrophysical Observatory under Ludendorff.[195] Carl Bosch guessed early on what this would lead to. He wrote to the Ministry on 4 April to point out "*that the Institute must continue under its present management under all circumstances, because only the intensive contact with outstanding researchers from abroad, which can only be guaranteed by the currently working persons at the Einstein Tower, will enable the Institute to continue to lead German astrophysics."*[196] On 19 May 1933, the Potsdam district leadership of the "National socialistic Operations Cell Organisation" reported to the government "*that Professor E. Freundlich has been employed as the principal observator for the Einstein Tower at the Astrophysical Observatory since 1922. As this gentleman is of Jewish descent, we request further arrangements. Heil Hitler!*" The date of receipt of this "request" at the Ministry of Science, Art and National Education is 28 June. According to the instruction of 16 June 1933, the heads of the independent scientific institutions such as the Observatories in Potsdam had to ensure that all employees

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[194] Klüber (1965). Almost 6000 professors and assistants had to leave the universities in 1933, around 20% of the teaching staff.

[195] Employees AOP 1933: Ludendorff (Director), Münch, Freundlich, Westphal, Hassenstein, Grotrian (principal observators, salary A2a), v. d. Pahlen, R. Müller (observators, salary A2b), Klüber (scientific assistant, salary 2b), Wurm, Brück (scientific employee). Source: GStAPK, I. HA Rep. 76, Va Sekt. 1, Tit. V No. 4 Adh.

[196] GStAPK, File I. HA Rep. 76, Vc Sekt. 1 Tit. XI No. 6b Vol. 10. See Appendix 2.

would submit the declaration that they are "not aware of any circumstances that could justify the assumption that I am descended from non-Aryan parents or grandparents". The next day, Freundlich from the Institute for Solar Physics applied to the Ministry for a one-week "vacation".[197] Prof Vahlen from the Berlin Ministry ordered an expert opinion on Freundlich's personality from the director of the Sternwarte Berlin-Babelsberg Paul Guthnick stating in the introduction that he had never passed a positive assessment on Freundlich. His opinion had "*not changed, as Professor Freundlich* had *not changed either"*. Now, however, there were new arguments: "*Professor Freundlich has always given me the impression of a fighter for the strengthening of Jewish influence in German cultural life ... From the point of view of Jewish imperialist endeavours, to which Freundlich is obviously very close, one must consider his entire activity, especially the founding of the Einstein Institute, which was essentially his initiative ... From the point of view of the preservation of German culture, I must unfortunately characterise him as a person to whom I consider it questionable to admit any decisive influence."*[198]

A "List of Officials and Employees" dated 18 July 1933 and signed by Wilhelm Münch[199] does not contain the usual entry "not to be arranged" for Freundlich but his name is underlined in red. On the same day, the "NS-Beamtenabteilung, Fachschaft Observatorien, Kreisgruppe Potsdam, Fachschaftsleiter Obst" denounced him as an "*anti-national thinking Jew descendant*", quoting some old political phrases by Freundlich from a collection of Münch and Wurm.[200] "*The entire conversation revealed a completely hostile and insultingly mocking attitude by Prof Freundlich towards the national movement.*"[201] This was very dangerous but not yet enough for Ludendorff especially as at the end of June the physics elite of the Academy of Sciences – almost all Nobel Prize winners – appealed to Minister Rust for the "*retention of the principal observator Freundlich in his position at the Astrophysical Observatory*",[202] but they underestimated Ludendorff. Nobel Prize

[197] Ibid.

[198] Guthnick to Vahlen 10 July 1933, ibid.

199 Wilhelm Münch (1879-1969), retired at 1944.

200 Letter to the Administrative Director at the Berlin University: "Reichskanzler Hitler was described by Freundlich as a 'sectarian', Minister Göring as a 'morphinist'" (Karl Wurm, 10 July 1933); "In a conversation I had with Mr Freundlich … he told me verbatim: I am a Bolshevik" (Wilhelm Münch, 11 July 1933), ibid.

201 Letter enclosure signed. K. Wurm, GStAPK, I. HA Rep. 76, Vc Sekt. 1, Tit. XI, Part II No. 6b, Vol. 10.138. See Apendix 1.

[202] "The undersigned hereby take the liberty of once again drawing the Minister's attention to the urgent request to leave the Principal Observator Professor Freundlich in his position at the Astrophysical Observatory Potsdam, which three of them (Laue, Paschen, Planck) had already made on 29 March 1933. They also refer to the expert opinions of the astronomers Kienle (Göttingen) and Kohlschütter (Bonn) of 1 and 3 April 1933 on Freundlich's scientific achievements. They would particularly like to emphasise Kohlschütter's reference to the excellent instrumental equipment of the Section of Solar Physics

winners did not impress as they "*cannot possess expertise in the field of astrophysics and astronomy, [and did] not consider it necessary to ask me as the director of the observatory about my opinion beforehand."* Early in October he started a written circular: "As I have been informed, the Hitler salute is not yet common practice in the Institute of Solar Physics. I make it everyone's duty ... to use this greeting in accordance with the existing regulations,[203] including in contacts with Jews. I shall immediately report any offences of which I become aware."[204] Likewise, on 7 October, the minister wrote to Freundlich: "*I have been informed that the Hitler salute ... is not being used in your Section. You must immediately inform all employees in your Section of the decree and ask whether anyone is unwilling to comply with it. The success is to be reported here with your own statement."*

The "information" of 5 October 1933 came from Ernst Kohlschütter, Director of the Geodetic Institute at Telegraphenberg, who passed on or had to pass on the statement of an administrative employee. He added that "*two officials of the Geodetic Institute, who had initially refused to use this salute, would have been dismissed from their jobs if they had not agreed to use the salute at the last minute.*" Freundlich would never give up at the last minute, Ludendorff must have thought, and knew how to get rid of him quickly. In fact, instead of his signature – provided by the other scientists without comment[205] – Finlay Freundlich asked[206] "to inform me from which side such a report is supposed to have been received." Ludendorff responded coolly that he did not owe anybody at the Observatory an account of his actions as director. "The complaints procedure is open to you. I would also like to inform that the day before yesterday the director of the Geodetic Institute received a complaint against you for not honouring the Hitler salute to a person from his institute. At the request of Prof Vahlen I handed this complaint over to him yesterday during a visit to the Ministry. The matter will therefore be dealt with directly by the Ministry."[207]

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created by Mr Freundlich - essentially with private funds - as well as his reference to the value of the scientific stimulation emanating from this Section to the entire Astrophysical Observatory." Source: GStAPK, I. HA Rep. 76, Vc Sekt. 1, Tit. XI, Part II No. 6b, Vol. 10.

[203] Ministerial decree no. 1712 of 22 July 1933.

204 Handwritten note: "Transmitted to Prof. Vahlen. H. Ludendorff". ABBAW, AOP, no. 149, note by B. Eggers, cf. Hentschel (1992), pp. 147-150, there with facsimile.

205 Finally, the signatures of Brück and Klüber will be missing but Ludendorff will have considered this as being unimportant. Neither of them mentions this affair in their autobiographies.

206 Freundlich with a Jewish grandmother on his father's side, had adopted his mother's maiden name ("Finlay") at an early age but used it in scientific publications for the first time in 1927 (and later irregularly).

207 Published by Freundlich in the Pariser Tageblatt, 25 March 1934, facsimile in Hentschel (1992), p. 150.

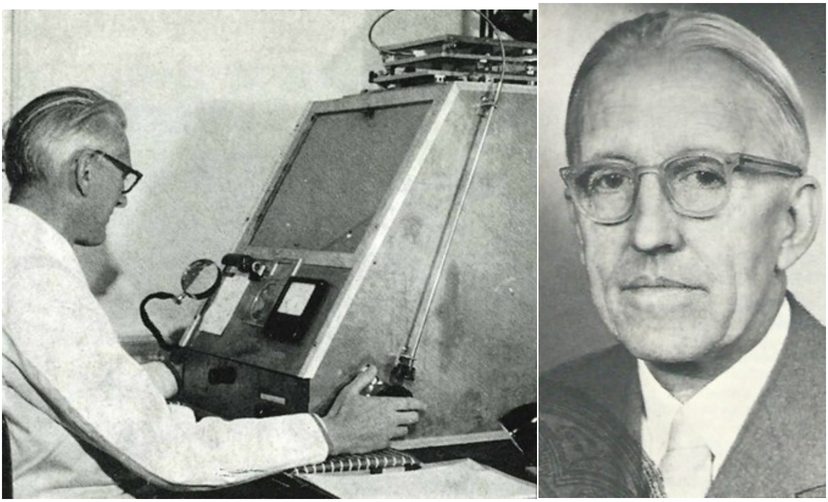

Fig. 33 left to right: Wilhelm Becker (1907-1996), Harald von Klüber (1901-1978). Sources: Orion 31 (1973) No. 134, p. 27; Sterne und Weltraum 18 (1979), p. 40.

Now everything went very quickly. Freundlich replied to the minister's enquiry on 20 October "that all those working in my institute have been informed of the decree on the Hitler salute for weeks and that no one has objected to its observance" – and left for Istanbul on 27 October without waiting for an answer to his request of 4 October on "a two-years leave of absence from 1 October this year"[208] and without waiting for the end of the campaign directed against him. Immediately, on 28 October, Ludendorff reported to the Ministry that the "Principal Observator Prof. Freundlich left his post yesterday and went abroad without requesting vacation from me and without informing me of his departure. I have instructed the Geodetic Institute's cash office to suspend salary payments to Prof. Freundlich for the time being" and added on 28 November that "Freundlich had gone abroad (Turkey), taking his furniture with him" and that the keys to the empty house had been handed over to a confidant (student).[209] Ludendorff had succeeded, Freundlich was finally taken off the payroll in November, "as he left for Turkey at the end of October ... without waiting for the decision on the application for leave he had provided." The promised pension will also never be transferred to Istanbul.[210]

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[208] Freundlich: "I have been appointed by the Turkish government as Professor of Astronomy at the reorganised University of Stambul to tackle the construction of a modern observatory in the Mediterranean region."

[209] GStAPK, I. HA Rep. 76, Vc Sekt. 1, Tit. XI, Part II No. 6b, Vol. 10.

[210] He was appointed to the Chair of Meteorology and Astronomy at the newly founded Istanbul Üniversitesi on 6 July 1933. His application for a two-year leave of absence as a German official was

"He is not to be informed of this. Should he assert any claims there, he must first report to me",[211] ordered the new Ministerial Director Vahlen; Ludendorff was put in charge of the Einstein Tower, and Freundlich received a copy of the corresponding decree. Kienle promoted Grotrian but on 1 March 1935 Paul ten Bruggencate from Greifswald became head of the Institute for Solar Physics as part of the AOP. Ludendorff had intensively supported the talented nuclear physicist Hermann Schüler, but Bruggencate had joined the SA in November 1933 and got the position.

The newly installed Miethe double reflector had exceeded all expectations, only the dome building formed a problem. In January 1935, a storm had shifted the dome as a whole, and the roof had to be thoroughly repaired the following year, including the renewal of the outer coating. Klüber carried out the fine adjustments for the commissioning of the telescope in a short time and a new electrical fine movement came from the Askania Werke in Friedenau. From autumn 1931 onwards, regular work was carried out in the Miethe dome. The optical quality of the 50-cm-mirror has proven to be excellent. In Ludwigshafen at IG Farben, it received a robust aluminium mirror coating, which, however, had to be carefully protected against condensation. The photographic observations were regularly listed in the annual reports from 1932 onwards, after which Klüber, Becker and Pahlen were persistent main observers of variable stars and open star clusters with the instrument. A publication by W. Krug[212] presented classical photometry in two spectral ranges of the young globular cluster M71, which is considered as one of the most interesting globular clusters today. "The necessary images were taken at the 50-cm Goerz-reflector of the Potsdam Observatory." The observers included the results in their textbooks.[213] On the other hand, since 1941 Klüber began to reorient the research at the Einstein Tower towards the solar magnetic fields; magnetic field measurements in spots and their surroundings are already listed in the observatory's annual report for 1942. After the war, the Goertz reflector, together with other instruments, ended up on a Soviet reparation list[214] signed by Kienle on 21 June 1945; it has been lost for ever.

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never answered (Hentschel, 1992, p. 152). On 17 June 1933, Freundlich had abruptly applied for a one-week vacation.

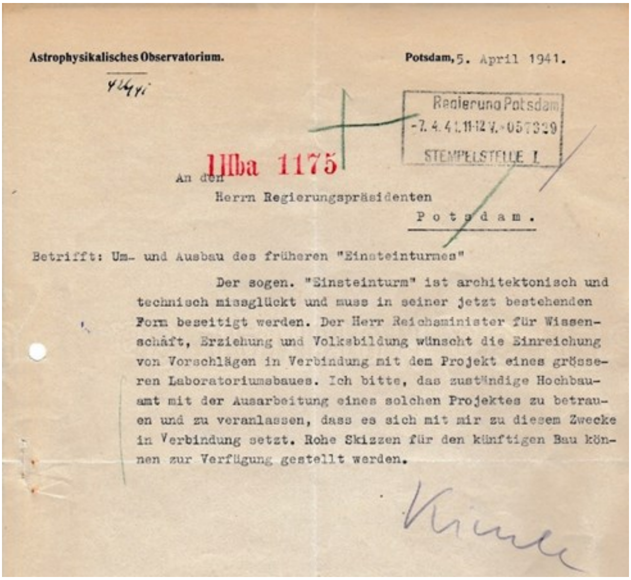
[211] Hentschel (1992), p. 152, note 22.

[212] Krug (1937).

[213] Emanuel v. d. Pahlen: Lehrbuch der Stellarstatistik (1937); Wilhelm Becker: Sterne und Sternsysteme (1942).

[214] Together with the photo refractor, the Zeiss-triplet and the 40-cm mirror of the east dome as well as the spectroheliograph system and with the only mechanical calculating machine "Brunsviga", many books and periodica. The "List of instruments and apparatus handed over to the Soviet Union" consists of 31 entries, see G. Kühn, "Chronik des Mietheteleskopes", in Miethe (2012). According to the annual reports the heliostat installation on the roof of the Beamtenwohnhaus was already "demolished" as

On 30 January 1941, Kienle as Ludendorff's successor applied for an important construction project to the District President of Potsdam "*... first of all to extend the main building in such a way that the available first-floor space is utilised. The Reichsminister for Science and Education will try to include the finances in the 1941 budget.*" The plan was already approved by the Ministry on 2 April 1941 "*in principle from a technical point of view*."[215] This much-promising success had made Kienle overconfident. As early as 5 April 1941 – Klüber had just begun to upgrade the Einstein Tower for magnetic field measurements – the archives contain a note "*Concerning the conversion and extension of the former Einstein Tower*" to the same District President that "*the so-called Einstein Tower ... failed in technical and architectonical respect*" and *"must be removed*".[216]


Astrophysikalisches Observatorium.

Potsdam, 5. April 1941.

Regierung Potsdam -7. 4. 41. 11-12 V. - 057329 STEMPELSTELLE I

IIIba 1175

An den
Herrn Regierungspräsidenten
Potsdam.

Betrifft: Um- und Ausbau des früheren "Einsteinturmes"

Der sogen. "Einsteinturm" ist architektonisch und technisch missglückt und muss in seiner jetzt bestehenden Form beseitigt werden. Der Herr Reichsminister für Wissenschaft, Erziehung und Volksbildung wünscht die Einreichung von Vorschlägen in Verbindung mit dem Projekt eines grösseren Laboratoriumsbaues. Ich bitte, das zuständige Hochbauamt mit der Ausarbeitung eines solchen Projektes zu betrauen und zu veranlassen, dass es sich mit mir zu diesem Zwecke in Verbindung setzt. Rohe Skizzen für den künftigen Bau können zur Verfügung gestellt werden.

Kienle

Fig. 34 Proposal to replace the Einstein Tower with a "larger laboratory building". Archive Eggers.

Already previously Kienle had made a name for himself as an architectural expert. On 13 October 1939 he informed the President that he needs a garage for

early as 1939.
[215] Not started due to the war.
216 BLHA, Potsdam-Golm. Probably, the Einstein Tower only survived this letter because of its meaning for the allegedly war-relevant radio wave research. The solar telescope remained the only active instrument of the AOP during the war years.

his "*official own car*" and that a "*room freed up by the relocation of the kitchen in the basement"* would be the most suitable option to house the car. The repeated exchange of letters finally ended in March because "*the planned action not be described as essential to the war success.*" In 1941 Kienle reported that "at the invitation of the German Scientific Institute in Copenhagen, the undersigned, together with Prof Heisenberg, Dr v. Weizsäcker and Dr Biermann took part in an astronomical-physical meeting, which provided a welcome opportunity for fruitful discussions with Danish colleagues." That "meeting" with the mysterious conversation between Bohr and his former student Werner Heisenberg on garden paths and without witnesses has entered the collective consciousness of the physics community. There were no joint talks at all, the Nordita institute in Copenhagen indicates today, one nation per table at lunch.

## The magnetic sun and a solar eclipse (1929)

Born in Potsdam, Harald von Klüber as the only descendant of an old family of diplomats and officers completed his doctorate in Berlin in 1924 with an observation project[217] completed at the Miethe Observatory in Charlottenburg. Since 1923, he worked at the Einstein Institute and at the Astrophysical Observatory, holding the position of observator and professor from 1940 and principal observator from 1946. He had upgraded the instrumentation of the Einstein Tower to measure solar magnetic fields, until then the unique selling point of the Mt. Wilson Observatory. The Potsdam astronomers' focus on the investigation of cosmic magnetic field can be traced back to him alone. To measure the Zeeman splitting of the 6302 Å iron line by the magnetic field of sunspots, wavelength differences of Å/1000 had to be resolved.[218] "The optics of the Einstein Tower telescope and its laboratory make it possible to carry out such investigations."[219] Klüber used a trick to separate the two minimally shifted line components by exploiting their different polarisation, so that "in the two superimposed spectra, the long-wave side component of the longitudinal Zeeman doublet is cancelled out in the upper spectrum and the short-wave side component in the lower spectrum."[220] The method was very effective, a spot photograph only required about 20 seconds of exposure time. The

[217] H. v. Klüber, "Effektive Wellenlängen und ein anderes Farbäquivalent für 25 nordpolnahe Sterne", Dissertation Berlin (1924).
[218] Similar to the gravitational redshift ($10^{-6}$) or a measurement of the protometer to a 0.001 mm tolerance.
219 Bruggencate & Klüber (1947).
220 Brunnckow & Grotrian (1949).

weak large-scale magnetic field of the sun had already been successfully observed in Potsdam during the 1944 spot minimum, although the values were still too high.

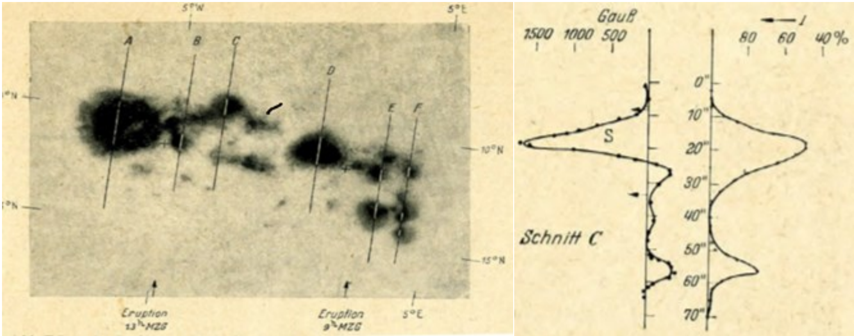



Fig. 35 Measurement of a group of spots: position of the spectrograph slit; field strength and brightness at section C (right). Source: Bruggencate (1947).

A waste of magnetic field measurements was accumulated in this way until the 1950s without coming closer to the explanation of the solar cycle. Finally, Klüber describes the fortunate composition of the Einstein Tower team with Freundlich, v. d. Pahlen, Grotrian and the mechanic Erich Strohbusch. He could not have found a better place in Germany at this time of rapidly developing research.[221] He would never have been forced into the military during the war, but like many of his colleagues he would have carried out extensive calculations on "astronomical navigation". All of the observatory's instruments that were not used for solar observations were decommissioned due to the war. [222] He seldom left Potsdam during this time. Grotrian commanded as military chief of a radio wave research detachment, commanded the soldier Künzel home to support Klüber's sunspot observations in Potsdam. On the other hand, Klüber's knowledge of ionospheric physics was so detailed after the end of the war,[223] that he was certainly involved in the military-motivated activities of Grotrian and Kiepenheuer.

In August 1914 in the Crimea, Freundlich, who was not yet 30 years old, was the first astronomer in the world to demonstrate during a solar eclipse the gravitational deflection of the starlight as it grazed past the sun, as predicted by Einstein during a solar eclipse.[224,225] The war destroyed his plans, he was forced to leave

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221 H. v. Klüber, "Short autobiography" (n.d.), See Appendix 3.
222 In 1940, the 80-cm objective of the Great refractor was revised by Carl-Zeiss for the last. Time.
223 Klüber (1947).
224 Still with the (wrong) Newtonian value.
225 Freundlich's 1914 expedition was largely privately funded (Krupp Foundation, Academy of

the location, interned in Odessa and later exchanged. Moreover, the spectacular eclipse of 1919 was tragically out of his reach for political reasons. Others had realised his ideas derived from his early theoretical background. He would not find peace with Einstein's predictions until the 1950s. His experiments in 1922 and 1926 remained without measurable success,[226] but the concept of the giant Potsdam double horizontal camera was developed step by step, with the first tube aimed directly at the eclipsed sun, while the second tube was pointed at a distant star field for comparison, which did not experience any light deflection. Both cameras with a focal length of 8.6 m (!) received their light from one and the same Zeiss heliostat. In 1929, from the total eclipse under a clear sky, four images of the solar neighbourhood and three of the comparison field were taken,[227] each on large 45 x 45 cm plates. For comparison, identical night photographs of the star fields at the same observation site were required; Klüber completed this task exactly 6 months later, which for the sake of simplicity he spent on Sumatra with extensive local expeditions through "Sumatra, through Java (Bosscha Sterrenwacht) and Bali."[228]

Klüber was a highly active participant, organiser and leader of solar eclipse expeditions throughout his life. The eclipses of 1923, 1926 and later 1952, 1954, 1955,[229] 1958 and 1959 were mostly used to investigate the spectral properties of the corona. The well-elaborated Potsdam expedition to Takengon (North Sumatra) on 9 May 1929 was a particular exception because it was dedicated to a seemingly solved problem. Ten years earlier, two British expeditions to Brazil and to an island off Spanish Guinea had measured the deflection of light from stars close to the sun and, with 1.98″ and 1.61″, almost exactly provided the Einstein value of 1.75″. Before his departure Eddington had predicted that "these eclipse expeditions will perhaps prove the weight of light for the first time; or they will prove Einstein's strange theory of non-Euclidean space; or they will produce a result with even more far-reaching consequences – no deflection."[230] The result of the expedition seemed to confirm the strange theory, establishing Einstein's world-wide fame overnight.

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Sciences) and did not belong to any official institution.
226 Grotrian (1952).
227 A fourth cassette has been lost.
228 See Appendix 3.
229 In Ceylon, together with Mattig and Strohbusch from Potsdam, unsuccessful due to the weather conditions.
230 Pais (1986), p. 307.

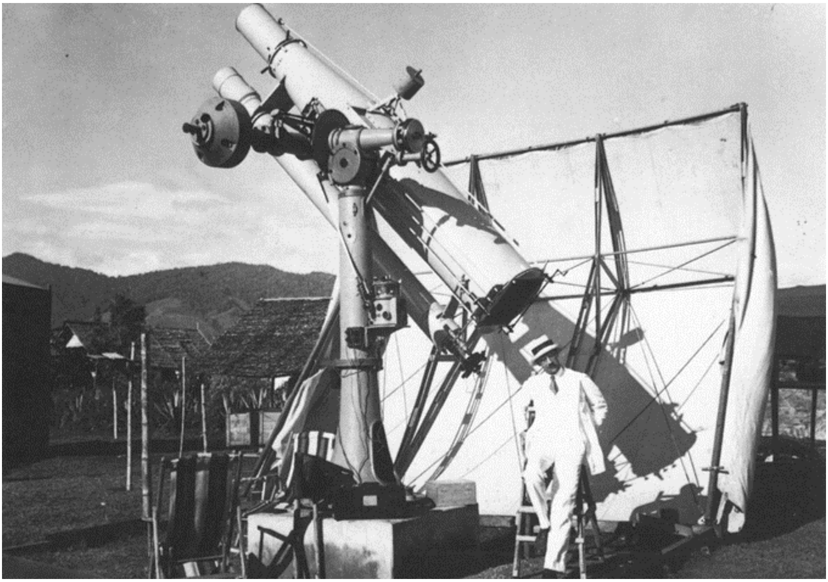

Fig. 36 Erwin Freundlich during the solar eclipse expedition 1929 on North Sumatra. Parallactically mounted astrograph with a focal length of 3.4 m. Source: MPI History of Science.

In the winter of 1928/29, the Potsdam expedition set off by ship from Antwerp to Sumatra with 15 t of luggage in 70 boxes. With their technical strategy – confirmation or correction of the results announced by Eddington – the Potsdam group was not alone. R. Süring as the head of the meteorological institute informed in the Berliner Lokalanzeiger that an "important item on the programme of the German, American and Japanese expeditions is the investigation of the deflection of light from stars close to the sun as they pass through the solar atmosphere in order to test Einstein's ideas." Under the direction of Erich Strohbusch two large devices including a complete electrical supply and radio equipment were brought to the Sumatran jungle for connection to the Nauen long-wave antenna. The classic eclipse instrument was an improved duplicate of the astrograph with a focal length of 3.4 m that Freundlich had lost on his Crimean expedition in 1914. The team Strohbusch/Klüber managed to take 6 images on 3 plates during the 5 min of total eclipse, 3 images of the stars surrounding the sun (up to 60 seconds exposure time) and 3 images each of a comparison field. Three times the long tube had to be moved in deep darkness from the sun to the comparison field. Freundlich's typical order was: "With the natural excitement of all participants, special care must be taken to minimise any uncertainty."

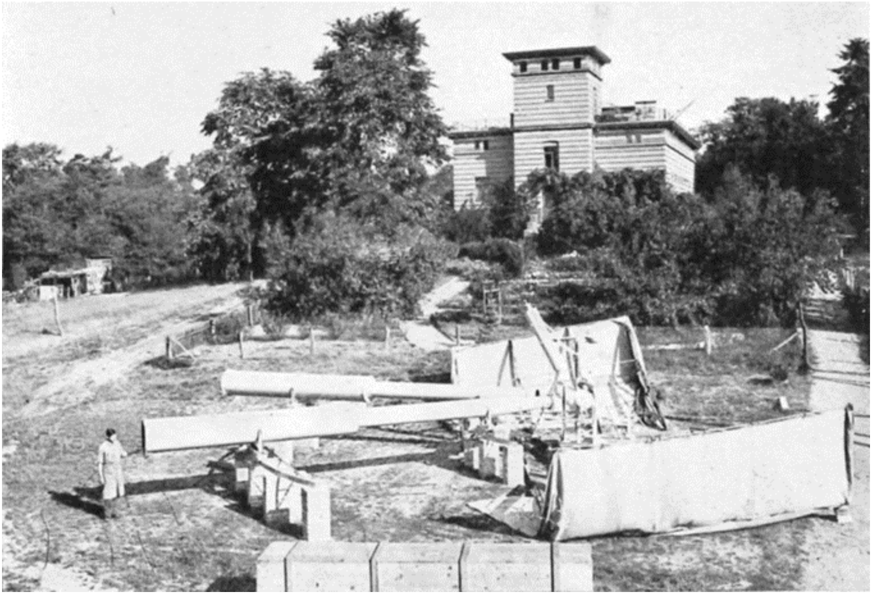

Fig. 37 Double horizontal camera with heliostat and deflection mirrors, focal length 8.6 m, assembled on the Telegraphenberg. In the background the Beamtenwohnhaus with spectroheliograph (Freundlich, 1930).

The weather conditions on the eclipse day must have been nerve-wracking. From 8 a.m., five hours before the event, there was complete cloud cover so that even the first contact of the moon with the sun remained invisible. However, Freundlich describes that "there was a full clearing before the onset of totality. Shortly before the complete eclipse of the sun, the lighting conditions in the atmosphere are so unusual that one loses all feeling about the sky. The fact that there was clear visibility in the near vicinity of the sun was shown by the corona, whose radiant structure stood out unusually clearly. Many bright stars were visible."[231] Klüber in his obituary to Freundlich: "The extensive reductions carried out at the Einstein Tower [1930-1933] gave the amount of light deflection with the smallest mean error yet achieved, but about 30% too large. Almost all earlier and later determinations also seem to indicate a somewhat higher value, and Freundlich pursued the clarification of this phenomenon throughout his life."[232] The Einstein Tower group had even argued that the globally celebrated minor values of the

231 Freundlich (1930).
232 Klüber (1965).

British expeditions of 1919 well-fitting Einstein's prediction, were based on wrong reductions.[233] Einstein did not really enjoy his friends from the Einstein Tower and this for the rest of his life.[234] To be on the safe side, he emphasised the beauty of his theory: "I do not see the main significance of the general theory of relativity in the fact that it has predicted a few tiny observable effects, but rather in the simplicity of its basis and in its consistency."[235] This sounded surprisingly. Before his Nobel Prize, at the beginning of 1916, in a letter to Schwarzschild stationed in Russia, he wrote on the possible measurement of light deflection on Jupiter: "As far as Jupiter is concerned, I recognise that it is a difficult task for astronomers. But in my opinion, the importance of the subject justifies only *one* point of view, and that is: It *has to* work!"[236]

After the expedition 1929 Freundlich formulated that "If the plate material which is still being processed leads to the same [Eddington] result, there will no longer be any doubt that the deflection of light predicted by the theory does exist, but if it had a greater value then it will be the task of the future to develop the theory of relativity in such a way that it is able to explain this phenomenon."[237] Of course, Freundlich was a "relativist" but he persistently intended to be involved in the development of the final version of relativity, not simply to confirm its existing form. After the Sumatra expedition the positions on Einstein had changed – which must have amused Ludendorff. In a public epistle, Ludendorff argues that the expedition data, if analysed slightly differently, would lead to a light deflection of 1.90″,[238] which the gentlemen from the Einstein Tower loudly denied. The dispute on Telegraphenberg could not have been presented to the public more precisely. Still 1952, at the 17th German Physics Conference in Berlin, Freundlich insisted that the Potsdam eclipse result of 1929 was too high compared to Einstein's predictions and said that "it must be expected that the observed phenomena of the propagation of electromagnetic energy (photons) in the gravitational field of the intensely radiating sun will not be fully described by the very formal and abstract solutions."[239] He had expressed similar scepticism about the gravitational redshift in 1930: The manifold attempts in America and England "to prove a general shift of the solar lines by $2 \cdot 10^{-6}$ times their wavelength" had not reached any conclusive result. "Although the existence of the effect is proven with a high

233 Freundlich, Klüber & Brunn (1931).
234 Einstein's redshift is today considered to be confirmed to 5% by solar observations, the deflection of light to only 20% (W. Kundt in: Springer tracts in modern physics 47, 1968).
235 Pais (1986), p. 274.
236 Hentschel (1995), p. 40.
237 Freundlich (1931).
238 Ludendorff (1932).
239 Finlay-Freundlich (1953).

degree of probability, the measurement results to date cannot be condensed into a conclusive proof in favour of the theory of relativity."[240]

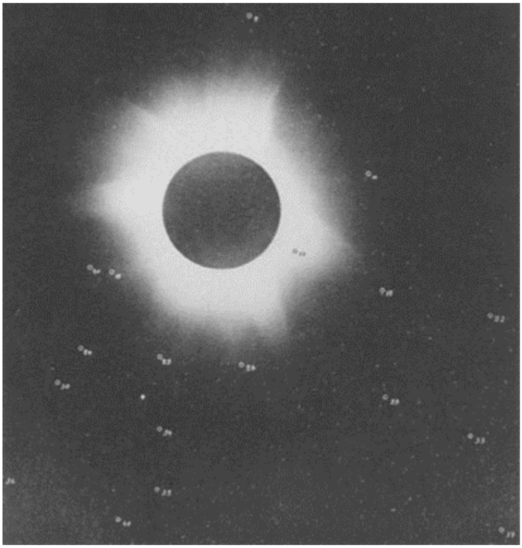

Fig. 38 Total solar eclipse of 9 May 1929, one of the four successful Potsdam images. The measurable surrounding stars are marked. From Freundlich et al. (1931).

During the eclipse Eva und Walter Grotrian unspectacularly used the three Potsdam spectrographs to produce six spectra tangential to the moon, however, the analysis and interpretation of which, after years of work,[241] will be by far the greatest success of the Potsdam expedition.[242] Additionally, the images showed the line spectrum of a bright prominence at the edge of the sun, whose systematic observations he was only able to continue decades later as the director of the Observatory Potsdam.

240 Finlay Freundlich (1930).
241 On 1 October 1932 Grotrian became principal observator at the AOP.
242 Mattig (1999).

## A coronagraph for the Einstein Tower

After the departure of Klüber who, at the age of 46, left for ever his lifework on the Telegraphenberg and his villa in Finkenweg,[243] the principal observator Grotrian became head of the Einstein Tower after a six-year absence due to war. From 1 January 1947, the German Academy of Sciences in Berlin (AdW) took over the institutes on Telegraphenberg alongside the Babelsberg and Sonneberg observatories by order of the Soviet military administration and made astonishing investments. For the reopening of the academy on 1 August 1946, Kienle had given the keynote speech "The scales of the cosmos".[244] The old project to add a storey to the attic of the main building was realised in 1948, finally creating seven new offices and in 1950, on the 250th anniversary of the Academy, the bomb-damaged Einstein Tower also received a general reconstruction – without the completely destroyed Bosch barrack. In the west dome, the Grubb-refractor with the new lens from Steinheil survived, while in the east dome in 1949 a self-built Schmidt camera was mounted.[245] Professor Grotrian who had never been a party member[246] became Managing Director on 1 October 1950 and Director of the Institute from 1 January 1951, but it was only a tiny command that he took over. Only Wempe had remained from the war period, the observators Daene and Schneller as well as Brunnckow as assistant had joined at the turn of the year 1948/1949. The astronomers Hassenstein, Klüber, H. Müller, R. Müller, Münch and Pahlen had left for various reasons. In his first annual report, Grotian stoically wrote about the former director Kienle: "Wartime and post-war times presented him with difficult tasks. The observatory thanks him for his preservation and reconstruction in connection with the integration of the Astrophysical Observatory into the Academy." No word about science.

Shortly before the WW II, Grotrian had made pioneering discoveries about the nature of the Nova Herculis and the solar corona and was now studying the solar magnetic fields full-time. "The magnetic fields of sunspots are the phenomenon in

243 Destination Zurich, according to annual AOP report 1950 on leave since 1947. From 1942/1943, von der Pahlen permanently went to a sanatorium in Davos retiring 1944 in Potsdam. W. Becker took over Pahlen's later professorship in Basel in 1953. Johann ("Hans") Kienle (1895-1975) headed the AOP from 1939 to 30 September 1950, after which he worked in Heidelberg. Johann Wempe came from Jena to Potsdam in 1944, where he habilitated and worked for Astronomische Nachrichten from 1947, becoming principal observator on 1 October 1949.
244 "I pursued and achieved the integration of the astronomical institutions into the Academy from the very beginning" (Kienle, 1949).
245 An eclipse astrograph had stood in the centre dome since 1941, see AOP annual report from 1950.
246 In WW I Grotrian was a front-line soldier and flight-observer. In WW II, as a major in the Wehrmacht, he was the military head of a special unit for ionospheric research. According to Kuiper (1946) non-membership of astronomers in the NSDAP during the war was rather exceptional – there were, after today's knowledge, prominent counter-examples at the AOP.

which it is most clearly and conspicuously apparent that electrodynamic forces also play a significant role in the interplay of all the forces that determine the structure of a star," he wrote in his last summary.[247] In an early plan for astronomy in the Soviet Zone for 1945/46, the "*state of the sun and the connection between solar and terrestrial phenomena*" was formulated as his new research goal, in the very spirit of the old Förster. At the end of 1949 it was stated that "*sunspots, corona, prominences and the measurement of temporal changes in magnetic fields are of central meaning.*" Grotrian wanted to solve the old puzzle of the 11-year Schwabe cycle and had focussed on determining the solar magnetic fluxes.

Grotrian also wanted to know whether the shape of the sun is influenced by the cyclic magnetic field. He wished an instrument to determine the solar diameter, but even more pressing was the lack of a dedicated coronagraph to define the edge of the sun and directly track the prominences up to high latitudes shooting into the atmosphere.[248] Klüber enthusiastically describes in these years how he was allowed to work with the coronagraph at the Arosa Observatory for almost a year in 1948. At this time, the connection between prominences and the sunspot cycle had already become part of the observation programs.[249] Grotrian in Potsdam also wanted to be present when the mysterious magnetic corona heating was clarified.

247 Grotrian (1952).
248 Waldmeier (1941).
249 Behr & Siedentopf (1952).

Fig. 39 Miethe dome, today A23. The 5-m-dome was removed after 1990 under unclear circumstances. Photo H. Strohbusch.

Another motive was radio wave research. Klüber had stated in 1946: "Observations of the corona at the eastern limb of the sun, which is turning towards us, indicate those places on the sun a week later which could possibly produce increased photoionization of the ionosphere on Earth. Corona observations ... are therefore particularly important for forecasting shortwave propagation."[250] Already Kienle had wanted a coronagraph for the institute to observe the solar limb.[251] In coronagraphs the bright solar disc in the main focus is covered by a conical diaphragm, as in a solar eclipse, in order to receive only the faint light from the inner corona.[252] Kienle had failed due to political difficulties. The then powerful Kiepenheuer had told him in the fall of 1942 that "all orders for solar physics in the Reich" could only come from him. Due to the low brightness of the corona, the instrumentational scatter light had to be suppressed by carefully processing the lenses. Kiepenheuer had denied the Potsdam team the necessary support.[253]

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[250] Klüber (1947).
[251] Kummer (1996), with an account of Kienle's far-sighted handling with the utensils of the Crimean Observatory stolen by the Wehrmacht in 1943/44.
[252] Lyot (1939).
[253] Seiler (2007), p. 122.

Fig. 40 left to right: Kienle, Künzel, Grotrian, unknown. Archive Förderverein Großer Refraktor.

The demolition of the Miethe-dome which was empty since 1945 is reported for 1950. At the same time, the Refractor building is restored and the *"Great Refractor was dismantled by Zeiss Jena in order to be completely reconstructed.*" Grotrian had worked with Erich Strohbusch to build a coronagraph with an aperture of 13 cm and a focal length of 190 cm for "*spectrohelioscope observations of time-varying processes on the sun*" and was clever enough to take advantage of an internal academy reconstruction programme for the Berlin area. VEB Bau-Union Potsdam was commissioned to build a new 5-m Zeiss-dome on the foundation walls of the Miethe building with a photo darkroom and a tiny office. In a letter dated 13 November 1952 to the Academy's Department of Mathematics and Natural Sciences, Grotrian and Brunnckow as the two remaining solar physicists at the observatory described the future work: "*Investigation of the magnetic fields of sunspots and evaluation of the observations from 1946 to 1951 with regard to polarity and maximum field strength.*" Brunnckow, however, "was unable to continue his work in Potsdam due to passport difficulties", as the annual report for 1953 laconically states.

It is possible that Grotrian had recognised the limited significance of his magnetic field measurements on sunspots for the explanation of the spot cycle. He wanted to investigate prominences as the other expression of the sun's magnetic activity.[254] It was not until the beginning of 1954 that his own coronagraph was fully installed in the new dome. It was put into operation the following year, complete with guide tube and recording camera with 6 x 6 cm roll film – too late for Walter Grotrian.

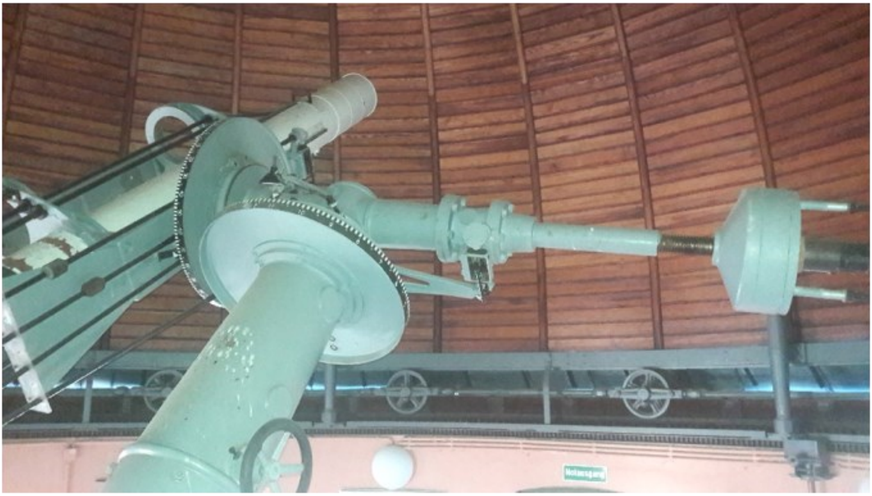

Fig. 41 Grotrian's coronagraph (guide tube), 13 cm refractor with 190 cm focal length, originally set up in the Miethe dome in 1952, now in the east dome of the main building (now the Michelson House of the Potsdam Institute for Climate Impact Research). Lens still available (information J. Rendtel).

From the very beginning, the guide tube of the new instrument had also been used for visual and photographic solar monitoring. From May 1955, "the entire solar limb was photographed on suitable days to determine the position of prominences." Working fast it was even possible to follow the explosive rise of the prominences. For the International Geophysical Year 1957/58, special funding enabled particularly intensive monitoring of the sun; the coronagraph provided photographic images of the solar limb on 76 days, which were sent into a database at

[254] Carrington was the first to report an eruption of bright spots on 1 September 1859, which lasted less than 5 min and caused a huge magnetic storm on Earth the following night.

the Fraunhofer Institute in Freiburg. The coronagraph material was never analysed for research, perhaps because Potsdam's geographical location could not keep up with other instruments on high mountains, but mainly because of the huge gap left by Grotrian's death in early 1954. Later, the dome is overgrown by the surrounding trees. In April 1985, the instrument was moved to the east dome of the main building and used for measurements in the chromosphere by attaching filters. It has been at rest there for a long time and observations have been cancelled.

In his diploma thesis, Grotrian's assistant Egon H. Schröter had discussed the almost circular isolines of the magnetic field of a sunspot, measured by rotating the image of the sun across the fixed slit.[255] He received his doctorate from the Humboldt University of Berlin in 1956. He successfully reinterpreted old redshift measurements from the tower spectrograph after re-discussion of the turbulent flow conditions on the sun, which had previously been ignored.[256] The often-lamented difference between the measured and the expected values can be understood as due to turbulence. "Even if our limited knowledge of convection and turbulence in the solar atmosphere leaves quite a lot of space for ... assumptions, the addition of unknown physical processes does not seem to be necessary,"[257] the candidate Schröter informed Freundlich in a preliminary report in January 1955. Magnetic fields and turbulence – Klüber, Grotrian and Schröter had fixed the direction that the work of the entire observatory would follow to its end.

# 4 The Daddy on the Hill

## Summer piece

The year 1951 the 61-year-old Walter Grotrian followed his new passion of researching the solar cycle with magnetic-field measurements. The idea was to measure the magnetic flux formed by all the sunspots on the surface over days, months and years in order to determine where the magnetic field moves during the spotless minimum that occurs regularly every 11 years.[258] The dissipative force of turbulent convection has not yet known, although one could observe it easily from the decay of isolated sunspots. Grotrian's data came from California and from the

[255] Schröter (1953). Vogel had demanded that the slit of the 50 kg spectrograph for the Great refractor should be freely rotatable.
[256] Schröter (1957).
[257] Schröter (1955).
[258] Grotrian & Künzel (1950).

Einstein Tower. The external measurement results had sent to friends in Westberlin, where his driver was able to pick them up, undisturbed by controls. As a full professor with a chair at the Humboldt University, Grotrian was very well known, privileged, a full member of the Academy and one of the very first Nationalpreisträger, at that time still with the claim to be "an all-German prize".

As early as 1921, the young Grotrian can be seen in a Berlin photograph right next to Einstein taken in Dahlem on the occasion of the retirement of James Franck as professor in Göttingen. There Grotrian had trained under his supervision as an experimental physicist. At the end of 1922, he accepted the offer to work in Potsdam as an assistant at the newly established Einstein Institute for Solar Research. There he discovered that the mysterious red corona line was actually a forbidden emission of the highly ionised iron atom, which had lost half of its electrons and which had remained unknown until then because it did not occur in the laboratory.[259] Its excitation requires extreme temperatures of millions of degrees. However, he has never written down this actually unmistakable consequence of his discovery, he avoided theoretical discussions and finally did not dare to give a numerical value, although he was regarded as the leading spectroscopist in Germany after publishing his famous term schemata of the permitted quantum transitions between the energy levels of the electrons in atoms.[260] Just two years later, H. Alfvén from Stockholm announced on the second page of one of his first publications "On the solar corona", that the sun's atmosphere was "absurdly" hot, much hotter than its surface, which would contradict the simplest laws of physics, because heat always flows towards the lower temperature, never the other way round. He argued that the magnetic waves he had recently discovered should be able to heat up the solar outer atmosphere.[261]

Grotrian had not only discussed forbidden lines of the solar corona. W. Münch had begun in mid-December 1934 to produce spectra of the recently discovered Nova Herculis 1934 (DQ Her) with the photographic 80-cm-refractor, which Grotrian was able to analyse with a student. All absorption lines proved to be blueshifted for expansion speeds of about 300 km/s, hydrogen even for 1000 km/s, whereas the emission lines characteristic of novae and planetary nebulae were mostly not. Grotrian concluded that this is an expanding gas nebula from the "largely symmetrical contours" of the emission lines. As they are broadened by all radial velocity components, he ruled out any noticeable coverage by the central star, so it is obviously very minor. "In this context, however, the forbidden O I

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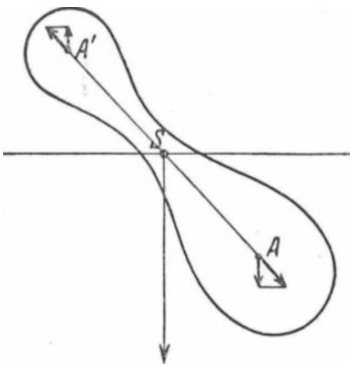
[259] Grotrian (1939).
[260] Grotrian (1928).
[261] Alfvén (1941). See, however, A. Russell, "Commentary: Discovery of the Sun's million-degree hot corona", Front. Astron. Space Sci. 5, 9 (2018).

lines must be mentioned in particular,"[262] which only occur at very low densities. With the help of the theory of E. A. Milne ("All ex-novae, as well as the nuclei of planetary nebulae, may therefore be ranked as ... white dwarfs"[263] ), Grotrian reconstructed the complex light curve of the nova using radiation gas dynamics calculations for the expanding thin envelope. He recognised that the envelope – in contrast to Milne's concept – cannot be spherically symmetrical, but has a "shape that corresponds to a central sector cut out of the sphere around the central star with a certain opening angle." Even rotation comes into play: If, as a result of rapid rotation, the star "would have the shape of an oblate ellipsoid, whose radiation would preferentially go in two directions exciting the nebular masses in these directions to glow." It can also be seen that "in the course of a few days, the nova has grown from the diameter of the sun to about half the diameter of the Earth's orbit. It may be left to the reader's imagination what will happen if the sun itself entered the nova stage." It would have relaxed him and not only him to know that the nova stage belongs to the cataclysmic binary stars which consist of an M star and a white dwarf.[264] Certainly, only the soon war will prevent the double star character of the Novae from being found in Potsdam.




[262] Grotrian & Rambauske (1935), "the green line and the red lines also observed in the Northern lights."
[263] Milne (1931).
[264] Distance 1.4 solar radius, eclipsing period 4.65 hours.

Fig. 42 Schematic representation of the nebular envelope of Nova Herculis 1934 by W. Grotrian[265] and a modern false colour image of the expanding gas disk. The line connecting the two stars defines the equatorial axis of symmetry of the nebula. Source: Wikipedia. The size of the nebular envelope (according to Grotrian $10^{15}$ cm) has no relation to the distance between the two double star components of about $10^{11}$ cm.

Grotrians current magnetic field calculations were very data-intensive; the spots move from day to day; they also decay rapidly and the observed areas and fields are constantly changing. A single mechanical calculator of that time helped with the addition and multiplication. Since last autumn, the young assistants Helga Starke and Ilse Schischkoff had been employed to support the calculations. Helga after finishing school in Naumburg wanted to study astronomy and had asked her widowed father to move to relatives living in Werder near Potsdam. The observatory couldn't have been better for her plans: textbooks everywhere, entertaining colleagues in every room, even the fulfilment of her greatest wish to work with the Great Refractor, which was still damaged at the time, was within reach.

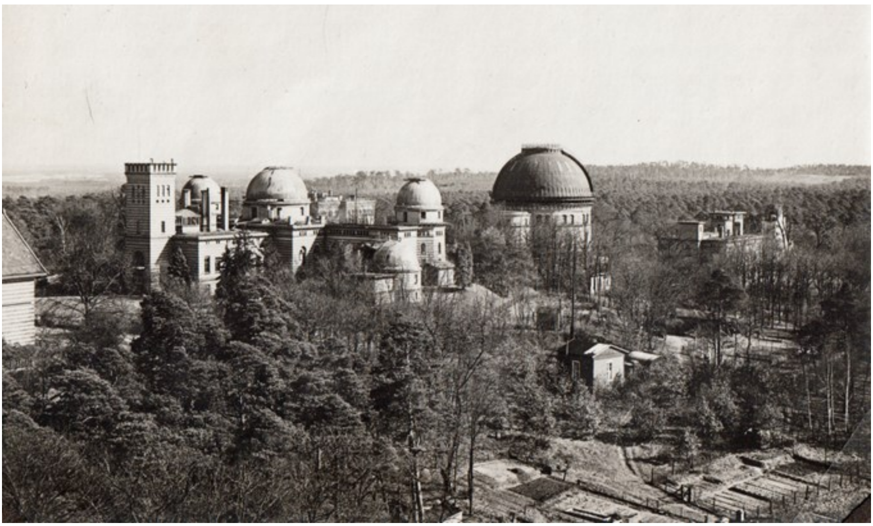


Fig. 43 Astrophysical observatory (before 1949); from left Direktorhaus (former residence of, among others, Vogel Schwarzschild, Kienle, Grotrian, Jäger), main building,

[265] Grotrian (1935).

Great Refractor, library building (former Beamtenwohnhaus), Einstein Tower. In the foreground dome of the sky map refractor. Archive H. Sperlich

It was a dream with a family connection. In the director house, right next to the main building of the observatory with the new second floor Mrs. Grotrian as "Tante Medi" regularly invited to lunch. In the evenings, they played music or cards and when it got late, some stayed overnight in one of the many rooms. The groceries were often from Westberlin where the driver knew the cheapest places.

At 6.30 a.m. on Wednesday 29 August 1951, the doorbell at Chausseestraße 169 in Glindow near Werder rang loudly. Two men in leather coats waited in tense attention, a car with running engine stopped in front of the house. Alfred Starke, a finance-officer[266] at the state transportation center of Brandenburg, who lived alone with his daughters, opened the door and the persons were immediately in the hall. "Criminal investigation. Your daughter Helga has to go to court in Potsdam to clarify a matter!" The young woman was still calm, it could have something to do with the arrests two months ago in Werder, she thought, they had heard about it, also from leaflets. She even knew some of the young people from dances and night parties – or maybe something had gone missing at the observatory. She pulled a light windbreaker over her summer dress in case it got late in the evening.

Fig. 44 Walter Grotrian (1890 – 1954) and Eva Grotrian née Merkel (1891 – 1958) in the Direktorhaus of the AOP. Archive Förderverein Großer Refraktor.

[266] Alfred Starke lost this position and was downgraded to the Glindow village mini-administration.

She remembered that she had visited her cousin, who had left Werder for Westberlin. He had wanted to meet the former leader of a private theatre group in Steglitz. In his flat, they talked about the current arrests in Werder and finally she had received an anti-communist satirical magazine to pass on to Potsdam. Later, over the months, she had been given a handful of closed envelopes – which she had never opened – to put in Potsdam post boxes to save postage. This kind of thing was part of everyday life in the four-sector city, other things besides food and magazines were smuggled across the almost open border – it couldn't be that, she assumed. At Luisenplatz in Potsdam, the car turned towards the remains of the bombed-out Stadtschloss. The car drove into the barracks in Bauhofstraße, the guarded gate closed behind the car and the 19-year-old was in hands of the Ministry for State Security (MfS) in a tiny dark cell, wearing a summer dress and a thin jacket. After a few days, she was given her belt and shoelaces back and thought she would be released, but the transport stopped after just a few minutes at nearby Lindenstraße 55, the prison of the Soviet secret police. The civil Potsdam prosecutor had previously reported the arrests to the Russian military authorities and listed the planned prison sentences of a few years only. As a consequence, the Russian military jurisdiction claimed most of the young people for sentencing including Helga Starke.

Fig. 45 Stadtschloss Potsdam, where 1921 the first meeting of the Astronomische Gesellschaft after the WW I took place, at 1950/1951. Bombed 1945, dynamited 1959/1960 to stop the detailed discussions of its reconstruction, today fully reconstructed as site of the Brandenburg parliament (since 2015). Here the first meeting of the Astronomische Gesellschaft after begin of WW I took place. Archive Rüdiger.

On the same day, the Physical Review published an article by scientists from the U.S. Naval Research Laboratory, the technology laboratory of the Navy and Marine Corps in Washington D.C. The head of the electron optics division, Herbert Friedman had developed Geiger counters for hard UV light and X-rays years ago, with which the Heaviside layer of ionised oxygen molecules known from radio technology was to be measured at an altitude of 100 km. Because this layer showed clear day-night changes, it was assumed that the X-ray light required for its ionisation came from the sun. Friedman had heard that more than a hundred German A4 rockets had been moved from Thuringia to the desert of New Mexico, including their documentation and German specialists, Wernher von Braun again produced secret military equipment. In February 1949, a new altitude record of 400 km was set with a two-stage version of the A4; in total, more than 70 German units were fired over the years.

In September 1949, they had launched one of these rockets, in whose empty warhead Friedman's photon counters had been installed as the payload.[267] The rocket showed a stable flight until the burn over, after which it slowly rotated around its own axis and after a few min reached its peak altitude of 150 km, where the instrument part was thrown off. The counters had registered UV light at 70 km and X-ray at 87 km.[268] As the surface of the sun is far too cold to produce such high-energy radiation, the conclusion was that the corona must be millions of degrees hot, as Grotrian's finding 12 years earlier had suggested. The actual mechanism of this heating is still unknown today. The sun as an X-ray star, a spectacular new chapter in the astronomy book had been opened with some participation from Potsdam. "Tell them a good story and you will get all the support," Friedman will later formulate the future science system.

## The missing Miss Starke

Grotrian will have heard the news quickly as he was also managing director of the German Physical Society during the WW II under Carl Ramsauer who lives in Westberlin. Now having just returned from the conference of the Astronomical society in Recklinghausen, the only topic of discussion at the Telegraphenberg was X-rays, the event was discussed in every room as if after an unexpected Nobel Prize announcement. But Grotrian did not publish the high temperature of the corona that followed almost directly from his interpretation of the observations.

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[267] According to Kuiper (1946), Kiepenheuer had followed similar plans in 1944 but was not provided with an A4 missile.
268 Friedman et al (1951).

At the beginning of August 1951, on the occasion of the World Festival of Youth and Students, his former chief Finley Freundlich had travelled from Scotland to Eastberlin to ensure, with the help of the party leadership, that Grotrian may again probe Einstein's prediction of the gravitational deflection of light during the solar eclipse in Sweden three years later. Freundlich wanted the observations "be repeated, preferably with the special telescope (horizontal camera) which was developed for this purpose and which has been in the custody of the Astrophysical Observatory in Potsdam since the last campaign in 1929." Academy director Naas wrote to Einstein on this question and received the cool reply "that the previous determinations of light deflection have attained the degree of accuracy that is achievable with the present tools. ... I doubt whether the progress due to a new expedition justifies the considerable costs of such a project."[269]

Grotrian who wanted to study only the magnetic sun and not the space around it, had also rejected the idea, saying that he did not feel at all qualified to "work on the problem of light deflection".[270] He preferred to have a coronagraph built in his institute with which the magnetic eruptions of the sun could be seen. It was at this time that the sun was becoming increasingly magnetic for research, and Grotrian wanted to play a part in this development.

A late summer party at the terrace of the director house, almost everyone had come, scientists, assistants and the mechanics, one of those barbecues for everyone. The front gardens of the residential buildings, which had been converted into vegetable gardens during the war, had been plundered. There was a babble of voices and laughter but suddenly Grotrian, in his patched grey-green knickerbockers and with his black cigarettes, asked: "Where is Miss Starke?" Nobody knew, someone whispered: May be in Werder? "What's in Werder?" "Young people are being picked up there because of the leaflets." "Miss Starke? She wants to study astronomy, that can't be right."

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269 Hoffmann (2015).
270 During the (unsuccessful) 1954 eclipse expedition to Sweden, W. Mattig and E. Strohbusch had concentrated to this subject. Grotrian had commissioned Carl Zeiss Jena to "restore and improve the double-horizon camera for eclipse observations." On 13 November 1952, he informed the Academy of one of the purposes of the expedition is "Testing the gravitational deflection of light."

Fig. 46 AOP 1951, farewell to H. Kienle to Heidelberg (1. 10. 1950); left to right: Czeschka, Borchert, Herzog, Brunnckow, Böcklein, Wempe, Starke, H. Strohbusch, Kienle, Grotrian, Daene, Künzel, Schneller, E. Strohbusch (incomplete). Kienle had carried out an enormous amount of reconstruction work in Potsdam in the post-war years - from the repair of the Great Refractor and the dome of the Einstein Tower to the development of the 2-m-telescope, after the loss of the Bosch barracks as well as instruments and journals, but he hardly published science results any more. Archive H. Sperlich (Starke).

The next day, Grotrian had himself chauffeured to Werder. As always, he did not want to drive through the completely destroyed city centre of Potsdam, but took the side route via Caputh near Einstein's summer house, which he had never seen from the inside. They reached Eichenallee before Werder along Reichsstraße No. 1, with the village of Glindow on the left and the striking villa on Chausseestraße. Alfred Starke came down the stairs from the roof apartment, opened the door, that he knew nothing was immediately obvious. People would say she had been arrested like dozens of young people in the neighbourhood. The father had searched everywhere in Potsdam and asked around, at the court and in the hospitals, even at the cemetery at the observatory – and had received no information anywhere. Grotrian promised to find the daughter, to clear up the matter, to stand up for her, with the support of professors, directors, academy members and Nationalpreisträger; it could not be that in the country where he now lived, someone could simply disappear without leaving a trace.

Back in his office, Grotrian dictated a letter to the AdW, Mathematics and Natural Sciences Department: *... I received the news that Helga Starke, employed at the Astrophysical Observatory, has not been here since Wednesday, 29 August 51*

*... She has regularly taken part in the training classes, has developed a lively activity in the FDJ and led a group of 50 participants at the World Youth Festival. Mrs Starke is also a member of the Society for German-Soviet Friendship DSF. If there is any possibility to clarifying the case soon and possibly releasing Miss Starke I would very much welcome this in the interests of the continuation of the work at the observatory. Prof Dr W. Grotrian*. After weeks did a manager reply "*that we cannot do anything about this matter. Further employment is only possible once the case has been clarified. Of course, the salary payments must be stopped immediately.*"[271]

## Tribunal

Shortly after the New Year, Grotrian again met Mr Starke but he still didn't know anything about his daughter's disappearance. He had not any information for months, not even at the headquarters of the Soviet Control Commission in Karlshorst, where the father had dared to go. On 8 January, Grotrian wrote as the Director of the institute to his president: *"... I informed the Academy on 3.9.51 that the Helga Starke had been arrested on 28.8.51. The Academy replied that the Academy could do nothing in this matter and that salary payments were to be stopped immediately. Four months have now passed since this incident. During this time, the Observatory has not received any notification of Helga Starke's situation and her father, as he informed me, did not receive any news in this regard. In view of this situation, I feel obliged to draw attention to this case once again with reference to Articles 134 and 136 of the Constitution laws of the GDR. I am asking the Academy of Sciences to take steps to clarify the case, in particular to establish whether a judicial arrest warrant has been issued, what crimes or offences Helga Starke is accused of and when a court hearing will take place. I would like to point out that this case has caused great concern among the staff of the Astrophysical Observatory.*"

Miss Böcklein had a lot of typing to do these days; the letter was distributed to the Academy Director, the Secretary of the mathematics and natural sciences class, the advisor of this class and also the personnel section, Grotrian wanted maximum publicity. At the end of January, he sent Professor Hans Heinrich Franck all the papers in the case and wrote *"I very much welcome the fact that you have also agreed to take an interest in this matter and I am grateful for the advice you have given. In the interests of my institute, the Academy and the opportunities discussed*

271 Wempe had kept copies of these files. They are now in the collection of the Lindenstraße 54-55 Memorial Centre in Potsdam at the instigation of Mrs Helga Sperlich (Starke).

*at the last faculty meeting to attract interesting colleagues from the West to our Humboldt University, I would greatly appreciate it if this matter could be dealt with and resolved correctly."* Franck, son of a well-known Berlin painter, early member of the SED and the Volkskammer from the very beginning, co-founder of the Chamber of Technology, academy member since 1950, was the chair of chemistry at Humboldt University and director of an academy institute. Grotrian sought support wherever he could find it. At this time Helga Starke was already on the long way to one of the camps in Workuta north of the Arctic Circle in the middle of winter.

On the same day when Grotrian dictated his letter, the first secret Werder tribunal took place in the building at Lindenstraße 55. In the oak-panelled lower hall, a table covered in green cloth separated the prosecutors from the four female defendants, the latter unwashed in rough remnants of uniform, guarded by heavily armed soldiers. The women, among them Helga Starke, still hoped for the end of their suffer as nothing had happened that they could have been accused of. There was an interpreter and only the Russian troika, a judge with two assessors, no defence counsel. The accusations varied slightly, in Helga Starke's case it was propaganda, agitation and dissemination of writings, one more charge than her neighbour, the four-year-older medical assistant Ines Geske. She was accused of transporting two letters, Helga six. The court took such differences indeed into account: Helga received 25 years in a Gulag camp, Ines only 15.[272] Such sentences would have been completely illegal, the Russian side will state in the rehabilitation letters after 1990, because the defendants had not harmed the USSR at all and all the trials had not taken place on Soviet territory.

## Commands and exclusions

In April 1952, Dr Naas reported to Professor Grotrian that he had a telephone conversation with the Minister for State Security, Mr Zaisser, who "*answered all enquiries satisfactorily*". The Minister herewith informs Prof. Grotrian *"that the assistant had been arrested in order to carry out an investigation and that, according to the status of the investigation, Prof Grotrian could not count on the accused person for length of time.*" In response to Prof Grotrian's reference to the Constitution law of the German Democratic Republic the Minister also added the general remark, namely that no innocent person has ever been arrested in the German

272 Minimum sentence 5 years in Gulag. At the next trial, on 11 January, the defendants (three men and a woman) were given death sentences, all of which were executed in Moscow (Spiegel, 2002).

Democratic Republic, nor has anyone who has been arrested been detained after being found innocent. Naas added that he had thanked the Minister for his personal words and that the information he had received was completely sufficient. This implied for Grotrian that there was nothing more to ask, in particular not in the future. Four weeks after this final "explanation", Helga Starke arrived in one of the northern work camps after weeks of transport, someone had slipped her a coat on the way. The prisoners of Workuta had to ballast freshly laid railway tracks; the brigadier, a young German-speaking Russian woman, remained her only contact person.

From Munich, from the 1952 meeting of the Astronomical Society,[273] Grotrian telegraphed to the Academy President on September 23: "*May I invite the Astronomische Gesellschaft to the 1953 autumn conference in Berlin?*" On the same day he received that "*I agree to the 1953 autumn meeting of the Astronomical Society in Berlin. Conference venue: Academy of Sciences*",[274] the AdW still saw itself as an all-German research community. The next day, Grotrian offered the now official invitation from the "Deutsche Akademie Berlin" to hold its 1953 meeting in Berlin. "The invitation was received with great approval"[275] and Grotrian was re-elected to the board of the Astronomical Society.

During the preparatory discussions with AG Chairman Otto Heckmann on March in Hamburg the real problems had been formulated. Heckmann demanded that "the modalities ... be organised in such a way that the members decide to participate in sufficient quantity." Still in March, Grotrian informed the presidium of the consequences of this "condition for the realisation of the conference". Firstly, the entry procedures should not be too inconvenient, which would require special instructions to the border police, and secondly, the costs should not exceed the usual costs for participants at meetings in western cities, as otherwise too few members would come. This condition could hardly be met without additional payments, not least because the planned excursion to Potsdam required additional expenses that were not easy to predict. The exchange modalities of the two currencies also resulted in a complicated calculation for the subsidy requirement of around 8,000 marks (East) including pocket money, which would have to be provided by the Academy. Grotrian informed "*that the board of the A.G. would only ask its members to hold the conference in Berlin*" if these demands were fulfilled. The presidium finally agreed to bear all the costs and to send the necessary residence permits by post in good time: best prospects for a successful meeting of all

273 During this meeting Kippenhahn (Bamberg) as well as Hoppe and Zimmermann (both Jena) were accepted as members.
274 Jägerstrasse 22/23.
275 Mitteilungen der Astronomischen Gesellschaft 4, 5 (1952).

German-speaking astronomers in Potsdam in one afternoon with a tour from Sternwarte Babelsberg via Sanssouci to Astrophysical Observatory. Grotrian had dozens of questions to answer in Potsdam: Scheduling, evening lecture, slide projector, microphones, restaurants, which hotels are available for the different price categories, where will the VIPs stay, who organises the ladies' programme, how to report on the considerable reparation losses of instruments and books of both institutes?

On 1 May 1953, in addition to the ongoing preparations for the solar eclipse expedition, also the observations started with the slightly dimmed guide tube of the new coronagraph.[276] At the same time, the organisational preparations for the autumn conference were in full swing. At the beginning of June, the concert programme for the conference designed by the orchestra musicians of the Komische Oper was printed, but suddenly political turbulence captured Eastberlin and the GDR. After Stalin's death in March, his successors had dissolved the Soviet Control Commission and ordered Walter Ulbricht to Moscow to stop his separatist course towards Germany, his absurd church struggle[277] and the system of economic impositions. The people found out about the "New Course" and the associated self-criticism of the party leaders – without resignations – from the newspapers on the morning of 12 June; some orders were indeed withdrawn, but not the hated standard norms for construction workers.

Until 17 June, there had been almost daily unrest and strikes, initially in the countryside or in small towns, also near Potsdam. By the 17th, more than 10,000 people were protesting against the government in the centre of Brandenburg/Havel with demands for its resignation. The buildings of the communist party SED and the district court were besieged, the prison and the police office were partially occupied. Shots fired to the march by the Red Army put an end to the revolt.[278] In Eastberlin and in large cities such as Halle, Leipzig and Dresden, tanks were deployed to cordon off streets and squares. The demonstrators' political demands were for free elections, the release of political prisoners and reunification of the two Germanies. The international press had carried the images of the tanks in Eastberlin all over the world, and the city resembled an army camp in the eyes of the reporters.[279] At 2 p.m. on 17 June, the Soviet High Commissioner radioed to Moscow that "*The demonstrators dispersed with the appearance of Soviet tanks.*"

276 The mounting was not completed until the following year.
277 The evangelic Junge Gemeinde was declared an illegal organisation and its members were removed from secondary schools.
278 Ciesla (2003).
279 Around 20,000 soviet soldiers, 800 tanks and 15,000 barracked police in Eastberlin (Ciesla, 2003).

On Friday, 26 June 1953, Grotrian made a call to the President in the afternoon. He had unexpectedly "*received a telegram from the chairman of the Astronomical Society in Hamburg stating that the meeting of the Astronomical Society in the Democratic Sector of Berlin was to be postponed to another year."* The file note by quoting him that this was the end of the matter for him. The "event" then took place in Bremen at the beginning of October instead. The Academy management yet approved currency travel funds for nine east German astronomers. The annual report of the AOP for 1953 states that the "annual meeting of the Astronomical Society, which was originally planned to take place in Berlin and Potsdam and whose preparation had required a considerable amount of work here, was attended in Bremen by 12 members of the observatory with the exception of the director, who was ill".

After Stalin died in March – mourned in East Germany with millions of black textiles outside the windows – conditions in the prisoner camps improved. Helga Starke was even released completely at the beginning of 1954 and transported back to Potsdam, but after a short visit to the observatory she decided to go to southern Germany which she was indeed free to do. Walter Grotrian had fallen seriously ill during the AG meeting and had to go to St. Josefs Hospital in Potsdam;[280] he died there early in 1954, before his institute's major solar eclipse expedition to Öland (Sweden).[281] The funeral procession at the municipal cemetery on the Telegraphenberg was unmissably long, writes Wempe in his obituary.[282] Grotrian's master students Mattig and Schröter published the last magnetic field results obtained at the Einstein Tower posthumously under his name[283] and left Potsdam and the GDR just in time at the beginning of August 1961.

280 Kienle (1956).
281 Expedition unsuccessful due to weather conditions on 30 June 1954. After dismantling the 20 tons equipment, the 10 AOP employees did not return to Potsdam until the end of July. The event could be observed quite well in Potsdam as a deep partial eclipse (88%) under clear sky.
282 Wempe (1955).
283 Grotrian (1956).

# Befehl

## über den Ausnahmezustand der Stadt und des Bezirks Potsdam

**Ab 17. Juni 1953 wird über die Stadt Potsdam und den Bezirk Potsdam der Ausnahmezustand verhängt.**

**Im Zusammenhang damit befehle ich:**

1. **Von 20 Uhr abends bis 6 Uhr früh ist jeglicher Verkehr der Zivilbevölkerung, mit Ausnahme der Angehörigen der Deutschen Volkspolizei, verboten.**
   **Ansammlungen von Gruppen über drei Personen sind untersagt.**
2. **Jeglicher Kraftfahrzeugverkehr von 20 Uhr abends bis 6 Uhr früh — mit Ausnahme der Dienstkraftfahrzeuge mit Sondergenehmigungen — ist verboten.**
3. **Die Sondergenehmigungen für die Dienstkraftfahrzeuge sind von den Dienststellen der Deutschen Volkspolizei auszustellen.**
4. **Personen, die sich diesem Befehl nicht unterordnen, werden dem Gericht des Kriegstribunals übergeben.**

**Der Militärkommandant**
**des Bezirkes und der Stadt Potsdam**

I/16/01 Märkische Volksstimme, Potsdam F 30/53 653 A 2104

Fig. 47 State of emergency on 17 June 1953 proclaimed by the military commander for Potsdam. In the Potsdam district, 575 people were arrested; the status lasted until 29 June, in Eastberlin until 11 July. Source: Internet.

Fig. 48 Solar eclipse expedition Öland (Sweden) 1954; left to right: Schürer, Freundlich, Mattig, Wempe. Archive M. Stix.

## Stillstand

The non-partisan Academy President Walter Friedrich, radiation physicist and Sommerfeld student, had high expectations of the scientific excellence of the heads of his research institutes and tried to avoid inhouse appointments. As Grotrian's successor he could only envisage an astronomer with an international reputation.[284] He headed a search commission of varying composition and with a well-equipped list of candidates, probably written by Kienle.[285] It contained names from Germany, Western Europe and USA. Copies of the presidential-letter to Professor Brück (Dublin) from May 1954 as well as the reply letters from Brück,[286] Chalonge, Minnaert, Schwarzschild, Swings and Wildt have been preserved. In

284 After Grotrian's death, the observatory was managed by a short-lived Scientific Board of Trustees: Hoffmeister, Kienle, Rompe, Wempe (Chairman).

285 Brück, ten Bruggencate, Chalonge, Haffner, Minnaert, Schwarzschild, Siedentopf, Swings, Wellmann, Wildt. The four West German names (ten Bruggencate, Haffner, Siedentopf, Wellmann) disappeard from the final list, after the East German slogan "Deutsche an einen Tisch" had become obsolete.

286 Hermann Brück (1905-2000), Daniel Chalonge (1895-1977), Marcel Minnaert (1893-1970), Martin Schwarzschild (1912-1997), Pol Swings (1906-1983), Rupert Wildt (1905-1976).

addition to the cover letter, Appendix 4 contains the replies from Brück, Minnaert and Schwarzschild as well as a corresponding letter from

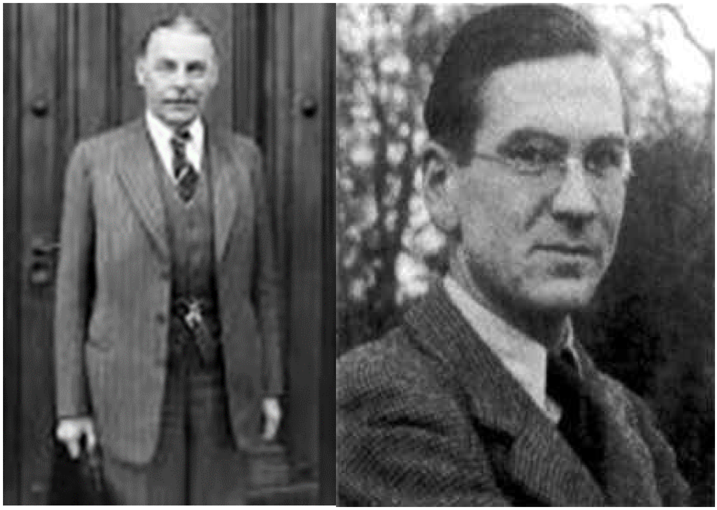

Fig. 49 left to right: Emanuel von der Pahlen (1882 - 1952), Hermann Brück (1905 - 2000).

Klüber dated January 1956 to Kienle who had apparently approached Klüber to send him back to Potsdam after receiving the negative replies. All the candidates had finally cancelled, Martin Schwarzschild with the explanation that it would be a great honour to be asked to head his father's former institute, but who would ever want to leave Princeton if he had already settled in there? Certainly not, as the rejections can be read throughout, after Soviet military tanks had recently rolled into Eastberlin so that the GDR could still celebrate its fourth birthday. The finding phase ended without result, and the time of President Friedrich had also expired. "*It is not possible to recruit a researcher from the Western democracy to head an institute of the DAW in Berlin*," Kienle wrote to Friedrich in 1956 on the situation of GDR astronomy.[287] The call for applications was cancelled and Grotrian's absence representative Johann Wempe became appointed director on 14 June 1956.

Only one of the candidates, Hermann Brück had wanted to "see the situation in Potsdam", the site of his first post-doc years as a scientific employee on the

287 Kienle had already complained in a letter at the end of 1946 that nobody dared to go to the East to help "with the reconstruction the Potsdam astronomy".

Telegraphenberg. Now he gave a seminar lecture and took part in a meeting on the 2-m-telescope – whose future location was still open – to which Kienle had also travelled to. The Potsdam of 1955 lay in ruins, the ruin of the Garnisonkirche – in front of which thousands of Potsdamer's had practised welcoming their new leaders in March 1933, first a few, then many, finally a sea of upraised right-wing arms – the remaining's of the destroyed Stadtschloss; the astronomers scowled, they knew who is visiting, what this finally could imply. Brück was one of the preferred students of Sommerfeld with the "opportunity of getting to know him on the ski slopes. He was an expert skier and had a hutte or cabin in the mountains at Bayerisch Zell where his assistants and senior students, as well as occasional foreign visitors – ten or so people altogether – would be invited to spend weekends. ... In those days we carried our skis on our shoulders, and trudged all the way up the icy track - a far cry from today's ski-lifts. These weekends in the mountains were among the highlights of my student days."[288]

Brück escaped his home town Berlin with his girlfriend[289] on 1 August 1936, the opening day of the Olympic Games. Since December 1928, Sommerfeld had organized with Freundlich a grant from the "Notgemeinschaft der deutschen Wissenschaft" and – after the external funding expired – was employed by Ludendorff on 1 September 1933 for life, backdating his qualifying age to 1930. A productive, professionally careless time, he writes in his biography,[290] they played tennis in the grounds, spent the night somewhere in the Great Refractor building over the week and had lunch together in the lecture room, delivered from a Potsdam restaurant. The director Ludendorff rallied his followers around him against Freundlich. Brück was catholic, his girl-friend jewish, ruling out a common future in Germany. It became more and more clear that he would have to choose between family and career in Germany. It was not without ulterior motives that Brück visited the Vatican Observatory in Castel Gandolfo for four weeks in the autumn of 1935; when astronomers have to leave, they will always try to reach another observatory. Ludendorff in the 1936 annual report: "The scientific assistant Dr Brück left his position here on 1 August." Because of more lax border controls to Austria during the Olympic games, both refugees reached Rome undisturbed, where they married in September and the young husband worked at the Vatican Observatory for some time, almost unpaid, before being employed by Eddington in Cambridge the following year. In late summer, Ludendorff wanted to lure him back to Potsdam "for the purpose of correct dismissal", but Brück had not been so naive as to fall for it. He wrote to the "*esteemed professor*" that he would be "*particularly*

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[288] Brück (2000). He studied astronomy, physics and mathematics in Kiel, Bonn and Munich until July 1928.

289 Irma Waitzfelder (1905-1950).

290 Brück (2000).

*grateful to him if I could settle the termination formalities by letters. At the same time, I will write to Rolf Müller*[291] *and ask him to take my few personal matters ... into his hands. My work is complete.*" Ludendorff replied "*Your abrupt departure from your position is a completely incomprehensible behaviour for which I have nothing but the strongest disapproval. Heil Hitler.*" But with "*Since Dr Brück has resigned ... without observing a period of notice, he is to be considered dismissed from the service as of 31 July 1936*" the Ministry of Science finished the dispute over the "*scientifically highly talented man ... who had enjoyed a high reputation with me and all his colleagues*" (Ludendorff).[292] Brück had successfully conducted[293] spectral statistics with 17,000 stars in the southern hemisphere with data from the "Potsdam Spectral Survey" for Ludendorff.[294]. He wanted to know whether the sun is located in a star cloud or even a star hole and found that "the middle spectral classes are almost evenly concentrated in the Milky Way, while the B stars and, to a lesser extent, the A stars show a stronger galactic concentration" and "that the sun is probably not located in a very pronounced star cloud."[295] Data on interstellar absorption were not yet available, and their consideration led to a partial revision of his views a short time later.[296] Nevertheless, it was "evident that, with only a few exceptions, the density is lower everywhere up to distances of about 2500 pc than in the immediate neighbourhood of the sun. The sun must therefore be located in a very star-rich region of the Milky Way system," Wilhelm Becker later confirmed the former colleague.[297]

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[291] Until then, both Brück and Müller edited "Die Sterne".
292 ABBAW, AOP, No. 149;
293 Brück was a funding applicant for the project "Spectral survey of the Kapteyn calibration fields of the southern sky" (1935).
294 60,000 stars up to 13th magnitude in the Kapteyn Selected Areas (see Becker 1929). The photographs were taken in 1927/1928 in La Paz (Bolivia) with a Zeiss triplet of 30 cm aperture with and without objective prisms (spectrum and brightness). Observers: Becker, Kohlschütter, Müller).
295 "The above investigations were largely carried out while I was still working at the Astrophysical Observatory in Potsdam" (Brück,1937).
296 See Brück (1938, 1942).
297 W. Becker (1942), 2nd edition from 1950 (Friedrich and Wilhelm Becker were brothers).

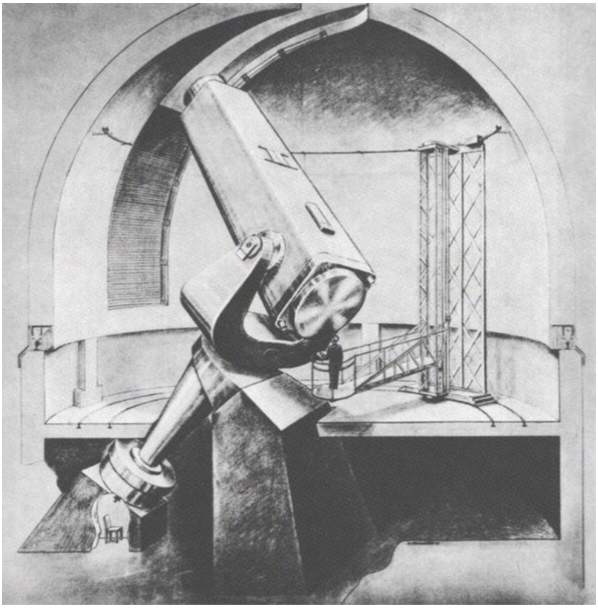

Fig. 50 Free mirror 200 cm, focal length = 4 m (direct focus), focal length in Cassegrain focus 27 m, focal length in Coudé focus 92 m. Schmidt system with wide field of view: clear aperture 1340 mm. 2 guide tubes 300/4000 built into the main tube. Status 1949.

Wempe who was never a member of any of the countless political Nazi organisations – except for the so-called Volkswohlfahrt from 1936 – was appointed professor at the Brandenburg State University in autumn 1948 with a full teaching position and a considerable honorarium. Coming to Potsdam from Heidelberg via Jena, he had, in order to continue the institute in Grotrian's sense, transferred his concept from the magnetic sun to the magnetic stars and appointed the previous assistants Mattig and Schröter to senior assistants. In his letter of rejection, Klüber had warned that "*today in Potsdam a whole group of ambitious young people are apparently muddling around without proper leadership*." However, the 2-m-telescope, which at Kienle's request of 11 April 1949[298] was already in production at Zeiss Jena, has been taken away from the new director and from the AOP. It has suddenly transplanted to Tautenburg/Thuringia for a newly founded Academy institute.[299] For the candidates succeeding Grotrian the Academy President had still

[298] In his application, Kienle had avoided all location details, but favoured the foundation of a "Central Institute for Cosmic Physics" within the AdW, consisting of the "remnants" of the AOP, the Babelsberg and Sonneberg observatories and the Astronomisches Recheninstitut (Kienle, 1949).
[299] Board of the 2-m-telescope from 14 June 1956: Görlich, Heckmann, Hoffmeister, Kienle (Chair),

promised on 31 May 1954 "that a 2-m-mirror telescope is planned for the Astrophysical Observatory."[300] However, the "planned location in Fläming was not approved", Wempe wrote suggestively without giving more details in the annual report for 1956.[301]

Fig. 51 Astronomers in the Ravensberge near Potsdam looking for a location for the 2-m-mirror telescope; left to right: unknown, Künzel, Strohbusch, Kahrstedt, Grotrian, Daene. Archive Förderverein Großer Refraktor.

On 1 April 1957, Wempe hired the polarisation expert F.W. Jäger who had completed his doctorate with ten Bruggencate in Göttingen, on a private contract as

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Lambrecht, Wellmann, Wempe. The Tautenburg site provides (only) 680 observation hours per year. The Ravensberg near Potsdam was the favoured location after Kienle's departure from the AOP (Wempe, 1976). Estimated construction was for 2 Mio M, final construction costs were 13 Mio M without dome.

[300] See Appendix 4.

[301] In 1957, AOP received a new 70-cm-mirror telescope including an observation house (A25, west of the library building, 40 m² area, retractable roof) for light-electric observations of variable stars by H. Schneller. A facility for a spectroheliograph was erected to the south of the refractor building. Neither installation had a long life. The disappearance of Schneller's reflector telescope after 1985 is unexplained; the observation house disappeared later than 1993. A copy of the building was erected in Shemacha/Azerbaijan in 1972 as an enclosure for the twin telescope.

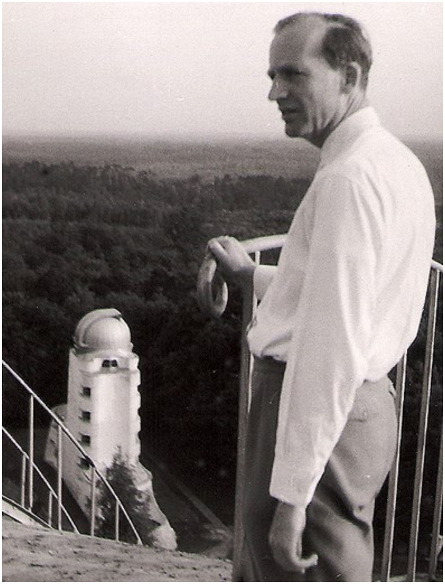

Fig.52 Friedrich Wilhelm Jäger (1914 – 2000). Archive Förderverein Großer Refraktor.

head of the Einstein Tower and Professor of Solar Physics with a full teaching assignment at Humboldt University. The Einstein tower, however, was soon assigned to the newly founded Central Institute for Solar-Terrestrial Physics (ZISTP), which challenged Jäger with unexpected requests including questions such as "whether, in addition to the effects [of solar activity] that are primarily of interest to science, there are also effects on the general living conditions on Earth" or how much solar energy differently orientated photovoltaic systems can collect from the sky.[302]

[302] Jäger (1972, 1979).

Fig. 53 Astrophysical Observatory Potsdam 1960, assistants; left to right: Brunhilde Schewe née Pagels, Charlotte Gußmann née Strohbach, Brigitte Haensch née Huhn, Herbert Borchert, Johann Czeschka, Marie-Luise Strohbusch née Erpel, Ilse Becker née Schischkoff, Gisela Zimmermann née Kallus, Dieter Ganzert. Archive Förderverein Großer Refraktor.

To make work easier for the people, Wempe had created additional rooms in 1961 by glazing the two arcades of the main building. Scruples about this intervention in the architecture of the observatory never completely left him; today's ambitious monument preservationists would probably scold him,[303] the original architects probably not.

[303] Giersberg (2000).

Fig. 54 Karl Schwarzschild Observatory Tautenburg board 1960; left to right: Hoffmeister (Chairman from 1961), Kienle (Chairman until 1960, then as guest), Görlich, Lambrecht, N. Richter (Director since 1961). The all-German board of trustees/directors existed until 1967. Archive Thüringer Landessternwarte Tautenburg.

# 5 Lauter vs. Undercover

## Secret service operations

On 18 September 1972, a special commando of the MfS[304] secretly searched the villa of Professor Ernst August Lauter in Kühlungsborn. A radio ("*suitable for short-wave reception*") and an EXAKTA camera were photographed, self-composed crossword puzzles, the existence of which had been pointed out by an informant, were copied. Another informant had noticed suspicious columns of numbers on a small sheet of paper in Lauter's Berlin office. The suspicion of espionage by an officer group of the MfS was considered to be substantiated, and an operative case was opened for treason and corruption. There had been indications that Lauter was "utilising *the potential of the Academy of Sciences on topics*

[304] MfS= Ministry of State Security of the GDR.

*recommended by Western countries.*" Because of him, the USA and West Germany were promoting "*cooperation with the GDR in the field of space research*", which was not compatible with the Soviet INTERKOSMOS programme and he would orientate towards "*cosmopolitan work*". At the beginning of 1972, the state leadership was informed that the General Secretary (GS) and Vice President of the Academy of Science of the GDR, Lauter, prevented "*the concentration of resources on INTERKOSMOS*". He also "*complained that the politics was interfering in science". There* was a negative attitude towards cooperation with the Soviet Union and its INTERKOSMOS programme; he preferred "*international projects with significant participation by the USA*."

Fig. 55 Ernst August Lauter (1920-1984), General Secretary of the Academy of Sciences of the GDR 1968-1972. Archive G. Entzian.

Just weeks later, Lauter lost his top position in the Academy but returned to work as Director of the Heinrich Hertz Institute for Solar-Terrestrial Physics, which he had already headed from 1966 to 1969. With numerous incorporations[305]

[305] Einstein Tower Potsdam, Satellite Ground Station Neustrelitz, Test Station Juliusruh, Observatory for Ionospheric Research Kühlungsborn, Observatory for Solar Radio Astronomy Tremsdorf, Observatory for Geomagnetism Niemegk.

in January 1969, he had formed a large institute for solar-terrestrial physics – pushing an international trend – in order to investigate the influence of the variable sun on the Earth's magnetosphere, its air envelope and its inner currents, the measured temperatures and the global climate, ultimately a late resurrection of the solar-telluric observatory of Wilhelm Förster a hundred years earlier as a future concept.

Lauter received his doctorate from the University of Rostock in 1950,[306] the following year, at the age of 31, he became Director of the newly established Observatory for Atmospheric Research in Kühlungsborn and also Professor of Atmospheric Physics in Rostock. As General Secretary of the academy he had been instrumental in pushing through the academy reform. He had travelled to Sonneberg himself to replace the elderly but lively director Hoffmeister without any plan for the time after. Lauter probably always believed that the new generation of directors, like him, wanted to establish an ambitious and effective science system that would have been able also to modernise the entire society. He couldn't imagine how vulnerable a scientific system is that systematically replaces output with attitude. "You have to be the first, even if you still lack perfection" was his slogan in doctoral seminars which certainly was too much for almost all of the party members of the academy. In June 1971, the IM[307] "Astronom" had denied almost all leadership qualities of Lauter to his MfS officer certainly not under torture. Lauter would always highlight only his own results and he demands "*that weak scientists should be gradually excluded*"[308] from the academy. In fact, Lauter did not know what to do with "weak scientists" – whether or not party members – and this will have worried the "Astronom" greatly.

The new leaders appointed after the academy reform had no scruple of contact with the security officers, sometimes turning the meetings into therapy sessions for their hidden battles. The numerous reports of "Schlüpos"[309] brought the occasionally choleric Lauter into ever new difficulties. Lauter's deputy as General Secretary, Heinz Stiller, complained that he had "*repeatedly warned leaders of the academy ... against appointments of the current General Secretary to higher functions.*"[310] In the spring of 1972, the director of the Meteorology Service, Wolfgang Böhme, informed the MfS that Lauter was "*focussing on the further connection between COSPAR and Interkosmos*" against the instructions of the GDR government.

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[306] E.A. Lauter, "Die Tagesionisationsschicht der mittleren Stratosphäre, D-Schicht", Diss. Rostock (1950).
[307] IM = unofficial employee of the MfS.
[308] See Buthmann (2020), p. 750.
[309] Unofficial employees in key positions = Schlüpos.
[310] Buthmann (2020), p. 746.

## INTERKOSMOS is technology, COSPAR is science

Right at the beginning of the space age, shortly after the launch of the first Sputnik, the Committee on Space Research (COSPAR) was founded in Paris as a global forum for research the Earth's atmosphere. Lauter soon became chairman of a working group, and from 1967 on he was a well-connected office member of the committee. COSPAR aimed to maximal transparency; everyone should be able to submit scientific data and everyone should receive all the data needed. The INTERKOSMOS programme, which was launched much later to integrate non-Soviet technology into Soviet space missions, demanded strict secrecy on the order of MfS-chief Mielke. INTERKOSMOS employees had to be confirmed according to political criteria, and many of them were eliminated. Those who, like Lauter, was mainly concerned with science, was walking on thin ice. Lauter demands, according to one informant, that "*science must be determined by the scientists and not by officers.*" In autumn 1970, as GS of the Academy, he is said to have rejected Stiller's appointment as an Academy member, which was immediately reported to the MfS and must have motivated them to intervene in favour of their hidden colleague. Almost all of Lauter's science policy theses later became generally accepted overnight and could all have been on the banners of demonstrators if they had existed in GDR academies and universities.

Lauter wanted to explore the Earth's atmosphere as a whole, using ground-based radio waves, balloons and rockets from his many observatories and from space. The sun determines the state of the high atmosphere with its variable magnetic activity. He was convinced that this concept also required control over solar research – to this end he had placed the Einstein Tower, the Tremsdorf radio observatory[311] and the Niemegk magnetic observatory under his own control.[312] The INTERKOSMOS programme not only promised no progress at all in this respect. "*The Russians should pay if they want something, we are not the boys of the others*," he is said to have rumbled, the purpose of cooperation being "*not just any experiments, but the solution of physical questions of the high atmosphere*."

For years, an overambitious quartet of officers from the MfS investigated Lauter for "actions against the national economy" with the threat of prison of up to 5

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[311] Monitoring of solar radio radiation from 1 October 1956.

[312] The return of these observatories to the Institutes for Astrophysics and Physics of the Earth in Potsdam in 1984 formally marked the failure of Lauters concept of solar-terrestrial physics on a large scale. The Tremsdorf radio observatory and the Einstein tower was additionally staffed by former ZISTP employees Böhme, Hildebrandt, Kliem, Krüger and Kurths.

years. They included a bunch of informants from his closer circle, "Hans", Bernhard", "Weiß", "Pavel", "Licht" and "Marianne". In addition, there were multiple break-ins into his living and office rooms, checking his bank account, medication prescriptions and the properties of his pens. A single white sheet of A4 paper, allegedly suitable for secret writing, was monitored almost monthly for changes in the location in the office. He represented an "*enemy base in the security area of space research, he constantly propagated its international character.*" Böhme alias "Hans" informed his personal officer that Lauter had proudly reported to him that the British and the Americans had pushed through his election as the person responsible for the high atmosphere at COSPAR, and that his own country had not even nominated him.

A few years earlier, Georg Dautcourt from the Sternwarte Babelsberg had experienced a very similar situation when he succeeded Treder as the GDR representative at the "Copenhagen Conference on Gravitation and Relativity Theory" in July 1971. Dautcourt vehemently disagreed with the Academy's command for his immediate public resignation.[313] Only the elected labour spokespersons (BGL) of the Central Institute for Astrophysics Potsdam (ZIAP) prevented Dautcourt from being dismissed from the institute, also Lauter, as the General Secretary of the Academy, refused to accept drastic actions. As a result of the battle, for many years Dautcourt's numerous science results were only be allowed as published in the collapsing Publications of the Astrophysical Observatory and the Monthly Reports of the AdW.

The MfS officers struck back, demanding that their minister may remove Lauter as director and withdraw him from all international responsibilities. Mielke indeed gave his authorisation at the beginning of 1974. Then the new General Secretary Grote explained to his precursor the travel ban imposed on him. Lauter fought for his believes: INTERKOSMOS is only equipment, whereas COSPAR is science, we have to be first on a global scale, and the solar-terrestrial physics is the most important research because environmental policy depended on the results. In the end he became desperate: I do not know where the conspirators are, I have always practised discipline. What is the case against me, Lauter asks. Nothing, as far as I know, Grote answers, nothing at all, unless you will now provoke an audible protest, this would be the end. The personal letters of resignation to prominent recipients all over the world that were forced on him, were indeed checked for secret messages before they were sent, mostly by "Hans". The Minister for Science and Technology, Weiz, to whom Lauter had once denied a desired professorship at the

[313] The GDR leadership's aggressive attitude against Israel also played a role, because the GR committee wanted to organise the next conference in Israel against the massive opposition of the Eastern bloc.

Academy, triumphed that "*the only question to be decided was INTERKOSMOS or COSPAR, which had nothing to do with your personality,*" he says, against his better knowledge, to Lauter's face.[314]

## Pessimism about the weather

Lauter recovered from the punishment, still he was head of a large, well-organised institute. Lauter was "*still doing what he had always done*", reported an informant, in Juliusruh he was "*having a huge antenna network built*" to investigate the ionospheric wind systems. He was pursuing a spectacular approach at the time: the sun shapes the earth's atmosphere through its variable radiation and magnetic fields and this determines the human environment. Such planetary "environmental research" had not existed before anywhere and even such programmes were still lacking internationally. His first lecture in Potsdam emphasised the fairly precise knowledge of the physical parameters of the atmosphere, in contrast to the chemical and biological parameters, about which almost nothing was known. The audience was interested, and Stiller as chairman of the meeting, promised further discussions on this new topic. In a representative anthology, Lauter formulated as early as 1975, the "importance of research into near-Earth space for mankind" as part of future environmental research. How constant is the energy flux from the sun, how does the "thermostat" that regulates the temperature of the biosphere work, how does the geomagnetic protective shield function? The search for answers is "not just a mere refinement of our knowledge, but a fundamental social necessity."[315] Similar concepts will be developed decades later, and the discovery of the role of the carbon dioxide and methane in the heat balance of the Earth atmosphere would certainly not have escaped him. In the same book, the future vice president of the AdW, Stiller, explained the distribution of mass and angular momentum in the solar system with the "dialectic unity of matter and motion" as "confirmation of the basic postulates of our Marxist-Leninist philosophy," but with a view to Lauter statements on the development of the biosphere as "too speculative." [316]

The four officers were once again alarmed, they now wanted to make their own science politics by turning big wheels. Unofficial informants "*who worked as distinguished scientists*" and enjoyed Lauter's confidence reported that he was working "*in order to achieve a spectacular scientific success that would restore his international reputation*." After he had also presented his theses on environmental

[314] Buthmann (2020).
[315] Lauter (1975b).
[316] Stiller (1975).

research[317] in the physics class at the AdW – successfully, as he believed – a final scandal in Potsdam has been organized. R. Rompe chaired a meeting at which Lauter was to prove his thesis, that all societies must be able to survive global climate catastrophes. Rompe asked, instead to understand the explosive nature of the matter, what this permanent "*pessimism about the weather*" shall bring. "*Catastrophe theories are born of the capitalist system,"* said the Einstein expert Treder "*to divert attention from the crisis of capitalism.*"[318] Director Böhme reported to his MfS officer that only the attitude of the people from the Institute for Science Theory, who believed everything and took it seriously, was destructive.

Lauter will have known that it was over for him. He declared after the meeting "*that he* would *cease these activities*" and also withdraw his new institute concept. President Klare immediately requested the dismissal of Lauter from the GDR Research Council. Probably the most promising large-scale project in the years following the academy reform was destroyed by envy and paranoia. After that, everything happened very quickly. The current chairman of the Bad Doberan district administration was a friend of the Lauter family since many decades. Lauter lost all distance from his provincial friend: "*The Soviet Union hasn't been able to build intelligence satellites for decades, they can't do it. The Americans had made a decisive contribution to research with the moon landing. They are now leaders in science and his Kühlungsborn observatory has also become a world leader.*" The supposed confederate informed the MfS, Lauter had full confidence in him. After years of search the officers had finally found what they were looking for. According to their report Lauter stands for the "*rejection of the state leadership of science in the GDR*", discredits the successes of the Soviet Union, admires the USA and hopes to "*participate in NASA projects.*" The special division of the MfS responsible for criminal matters had fully agreed with these conclusions, but the names of the agents were missing. "*The available evidence is not sufficient*". More precisely: apart from baskets full of slander, the officers had nothing to present. In August 1976, Stiller informed Lauter that he would no longer be proposed as Director of his institute for solar-terrestrial physics.[319] The INTERKOSMOS co-operation had entered a new phase, for which he had not been confirmed. Lauter was so affected "*that he was not able to make a statement.*" The official operational case of the MfS was stopped in 1979 because "*all activities to significantly limit its influence*" were finally successful.

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[317] Lauter (1975a).
[318] Ironically, H.-J. Treder will end his lifework with a series of contributions to solar-terrestrial physics that are not too far from P. Kempf's attempts to estimate the number of sunspots with precise measurements of the temperature in a deep well, see Schröder et al. (2004).
[319] Succeeding director 1976-1981: Jens Taubenheim.

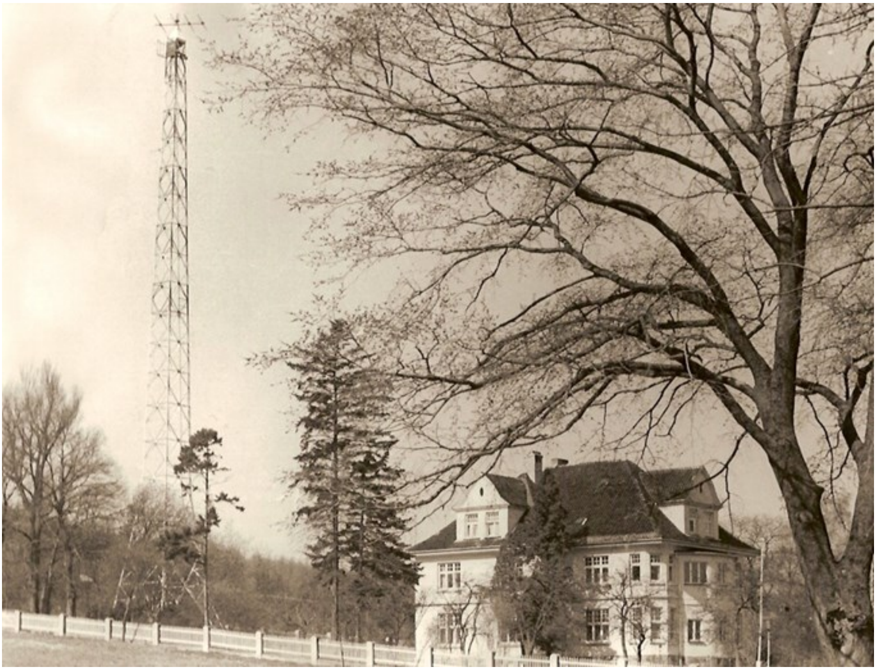

Fig. 56 Antenna from 1957 (50 m, Kühlungsborn) of the 33 MHz radar systems for locating auroras and meteor trails. Villa of the institute management. Archive G. Entzian**.**

Lauter retired to his home institute in Kühlungsborn. He worked tirelessly – without any official function – on ionospheric physics, interplanetary magnetic fields[320] and solar-terrestrial relationships,[321] often with younger colleagues in his nearby house, never in his institute office. When asked what had happened to him, he answered truthfully that he does not know.[322] In his last year, the Academy published an article by him in an issue entitled "Development trends of the Earth as a planet" on the current directions in his science: "The oldest observed changes in nature include excessive weather patterns, luminosity phenomena in the atmosphere and variations in the spot coverage of the sun." This strongly remembers

[320] Lauter (1978).
[321] Lauter (1977).
[322] Entzian (2021).

Förster's original concept for the AOP on the Telegraphenberg. Lauter digitised the magnetic observations and found that "significant correlations with the temperature of Central Europe can only be established for the winters up to the end of the last century. ... Since the pronounced maritime climate period at the beginning of this century, such a correlation of climate with solar activity is no longer recognisable in a simple form, and one may suspect that industrial interventions in Europe's temperature regime ($CO_2$ enrichment) already dominate in the warm winters of the 1970s.[323] The overstrained academy administration hid the result behind a "for official use only" stamp. Four years later, in 1988, the IPCC[324] was founded by the United Nations in New York  to answer Lauter's questions on a larger scale.[325]

Lauter died in 1984 at the age of 63 in Rostock University Hospital, not without having ensured before that no one from Berlin and Potsdam would be allowed to speak at his funeral service.[326]

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[323] Lauter (1984).
[324] IPCC = Intergovernmental Panel on Climate Change.
[325] The famous hockey stick diagram of M. E. Mann only dates back to 2001.
[326] Information G. Entzian who delivered the eulogy.