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HERMANN CARL VOGEL

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It seems more fitting at this time to record the eminent services to science and the principal features of the life of this distinguished astrophysicist, rather than to seek appropriate words in which to deplore his loss, keenly as we feel it.

His place will be filled—no one man is any longer indispensable in the affairs of any properly regulated institution—and the splendid research observatory which he did so much to establish will continue its work, doubtless with little departure from the course which he had carefully laid out for it. But his pioneer researches, and his administrative achievements, opening an opportunity for many other significant investigations by his assistants and successors, have a permanent place in science. Their importance will later be even better appreciated than now, in the improved perspective which time alone can furnish.

Hermann Carl Vogel was born at Leipsic on April 3, 1842. As one of the youngest sons in a large family, in which high intellectual ideals prevailed, rather than considerations of material prosperity, his destiny was to be largely in his own hands. His father, Carl Cristoph Vogel, was a well-known educator, with practical tendencies, and superintendent of the schools of Leipsic. He was the author of several books on educational subjects and was the founder of the *Realschulen* of Leipsic, which afforded opportunity for a better preparation in prac-

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tical and scientific lines for the subsequent university course than did the *Gymnasia.*

The intellectual inheritance and early training of this family is further evidenced by the careers of others of its members. An older brother of Hermann, Eduard, after completing a brilliant course at the university, was called to London to take part in the work of Mr. Bishop's private observatory, then in charge of Dr. Hind. Diverted from astronomy by his interest in exploration and the natural sciences, he entered in 1850 upon extensive and ultimately fatal travels in Africa, under the auspices of the Royal Geographical Society. A sister was well known in recent German literature under the pseudonym of Elise Polko, writing principally on topics connected with music.

The natural tendencies of Hermann Vogel were toward practical things: his early intention was to become a locomotive builder. This interest and ability in mechanical matters was of much advantage in his subsequent career, greatly assisting him in designing new instruments and apparatus. While at the Polytechnic in Dresden both of his parents died, and his lack of both health and means compelled him to forego his ambitions for a profession in technology. At this juncture relief came in the person of a Russian prince desiring instruction in photography, which Vogel later assisted in making such a powerful auxiliary of the new astronomy. With the assistance of his patron he was able to get a fresh start, and he returned to Leipsic. Here, Carl Bruhns, himself a self-made man, recognizing young Vogel's ability, gave him a position in the newly established observatory at the princely salary of $150 per year. The columns of the *Astronomische Nachrichten* from 1866 onward attest to the activity of the young assistant in his new position, his observations being chiefly on asteroids, comets, and nebulae.

At this period Zöllner was by his masterly researches opening the way for astrophysics, and his influence is doubtless in a measure responsible for Vogel's subsequent interest in this branch. Vogel was meanwhile pursuing his studies in the university, although his lack of funds did not allow him to hear many of the courses of lectures. In 1868 he took his doctor's degree at Jena with a thesis on the micrometrical determination of the positions of nebulae and star clusters, with a historical sketch of the observations of nebulae.

In 1870 he was appointed director of the newly established and finely equipped private observatory of Chamberlain von Bülow at Bothkamp in Holstein, not far from Kiel. Here in the next four years he planned and executed many important researches in astrophysics, which are recorded in the first two volumes of publications of that observatory. A large part of the programme was given to spectroscopic observations of sun, stars, nebulae, planets, comets, aurora, and lightning, including line-of-sight measurements on sun and stars. Provision was also made for solar photography, the dry-plate process of Fothergill, as modified by Gordon, being successfully employed (1871).

The work at Bothkamp was done with the assistance of Dr. O. Lohse, who was subsequently one of the first observers appointed at the Potsdam Observatory.

It is interesting to note that the admirable style of publication later characteristic of the Potsdam *Publicationen* was introduced by Vogel in the volumes recording the observations made at Bothkamp.

The work so effectively commenced at the private observatory was not long to be continued, for the call soon came to the young man to enter the service of the Prussian state, and assist in developing plans for an astrophysical observatory to be established in the vicinity of Berlin. The brilliant researches of Kirchhoff had aroused the desire for such an institution, which at first was planned to be rather a *Sonnenwarte* than a *Sternwarte.* The interest of the crown prince, later Kaiser Friedrich, materially assisted toward the realization of the hopes of the scientific men principally active in the new enterprise. The minister of education in 1873 appointed a special committee, with Professor E. du Bois-Reymond as chairman, and the work of preparing plans for the institution was undertaken by a subcommittee consisting of Professors Auwers, Förster, and Kirchhoff. In 1874 appointments were made of two observers, Professors Vogel and Spörer, the latter having become well known for his faithful observations of the sun while a teacher in the *Gymnasium* at Anklam; and to them was assigned the duty of planning the initial instrumental equipment of the institution, the site for which had now been definitely located in the "Telegraphenberg" at Potsdam. In connection with these

duties Vogel made a visit to England, Scotland, and Ireland, ordering some of the instruments. Otherwise he traveled but little.

The first idea of having the new institute associated with the Observatory of Berlin was given up, and no provision was made for instruction. The observatory was not completed until 1879, but during these five years largely devoted to planning and executive duties, Vogel's observational activity was not suspended, and a number of his earlier pieces of work were published. Until 1882 the scientific and business administration of the institution was provisionally in the hands of a directorate consisting of the three gentlemen previously serving as a subcommittee. Vogel was then appointed director, a position he was to fill with eminent success for the next quarter of a century.

The equipment of the new institute was admirably adapted to its purposes, and fairly liberal appropriations were made for new apparatus; the principal telescopes (refractors of 13-, 8-, and 5-inches aperture) were, however, comparatively small. Activity was principally directed to celestial spectroscopy, celestial photometry, observations of the solar surface, both visual and photographic, direct planetary observations, and laboratory investigations of a physical nature. The director was fortunate in his choice of assistants, as the budget gradually permitted an enlargement of the staff; results were promptly published, in separate parts, as they were ready, in a clear and sufficiently detailed manner, which might well serve as a model for other institutions; and the premier position of the observatory in astrophysics was very soon established.

During Professor Vogel's administration the principal new developments were (1) the application of photography in stellar spectroscopy, particularly for determinations of velocities in the line of sight; (2) the construction of a new style of instrument (32-cm refractor) for stellar photography, and co-operation in the planning and subsequent work on the astrographic chart; (3) the construction and equipment of a large (80 cm) refractor particularly adapted for astrophysical research.

The first of these new departments opened the way for the modern investigations of the radial velocities of stars; it caused the evolution of the spectroscope into the spectrograph, and led to new types of

construction of that effective instrument both at Potsdam and elsewhere; it carried much farther the pioneer work of Huggins on photographic spectra of stars. It also led (1889) to the spectrographic demonstration of the correctness of the eclipse theory of the light-variation of *Algol*, which Vogel had unsuccessfully attempted with a visual spectroscope in 1875; and to the discovery of the existence of spectroscopic binary systems in which one component star was relatively dark (*Spica*, 1889). Vogel's name will perhaps be longest remembered for this discovery of spectroscopic binaries; and he will share in its credit with Professor E. C. Pickering, who was simultaneously interpreting in a similar manner the varying duplicity of lines in the objective-prism spectra of *Mizar* and *β Aurigae*.

By his use of metallic terminals (iron) as a source of the comparison spectrum, in addition to, or substitution for, the hydrogen tube generally employed, Vogel also opened the way for what is now the universal practice, although he seems not to have fully appreciated its advantage, and only employed the method in exceptional cases.

In 1892 he was able to publish (Bd. VII, Theil I) a catalogue of the radial velocities of 52 stars determined with a precision very superior to that of the visual measures then extant, which were hardly competent to give even the direction of motion of the stars—whether approach or recession; and in view of the extreme difficulty of such measures visually, this may be said without any discredit to the visual observers. In these spectrographic investigations, as in many others, Professor Vogel had the efficient collaboration of Dr. Scheiner.

With this list of stars the limit of the 12-inch (30 cm) Schröder refractor was practically reached for spectrographic observations, and for this work the director's desire grew keener for a larger telescope, comparable with those in use in foreign observatories. But the government's financial condition did not then permit the desired enlargement of the telescopic equipment.

Meanwhile the observatory undertook an active part in the preparations for the astrographic catalogue (but abstained from co-operating on the astrographic chart), and the photographic refractor of 32.5-cm (12.8 in.) aperture and 343-cm (145.7 in.) focal length was designed on a new principle and constructed by Repsold (optical parts by Steinheil). The pier was made of two riveted castings set at such

an angle that the upper casting pointed toward the pole,[1] permitting an unhindered motion of the instrument in right ascension (a point of great importance in long exposures) and combining the advantages of the so-called "English" and "German" types of mounting. The guiding telescope, rigidly attached within the same tube, is of aperture 23.5 cm and of the same focal length. This effective telescope was Vogel's favorite instrument in recent years and he designed in succession a number of spectrographs for it, after a provisional spectrograph had yielded useful results on *Nova Aurigae* in 1892.

In conjunction with Professor Wilsing he published in 1898 a valuable work of reconnaissance entitled *Untersuchungen über die Spectra von 528 Sternen* (from spectrograms taken with this telescope), dealing principally with stars of the first type and referring especially to the presence in them of helium. Professor Vogel's last published paper (constituting Part 1 of the fifteenth volume of the Potsdam Publications), issued shortly before his death, gives a detailed description of "Die zwei Doppelrefraktoren des Observatoriums," referring to this telescope and the great 80-cm refractor to which allusion will next be made.

It is doubtful if any large refractor has ever been constructed with a more thorough advance study of its adaptation to the purposes for which it was to be used than this great photographic telescope of 31.5-inches aperture. Extensive measurements were made at the observatory of the absorption of various kinds of glass for the different rays, and the size of the objective was determined in accordance with the data gained.[2] During the years of waiting for the necessary grant from the government, the details of the mechanical construction had been minutely worked out, so that contracts could be let quite promptly after imperial influence had led to the authorization of the instrument in 1895. Some features were novel, particularly in regard to the observing platform. The large object-glass, when delivered, was subjected to more extensive and thorough tests, chiefly by Pro-

[1] It was long supposed by all concerned that this design was unique, but it subsequently appeared that a similar type of construction had been used at the Orwell Park Observatory, Ipswich, England, in 1874.

[2] H. C. Vogel, "The Absorption of Light as a Determining Factor in the Selection of the Size of the Objective for the Great Refractor of the Potsdam Observatory," *Astrophysical Journal*, 5, 75–91, 1897.

fessor Hartmann, than has probably ever been the case previously. In his last paper Vogel gives an interesting account of these investigations, which must have given him much concern, and he candidly prints both the more favorable and the less favorable opinions of those charged with making trials of the performance of the lens. This somewhat extended reference to the construction of these telescopes is made here, because they absorbed no small part of the director's energies in recent years. He writes with a natural satisfaction that during his administration the instrumental equipment could thus be brought to a certain state of completeness, particularly as provision had also been made for securing reflecting telescopes of short focus, the advantages of which he fully appreciated.[1]

In his astrophysical researches and publications Professor Vogel's attitude was rationally conservative, but his mind was fully open to new developments. His point of view may be seen from *Newcomb-Engelmanns Populäre Astronomie*, two editions of which he edited. The last edition (1905), practically a new book, is now probably the best work on astronomy for the general reader. Of his contemporaries in pioneer astrophysical research, he seemed most in sympathy with Huggins, whose views were much like his own.

Vogel's published papers are very numerous. Aside from his many observations and orbital computations on asteroids and comets, he observed the satellites of *Jupiter* and *Uranus*, and triangulated the star cluster χ *Persei* while at Leipsic. He also made an extended study of the absorption in the solar atmosphere of the chemical rays, which was published in the *Berichte* of the Royal Saxon Academy for July 1, 1872. This research was extended to the yellow rays at Bothkamp, and was later (1876) greatly broadened so as to include many spectral regions, the observations being made with Vogel's modification of the Glan spectral photometer attached to the 9-inch refractor of the Berlin Observatory. It was published under the title "Spectralphotometrische Untersuchungen insbesondere zur Bestimmung der Absorption der die Sonne umgebenden Gashulle," in the *Monatsbericht* of the Berlin Academy for March, 1877 (41 pages). A brief set of spectral photometric observations of stars was also made at

[1] H. C. Vogel, "On Reflecting Telescopes of Relatively Short Focus," *Astrophysical Journal*, 23, 370–389, 1906.

Berlin, in conjunction with Dr. G. Müller, and later published by the same society.

An early investigation of much importance was *Untersuchungen über die Spectra der Planeten* (8vo, pp. 64, Leipsic, 1874), which was successfully submitted for a prize competition of the Copenhagen Academy of Sciences. These difficult visual observations were made at Bothkamp and include all the major planets, two asteroids, and the satellites of *Jupiter*. Twenty-one years later Vogel contributed to the Berlin Academy a paper upon the same subject: "Neuere Untersuchungen über die Spectra der Planeten." He comments on the fact that the observations of planetary spectra elsewhere published in the lapse of two decades had hardly done more than confirm his original results. This later discussion of the subject was based upon spectrograms taken for the most part with low dispersion, but not including the more refrangible regions of the spectrum. In the case of *Mars*, Vogel also made visual observations which appeared to confirm the earlier detection of atmospheric bands.

At Bothkamp he observed the Doppler effect at the opposite limbs of the sun, due to its rotation, and he made some observations of sunspot spectra and prominences; but in solar spectroscopy his principal piece of work was his *Untersuchungen über das Sonnenspectrum* (Part III of the first volume of the Potsdam Publications), in which, in conjunction with Professor Müller, he measured directly and on photographs the positions of some 2,600 lines between E and H, referred to Ångström's scale, and charted their positions in an atlas. The inaccuracy of Ångström's system being increasingly felt, new absolute determinations of the wave-lengths of 300 lines in the solar spectrum were later made by Müller and Kempf, and the 2,600 lines of Vogel's list were re-reduced to this system. These, with others measured by Müller and Kempf, making a total of 4,020 lines, constituted the Potsdam system of wave-lengths. But Rowland's photographic map, made with the concave grating, and his more extensive tables of wave-lengths, soon appeared and naturally superseded all others.

Vogel's field for personal research in the last twenty years was almost entirely in stellar spectroscopy. He had devoted much time to visual spectra at Bothkamp, and upon those observations he based his widely used classification of stellar spectra, first stated in *Astrono-*

mische Nachrichten, (**84**, 113, 1874). While adhering to Secchi's classification in a general way, Vogel enunciates distinctly that the guiding principle should be that of stellar development. He regards Secchi's third and fourth types as co-ordinate, distinguishing them as subdivisions of his third type. Vogel's system also makes an important addition, in differentiating three subdivisions of the first type, thus providing for stars of the *Orion* type and those having bright lines like γ *Cassiopeiae*. He also added a second subdivision to the second or solar type, II*b*, to include stars of the Wolf-Rayet type, having bright lines.

In a paper presented to the Berlin Academy in 1895, "Ueber das Vorkommen der Linien des Cleveitgasspectrums in den Sternspectren und über die Classification der Sterne vom ersten Spectraltypus," he avails himself of the data meanwhile gained by photography, and particularly after the discovery of helium, and the assignment to it of many significant lines previously unidentified, and he further differentiates the spectra of the first type. Subdivisions I*a*1 and I*a*2 and I*a*3 represent very marked differences in spectra. This restatement of his classification, particularly applying to the first type, is also given in the valuable paper on the spectra of 528 stars, already referred to (Bd. XII, Stück 1, *Publicationen*, Potsdam).

An earlier spectroscopic investigation, undertaken in conjunction with Dr. Müller, forms the third part of the third volume of the observatory's publications. It was the beginning of an attempt at a spectroscopic *Durchmusterung* of all the stars to magnitude 7.5 (inclusive) of the northern heavens. This paper (published in 1883) gives the results of a visual examination of over 4,000 such stars in the zone from $-1°$ to $+20°$ of declination. All honor to the skill and perseverance of the observers! Present-day workers who have dealt wholly with photographic spectra can scarcely appreciate the difficulties of such visual observations. This particular investigation was not extended to other zones, as the paramount advantages of photography for such surveys had meanwhile been demonstrated, principally at the Harvard Observatory by E. C. Pickering.

After his election to a seat in the Berlin Academy of Sciences in 1892, Vogel's papers chiefly appeared in the publications of that society, and were commonly translated for the *Astrophysical Journal*

from advance sheets at his request. These papers show the same careful study, and cautious, undogmatic expression, in regard to the qualitative part of an investigation as to its quantitative features, and they may well serve as models for younger men. Among these articles the following may be mentioned particularly:

"Ueber den neuen Stern im Fuhrmann," 1893, an especially thorough study of *Nova Aurigae* (60 pages).

"Ueber das Spectrum vom *β Lyrae*," 1894.

"Ueber das Spectrum von *Mira Ceti*," 1896.

"Ueber das Spectrum von *α Aquilae* und über die Bewegung des Sterns im Visionsradius," 1898.

"Ueber die in letzten Decennium in der Bestimmung der Sternbewegungen in der Gesichtslinie erreichten Fortschritte," 1900.

"Ueber das Spectrum der *Nova Persei*," 1901.

"Der spectroskopische Doppelstern *Mizar*," 1901.

"Ueber die Bewegung von *α Persei* in der Gesichtslinie," 1901.

"Ueber die Bewegung des Orionnebels im Visionsradius," 1902.

"Der spectroskopische Doppelstern *o Persei*," 1902.

"Untersuchungen über das spectroskopische Doppelsternsystem *β Aurigae*," 1904.

Appreciative references to Vogel's many inventions and devices in connection with spectroscopic apparatus will be found throughout Scheiner's *Spectralanalyse der Gestirne.*

Personally Professor Vogel was quiet and reserved; his health had been poor for a number of years, and it was only by the strictest care of himself that he was able to accomplish so much. He was a staunch friend, and always encouraged conscientious work of men younger than himself. Faithful to the memory of an early attachment he never married, but he took a warm interest in the *Familienglück* of his friends. He found great solace and relaxation in music, and both a large and small organ were at hand in his house. Sometimes, too, he went down to the famous old church in the crypt of which lies the body of Frederick the Great, and there played on the large organ with himself the only auditor. He had always been interested in entomology and had a fine collection, which he delighted in showing to interested friends. He frankly appreciated approbation, and was

the recipient of many honors, and of elections to membership in most of the leading learned societies of the world.

The condition of his health took a rather sudden change for the worse in the past summer, and on the evening of August 13, he passed away. Two days later he was borne for the last time to the great dome, where funeral services were appropriately held on August 17.

His achievements in research now become a part of scientific history; the memories of his personal qualities are a priceless possession of those privileged to be his friends.