

Research on Asteroids of Christian Ludwig Gerling and His Students in the Nineteenth Century

Journal for the History of Astronomy

2018, Vol. 49(1) 83–98

© The Author(s) 2018

Reprints and permissions:

sagepub.co.uk/journalsPermissions.nav

DOI: 10.1177/0021828617746805

journals.sagepub.com/home/jha**Julia Remchin**

Independent Scholar, Germany

Andreas Schrimpf

Philipps-Universität Marburg, Germany

Abstract

One of the major topics in astronomy at the beginning of the nineteenth century was the interpretation of the observations of the first asteroids. In 1810, Christian Ludwig Gerling at the age of 22 came to Göttingen University to continue his academic studies. Supervised by Carl Friedrich Gauß at the observatory, he was engaged in studies of theoretical and practical astronomy. Starting in 1812, Gerling accepted the responsibility for collecting observational data of the asteroid Vesta from the European observatories and for calculating the ephemeris of this new minor planet. In 1817, Gerling was appointed professor at Marburg University. One of his early astronomical projects in Marburg was his contribution to the *Berliner Akademische Sternkarten*. After completion of his observatory in 1841, Gerling's students started observing and theoretically analysing the orbits of the continuously newly discovered asteroids including the perturbation of the larger solar system bodies. The observations at Gerling's observatory are the first astrometric measurements of solar system's minor bodies of Hesse.

Keywords

Asteroids, star maps, orbit calculation of asteroids, astronomy in the nineteenth century, Gerling Observatory, Marburg

Corresponding author:

Andreas Schrimpf, History of Astronomy and Observational Astronomy, Philipps-Universität Marburg, Renthof 7b, D-35032 Marburg, Germany.

Email: andreas.schrimpf@physik.uni-marburg.de

Introduction

The starry sky was and still is fascinating. Since ages, all cultures have been studying the motions of stars and solar system bodies. At the edge of modern ages based on observations without telescopes, the positions and motions of Sun, Moon, and the planets could be predicted with considerable precision. Kepler's laws and the development of telescopes increased the knowledge of the orbits of solar system bodies to a great extent, leading to a new view of world, the Copernican system, which finally became accepted after the publication of Newton's law of gravity.

The discovery of Uranus, the seventh planet, in the year 1781 by Wilhelm Herschel triggered a euphoric search for further solar system bodies. In fact, the first four asteroids were discovered at the beginning of the nineteenth century between 1801 and 1807, and the story of their discovery was studied and told by many authors from the very beginning; see, for example, G. Jahn,¹ for a very recent and very detailed exploration by C. Cunningham.²

The orbits of the first four asteroids roughly are located at the same region between Mars and Jupiter. The sizes of these asteroids were not known at that time so they were reckoned as ordinary planets. But this clearly opened a new problem: the Titius-Bode law³ predicted one planet between Mars and Jupiter not four. Were the asteroids fragments of a former collision? To answer these questions, further observations seemed to be necessary. All observatories in Europe monitored the new four planets. Besides Carl Friedrich Gauß, his students Friedrich Bernhard Gottfried Nicolai, Johann Franz Encke, Friedrich Ludwig Wachter, Christian Ludwig Gerling, and August Ferdinand Möbius calculated new orbital elements and ephemerides. Wachter and Möbius took care of Juno, Encke was responsible for Pallas, and Gerling was busy with Vesta.⁴

It was clear, further solar system bodies had to be less bright than the ones known; otherwise, they would have been detected till then. Therefore, one of the major demands was the improvement of star charts, that is, less bright stars should be included. The catalogues of Jérôme Lalande, the *Histoire Céleste*, and Giuseppe Piazzi increased the number of recorded stars to about 50,000.⁵ However, those catalogues were not complete, they did not contain all stars down to a certain brightness. Hence, in 1824, Friedrich Wilhelm Bessel initiated the compilation of the *Berliner Akademische Sternkarten*,⁶ thus supporting the search for new smaller solar system bodies.

For many years following 1807, no new minor planet was discovered. Then, in December 1845, 38 years after the first observation of Vesta, Karl Ludwig Hencke discovered the fifth minor planet Astraea. Although the new solar system bodies are much smaller than any other planet, they had been counted as regular planets. When Neptune was discovered in 1846, it became the 13th planet of our solar system.⁷ In July 1847, the sixth minor planet was discovered, and then no year passed without new discoveries. Accepting the proposal of Alexander von Humboldt,⁸ in 1851, a new class of solar system bodies finally was introduced. The minor planets were named *asteroids*, just as Herschel had suggested already in 1802.

With the increasing number of discovered asteroids and the increasing precision of observations, the perturbations of the large solar system bodies on the orbits of the asteroids came into focus, which finally led to the discovery of the Kirkwood gaps and the chaotic properties of asteroids in the main belt.⁹

In this paper, we will review the up-to-date somewhat overseen contribution of Christian Ludwig Gerling in the beginning of the research on asteroids. His ephemeris calculations



Figure 1. Christian Ludwig Gerling (1788–1864).

have been shortly summarized by G. Jahn¹⁰ and were cited by C. Cunningham.¹¹ However, his contributions to the improvement of the star maps and his observatory at Marburg and the observations of his students in the mid of the nineteenth century as well as the theoretical investigations of perturbations of the larger planets on the orbits of smaller asteroids were not recognized so far. The paper presented here is based on publicly available information and the scientific estate of Chr. L. Gerling, containing his correspondence and notes.¹²

Christian Ludwig Gerling

Christian Ludwig Gerling (Figure 1) was born in Hamburg, Germany, in 1788 as a son of a preacher. His education started with private lessons at home and continued at the grammar school “Johanneum,” Hamburg, together with his long-time friend Johann Franz Encke. After school, Gerling registered at the University of Helmstedt, Lower Saxony, for theology. In addition, he attended lectures in mathematics of professor Pfaff. In 1810, the University of Helmstedt was closed and Gerling decided to continue his academic studies in mathematics and astronomy in Göttingen. At the observatory, he kept himself busy with theoretical and practical astronomy under supervision of Carl Friedrich Gauß and Karl Ludwig Harding.¹³ There, he got to know Gottfried Nicolai, who later became director of the observatory in Mannheim, Germany, and Friedrich Ludwig Wachter. Encke joined this group in 1811. He later became director of Seeberg Observatory, Gotha, and finally in 1825 of the Berlin Observatory.

Studying under Gauß, Gerling learned not only the appropriate use of instruments but also the mathematical methods for analysis of geodetic and astronomic measurements. Later, Gerling published among others a book about the practical use of least squares in geodetic data analysis.¹⁴

In 1812, Gerling finished his doctoral thesis about a calculation of the path of the solar eclipse in 1820 in northern Europe. After he received his PhD, Gerling entered a position at a high school in Kassel, Hesse. At that time, he used a small observatory in Kassel for astronomical observations. He continued to seek a university position and finally in 1817 was appointed full professor of mathematics, physics, and astronomy and director of the “Mathematisch-Physikalisches Institut” at the Philipps-Universität of Marburg. In spite of several offers, he remained at the university in Marburg till his death in 1864.¹⁵ During his career, three times he kept the position as prorector of the university, he was representative in the chamber of the Electorate of Hesse, and in 1857, he was appointed court counsellor. Due to his scientific reputation, he was nominated member of several scientific societies, e.g., the Göttingen Royal Society of Sciences.¹⁶

Gerling’s scientific work in Marburg was affected by two major topics: in his early period from 1817 to 1838, he was well occupied with organizing the triangulation of Kurhessen.¹⁷ During that time, Gerling did not have an observatory, so his astronomical work was reduced mainly to corrections and additions on a section of Encke’s “Berliner Akademische Sternkarten.” In 1838, the institute moved to a new home in Marburg at the “Renthof.” After the building was reconstructed in 1841, he could finally put into operation his new but small observatory, built on top of a tower of Marburg’s old city wall.¹⁸ Gerling pursued the scientific topics of astronomy of that time, making meridional observations and differential extra-meridional measurements of stars, planets, and asteroids; observations of lunar occultations; as well as astronomical time determinations mainly to improve the precision of star catalogues, improving orbital parameters of solar system bodies and the solar parallax.

Carl Friedrich Gauß and Christian Ludwig Gerling started their relationship as a teacher and his student but during the following years, they became each other’s counsellor and finally close friends. Their correspondence not only contains details of scientific discussions but also reflects their close relationship.¹⁹ Gerling infected his students with his enthusiasm for astronomy: Carl Wilhelm Moesta became the first director of the National Observatory of Chile;²⁰ Eduard Schönfeld became director of the observatory in Mannheim, Germany, and later the successor of Friedrich Wilhelm August Argelander in Bonn; and Ernst Wilhelm Klinkerfues became assistant and later successor of C. F. Gauß in Göttingen. Gerling died in 1864 at the age of 76. His estate has been stored in the library of the Philipps-Universität Marburg. About 1000 letters of his correspondence with Gauß, Encke, Nicolai, and many more give an insight into his personal and professional life and can be a valuable source for historians.²¹

Gerling’s Vesta calculations

Gerling calculated his first Vesta ephemeris for 16 July 1812 to 30 April 1813 in 1811, while he still was in Göttingen with C. F. Gauß. It was published in the *Monatliche Correspondenz*.²² After starting his job in Kassel, Gerling struggled to get access to a small observatory, which was not in good shape. In October 1813, he observed Vesta at RA = 133°, DEC = 18°20’ and marked it in Harding’s star map, not really being convinced that the object he had observed was Vesta.²³ On 17 February 1814, he sent a note to Gauß that to his surprise, he observed Vesta just at the position his own ephemeris had predicted.²⁴ In the same letter, Gerling asked Gauß for observational data of Vesta in order to take care of

Nun ganz artig, sehr auf Ihnen, liebster Gerling,
 für ein Abkriech von Bessels Beobachtungen
 die ich so eben erhalten habe. Die große Länge von dem Seeberg
 wissen Sie aus der Conn. des Venus aufsteigen, denn die große Entfernung
 um die Plätze der neuen Perseiden hat er nicht auf sich selbst
 Welt.

1814 Jan 31.	13 ^h 28' 25"	152 40' 16" 8	19 6' 37" 9	* mißbrauch 9799.
febr 9.	12. 45. 5	150 40 49. 2	20 22 6. 3	
13	12. 25. 30	149 42 44. 3	20 54 39. 1	
14	12 20 35	149 27 56. 6	21 2 39. 3	
19	11 55 58	148 13 33. 3	21 40 16. 5	
21	11 46 8	147 43 51. 5	21 54 28. 3	:
22	11 41 13	147 29 9. 1	22 1 8. 1	
25	11 26 33	146 45 47. 0	22 20 35. 2	
26	11 21 40	146 31 36. 8	22 26 30. 6	

Das Tableau der Abweichung aller Beob. hat ich mir erst selbst
 gelesen, so daß Sie die Genauigkeit davon ablesen
 Göttingen 16 April 1814. Ihr ergebener Off.
 Ihre Entke werden Sie die Aufmerksamst Ihre Beobachtung
 dieß diesen selbst aufpassen.

54. 42. 12

Die Entke werden Sie die Aufmerksamst Ihre Beobachtung
 dieß diesen selbst aufpassen.

Figure 2. Letter from C. F. Gauß to Gerling dated 16 April 1814. The letter contains the Vesta observational data from F. W. Bessel,²⁹ see transliteration in the appendix.

further orbital calculations of this asteroid, if Gauß had not appointed this task already to someone else. Gauß appreciated Gerling's offer and sending his own observation taken with a mural instrument as well as observations from Nicolai and Bessel (Figure 2), he asked Gerling to calculate the orbital elements of Vesta based on the four oppositions from 1810 to 1814.²⁵ Gerling's results were published in the *Göttinger Gelehrte Anzeigen*, the journal of the Göttingen Royal Society of Sciences, and in Bode's *Berliner Astronomisches Jahrbuch*,²⁶ where Gerling added a forecast of the oncoming Vesta opposition in July 1815. By the end of August 1814, Gerling finished the calculation of the ephemeris of Vesta in 1815 and sent them to Gauß, Harding, and Bode, just in time to be included in the *Berliner Astronomisches Jahrbuch*.²⁷ Gerling commented his results in his letter to Gauß, stating that "due to the small distance of Vesta in the next opposition its brightness would be extraordinary if it would not have such a large southern declination."²⁸

In summer 1815, Gerling received observational data of that Vesta opposition from Seeberg Observatory by Bernhard v. Lindenau and Nicolai, who at that time was

working at Seeberg Observatory; as well as from Königsberg Observatory by Bessel; from Mannheim Observatory by Friedrich Georg Wilhelm Struve, visiting at Mannheim; and from Milan Observatory by Francesco Carlini.³⁰ The final 1815 oppositional data were published in the *Berliner Astronomisches Jahrbuch*.³¹

Vesta reached its sixth opposition on 4 December 1816. In fall 1815, Nicolai³² sent Bode's Vesta observations to Gerling, and by the end of March 1816, Gerling finished the new ephemeris for August 1816 to March 1817 and sent them to Gauß³³ and Bode.³⁴ In the new volume of the *Berliner Astronomisches Jahrbuch* ephemeris, orbital elements, dates for eastern and western quadrature and the opposition, as well as the brightness for all oppositions from 1808 to 1816 were published.³⁵ Again, Gerling received observational data of the Vesta opposition from many European observatories (Mannheim, Seeberg, Königsberg, Berlin, Wien, Milan),³⁶ which he used to calculate the final data for the opposition on 4 December 1816.³⁷

In May 1817, Gerling was appointed full professor at Marburg University. His new tasks took most of his time. In fall 1817, he calculated his last Vesta ephemerides for dates from 2 January 1818 to 21 July 1818 and sent them to Bode for publishing³⁸ and to Gauß.³⁹ Encke continued the Vesta calculations in the following years.

Orbital calculations obviously were very time-consuming in the nineteenth century. More than once, Gauß was faced with cancellations by his colleagues. In 1816, he was in need for someone to follow Juno. He sent Gerling a few observations of Juno from Harding, and Gerling calculated the opposition.⁴⁰ However, Gerling asked Gauß to pass this task to someone else and suggested Encke, but finally, Nicolai continued the Juno calculations for several years.

During the years Gerling assumed the responsibility for the Vesta calculations, he was in continuous correspondence with Gauß, Encke, Nicolai, Bode, and v. Lindenau. The letters he received are stored in the archive of Christian Ludwig Gerling in the library of the Philipps-University Marburg; one of them is shown in Figure 2. Some of the results of Gerling's calculations were also published in *Zeitschrift für Astronomie und verwandte Wissenschaften* edited by B. von Lindenau and J. G. F. Bohnenberger.

Gerling's contribution to the *Berliner Akademische Sternkarten*

After the discovery of the first four asteroids, it soon became obvious that further less bright objects could be found more easily if the star charts would contain more less bright stars. In 1824, Bessel initiated the compilation of the *Berliner Akademische Sternkarten*,⁴¹ a belt from 15° north to 15° south of the equator containing all the stars down to a brightness of 9 mag. to 10 mag. On 1 November 1825, Encke published a call in the *Astronomische Nachrichten* to join that campaign. Every participating observatory or astronomer should take care of a chart 15° (1 hour) wide and was promised a reward of 25 Dutch guilders.⁴² Gerling offered his help and the committee of the academy agreed that Gerling should take care of the star field from RA 15:56 to RA 17:04, i.e., Hora 16.⁴³

At that time, Gerling did not have an observatory with a larger telescope at his disposal. However, this was not urgently necessary for the improvement of the star charts. In November 1826, Gerling sent a note to Gauß that he had built himself an equatorial

mount for his smaller telescope⁴⁴ to participate in that project. Two years later, in November 1828, he told Gauß that his observations for this campaign had taken all his time in summer 1828.⁴⁵ However, Gerling's activity must have been stalled. In 1831, he received a letter from Encke on behalf of the committee, urging him to continue his part of the work. In the interim report dated 1833, Encke mentioned that Gerling still was willing to finish his part of the chart, but he could not give a final date.⁴⁶ Gerling was not able to resume his contribution, and in 1840, he finally ceased his participation in the star charts. Encke passed Gerling's Hora 16 to Dr Jakob Philipp Wolfers, Berlin, who finished this part in 1843. In his epilogue, Wolfers thanked Gerling sincerely:⁴⁷

Professor Gerling of Marburg had begun to work on the present chart before I did but was prevented from completing it. When he learned I had taken over the process, he was more than willing to place all the work he had accomplished thus far at my disposal and this proved to be an essential service particularly in the reduction of stars. In some ambiguous cases I was able to compare with Gerling's reduction and readily attain certainty. I therefore feel compelled at this occasion to express my most profound gratitude to Professor Gerling.

The Gerling Observatory at Marburg University

When Gerling accepted his professorship at Marburg University in 1817, the physical and astronomical sections were not in an appropriate organized state. A well-constructed institute including an observatory was of particular concern to Gerling. He had to wait until 1838 before the university offered him the *Dörnberger Hof* at the castle hill, a former estate for supply of the landgraves in the near castle. The massive reconstruction including the provision of lecture hall and laboratories for the institute, of the apartment for the institute's director, and of an observatory on top of the tower lasted until 1841.⁴⁸

In the upper part of the tower, Gerling established his observatory, consisting of an octagonal small house surrounded by a gallery (Figure 3). A post was mounted at the gallery. It was supported by a vault underneath, to provide a solid and low vibrating mount for the telescope. To protect the telescope, a partly removable case was constructed, easily visible on the left in front of the observatory house (Figure 3). Unfortunately, this case later was demounted; it does not exist anymore. From this post, Gerling and his students could observe the southern, western, and northern parts of the sky. For observations in the prime vertical (i.e. East and West), the windows of the small house were opened to the East. Thus, observations up to a zenith distance of 12° in eastern direction could be made.

The main instrument was a transit telescope with a kinked tube design (focal length 596 mm, aperture 54 mm), which Gerling bought from Ertel & Sohn (Figure 4). For meridional and prime vertical observations, a Kessels box chronometer was used. A meridian stone painted with a scale was placed at about 4 km distance north of the observatory for easy alignment of the telescope.⁴⁹ Later, in 1862, two further stone marks each painted with a scale were placed in East and West direction of the observatory for use in connection with the prime vertical observations.⁵⁰

Furthermore, Gerling's equipment included a 5-foot Fraunhofer retractor, an English 4-foot refractor on an equatorial mount, a small refractor with larger focal ratio, and a prism sextant.⁵² For differential position measurements, a ring-micrometer was available.⁵³ The small house was used for storage and casual observations with the small telescopes.



Figure 3. The *Mathematisch-Physikalische Institut* at Renhof, 1880. The observatory is located on top of the tower in the back of the building. (Photo: Bildarchiv Foto Marburg. Photographer: Ludwig Bickell).

After finishing the reconstruction of the new institute in fall 1841, Gerling put into service his observatory on 12 October 1841 with an observation of Polaris.⁵⁴ The equipment of the observatory mainly was aimed at the education of young scientists. Gerling and his students did not start a continuous observational programme nor did they participate in campaigns. However, there exist reports on observations of eclipses, occultations, planets and their moons, asteroids, comets, and meteor showers.⁵⁵ The coordinates for the observatory were determined by Gerling,⁵⁶ and a small improvement was achieved by Richard Mauritius, one of Gerling's students:⁵⁷

Longitude	8°46'24.3"E
Latitude	50° 48' 44.1"N
Height	263.7 m

A recent global positioning system (GPS) measurement resulted in coordinates shifted by about 15" to the West.⁵⁸ The observatory is referred to observatory code 525 at the Minor Planet Center (MPC) of the International Astronomical Union.

Franz Melde, Gerling's successor, mainly used the observatory for time determinations.⁵⁹ The most well-known director of the observatory besides Gerling surely was Alfred Wegener, who had a job as assistant professor at Marburg University from 1909 to 1919. He was not involved in any research at the observatory, though. The last observations at Gerling Observatory, dealing with variable stars, were reported in the 1930s.



Figure 4. Gerling's transit telescope, Ertel & Sohn, 1841. Reproduction from *Astronomische Zeitbestimmungen*⁵¹ with kind permission of the Hochschul- und Landesbibliothek Fulda, Hesse.

Observations and orbital calculations of asteroids in Marburg

Gerling mentioned his first attempts of observing asteroids, (6) Hebe and (7) Iris, in a letter to Gauß in fall 1847, but due to bad weather conditions and a deterioration of his eyes, Gerling failed.⁶⁰ In 1849, Gerling's student *Wilhelm Klinkerfues* carried out the first astrometric observations of an asteroid at Marburg observatory on the 1801 discovered (1) Ceres.⁶¹

From 1851 to 1852, Eduard Schönfeld started his scientific education at Marburg University and joined Gerling's group. On 27 May 1851 and the following days, he observed (14) Irene 8 days after its discovery by John Hind at Greenwich Observatory. His measurements were published in the *Astronomische Nachrichten*.⁶² Gerling also mentioned these observations in a letter to Gauß.⁶³ Surprisingly, Schönfeld could find Irene 8 days after its discovery at a time, where data about Irene had not yet been published. Presumably, Gerling had received news about Irene by a letter, but unfortunately, no note about Irene could be found in the Gerling Archive so far. Besides the data from the observatories in Hamburg, Bonn, and Berlin, the Marburg observations were among the early observational data from German astronomers.⁶⁴ Later, in 1852, Schönfeld calculated a small correction for the Marburg Irene data and reported them together with an observation of (6) Hebe.⁶⁵ With a letter of recommendation from Gerling, Schönfeld left

Marburg in April 1852 and continued his education under the supervision of Friedrich Wilhelm August Argelander at Bonn Observatory.

In fall 1849, Otto Lesser came to Gerling at Marburg University as a student. His first publication – together with E. Schönfeld – dealt with the calculation of orbital element of the third comet in 1851.⁶⁶ In spring 1852, shortly after the announcement of the discovery of (17) Thetis, he observed this asteroid⁶⁷ and calculated orbital elements and an ephemeris from observations at Berlin and Hamburg.⁶⁸ At the beginning of July 1852, he observed (18) Melpomene,⁶⁹ which was discovered on 24 June 1852. Lesser left Marburg in fall 1852 and could find an employment with Encke at Berlin Observatory and continued his studies of asteroids. On 14 September 1860, together with Wilhelm Förster, he discovered the asteroid (62) Erato. In 1861, he returned back to Gerling for continuing his studies of the perturbations of the outer planets on the orbits of the asteroids (9) Metis and (32) Pomona.⁷⁰ He finished his PhD thesis on the perturbations of Jupiter, Saturn, and Mars on the orbit of (9) Metis in 1861; a summary was published in the *Astronomische Nachrichten*.⁷¹ Lesser left Marburg again and continued his research on asteroid observations and orbital analyses at Altona Observatory.

The published asteroid observations during Gerling's creative period will be appreciated in the next section. No further activity in asteroid research was reported by Gerling's successors.

Analysis of the asteroid observations at Marburg

So far, the Marburg (17) Irene observations are the only ones included in the database of the MPC. To get an idea about the accuracy of the historical asteroid observations in Marburg and to prepare them for insertion into the MPC database, the published observational data were compared with orbital calculations using the National Aeronautics and Space Administration (NASA) Horizons On-Line Ephemeris System.⁷² For all local calculations, the software packages Astropy⁷³ and NOVAS⁷⁴ were used.

In a first step, the given dates of observations have to be converted to universal time (UT). For the Ceres observations, the local mean sidereal time, and for all other measurements, the local mean solar time with an offset of 12 hours was given. For conversion of these dates to UT, the geocentric longitude and latitude listed above have been used.

All asteroid observations at Marburg were carried out extra-meridional using a ring-micrometer by comparing the transits of asteroid and a comparison star passing through a ring in the focal plane of the eyepiece. Using this method, it must have been difficult to determine right ascension and declination in one and the same observation. In most cases, apparent RA and DEC were listed at different observation times. Unfortunately, no lab notes with further details of these observations could be found in Marburg. As all published observations were made by Gerling's students, they probably took their personal lab notes when they left Marburg.

For change of equator and equinox to epoch J2000.0, we concatenate observations within a couple of minutes; 23 minutes is the largest time between the observations of the first listed pair of (18) Melpomene measurements. Aberration and nutation corrections were applied to the apparent coordinates before they were rotated according to the precession from observational date to J2000.0. Finally, coordinates of the asteroids were calculated for the given observational dates and the coordinates of the observatory using

Table 1. Asteroid positional data calculated from the observations at Gerling Observatory Marburg. The observations have been converted to J2000 coordinates. The last two columns show the deviations in arcsec from the NASA positional data. For details, see text.

Asteroid	Date (UT)	RA J2000 (hms)	DEC J2000 (dms)	Δ RA (")	Δ DEC (")
(1) Ceres	1849-06-21 00:14:03.136	18 45 57.71	-27 07 28.67	-13.981	-8.918
(1) Ceres	1849-06-21 00:29:45.556	18 45 57.43	-27 07 22.73	-8.600	0.376
(1) Ceres	1849-06-22 23:47:23.389	18 44 4.82	-27 16 09.04	-14.934	-1.870
(1) Ceres	1849-06-23 22:13:48.205	18 43 12.06	-27 20 13.41	-0.279	-1.846
(1) Ceres	1849-06-23 22:13:48.205	18 43 12.19	-27 20 16.38	1.756	-4.867
(1) Ceres	1849-06-23 22:59:52.636	18 43 10.11	-27 20 17.83	-1.239	2.200
(1) Ceres	1849-06-23 22:59:52.636	18 43 9.55	-27 20 11.95	-9.726	8.178
(14) Irene	1851-05-28 22:28:24.080	16 03 36.78	-14 04 06.16	2.801	-0.775
(14) Irene	1851-05-31 22:58:47.180	16 00 41.64	-14 11 07.76	-9.996	2.685
(14) Irene	1851-06-01 22:48:54.180	15 59 46.47	-14 13 39.00	0.731	-0.614
(14) Irene	1851-06-02 22:34:05.580	15 58 51.62	-14 16 08.64	0.765	1.582
(6) Hebe	1851-07-01 00:07:24.280	19 37 32.32	-07 30 58.96	-0.619	-2.808
(18) Melpomene	1852-07-08 22:58:27.180	18 06 45.12	-09 06 21.83	0.304	-5.014
(18) Melpomene	1852-07-09 22:41:45.880	18 05 48.55	-09 11 15.61	3.935	2.127
(18) Melpomene	1852-07-10 22:41:01.580	18 04 51.89	-09 16 28.51	1.886	1.816
(18) Melpomene	1852-07-11 22:22:45.380	18 03 57.01	-09 21 41.84	0.781	5.548

NASA: National Aeronautics and Space Administration; UT: universal time.

the NASA Horizons software. Transformed asteroid coordinates and difference to NASA coordinates are listed in Table 1.

The errors of the observations are in the range of $1''$ – $2''$ with a few outliers, very well in the range of the accuracy of measurements from other observatories at that time listed in the MPC database. In 1842, Hermann Libert Westphalen, a student in Gerling's group who later worked as an assistant to Bessel at Königsberg, characterized the Marburg ring-micrometer and determined an uncertainty of $3.0655''$,⁷⁵ which matches nicely to the error of the observations.

The asteroid positional data calculated from the observations at Gerling Observatory Marburg have been transferred to the MPC for insertion into the database.

Conclusion

Gerling got in contact with asteroid research early in his career while he was working with Gauß and Harding in Göttingen. During his time in Kassel, he took care of orbit and ephemeris calculations. At Marburg University, he was participating in improving star maps, and after he put into operation his new observatory, he supervised his student's observations and perturbation calculations, thus ensuring the continuation in the next generation. Gerling started his research on asteroids with an analysis of the Vesta orbit. Shortly before his death, he was involved in calculations of the influence of the large planets on the orbits of asteroids just at the threshold of Kirkwood's discovery of the gaps in the distribution of periods of the main belt asteroids. The asteroids definitely have been a lifelong topic of Gerling's research reflecting the latest developments.

Nowadays, the search for solar system objects mainly is done with robotic survey telescopes and automated software pipelines analysing differences of succeeding observations. However, it was the enthusiasm of our predecessors – the commitment to go to the limits of available technique in the nineteenth century – that laid the path to modern solar system astronomy.

One of the most successful German groups in searching for new asteroids without a robotic survey programme are the astronomers of the *Frankfurter Physikalische Verein*, Erwin Schwab and Rainer Kling, using the Hans–Ludwig–Neumann Observatory (Code B01) North West of Frankfurt, Hesse; they discovered more than 100 new asteroids in the last 20 years. On 11 February 2008, a new minor planet, 2008 CW16, could be detected,⁷⁶ and in the next years, the orbit was determined with high precision. After proofing that no earlier identifications exist, they suggested to name it “Marburg.” On 12 October 2011, the MPC published this name in the circular # 76677:

(256813) Marburg=2008 CW116

Discovered 2008 Feb. 11 by E. Schwab and R. Kling at Taunus.

Marburg is a German city, first mentioned in 1138. A castle and Germany's oldest gothic church dominate the medieval cityscape. In 1527 the oldest protestant university in the world was

founded, which has operated the Marburg Observatory (later renamed Gerling Observatory) since 1841.

Gerling's contribution to the asteroid research is at the same level as that of others of that time and should not be missed. Naming an asteroid after the city where he founded his observatory seems to be an adequate appreciation of Gerling's and his students' research.

Acknowledgements

We like to thank Gesine Brakhage and Dr Bernd Reifenberg for their very helpful support in searching and reviewing the archive of Christian Ludwig Gerling at the library of the Philipps-Universität Marburg as well as scanning some of the letters for reproduction, Rudi Czech for help in the transliteration of nineteenth-century handwritings, and Judith Whittaker-Stemmler for the translation of German quotations. We also acknowledge an anonymous referee for helpful suggestions to strengthen the central idea of the paper. This research made use of Astropy, a community-developed core Python package for Astronomy (Astropy Collaboration, 2013) and of data and/or services provided by the International Astronomical Union's Minor Planet Center and the Solar System Dynamics Group of the Jet Propulsion Laboratory.

Supplemental material

Transliteration of a letter from C. F. Gauß to Chr. L. Gerling dated 16 April 1814

In great haste I am sending you here, dearest Gerling, a manuscript from Bessel's observations of Vesta, which I have just received. You will have to take the geographic location of Königsberg from the *Conn. des Tems*, for he failed to name the exact position of the new observatory's site to me, also.

<List of observational data from 31 January 1814 to 26 February 1814: date and time, RA, DEC>

May I ask you to disclose the tableau of comparisons of all observations to me first before you derive the opposition from it.

Göttingen, 16 April 1814 Most respectfully yours, CFG

Concerning Encke, you will receive the news from your fellow countryman himself.

The declinations that are printed in the *Göttinger Gelehrten Anzeigen* (Academic Journal of Göttingen) were sent in later to B. and G.

Notes on Contributors

Julia Remchin studied physics and mathematics for high school teaching at Justus-Liebig Universität, Gießen, Germany and at Philipps-Universität Marburg, Germany, finishing in 2017. She joined the group History of Astronomy and Observational Astronomy, Philipps-Universität Marburg, and reviewed and compiled the historical documents about Gerling's asteroid research for her thesis.

Andreas Schrimpf has a PhD and a habilitation in solid state physics from Philipps-Universität Marburg, Germany. Since 2004, he has served as head of a workgroup on History of Astronomy and Observational Astronomy at Marburg and, since 2015, has been associate professor in the Physics Department there. His publications cover both solid-state physics and history of astronomy.

Notes

1. One of the first detailed reports about the discovery of the asteroids was published by G. Jahn in 1844: G. Jahn, *Geschichte der Astronomie vom Anfange des neunzehnten Jahrhunderts bis zum Ende des Jahres 1842* (Leipzig, 1844).
2. C.J. Cunningham, Series of four volumes: *Discovery of the First Asteroid, Ceres – Historical Studies in Asteroid Research* (Cham: Springer, 2016); *Early Investigations of Ceres and the Discovery of Pallas: Historical Studies in Asteroid Research* (Cham: Springer, 2016 [2004]); *Studies of Pallas in the Early Nineteenth Century: Historical Studies in Asteroid Research* (Cham: Springer, 2017 [2007]); *Bode’s Law and the Discovery of Juno – Historical Studies in Asteroid Research* (Cham: Springer, 2017); *Investigating the Origin of the Asteroids and Early Findings on Vesta: Historical Studies in Asteroid Research* (Cham: Springer, 2017).
3. J.E. Bode, *Von dem neuen zwischen Mars und Jupiter entdeckten Hauptplaneten des Sonnensystems* (Berlin, 1802).
4. Jahn, *Geschichte der Astronomie vom Anfange*.
5. J.F. Encke, “Entwurf zu einer Herausgabe neuer Himmelskarten,” *Astronomische Nachrichten*, 4, 1826, pp. 297–301.
6. F.W. Bessel, “Vorbericht,” in *Akademische Sternkarten für den Gürtel des Himmels von 15° südlicher und 15° nördlicher Abweichung* (Berlin, 1859), pp. 3–5.
7. A.V. Humboldt, *Kosmos – Entwurf einer physischen Weltbeschreibung*, vol. 3. (Stuttgart and Augsburg, 1850).
8. Humboldt, *Kosmos*.
9. P. Murdin, *Rock Legends – The Asteroids and Their Discoverers* (Cham: Springer, 2016).
10. Jahn, *Geschichte der Astronomie vom Anfange*.
11. Cunningham, *Discovery of the First Asteroid; Early Investigations of Ceres; Studies of Pallas in the Early Nineteenth Century; Bode’s Law and the Discovery of Juno; Investigating the Origin*.
12. Archive of C.L. Gerling, Library of the Philipps-Universität Marburg, (Marburg).
13. K.C. Bruns, “Christian Ludwig Gerling,” in *Allgemeine Deutsche Biographie* (München, 1879), pp. 26–9.
14. C.L. Gerling, *Die Ausgleichungs-Rechnungen der praktischen Geometrie, oder die Methode der kleinsten Quadrate* (Hamburg, 1843).
15. O. Madelung, *Das mathematisch-physikalische Institut der Universität Marburg 1800 bis 1920* (Marburg: Department of Physics, Philipps-Universität Marburg, 1996).
16. Bruns, *Christian Ludwig Gerling*.
17. C. Reinhertz, Christian Ludwig Gerling’s geodätische Thätigkeit. *Zeitschrift für Vermessungswesen*, 30, 1901, pp. 1–56.
18. A. Schrimpf, J. Lipphardt and B. Heckmann, Wiederentdeckungen an der alten Gerling-Sternwarte in Marburg, *DVW-Mitteilungen Hessen/Thüringen*, 2, 2010, pp. 27–37.
19. Letters of C.F. Gauß and C.L. Gerling: C. Schäfer, *Briefwechsel zwischen Carl Friedrich Gauß und Christian Ludwig Gerling* (Berlin: Otto Elsner Verlagsgesellschaft M.B.H., 1927); T. Gerardy, *Christian Ludwig Gerling an Carl Friedrich Gauß. Sechzig bisher unveröffentlichte Briefe* (Göttingen: Vandenhoeck und Ruprecht, 1964).
20. A. Schrimpf, An international campaign of the 19th century to determine the solar parallax: The US Naval expedition to the Southern Hemisphere 1849–1852, *European Physical Journal H*, 39, 2014, pp. 225–44.

21. Archive of C.L. Gerling.
22. C.L. Gerling, Lauf der Vesta vom 16. Jul. 1812 bis 30. April 1813, *Monatliche Correspondenz zur Beförderung der Erd- und Himmelskunde*, 24, 1811, pp. 500–2.
23. Gerling, Letter no. 28, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
24. Gerling, Letter no. 39, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
25. Gerling and Gauß, Letters no. 40, 48 and 50 Gauß to Gerling, letters no. 44, 45 and 49, Gerling to Gauß, Gauß et al., *Briefwechsel zwischen*.
26. C.L. Gerling, Aus einem Schreiben des Hrn. Prof. Gerling in Cassel vom 10. April 1814, *Astronomisches Jahrbuch für das Jahr 1817* (Berlin, 1814), pp. 254–5.
27. C.L. Gerling, Geocentrischer Verlauf der Vesta von Anfang März bis Anfang Dezember 1815 berechnet von Hrn. Prof. Gerling in Cassel, *Astronomisches Jahrbuch für das Jahr 1817* (Berlin, 1814), pp. 94–6.
28. Gerling, Letter no. 51, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
29. C.F. Gauß, Letter from Gauß to Gerling dated 16 April 1814, Archive of C.L. Gerling, Library of the Philipps-Universität Marburg, sig. Ms 347, 1b, (1814).
30. Archive of C.L. Gerling (Note 31), sig. Ms 347 and letter no. 67, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
31. C.L. Gerling, Aus einem Schreiben des Hrn. Doct. Gerling in Cassel vom 31. October 1815, *Astronomisches Jahrbuch für das Jahr 1819* (Berlin, 1816), p. 260.
32. G.B. Nicolai, Letter from Nicolai to Gerling dated 20. October 1815, Archive of C.L. Gerling, Library of the Philipps-Universität Marburg, sig. Ms 319, 505, 1815.
33. Gerling, Letter no. 82, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
34. J.E. Bode, Letter from Bode to Gerling dated 15 October 1816, Archive of C.L. Gerling, Library of the Philipps-Universität Marburg, sig. Ms 319, 45, 1816.
35. C.L. Gerling, Geocentrischer Verlauf der Vesta vom 4. August 1816 bis zum 26. März 1817, und elliptische Elemente ihrer Bahn, von Hrn. Doct. Gerling in Cassel, *Astronomisches Jahrbuch für das Jahr 1819*, (Berlin, 1816), pp. 222–4.
36. Archive of Gerling, “Aus einem Schreiben,” sig. Ms 347 and letter no. 94, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
37. C.L. Gerling, Astronomische Bemerkungen und Berechnungen der Bahn der Vesta, im Jahr 1816 und der Sonnenfinsternis vom 1820, vom Hrn. Doct. Gerling in Cassel, *Astronomisches Jahrbuch für das Jahr 1820* (Berlin, 1817), pp. 109–12.
38. C.L. Gerling, Geocentrischer Verlauf der Vesta vom 25. Dezember 1817 bis zum 21. Juli 1818 vom Hrn. Prof. Gerling in Marburg, *Astronomisches Jahrbuch für das Jahr 1820*, (Berlin, 1817), p. 235.
39. Gerling, Letter no. 106, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
40. Gauß and Gerling, Letter no. 86, Gauß to Gerling, and no. 87, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
41. Bessel, “Vorbericht.”
42. Encke, “Entwurf zu einer Herausgabe.”
43. J.F. Encke, Letter from Encke to Gerling dated 4 May 1826, Archive of C.L. Gerling, Library of the Philipps-Universität Marburg, sig. Ms 319, 179, (1826).
44. Gerling, Letter no. 174, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
45. Gerling, Letter no. 178, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
46. J.F. Encke, Bericht über den Fortgang des Unternehmens der akademischen Sternkarten, *Astronomische Nachrichten*, 11, 1834, pp. 33–8.
47. J.P. Wolfers, Verzeichnis der von Bradley, Piazzi, Lalande und Bessel beobachteten Sterne in dem Theile des Himmels zwischen 15h 56' bis 17h 4' gerader Aufsteigung und 15° südlicher bis 15° nördlicher Abweichung, In *Akademische Sternkarten* (Berlin, 1843).

48. Gerling, Letter no. 317, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
49. C.L. Gerling, Schreiben des Herrn Professors Gerling an den Herausgeber, *Astronomische Nachrichten*, 22, 1845, pp. 371–2.
50. R. Mauritius, “Bestimmung der Polhöhe von Marburg,” (PhD Thesis, Marburg, 1862).
51. F. Melde, *Astronomische Zeitbestimmungen* (Tübingen, 1876).
52. C.L. Gerling, Schreiben des Herrn Professors Gerling an den Herausgeber, *Astronomische Nachrichten*, 20, 1843, pp. 23–6.
53. H.L. Westphalen, Vorläufige Bestimmung des Gesichtsfeldes des Kreismikrometers zu Marburg, Archive of C.L. Gerling, Library of the Philipps-Universität Marburg, sig. Ms 346, 25, (1842).
54. Gerling, Letter no. 316a, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
55. Observations at the Gerling Observatory Marburg have been published in various volumes of *Astronomische Nachrichten*, see, e.g., C.L. Gerling, Schreiben des Herrn Professors Gerling an den Herausgeber, *Astronomische Nachrichten*, 22, 1845, pp. 355–8; C.L. Gerling, Schreiben des Herrn Professors Gerling an den Herausgeber, *Astronomische Nachrichten*, 25, 1847, pp. 47–8.
56. C.L. Gerling, Geodätische Festlegung des Dörnberger – Hof – Thurms zu Marburg, *Astronomische Nachrichten*, 20, 1843, pp. 25–8.
57. Mauritius, “Bestimmung der Polhöhe.”
58. The coordinates of the Gerling Observatory are lon = 8°46'9.00"E, lat = 50°48'42.57"N, determined from the Gauß–Krüger data given in Schrimpf et al.
59. Melde, *Astronomische Zeitbestimmungen*.
60. Gerling, Letter no. 367, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
61. W. Klinkerfues, Oerter der Ceres, aus Kreismikrometer-Beobachtungen in Marburg geschlossen, *Astronomische Nachrichten*, 30, 1850, pp. 73–4.
62. E. Schoenfeld, Scheinbare Oerter der Irene, berechnet aus Kreismikrometer-Beobachtungen, *Astronomische Nachrichten*, 32, 1851, pp. 307–8.
63. Gerling, Letter no. 376, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
64. Asteroid (14) Irene in the database of the Minor Planet Center, <http://www.minorplanet-center.net/db_search/show_object?utf8=> (accessed 7 August 2017).
65. E. Schoenfeld, Beobachtungen auf der Sternwarte in Marburg, von Herrn E Schoenfeld, *Astronomische Nachrichten*, 33, 1852, pp. 123–4.
66. E. Schoenfeld and O. Lesser, Elemente des Cometen (1851. III.), *Astronomische Nachrichten* 33, 1852, pp. 339–40.
67. Gerling, Letter no. 381, Gerling to Gauß. Gauß et al., *Briefwechsel zwischen*.
68. O. Lesser, Elemente der Thetis, von Herrn O. Lesser, *Astronomische Nachrichten*, 34, 1852, pp. 391–2.
69. Observations of Melpomene, see J. Challis, Observations of (18) Melpomene, (17) Thetis, (14) Irene, (15) Eunomia, *Astronomical Journal*, 2, 1852, pp. 181–3; Beobachtungen, Elemente und Ephemeride der Melpomene, *Astronomische Nachrichten*, 35, 1853, pp. 45–8.
70. O. Lesser, “Untersuchungen über die allgemeinen Störungen der Metis,” PhD thesis, (Marburg, 1861); Allgemeine Jupiterstörungen der Ponomia, *Astronomische Nachrichten*, 40, 1862, pp. 161–70.
71. Literarische Anzeigen, *Astronomische Nachrichten*, 59, 1863, pp. 239–40.
72. J.D. Giorgini and JPL Solar System Dynamics Group, NASA/JPL Horizons On-Line Ephemeris System, <<http://ssd.jpl.nasa.gov/?horizons>>
73. Astropy Collaboration, T.P. Robitaille, E.J. Tollerud et al., Astropy: A community Python package for astronomy. *Astronomy & Astrophysics*, 558, 2013, p. A33.
74. J. Bangert, W. Puatua, G. Kaplan et al., *User's Guide to NOVAS Version C3.1* (Washington DC, USNO, 2011).
75. Westphalen, “Vorläufige Bestimmung.”
76. E. Schwab, “Kleinplaneten Entdecker Erwin Schwab,” <<http://erwinschwab.de/asteroid-marburg>> (accessed 7 August 2017).