

**Figure 30.1:** Above: Christopher Hansteen (1784–1873); Below: The Observatory in Christiania (Above: Portrait from his *Reise-beretninger*. Christiania: Chr. Tønsbergs forlag 1859. Below: Draft by Heinrich Christian Grosch sent to Schumacher in 1828. From Elisabeth Seip (ed.): *Chr. H. Grosch. Arkitekten som ga form til det nye Norge*. Oslo: Pax forlag as (2001) 2007, p. 135.)

## 30. Christopher Hansteen and the Observatory in Christiania

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### 30.1 Introduction

The early nineteenth century was a turbulent period in Norway due to Napoleonic wars. As a result Denmark had to turn over Norway to Sweden at the peace treaty in Kiel on 14 January 1814, and the Constitution of Norway was introduced on 17 May 1814. In the preceding years, however, an important feature of the growing nationalism was the insistence on a separate university in Norway. Thus, the Royal Frederik's University in Christiania (today: Oslo) was officially created through a royal decree by Frederik VI, the king of Denmark and Norway, on 2 September 1811. In the first decades the most important Norwegian scientist was Christopher Hansteen (1784–1873), professor of applied mathematics and Director of the observatory in Christiania. Not only did Hansteen put Norway “on the map” through his many international networks within geomagnetism, astronomy and geodesy, he also located Norway in relation to astronomical time and geographical space. In this paper we will primarily focus on the construction and instrumentation of the observatory in Christiania during a period of gradual political separation from Copenhagen. At the same time we will emphasize the close collaboration between Christopher Hansteen in Christiania and Heinrich Christian Schumacher (1780–1850) in Altona at the south border of the Danish-Norwegian kingdom, thus highlighting the close relationship between Hansteen and the Hamburg area at the beginning of the nineteenth century.

### 30.2 Hansteen in Christiania

Christopher Hansteen initially studied jurisprudence at the University of Copenhagen, but his interests were soon drawn towards geomagnetism and astronomy. In 1811 he won a gold medal for a treatise on geomagnetism which was later expanded and published as *Untersuchungen über den Magnetismus der Erde* (1819).<sup>1</sup> Meanwhile, on 1 June 1814, he was formally appointed Lecturer of applied mathematics at the newly established University in Christiania, and on 4 March 1816 he was promoted to professor. Hansteen is perhaps best known for his work on geomagnetism and his elabora-

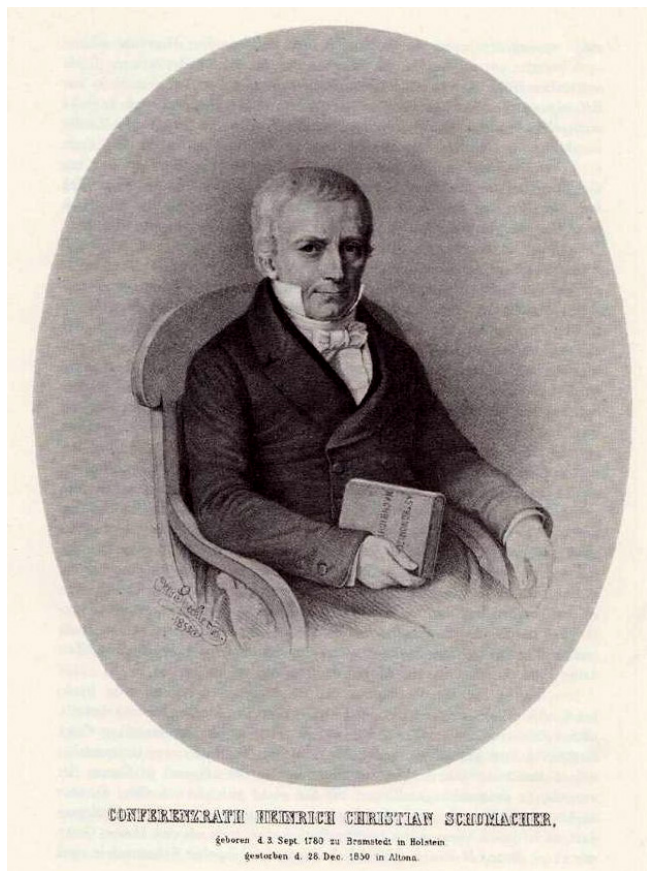
tion of a model of the earth consisting of two magnetic axes and four magnetic poles. Based on this theory, Hansteen carried out an expedition to Siberia between 1828 and 1830 in search of the second magnetic north pole.<sup>2</sup> Despite a negative result, Hansteen's expedition was of great importance to the new nation. Upon his return in 1830 Hansteen's efforts were rewarded by the government, who approved the construction of a new astronomical observatory. It was completed in 1833.

Hansteen and the observatory served many social, cultural and political purposes within the new national state. Along with his duties at the university, Hansteen also gave lectures at the military academy in mathematics, mechanics, geodesy, and astronomy. He further attracted general attention as the editor of the official *Almanac* of Norway from 1815 to 1862. In 1817 he took up a part time position as Director of *Norges geografiske Opmaaling* (Geographical Survey of Norway) which he held until 1872. In 1823 he began publishing *Magazin for Naturvidenskaberne* (Journal of Natural Sciences) with two other professors, thus creating a forum for science news and extended papers on specialized topics. The following year he was co-founder of a scientific society called *Den physiographiske Forening*, which served as a precursor to the Academy of Science in Christiania established in 1857. Finally, Hansteen was appointed to the national commission for weight and measures in 1818. He designed the new Norwegian system of standards in 1824, and he served on this body until 1872. Most of his functions, however, were related to his work at the university observatory in Christiania where Hansteen served as Director from 1815 to 1861.<sup>3</sup>

### 30.3 Schumacher in Altona

Christopher Hansteen's most important contact and collaborator on the continent was Heinrich Christian Schumacher. He was Director of the new observatory in Altona outside Hamburg from 1823 and is perhaps best known as the founder of the journal *Astronomische Nachrichten* which he edited from 1821 to 1850. It was the leading international journal in the field of astronomy in this period and it made the observatory in Altona “the centre of international relations between

astronomers.”<sup>4</sup> For instance, Hansteen published regularly in *Astronomische Nachrichten* and he had a total of ten contributions to the first full volume which was published in 1823.



**Figure 30.2:** *Heinrich Christian Schumacher (1780–1850)* (Portrait from Einar Andersen: *Heinrich Christian Schumacher. Et mindeskrift. København: Geodætisk Instituts forlag 1975, p. 102.*)

In the early nineteenth century the city of Altona, being a part of Schleswig-Holstein, was subject to the Danish-Norwegian kingdom under king Frederik VI. During the preceding one and a half century the observatory on top of the Round Tower in Copenhagen was the centre of the Danish-Norwegian network of astronomical and geodetic sciences. Both Hansteen in Christiania and Schumacher in Altona developed new and more sophisticated observatories in the periphery of the kingdom during the 1820s and 1830s. In the following we will focus on the circulation of knowledge, skills and instruments between Hansteen in the north and Schumacher in the south of the double-monarchy. We will emphasize Schumacher’s role as Hansteen’s mentor and his mediator with German scientists and instrument makers like Johann Georg Repsold – the Director of the new state funded observatory at Millerntor in Hamburg from 1825 – in addition to Ertel, Kessels, Merz, Reichenbach, Utzschneider and Fraunhofer.

Schumacher was born in 1780 in the small town of Bramstedt in Holstein between Kiel and Hamburg. His father Andreas Schumacher, a senior civil servant who

was close to king Frederik, died early and the mother, Sophia Hedevig Rebecca Schumacher, moved to Altona. Here the young Heinrich Christian attended school from 1794 to 1799 under Rector Jakob Struve, father of the astronomer Friedrich Georg Wilhelm Struve who was born in Altona and later, in 1839, became Director of the new observatory in Pulkovo near St. Petersburg. From April 1799 Schumacher studied jurisprudence in Kiel and two years later in Göttingen. Here he met Carl Friederich Gauß who in 1807 had become Director of the new observatory in Göttingen, and Schumacher studied with him during the winter of 1808–1809.<sup>5</sup> In 1810 Schumacher was appointed extraordinary professor of astronomy in Copenhagen. Still, as he did not get along well with Thomas Bugge, the ordinary professor of astronomy and director of the Round Tower observatory, he resided in Hamburg in this period and began a three-year observing programme of circumpolar stars with Repsold’s meridian circle. By 1811–1812 he acquired a flat at Herrengraben 12 near the observatory at Millerntor so he could collaborate closely with Repsold. 1813 Schumacher temporarily accepted the position as director of Mannheim observatory, but two years later, when Bugge died on 15 January 1815, Schumacher was appointed his successor to the ordinary professorship and called to Copenhagen.<sup>6</sup>

In the meantime Schumacher actually tried to obtain a position at the proposed university in Norway. During the winter of 1811–1812 he wrote to the university planning commission in Copenhagen offering his services and at the same time suggesting the construction of a new and well equipped Norwegian observatory (not in Christiania, actually, but at Königsberg, which was a possible location for the university at this point).<sup>7</sup> About the same time the planning committee received an offer for a meridian circle from Johann Georg Repsold in Hamburg. On this occasion, the committee requested the advice of Thomas Bugge, who was negative to the proposal: “Bugge had no confidence in this new idea”; Hansteen later explained, “the zenith distance of the celestial pole would have to be determined with a mural quadrant and a 12 foot zenith sector of the kind available at the Round Tower in Copenhagen.”<sup>8</sup> Thus, following Bugge’s advice, the committee turned down Repsold’s proposal. Instead, the instrument was acquired by Gauß and after further modifications during 1817 it was mounted by Repsold personally in the eastern meridian room of the Göttingen observatory.<sup>9</sup> Later, Hansteen saw the instrument here on his visit to Gauß in 1839 when he was introduced to his geomagnetic observatory and its instruments. Yet, Repsold’s proposal may have been intended to serve an additional purpose, as support for Schumacher’s and as foundation for an even closer collaboration and integration between Christiania and Altona/Hamburg. It was an obvious strategic move to combine Schumacher’s application to the Norwegian university with an instrument proposal from his close friend and collaborator Repsold, since this new university had to establish everything from scratch. In

his application Schumacher offered to build a first-rank observatory with instruments from Hamburg and Munich, provided sufficient funds were granted. He also requested Gauß to send him a letter about the Mannheim position in such wording that he could use it to influence decision makers in Copenhagen towards an appointment in Christiania, stating to Gauß that he would not seriously consider going to Mannheim. Nonetheless, instead of Schumacher, Hansteen was appointed to the position at the new Norwegian university.

Schumacher's main activities in the early nineteenth century were related to surveying, mapping and the determination of correct time and position. His plans were sketched out in a letter to king Frederik dated 14 April 1816. Schumacher suggested a major operation of astrogeodetic observations to measure the length of the meridian from Skagen at the north-tip of Jylland to Lauenburg in the south of the kingdom just east of Hamburg. The king responded positively in a letter dated 18 May 1816, thus laying the foundation for *Den danske Gradmaaling*.<sup>10</sup> As part of the project Schumacher would also produce an improved national network based on new triangulations which in turn could be used for mapmaking: *“Mit seinem Vorschlag einer Gradmessung brachte Schumacher das dänische Königreich nicht nur in die erste Linie aktueller Forschungen, sondern flocht es auch in ein Netz der internationalen wissenschaftlichen Zusammenarbeit ein.”*<sup>11</sup> Only later, from 1821, and quite reluctantly, Schumacher also accepted the task of conducting a topographical survey of Holstein, a part of Denmark-Norway which had not been included in the previous survey by his predecessor Thomas Bugge in the 1770s.<sup>12</sup>

Schumacher chose the church tower of St. Michaelis in Hamburg as the starting point of his triangulations. Together with Repsold he located suitable observation stations around the city, and they further located a suitable location for the baseline at Braak near Ahrensburg to the north-east of Hamburg. Here they conducted precision measurements of the 1,8 km long “Braaker Basis”. Both end points were astronomically determined with a portable universal-instrument so they might serve as starting points for further triangulations. With a specially designed baseline instrument constructed by Repsold the measurements of the “Basis Braak” was largely complete by September 1819. Based on control measurements the next year it was determined that the divergence of the 1800,876 meter long baseline was only 3,6 mm.<sup>13</sup> Schumacher had recruited two military officers to assist him with the observations and measurements, as he explained in a letter to Gauß on 16 November 1817, *“weil diese den meisten Einfluss auf Bauern haben, und eine etwas militärische Behandlung mitunter nicht ohne Nutzen ist.”*<sup>14</sup> In the same letter Schumacher had also suggested his own survey of Holstein to be connected with Gauß' triangulation of Hannover south of the national border, by establishing a common baseline. Thus, Gauß participated with Repsold and Schumacher at the “Braaker Basis” while

Friedrich G.W. Struve visited regularly to learn more about this scientific enterprise.<sup>15</sup> The official triangulation of Hannover was not commissioned to Gauß by George IV of England until 1820. By this time he had already learnt much from the collaboration with Schumacher and Repsold in the area of Hamburg: *“In Jahren 1821 bis 1823 hat Gauß die Messungen zur Bestimmung des rund zwei Breitengrade umfassenden Gradbogens Göttingen-Altona durchgeführt.”*<sup>16</sup>

Naturally, Hansteen would be involved in the same kind of topographic and astrogeodetic surveys in Christiania in the northern part of the kingdom as director of *Norges geografiske Opmaaling*. In 1824 he measured a baseline on the frozen Christiania-fjord to set the scale of triangulations in the region.<sup>17</sup> Questions regarding surveying instruments would also form the main content of the correspondence between Hansteen and Schumacher, of which 93 letters from Schumacher, dating from October 1815 to January 1849, are being kept at the Institute of Theoretical Astrophysics at the University of Oslo, while Hansteen's letters to Schumacher are deposited at the Staatsbibliothek zu Berlin. The other main topic in the correspondence was their common efforts towards building new observatories in Christiania and Altona, respectively.

### 30.4 The Observatories in Altona and Christiania

When Hansteen was appointed at the new University, no appropriate place existed for astronomical observations. Initially he conducted his observations from a pavilion in the garden of his private house in the city. By a royal decree of 25 February 1815 the university decided to fund a small octagonal observatory for Hansteen the walls of Akershus fortress in Christiania. The initiative, however, did not come from Hansteen:

As early as 1813 the establishing of an observatory at Akershus had been suggested by Major Benoni Aubert, the Director of the military geographical survey of Norway. Also, it was Aubert who initially suggested that Hansteen, as newly appointed professor in applied mathematics at the university, should be appointed co-Director of the national topographical survey with responsibility for the civilian and scientific aspects of the institution – a position Hansteen officially had from 20 May 1817.<sup>18</sup> The initial proposal for an observatory, however, was submitted by Aubert to Copenhagen with a negative result largely because of the political situation with Norway being separated from Denmark after the peace negotiations in Kiel. The new Norwegian nation, however, immediately recognised the need for such an institution in relation to national surveying and mapmaking. This first university observatory became a site where geodetic techniques suitable for establishing an improved national geodetic net based on triangulation and astrogeodetic observations were developed.<sup>19</sup>

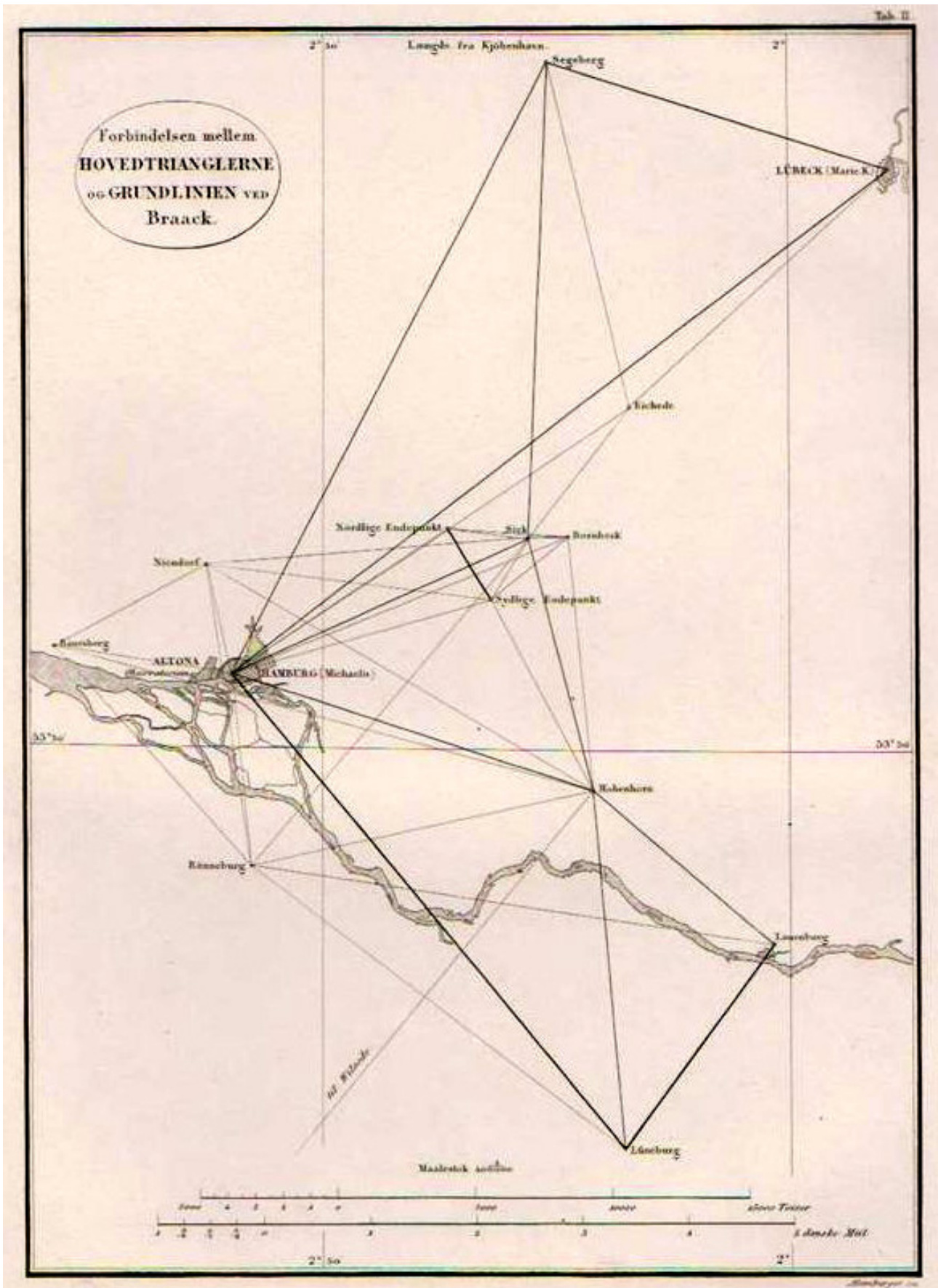


Figure 30.3: The Baseline at Braak (From Einar Andersen: *Heinrich Christian Schumacher. Et mindeskrift. København: Geodætisk Instituts forlag 1975, p. 39.*)

## 30.5 The Astronomical Instruments

Nevertheless, the quality of the building was poor and Hansteen kept conducting most of the observations from his private house while at the same time working relentlessly to establish a proper observatory. Thus, a royal resolution of 11 December 1826 stated that the university should indeed invest in a new and proper observatory building. A suitable location was bought by the university at Sollie just outside the city in 1827. On 28 August 1830 it was decided by the National Assembly that the necessary funds should be allocated to the construction of the new observatory.<sup>20</sup> The most decisive argument – strategically and successfully used by Hansteen throughout the process – was that the gradually increasing collection of valuable scientific instruments needed a proper place for protection.

The close collaboration between Hansteen and Schumacher was crucial, regarding the building itself as well as the instrumentation. In fact, the most important features of the new observatory in Christiania were directly imported from Altona. Initially Schumacher made most of his observations from his private house on Palmaille, a building he bought when permanently settling down in Altona in 1821. Unfortunately, few details exist concerning his new observatory which was funded directly by the Danish king and was first mentioned in *Astronomische Nachrichten* in March 1823.

The building was constructed to contain the main instrument, a meridian-circle by Repsold, which defined the main meridian for the Danish land survey. In addition to the meridian room, which had a movable roof on wheels opening a small slit necessary for making observations, the building also had a small round tower in the south-west corner containing a Borda-circle acquired from Reichenbach in Hamburg in 1819, only later to be replaced by a Fraunhofer-refractor (1.28 m). “*In summa handelte es sich also um ein kleines, aber feines Observatoriumsgebäude, oder wie G. SVANBERG es später ausdrückte, um ein ‘Musterobservatorium’.*”<sup>21</sup>

Schumacher’s observatory in Altona most literally served as a model for Hansteen’s observatory in Christiania. Hansteen visited Schumacher and his new observatory in 1825 and he was very much impressed by the building. In April 1827 Hansteen sent to Schumacher a series of sketches for the new observatory in Christiania made by his architect Christian Henrik Grosch, and in November the same year Schumacher sent drawings of his observatory in Altona to Christiania. Hansteen also sent architect Christian Heinrich Grosch to Altona to make detailed sketches and measures of Schumacher’s observation rooms.<sup>22</sup> As a result, the meridian room in Christiania has exactly the same dimensions as in Schumacher’s observatory. Even the construction of the movable roof was copied. Despite other obvious architectural and structural differences, Schumacher’s observatory in Altona was the main inspiration and model for Hansteen’s observatory in Christiania. In what follows we will further elaborate how Schumacher and the Hamburg-connection was important also for the instrumentation of the Norwegian observatory.

Hansteen developed a wide network of personal contacts within the university as well as in national politics and in ministerial circles, including Norwegian civil servants and military officers. This network was used both as a source of information and to help promote his own scientific goals. Within the university, Hansteen continuously argued that new instruments were required to improve his preliminary results. As a new nation within a double monarchy, Hansteen argued that the country and its natural resources must be surveyed and mapped in order to facilitate further national development and prosperity. He received funds from the university to acquire improved astronomical and magnetic equipment and from the Geographical Survey of Norway to acquire geodetic instruments. He thus made a name for himself as a purchaser of scientific instruments in the international markets and demonstrated ability to specify requirements and select the proper instrument maker for the job. He kept himself informed about the product line, quality and prices of the various companies in Denmark, England, France and Germany through correspondence with Schumacher. He used this unique role at the university to obtain repeated annual grants for new instruments in astronomy and geodesy. The first decade or so he focused on portable instruments (accurate chronometers, sextants, universal theodolites, and magnetic devices), since these were needed both to improve his positioning work in Christiania and could be used for national surveying purposes, plus would serve him on expeditions to remote areas of Norway, and to Denmark, Sweden, England, Germany, and Russian Siberia.

From the interim observatory and the Siberian geomagnetic expedition he possessed a transportable universal instrument by Reichenbach, an astronomical theodolite by Ertel, a pendulum clock by Abraham Pihl, a small transportable refractor by Fraunhofer, and a collection of chronometers and sextants.<sup>23</sup>

When Hansteen moved into the nearly completed observatory building with his family in September 1833 he had also acquired a meridian circle by Ertel in Munich with 11 cm objective lens by Fraunhofer; a pendulum clock by Urban Jürgensen in Copenhagen; and an 11 cm refractor by Utzschneider in Munich on alt-azimuth mounting by Repsold in Hamburg.

Several expansions took place during the following decades. An equatorial refractor by Repsold was installed in the tower observing room in 1842. A portable comet seeker by Merz was acquired in 1851. A pavilion to the north of the main building was set up to accommodate a 19 cm equatorial refractor by Merz in 1857. A transit instrument by Pistor and Martins was acquired in 1869 and set up in a separate observing hut due south of the meridian circle. A pavilion to the east of the main building was set up in 1884 to house a 13 cm refractor by Merz on equatorial mounting by Olsen.

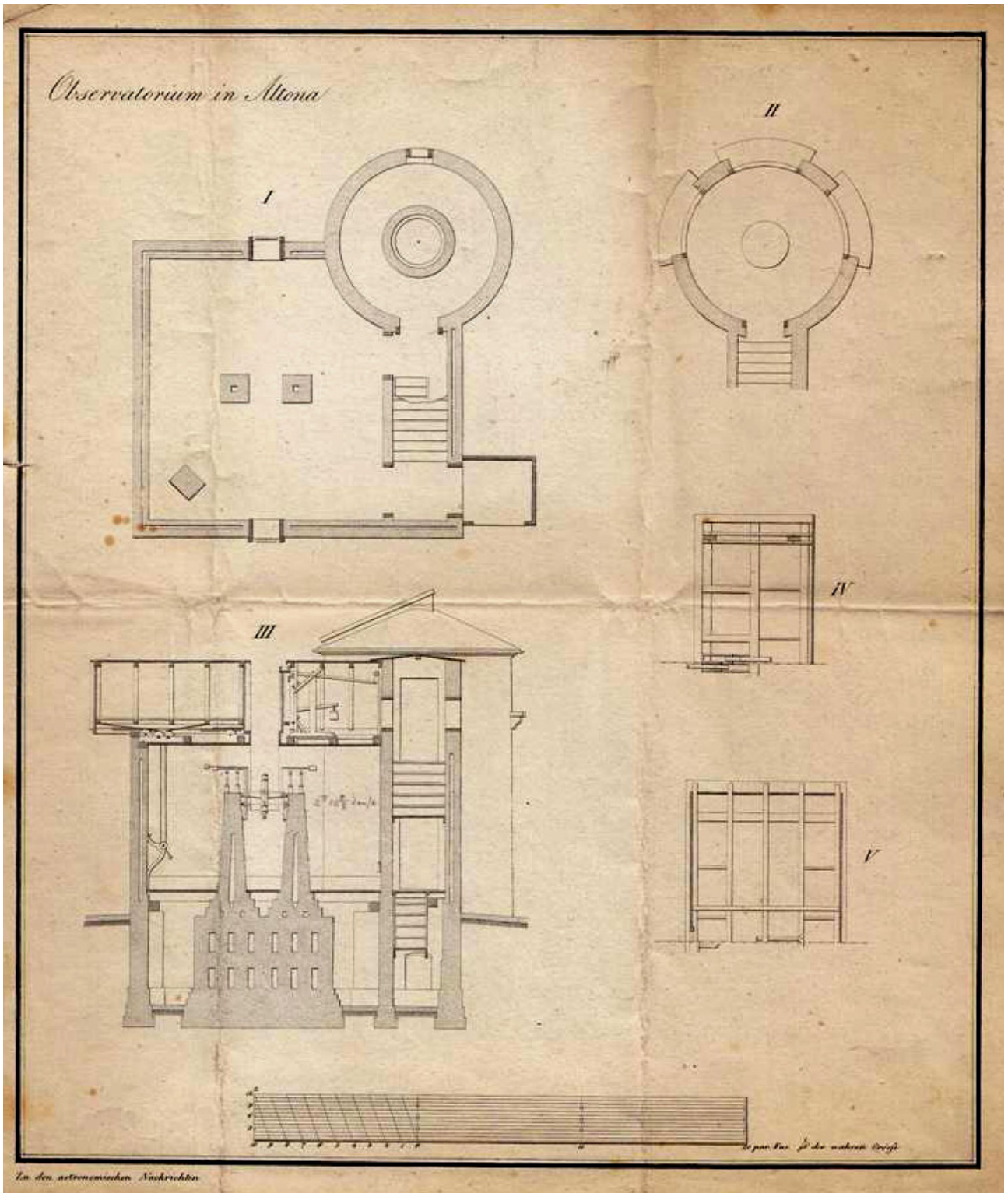


Figure 30.4: The Observatory in Altona. Draft sent by Schumacher to Hansteen in 1827. From the Archives of the Institute of Theoretical Astrophysics, University of Oslo.()

During its 100 years of existence, the activity at the observatory evolved along the research lines of classical astronomy. Some observing projects were carried out exclusively with one instrument, while others used the available instrument collection at any given time. There were occasional observing campaigns with additional observers recruited from other sciences, but the major projects lasted for decades and were carried out by the director/professor and his assistant.

### 30.5.1 The Meridian Circle

The meridian circle remained the main instrument of the observatory throughout its history. It was initially used to determine an accurate geographical position for the observatory, which came to serve as the fundamental point for all geodetic surveying and national mapping in Norway till 1950. This also included the Norwegian part of the *Mittel-Europäische Gradmessung* 1862–1883.<sup>24</sup> Qualifications and experiences for such work had been established during participation in the Struve geodetic arc in Finnmark 1845–1850.<sup>25</sup>

The most significant observational contribution to astronomy was the meridian circle astrometry program (1870–1887) for the *Astronomische Gesellschaft* zone catalogue and its follow-up (1897–1907) to determine stellar proper motions. The meridian circle was also used for targets of opportunity, e. g. astrometry of Neptune for the first decade after its discovery in 1846, and astrometry of numerous asteroids and comets between 1847 and 1919.

The meridian room was in the east wing of the observatory building. Hansteen had ordered the meridian circle from Ertel in Munich in November 1826 through the assistance of Schumacher. The Norwegian National Assembly funded a 3-year instrument grant in the autumn session that year. At the time Ertel was producing a meridian instrument for Stockholm. Schumacher somehow persuaded him to sell it to Christiania and when half the price was paid in advance by Hansteen, the matter was settled.<sup>26</sup> Ertel indicated delivery by the end of 1827, but the silver limb of the divided circle cracked and had to be remade. The meridian circle left Ertel's workshop in February 1828 and arrived Hamburg about a month later where it had to await shipping opportunity for Christiania. International communications opened up when the Christiania Fjord became ice free in mid April and the instrument arrived in May 1828. Hansteen left for his Siberian geomagnetic expedition a week later, so the instrument was stored for several years with Mr. Clausen, a local instrument maker. It was assembled and mounted in the meridian room in 1834 and was first submitted to considerable testing.

The objective lens by Fraunhofer had a focal length of 163 cm and observations were usually made with a magnification of 180. The 3 feet vertical circle ( $\varnothing=94$  cm) was divided to 3' and could be read directly to 2'' using 4 verniers and 2 microscopes.

On a separate pillar in the meridian room a pendulum clock by Urban Jürgensen in Copenhagen was mounted and regulated to show sidereal time. It had been ordered already in 1815 and was delivered to Hansteen in the summer of 1826. It served as the main clock of the observatory till mid 1841, when it was replaced by No. 1365 by Johann Heinrich Kessels in Altona. A meridian marker was put up on the island Lindøya in the Christiania Fjord, 2,7 km due south of the observatory.

The initial adjustment and testing of the meridian circle allowed Hansteen to derive a preliminary latitude value in April 1835, but also revealed mechanical deflections and problems related to reversals of the horizontal axis when alternating the divided circle east and west of the telescope. This required the construction of a horizontal levelling device, delivered from A. & G. Repsold at the end of 1838. Mechanical deviations could now be monitored and the instrument began producing consistent results. Hansteen rejected all previous efforts and carried out a new observing program from October 1839 to July 1841, involving 11 reversals of the axis and 113 individual observations. The result was a latitude value of  $59^{\circ}54'43.19'' \pm 0.36''$ .

Carl Fredrik Fearnley had just graduated at age 25 when he was appointed *Observer* in 1844. He immediately planned a new and larger meridian observing program to control and improve Hansteen's latitude value. A collimator arrived that summer from Repsold to monitor any deviations of the telescope optical axis away from the meridian. Fearnley carried out 894 individual observations from September 1844 to June 1848, involving 30 reversals of the axis. The result matched Hansteen's value at  $59^{\circ}54'43.21'' \pm 0.55''$ .<sup>27</sup> Fearnley then applied corrections to the stars' declinations and arrived at the official latitude value for Christiania;  $59^{\circ}54'43.7''$ .

Hansteen and Fearnley attempted several types of observations to determine the longitude of the observatory. They observed lunar occultations of stars with the Utzschneider and Repsold refractors in the tower and timed solar eclipses with a portable, small Fraunhofer refractor. The accuracy of these results would only allow a preliminary longitude value and was never published.

During the summer of 1847 up to 21 chronometers were repeatedly sent by steamship between Christiania and Copenhagen to determine

the longitude difference ( $7^m25.0^s$ ) from astronomical time determinations at the two observatories. This provided the official longitude value of Christiania. These coordinates defined the fundamental reference point in the geodetic datum for Norway for more than a century, and compare well to more modern results. In 1865, telegraphic signals were used to calibrate clocks in Copenhagen, Christiania and Stockholm during meridian circle observations.<sup>28</sup> This yielded a longitude difference between Christiania and Copenhagen of  $7^m25.15^s \pm 0.06^s$ .





**Figure 30.5:** *The Utzschneider/Repsold refractor, kept at the Institute of Theoretical Astrophysics, University of Oslo.  
(Photo: Kine Selbekk Ottersen)*

### 30.5.2 The Utzschneider/Repsold Alt-azimuth Refractor

The 11 cm Utzschneider refractor appears to have been mostly used to entertain visitors (sometimes royals and other dignitaries), except for timing of the occasional solar eclipse or lunar occultation. Hansteen had ordered it from Utzschneider and Fraunhofer in 1826, but when it was delivered in 1828, two years after Fraunhofer's death, Utzschneider had sold the Fraunhofer lens to someone else and put in a 11 cm objective lens made by one of Fraunhofer's pupils. It did not deliver the image sharpness expected by a Fraunhofer lens. Hansteen sent the telescope to Georg Repsold in Hamburg and asked him to construct the mounting for it while he was on his geomagnetic expedition in Siberia. The instrument arrived Christiania in 1833 with a portable alt-azimuth mounting and was put up in the tower observing room. It was replaced by a Repsold equatorial refractor in 1842. From then on it was put out on the rooftop balcony when an astronomical event called for it.

### 30.5.3 The Repsold Equatorial Refractor

By saving a fraction of his annual budget since 1828, Hansteen had accumulated a sum large enough to acquire an equatorial refractor ten years later. Upon request, Schumacher advised him strongly to order the instrument from A. & G. Repsold in Hamburg.<sup>29</sup> Hansteen accepted this and discussed technical details by correspondence with Repsold during 1838.<sup>30</sup> The instrument had divided circles on both axes with diameter 50 cm and was intended for position determinations of objects outside of the meridian. An interesting detail is that Repsold proposed to make the divided circles on glass rather than on a silver limbus in a brass wheel, which was customary at the time.<sup>31</sup> Hansteen worried that the glass might break and went for the traditional solution. Further discussions took place at Repsold's workshop during a visit by Hansteen in July 1839, and upon his return to Christiania, Hansteen transferred advance payment. When the instrument left Repsold's workshop in June 1841, Hansteen removed a window and parts of the brick wall of the tower observing room to gain access from the outside to bring in a heavy telescope stone pillar in the centre of the room. The wall was restored, but the masonry remained wet for weeks due to an unusually rainy summer. Hansteen did not risk putting up the instrument in these humid conditions and delayed the operation till the following summer. In August 1842 Repsold's assistant, Mr. Flittner, arrived Christiania to mount and adjust the 12 cm equatorial refractor.

The refined adjustment was left to Hansteen's newly appointed assistant, Emil Bertrand Münster. He observed stars at right ascensions 6, 12, 18, and 24 hours and near the celestial north pole to determine the accurate orientation of the telescope axes, the location of the zero points on the divided circles, and the collimation

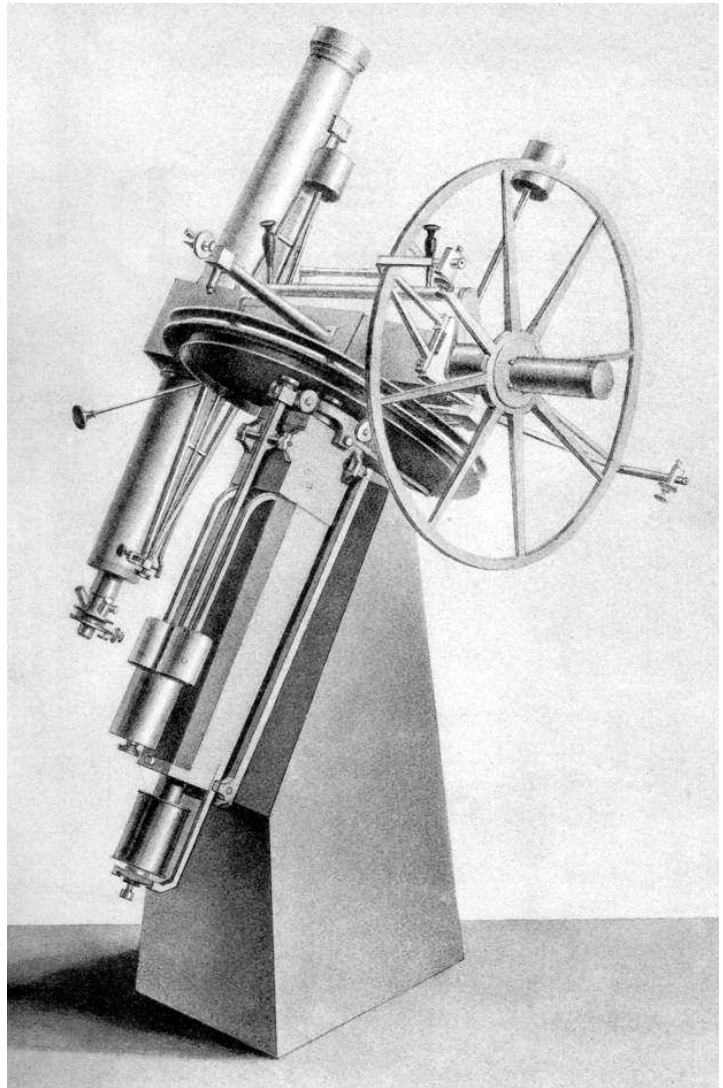
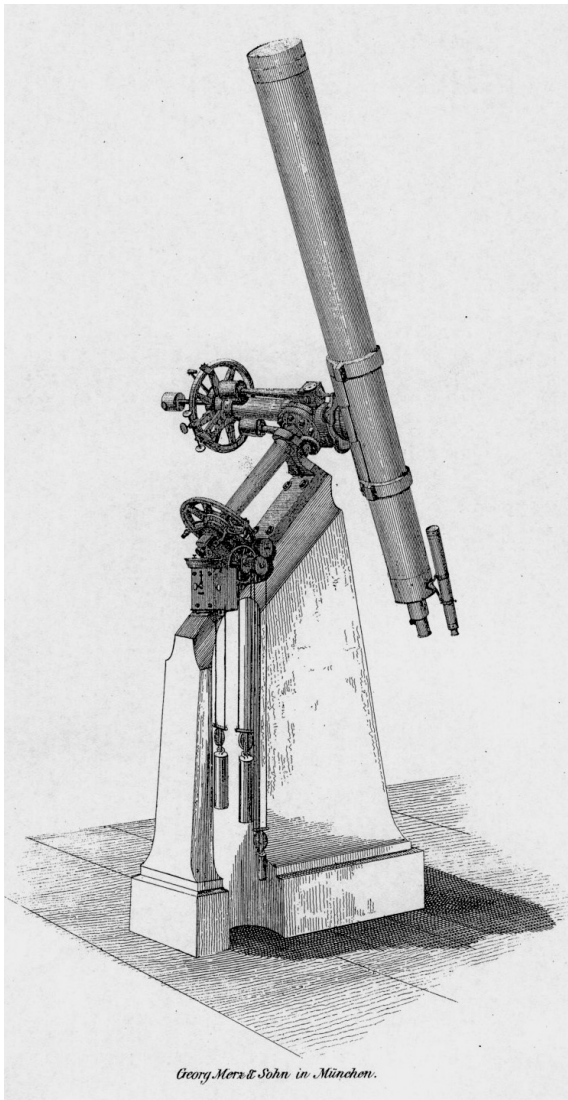
error. This would allow absolute values of equatorial coordinates to be determined directly with the instrument. When Münster resigned in 1844 to build a career in mineralogy, the work was completed by his successor as *Observer*, Carl Fredrik Fearnley.<sup>32</sup> The Repsold equatorial refractor was the last instrument acquired with Schumacher's assistance and advice.

Fearnley equipped the Repsold equatorial with filar and ring micrometers in 1847 to derive positions of comets and asteroids relative to nearby comparison stars. When needed, he used the meridian circle to determine positions of new comparison stars, which then served to determine positions of comets and asteroids with the equatorial refractor. Determinations of comet positions on the equatorial refractor evolved into a routine program that continued for 67 years. A total of 36 comets were observed. In 1874 Fearnley studied the bright comet Coggia through a direct vision spectroscopy. By narrowing the entrance slit to the size of the core itself, he searched for emission lines and molecular bands. He concluded that the observed spectrum was dominated by reflected sunlight from the comet and the sky background. These were the first night-time spectroscopic observations in Norwegian astronomy.

The solar eclipse of 28 July 1851 was total in Christiania. Hansteen timed the events and concluded that the zone of totality was somewhat south of the predicted location. Thus the theory of lunar motion was in need of improvement. He also observed the apparent changes of a prominence during totality. So did Fearnley, who was on leave in Germany at the time. He made detailed drawings of the prominences and concluded as Hansteen that the prominences were solar phenomena and not lunar. The observed changes were only due to the moon acting as a moving curtain that gradually revealed more of the prominence. This view was generally accepted after the solar eclipse in 1860.

A giant sunspot appeared in May 1857 and was visible for more than three solar rotations. Fearnley made accurate drawings to determine positions and morphological changes. He detected sunspot proper motions in solar latitude and different rotation periods due to the differential rotation of the Sun. In 1858 he also monitored sunspots, and when he noted a prominence during the annular solar eclipse of 15 March 1858, he related its limb position to the projected location of a sunspot he had measured on the disk 6 days earlier, and realized that the two phenomena were geometrically and physically related.

In 1873 Fearnley acquired a spectrohelioscope from Merz in Munich which enabled him to view solar prominences in  $H_{\alpha}$ -light outside of eclipses. He studied the morphology and size of numerous prominences and made very detailed drawings with excellent spatial resolution.



**Figure 30.6:** *Left: The Merz equatorial refractor; Right: The Repsold equatorial refractor (1842) (Photocopy from a print in the Archives of Deutsches Museum, München, Merz papers. Repsold, Johann Adolf: Zur Geschichte der Astronomischen Messwerkzeuge von 1830 bis um 1900. Zweiter Band. Leipzig: Verlag von Emmanuel Reinicke 1914, Fig. 27.)*

### 30.5.4 The Merz Equatorial Refractor

The 19 cm f/17 Merz refractor on equatorial mounting was the largest instrument at the observatory. It was ordered in 1853 and arrived two years later. It was mounted in the north pavilion in 1857 and was the last instrument acquisition during Hansteen's Directorship. As the city expanded, observing conditions deteriorated and in 1908 the Merz refractor and the north pavilion was dismantled to give space for a new University Library.

The Merz refractor was used to determine positions of comets and asteroids with a ring micrometer. During the Eros opposition in 1900 a filar micrometer was used to obtain relative positions on 49 nights. They were supplemented by meridian circle observations on 11 nights. This data set was combined with observations from many other observatories to determine a solar parallax value of 8.807".

### 30.5.5 The Merz/Olsen Equatorial Refractor

A 13 cm Merz refractor was furnished with an equatorial mounting by Christian H.G. Olsen, the leading instrument maker in Norway at the time.<sup>33</sup> It was put up in the east pavilion in 1884 where it continued to be available to the public twice a week for the next 50 years. It was used occasionally for timing astronomical events, e. g. lunar occultations, partial solar eclipses, and the transits of Mercury in 1891 and 1907. (A historical detail is that occultation timings generated the first published results from each of the equatorial refractors).

When the University Observatory closed down in 1934 the Merz refractor was lent to a nearby school where it was actively used for a couple of decades. It was recovered from storage in 1990 and was refurbished to serve the public at Oslo Solar Observatory until 2008.

## 30.6 The Future of Hansteen's Observatory

In 2011 the University of Oslo will celebrate its 200<sup>th</sup> anniversary. Plans have been made to establish a visitor centre in Hansteen's observatory aimed as school children and promoting both the sciences and the cultural history related to the building. This will include not only the international dimensions of Hansteen's scientific work – for instance his close collaboration with Schumacher in Altona – but also the history of scientific instruments and instruments makers like Repsold, Kessels, Reichenbach, Utzschneider, Fraunhofer and Merz who – in addition to the Norwegian instrument maker Olsen – contributed to Hansteen's observatory.

Hopefully this recognition of the international dimensions of Norwegian science in the early nineteenth century will be relevant also for other international efforts promoting science and the history of science in relation to observatories today.

1. Hansteen 1819.
2. Hansteen and Due 1849.
3. Schroeter 1911.
4. Hamel 2001, p. 118.
5. Bauermann 2005.
6. Andersen 1975. Lühring 2007, Ch. 5.
7. Grønningsæter (1984) 2001, p. 17–18.
8. Hansteen 1854a, p. 6–7 (our translation).
9. Bauermann 2005, p. 64. Koch 2005.
10. Andersen 1975, p. 26.
11. Lühring 2007, p. 74.
12. Andersen 1968.
13. Lühring 2007, p. 85.
14. Quoted from Andersen 1975, p. 32.
15. Andersen 1975, p. 45.
16. Kertscher 2005, p. 157.
17. Pettersen 2002.
18. de Seue 1878, p. 53, 72.
19. Pettersen 2002.
20. Schroeter 1911.
21. Lühring 2007, p. 90ff., quoted from p. 100.
22. Grønningsæter (1984) 2001, p. 75–76. Rogstad 2003, 70f. Seip (2001) 2007.
23. Pettersen 2002.
24. Pettersen 2007a.
25. Pettersen 2007b.
26. Letter from Schumacher to Hansteen 29 December 1826, archived at University of Oslo, Norway.
27. Hansteen and Fearnley 1849.
28. Fearnley et al. 1890.
29. Letter from Schumacher to Hansteen 26 December 1837, archived at University of Oslo, Norway. In our translation, Schumacher wrote: "*With respect to your equatorial (telescope), my remark is that Ertel is not Reichenbach, as you already know from your meridian circle. Ertel's workshop has become more and more like a factory. He looks only for profit. Under no circumstances would I advise you to have your instrument made in Munich. But the young Repsold is by far the best artist of today. Even Struve, who is one of Ertel's closest friends, could not overlook the evidence and had to order both main instruments for Petersburg Observatory with Repsold, namely a meridian circle and a transit instrument, both 8 feet long. These instruments are almost completed and you may see them if you come here early this year before they are shipped away. My honest advice, given in total conviction, is to order your equatorial with Repsold. If you request so, he will send you a preliminary drawing and when you have reached agreement about the construction, he will estimate the cost. The funds at your disposal are more than enough.*"
30. Letter from Hansteen to Schumacher 4 January 1838, archived at Staatsbibliothek zu Berlin, Germany, and from Hansteen to Repsold the same day, archived at Staatsarchiv, Hamburg.
31. Letter (and instrument description) from Repsold to Hansteen 23 November 1838, archived at University of Oslo, Norway.
32. Münster was appointed professor of mineralogy in 1862.
33. Pettersen 2004.



**Figure 30.7:** *The Merz/Olsen refractor (Photo: Bjørn Ragnvald Pettersen)*

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