The Physical Tourist. A Science Guide for the Traveler
edited by John S. Rigden and Roger H. Stuewer

Historical Sites of Physical Science in Copenhagen

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Copenhagen

Each section below describes a particular place in the Danish capital. A map of Copenhagen can be found at the web site <www.nbi.dk/how-to-get-here.html>. The map is divided into four sections, I–IV, each of which consists of particular horizontal coordinates A…, and particular vertical coordinates 1…, as follows: I (A–C, 1–4); II (D–F, 1–4); III (A–C, 5–8); and IV (D–F, 5–8). The coordinates of the sites described in the sections below are given in parentheses at the end of each section heading. A map with a street index can be obtained free of charge at the main railway station, the airport information desk, and tourist offices. The web site <www.aok.dk> provides useful general information about Copenhagen.

Bredgade 62 (F4)

Our physical tour of Copenhagen starts at Bredgade 62, the building of the former Kirurgisk Akademi (Academy of Surgery), which was established in 1785 and completed in 1787. It became the residence of Christian Bohr (1855–1911), when he moved into Bredgade 62 (figure 1) in 1886 as senior lecturer at the University of Copenhagen; he was appointed professor of physiology in 1890.

Since 1948 Bredgade 62 has been the home of the Museum of Medical History (recently renamed Medical Museion; see web site <www.museion.ku.dk> for opening hours and other information), which is part of the University of Copenhagen's Institute of Public Health. It was the childhood home of Jenny (1883–1933), Niels (1885–1962) and Harald Bohr (1887–1951). Niels Bohr lived here until he received his doctorate in 1911. Before then he attended Gammelholm School a few streets away, and after 1903 he studied physics at the University of Copenhagen. Bohr was used to working in his father's physiology laboratory in a building behind the Academy of Surgery, and it was here as a student that he made the experiments to determine the surface tension of liquids for which in 1907 he won a gold medal for a prize investigation announced by the Royal Danish Academy of Sciences and Letters, applying a method proposed by Lord Rayleigh in 1879. His paper was published in

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Fig. 1. Bredgade 62. Courtesy of the Niels Bohr Archive.

English in 1909 in the *Philosophical Transactions of the Royal Society of London*. This was his first published paper, and the only one reporting Bohr's own experimental work.

Ved Stranden 14 (E5)

Niels Bohr was born here on October 7, 1885, when it was still the home of the Adler family, his maternal grandparents. A plaque on the building's facade records that Niels Bohr was born there: I DETTE HUS FØDTES/ATOMFYSIKEREN/NIELS BOHR/7.10.1885. It was unveiled in October 1960 on the occasion of Bohr's 75th birthday.

The Royal Danish Academy, Dantes Plads (E5)

From its foundation in 1742, the Royal Danish Academy of Sciences and Letters has played an important role in Danish science. Hans Christian Ørsted was Secretary from 1815 to 1851. The Academy moved into its present quarters (figure 2) in 1899, after the Carlsberg Foundation (see below) in 1893 offered to pay for new shared premises for the Foundation and the Academy in central Copenhagen. Niels Bohr was President

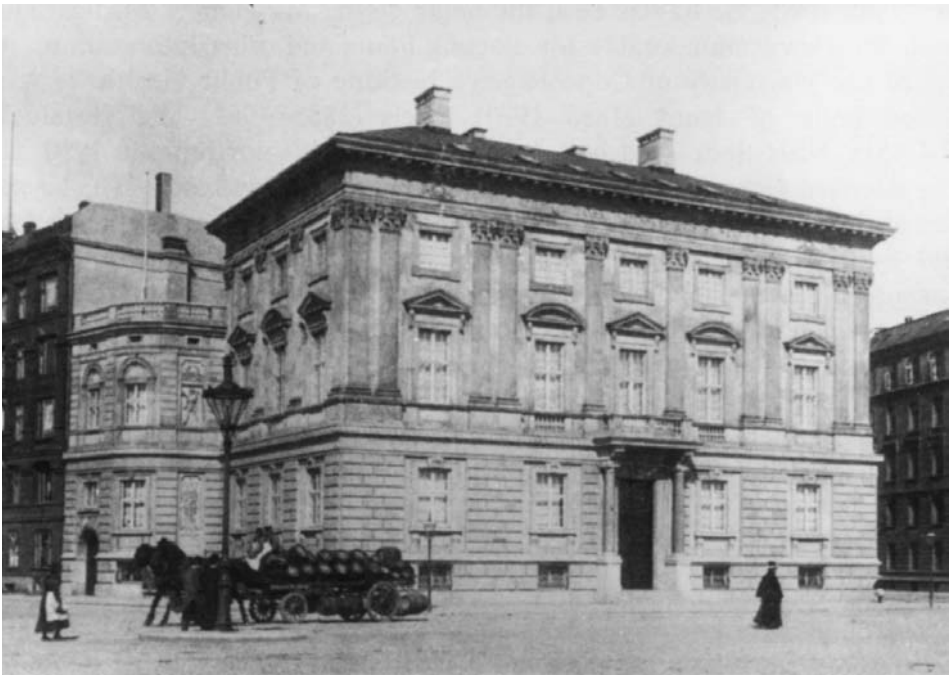

Fig. 2. Fig. 2. The Royal Danish Academy, *ca*. 1900. Courtesy of the Niels Bohr Archive.

from 1939 until his death in 1962. The Academy building's closest neighbor across the street is the New Carlsberg Glyptotek, the magnificent museum constructed to house the brewer Carl Jacobsen's considerable art collection. While the museum at Dantes Plads 7 (web site <www. glyptoteket.dk>) is open to the public, the Academy and the Carlsberg Foundation can be seen only upon special appointment with the Carlsberg Foundation (web site <www.carlsbergfondet.dk>; e-mail: carlsbergfondet@carlsbergfondet.dk).

Klareboderne/Købmagergade (E5)

On the street Klareboderne, close to its intersection with Købmagergade, there is a plaque on the wall that commemorates the birthplace of Niels Steensen (or Stensen; in Latin, Steno): HER FØDTES/NIELS STENSEN/1638 1686/ANATOM GEOLOG BISKOP (The birthplace of Niels Stensen, 1638–1686, anatomist geologist bishop).

Steensen (figure 3) made fundamental discoveries in anatomy ("Steno's duct," the excretory duct of the salivary glands), and in mineralogy ("Steno's law," according to which the angles between crystal surfaces of a given species of mineral are characteristic constants independent of the crystal's size). He is known as the father of geology and for having established the science of paleontology.

Fig. 3. This picture of the mature Niels Steensen hangs at the Medical Museion. Courtesy of the Medical Museion, Copenhagen.

The Round Tower, Købmagergade 52A(E5)

To the right of the entrance to the Round Tower (figure 4) there is a bust (figure 5) of Tycho Brahe (1546–1601) by S. Wagner (1932). Brahe was born in Skåne (Scania), then Danish, now part of Sweden. He studied law at the University of Copenhagen from 1559 to 1562 according to the wishes of his family, but eventually became an astronomer after years of study in Leipzig and Wittenberg, among other places. In 1576 the Danish King Frederick II gave him the island of Ven in the sound between Denmark and Scania, on which he practiced astronomy as well as alchemy and astrology. Brahe left Denmark in 1597, when he lost favor with the Danish King Christian IV, and settled in Prague, where he was joined by Johannes Kepler (1571–1630) who became his assistant. Brahe died there in 1601.

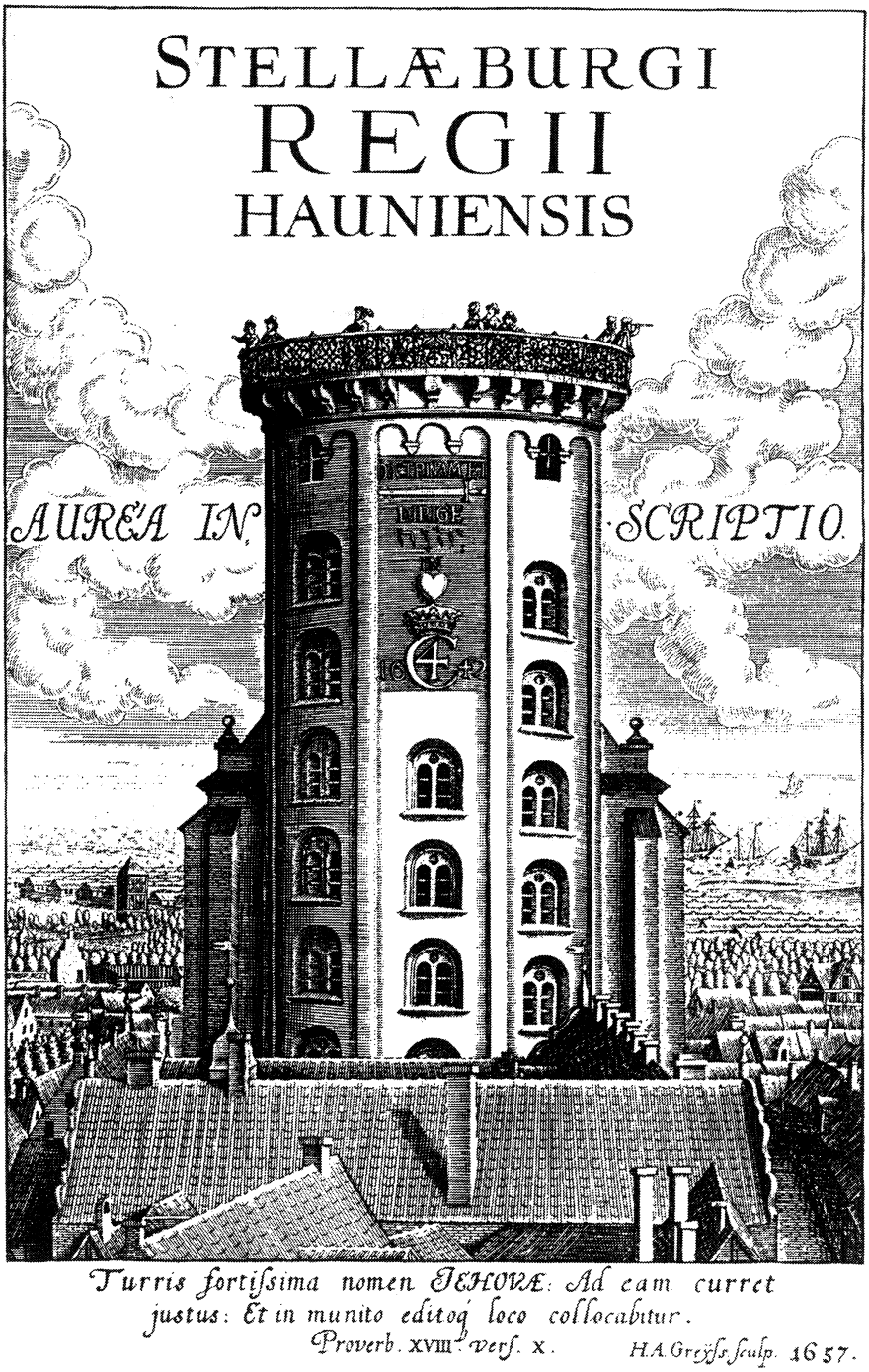

Fig. 4. The Round Tower. Copperplate, 1657.

Fig. 5. Statue of Tycho Brahe at the entrance to the Round Tower. Courtesy of the Niels Bohr Archive.

The Round Tower (web site <www.rundetaarn.dk>) is the oldest preserved observatory in Europe. It still functions as such; it served as the University of Copenhagen Observatory until 1861, and nowadays in the winter period anyone can observe the night sky through its fine astronomical telescope.

The foundation stone of the Round Tower was laid in 1637, and the building was completed in 1642. The observatory was the first of a complex of three buildings built in the 17th century for use by scholars, the other two being the students' church (Trinitatis or Trinity Church, consecrated in 1656) and the university library (above the church). These buildings were commissioned by King Christian IV, who reigned from 1588 to 1648. There is a large and decorative riddle, designed by the King himself, on the outside of the Round Tower, which can be interpreted as follows: "Lead, O God, learning and justice into the heart of the crowned King Christian IV, 1642." Inside the tower a 209-meter-long spiral ramp leads up to the astronomers' study, directly underneath the observation platform, which is reached by a winding staircase. From here the visitor has a magnificent view of the old part of Copenhagen, including the University district, the Latin quarter. The first director of the observatory was Christian Longomontanus (1562–1647), one of Tycho Brahe's students.

Copenhagen has suffered many fires and bombardments over the centuries. The observatory and the university library burned in the fire of 1728, in which Tycho

Brahe's celestial globe (which had been returned to Denmark in 1632) melted. Not one of Brahe's instruments is now to be found in Denmark.

At the end of the spiral ramp there is a planet plotter, installed in 1928, which shows the six inner planets' orbits around the Sun. The original planet plotter was constructed in 1697 by Ole Rømer, who was a convinced Copernican, but out of veneration for Tycho Brahe, Rømer adapted the first planet plotter according to Brahe's system with the Earth at the center, the Sun moving around the Earth, and the rest of the planets moving around the Sun.

The library hall above the church was used as the university library in the years 1657–1861. It is now used as an exhibition hall. The entrance is halfway up the spiral ramp.

Store Kannikestræde 16 (E5)

This street is part of the University quarter. There is a memorial plaque for Ole Rømer (figure 6) on the front of Store Kannikestræde 16: HER LAA INDTIL 1728/DEN PROFESSOR-RESIDENS HVOR/OLE RØMER/PROFESSOR I ASTRONOMI/ POLITIMESTER I KØBENHAVN/BOEDE TIL SIN DØD 19 SEPTEMBER 1710 (Here stood until 1728 the professorial residence where Ole

Fig. 6. Ole Rømer. Portrait at the Institute of Astronomy, University of Copenhagen. Courtesy of the Ole Rømer Museum.

Rømer, professor of astronomy, chief of police for Copenhagen, lived until his death, 19 September 1710).

Danish astronomer Ole Rømer (1644–1710) studied at the University of Copenhagen. He assisted Erasmus Bartholin (1625–1698), who is renowned for his study in 1669 of the passage of a beam of light through a crystal of Iceland spar, with the publication of Tycho Brahe's "observation plates" (which were bought by Danish King Frederik III from Johannes Kepler's son). From 1671 Rømer continued this work with Jean Picard (1620–1682) in Paris where, among other things, he designed the fountains at Versailles for Louis XIV. In 1676 he wrote what would be his only paper of any importance published during his lifetime – on his discovery of the "hesitation" of light, that is, that light has a finite velocity. He returned to Copenhagen in 1681, where he became the king's mathematician, professor of astronomy at the university, and thereby director of the observatory at the Round Tower.

Rømer reordered the system of weights and measures in Denmark on the basis of a single unit, thus combining weight and length. Among his numerous public duties, he also was involved in providing street lighting for Copenhagen. He was responsible for introducing the Gregorian Calendar in Denmark in 1700. Rømer was a great instrument maker, developing the transit instrument (figure 7) in 1689. His studies on temperature corrections led him to invent a thermometer that was based on the freezing and boiling points of water. Daniel Fahrenheit (1686–1736) learned about this idea from Rømer in 1708.

Rømer made his astronomical observations from his home in Kannikestræde and at a new observatory built to the west of Copenhagen, now the site of the Ole Rømer Museum (see Appendix). Most of Rømer's papers were destroyed in the fire of 1728.

Vor Frue Kirke, Vor Frue Plads (E5)

Ole Rømer was given a state funeral and was buried in Vor Frue Kirke (the Cathedral of Our Lady). This church and neighboring houses were burned to the ground in 1807, when General Arthur Wellesley, later the first Duke of Wellington, and the British bombarded the church tower with the newly-invented Congreve rockets. A new church, designed by C. F. Hansen, was built above the old, and Rømer's grave is marked by a stone (erected in the right-hand aisle in 1945) with a carving and an epitaph: OLE RØMER/XXV.IX.MDCXLIV XIX.IX.MDCCX/ HAN MAALTE LYSETS HAST (Ole Rømer, 25.9.1644 [25 September 1644] – 19.9.1710 [19 September 1710], he measured the speed of light).

There is a bust of Niels Bohr by J. Gudmundsen-Holmgreen (1965) in front of the University building on Vor Frue Plads.

Nørregade 21 (E5)

Hans Christian Ørsted (1777–1851) was born on the Danish island of Langeland. The son of an apothecary, he studied pharmacy at the University of Copenhagen, as no institutes for physics or chemistry had been established by that time. From 1800 he taught university students, and was appointed professor of physics in 1817.

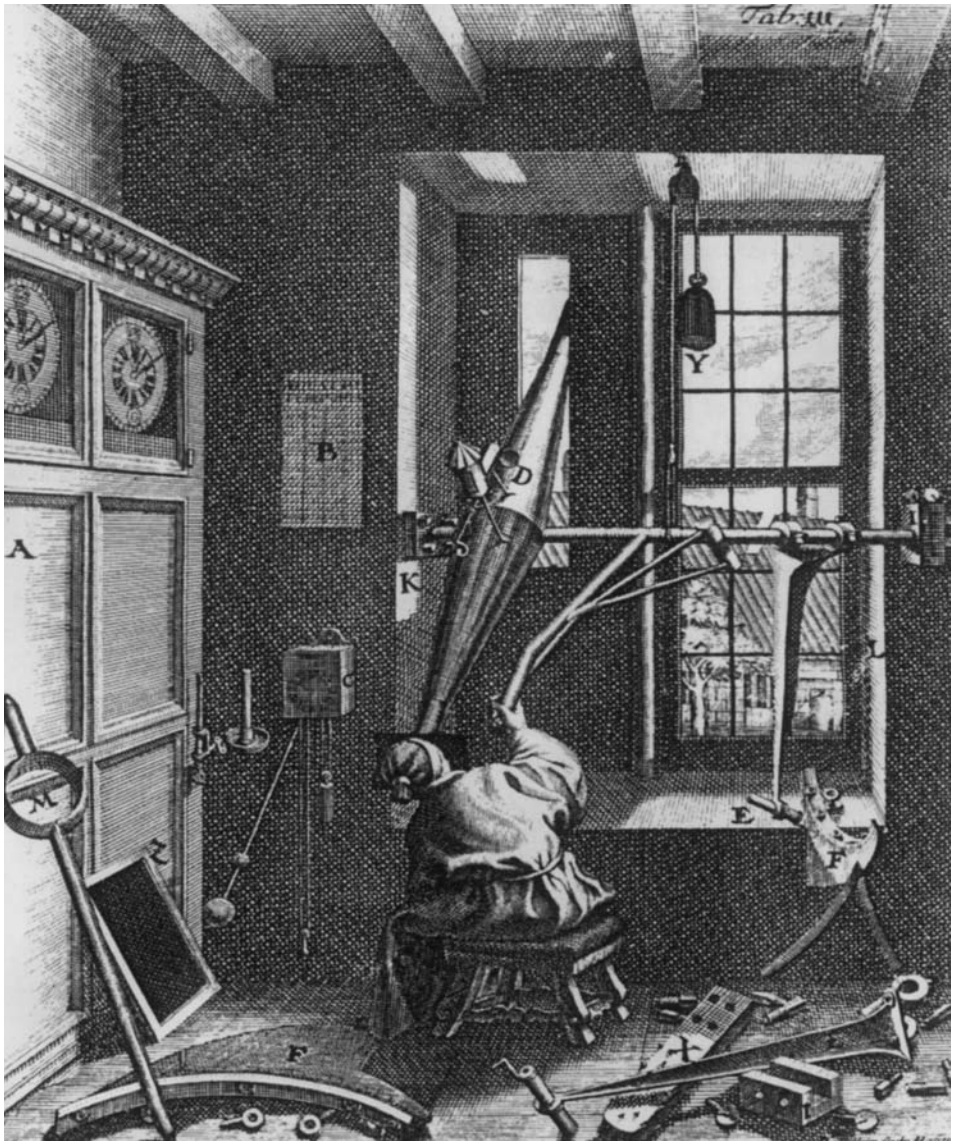

Fig. 7. Rømer's Machina domestica, or house instrument, was set up in Rømer's home in Store Kannikestræde. The telescope is set in the plane of the meridian. Note that in the house opposite, Rømer has cut an opening in the roof to extend the circle of observation. A counterweight Y is used to prevent the axle from sinking due to the weight of the telescope. At D a lamp was placed that illuminated the threads in the telescope. The declination of the star is read on the curve F through the microscope E. The other celestial coordinate, the right ascension, was given by the time when the star crossed the meridian. As Rømer could not simultaneously read the clocks and observe the passage of the star across the meridian, he noted the time on the clock immediately before the star appeared in the field of the telescope. On the wall there was a pendulum that ticked every second. Thus Rømer could hear how many seconds passed before the star crossed the meridian. Source: Horrebow, "Basis Astronomiae," 1734–1735.

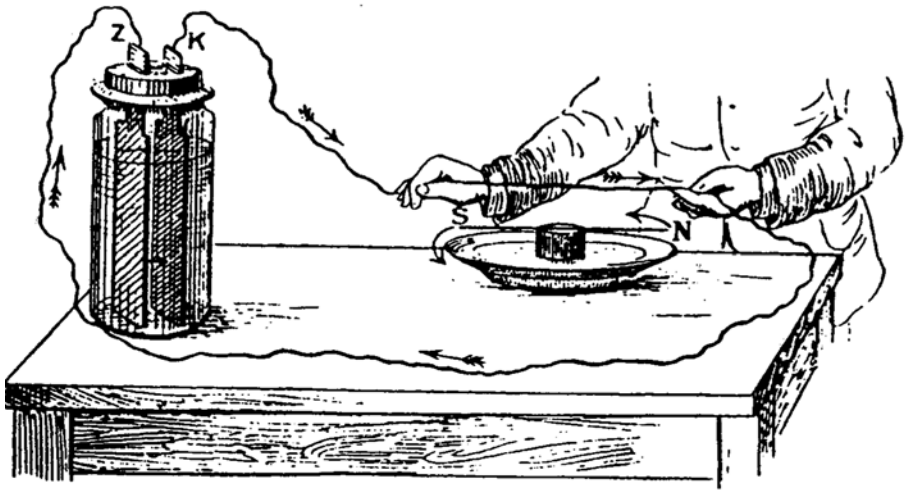

Fig. 8. Ørsted discovers electromagnetism. Illustration from a Danish school book, 1910.

Ørsted lived at Nørregade 21 from 1819 to 1824. This building also housed the University's Physics Collection and Chemistry Department. It was in its auditorium that Ørsted discovered electromagnetism in April 1820 (figure 8), when giving a lecture to his students; the auditorium no longer exists, as the premises have been replaced. The present building on the site, Telefonhuset (The Telephone House), bears the inscription: I ET HUS PÅ DETTE STED/OPDAGEDE FYSIKEREN/ HANS CHRISTIAN ØRSTED/ELEKTROMAGNETISMEN/I ÅRET 1820 (In a house on this spot, the physicist Hans Christian Ørsted discovered electromagnetism in the year 1820). Ørsted later described 1820 as being "the happiest year of my life."

Studiestræde 6 (E5)

These are the premises of the new laboratories and professorial accommodations built by the University in 1824. A marble plaque above the entrance to the courtyard (Studiegården) states: HANS CHRISTIAN ÖRSTED/BOEDE HER/ FRA OCTOBER 1824/TIL SIN DÖDSDAG/DEN 9DE MARTS 1851 (Hans Christian Ørsted lived here from October 1824 until the day of his death 9 March 1851).

Ørsted (figure 9) discovered aluminum in 1825 in the Chemistry Laboratory of the University situated in the courtyard here. His other investigations carried out here included those on the compression of liquids using a piezometer of his own construction.

Fig. 9. Hans Christian Ørsted. Drawing by I.V. Gertner. Courtesy of the Niels Bohr Archive.

Across the courtyard is the building now called the University Annex. In 1829 these premises were made available by Ørsted to house the Polyteknisk Læreanstalt (College of Advanced Technology), which was founded by him along the lines of the École Polytechnique in Paris. This institution was moved to larger premises in 1890 (see below).

Ørsted was director of the Læreanstalt and taught physics there from 1829 until his death in 1851. The teaching in physics, chemistry, and mathematics was shared with the University, whose science faculty was founded in 1850. Introductory teaching in physics, both theoretical and experimental, for students in astronomy, mathematics, physics, and chemistry continued at the Polyteknisk Læreanstalt until 1957.

Ørstedparken, Nørre Voldgade (D5)

This park is named after the two Ørsted brothers, Hans Christian (1777–1851) and Anders Sandøe (1778–1860), politician and lawyer. In the park, which is a part of the old city ramparts and includes part of the moat as a lake, there are many sculptures and monuments. The statue of Hans Christian Ørsted by J. A. Jerichau (1876) is on a mound facing Nørre Voldgade and can be seen from there. At the base of the plinth there are statues of three Norns, goddesses of fate, looking peaceful and resigned. The plinth alone is four meters tall, and Ørsted is giant-sized. The statue was erected in connection with the establishment of the Carlsberg Foundation (see below) in 1876.

Rosenborg Castle, Øster Voldgade 4A(E4)

Now a museum, this castle houses the Danish Royal Collections. In its basement, which also contains the Green Cabinet and the Treasury, there is an Ole Rømer Room, in which are displayed:

- A Planetarium (Museum Catalogue Number 3700), a planet machine constructed by Ole Rømer to demonstrate the orbits of the planets around the Sun. It was made in Paris in 1678–1679 by Isaac Thuret, royal clockmaker.
- An Eclipsarium (Number 3702) constructed by Ole Rømer to calculate the orbit and eclipses of the Moon. It was made in Paris in 1678–1679 by Isaac Thuret, royal clockmaker.
- The original "national standard prototypes" of the weights and measures system introduced by Ole Rømer, which were presented to the Danish King Christian V in 1683–1684 (Numbers 3704, 3706, 3708, 3710, 3712, 3714, 3716, 3718).

Among the other curiosities may be mentioned Frederik VII's general's helmet made of aluminum by J. B. Dalhoff (1859), at a time when lightweight aluminum was a new and precious metal (Room 18, Number 1828).

The catalogue, *Rosenborg Castle: A Guide to the Danish Royal Collections* (Copenhagen: 2005), can be purchased in the museum shop.

Øster Voldgade 3 (E4)

The University of Copenhagen Observatory on Østervold was erected in the years 1859–1861 on one of the bastions of the old city to accommodate the need for new buildings. The University Observatory remained here until 1996. In front of the building there is a fine statue of Tycho Brahe by H. W. Bissen (1866). The Observatory had several astronomical instruments of which today only the 25-centimeter refracting telescope remains. The Observatory was the home of the news service bureau of the International Astronomical Union from 1922 to 1965, which was ably managed by the Observer Julie Marie Vinter Hansen from 1922 to 1960.

The westernmost part of the building was the Professor's Residence, and the easternmost part was the home of the Observer. Today the building houses the administration of the Science Faculty of the University of Copenhagen.

Geological Museum, Øster Voldgade 5–7 (E4)

The present Geological Museum (web site <geologi.snm.ku.dk>) was opened in 1893 and was called the Mineralogical Museum, an institution that can be traced back to 1772, when the University of Copenhagen's New Natural Theater was inaugurated in Nørregade, near the University. A fresco painting by O. Matthiesen (1916) on the wall of the staircase shows Niels Steensen in the Tuscany countryside outside Florence sketching a sedimentary formation at the moment when his practiced eye sees that these strata must have been formed under water and then elevated by volcanic forces.

There is an inscription under the picture: NICOLAO STENONI/GEOLOGIAE PARENTI/ HONORIS CAUSA (In honor of Niels Steensen, father of geology).

The collection of minerals in the museum contains a number of samples of Norwegian zirconium-rich minerals, which were used by George de Hevesy and Dirk Coster in 1922 in their effort to identify the X-ray lines expected for an element of atomic number 72. They succeeded and named the element Hafnium, Latin for Copenhagen.

Polyteknisk Læreanstalt, Sølvtorvet, Sølvgade 83 (E4)

These buildings (figure 10) date to 1890, with the physics wing on the left and the chemistry wing on the right. In the courtyard there is a statue of the Læreanstalt's founder, Hans Christian Ørsted, by H. W. Bissen (1880), which was moved here from Studiestræde in 1890. The Læreanstalt, which is now called the Technical University of Denmark (web site <www.dtu.dk>), is presently at Lundtofte, north of Copenhagen, whereas the buildings in Sølvgade have become the home of the Institute of Microbiology of the University of Copenhagen. This is where Niels Bohr spent most of his time as a university student, and his first appointment as assistant lecturer from 1912 to 1914 was based here. When he was named professor of theoretical physics in 1916, this became his place of work for four years. He had one small room of about 15 square meters at his disposal, which he shared with H. A. Kramers (1894–1952), his assistant who arrived

Fig. 10. Polyteknisk Læreanstalt, 1900. Courtesy of the Niels Bohr Archive.

from Holland in 1916 and stayed until 1926. This room is on the top floor of the south wing, facing the Botanical Gardens, and is now part of the Department for Biological Chemistry.

Blegdamsvej 17 (E3)

The Niels Bohr Institute at Blegdamsvej 17 (figure 11) was established for Niels Bohr and inaugurated in 1921 as the Institute for Theoretical Physics of the University of Copenhagen, five years after Bohr had obtained the new professorship. Renamed in 1965 on the occasion of Bohr's 80th birthday, the institute has played a remarkable role in the history of twentieth-century physics. In the 1920s it was the meeting place of the young theoretical physicists who developed and refined quantum mechanics, and in the 1930s Bohr redirected the research there to the new and expanding field of nuclear physics. Established just after the end of the Great War when the victorious Allies wanted nothing to do with the Axis powers, Bohr successfully created a truly international atmosphere for physicists in neutral Denmark. Later, this international emphasis became apparent once again at the height of the Cold War, when the institute was the first in the Western world to be visited by Soviet physicists. Another of Bohr's precepts in establishing the institute was that an institution for theoretical physics should include relevant experimental equipment so that theoretical physicists would have constant and immediate opportunities to have their hypotheses tested.

Fig. 11. The University Institute for Theoretical Physics, 1921. Courtesy of the Niels Bohr Archive.

The Blegdamsvej institute, which was integrated recently into an expanded Niels Bohr Institute at the University of Copenhagen incorporating teaching and research in astronomy, physics and geophysics, continues to this day as an international center for physics (web site <www.nbi.dk>). Prospective visitors who wish to include the institute in their physical tour of Copenhagen are encouraged to make prior contact with the Niels Bohr Archive (web site <www.nba.nbi.dk>), an independent institution located at the institute, that holds the papers of Niels Bohr and those of some of his closest colleagues. Although still in use, the institute's original lecture hall, Auditorium A, and Bohr's personal office have been kept intact and may be seen. There also may be an opportunity to consult original archival materials as well as to meet the institute's physicists.

Assistens Kirkegård, Kapelvej 2 (D4)

The first area of this cemetery was established in 1760 as an overflow cemetery for the churches of the old city of Copenhagen. Initially a cemetery for the poor, from the late 18th century the rich and famous also were buried here. The cemetery has been extended many times, and although some areas are still used today for burials, the cemetery as a whole is a historical cemetery with many monuments that display the customs and history of burial practices over a period of more than two hundred years. Among the graves are those of the philosopher Søren Kierkegaard (1813–1855) and the story-teller Hans Christian Andersen (1805–1875). Hans Christian Ørsted is also buried here; he was called Store Hans Christian (Great Hans Christian) by Hans Christian Andersen, who was a family friend and had a standing invitation to dine once a week at the Ørsted home. The Bohr family grave is also found here, with a fine monument (figure 12) with an owl on a pillar by J. F. Willumsen (1912). The remains of Niels Bohr and those of his father, Christian, and his brother, Harald, are interred here.

At the main entrance (Kapelvej 2) there is an information office where maps of the cemetery are available. Bohr is buried in section Q, Ørsted in section E, Kierkegaard in section A, and Andersen in section P. Details about opening hours and much more (in Danish) may be found at the web site <www.assistens.dk>.

The Carlsberg Honorary Residence, Gamle Carlsbergvej, Valby (C6)

The Carlsberg Brewery was established by Jacob Christian Jacobsen (1811–1887) in Valby, just outside Copenhagen. It was named after his son Carl (1842–1914).

Jacobsen the elder set up his residence there in 1854. When he died in 1887, his will stipulated that after the villa had been occupied for life by Carl, it should be used as an Honorary Residence (figure 13) by "a man or a woman deserving of esteem from the community by reason of services to science, literature, or art, or for other reasons." The residents were to be chosen by the Royal Danish Academy of Sciences and Letters, whereas the upkeep should be the responsibility of the Carlsberg Foundation, a major benefactor of Danish science, which was established by Jacobsen in 1876.

Fig. 12. The Bohr Family Grave. Courtesy of the Niels Bohr Archive.

The most prominent occupant of the Honorary Residence was Niels Bohr, who lived there from 1932 until his death in 1962. After the last resident died in 1995, the Honorary Residence was transformed into the Carlsberg Academy (web site <www.carlsbergfondet.dk/Akademi>), the ground floor of which the Royal Academy now utilizes as a conference center, while the top floor constitutes an apartment for a prominent visiting foreign scientist for a limited period. Jacobsen's villa is a next-door neighbor to the Carlsberg Laboratory, which was established by Jacobsen in 1875 as an institution for chemical research in connection with the brewery (figure 14).

Fig. 13. Margrethe and Niels Bohr in the garden of the Honorary Residence. Courtesy of the Niels Bohr Archive.

The Carlsberg Visitor's Center at Gamle Carlsbergvej 11, DK-2500 Valby (web site <www.visitcarlsberg.dk>) is currently open to visitors from 10:00 a.m. to 4:00 p.m. Tuesday to Sunday. It is a combined museum and exhibition center, providing the visitor with information regarding the history and current activities of the brewery. A glimpse of the Honorary Residence is provided during the tour.

The Carlsberg Museum, Valby Langgade, deals with Jacobsen family history and also the Carlsberg Laboratory. Opening hours are from 10:00 a.m. to 3:00 p.m. Monday to Friday.

Appendix. Museums beyond the Center of Copenhagen of Related Interest

- The Ole Rømer Museum, outside the center of Copenhagen (web site <www.kroppedal.dk>).
- The Tycho Brahe Museum, Ven (web site <www.tychobrahe.com>, click "The Museum").
- Denmark's Technical Museum, Elsinore (web site <www.tekniskmuseum.dk>).
- The Steno Museum, Aarhus, covering the history of the natural and medical sciences (web site <www.stenomuseet.dk>).

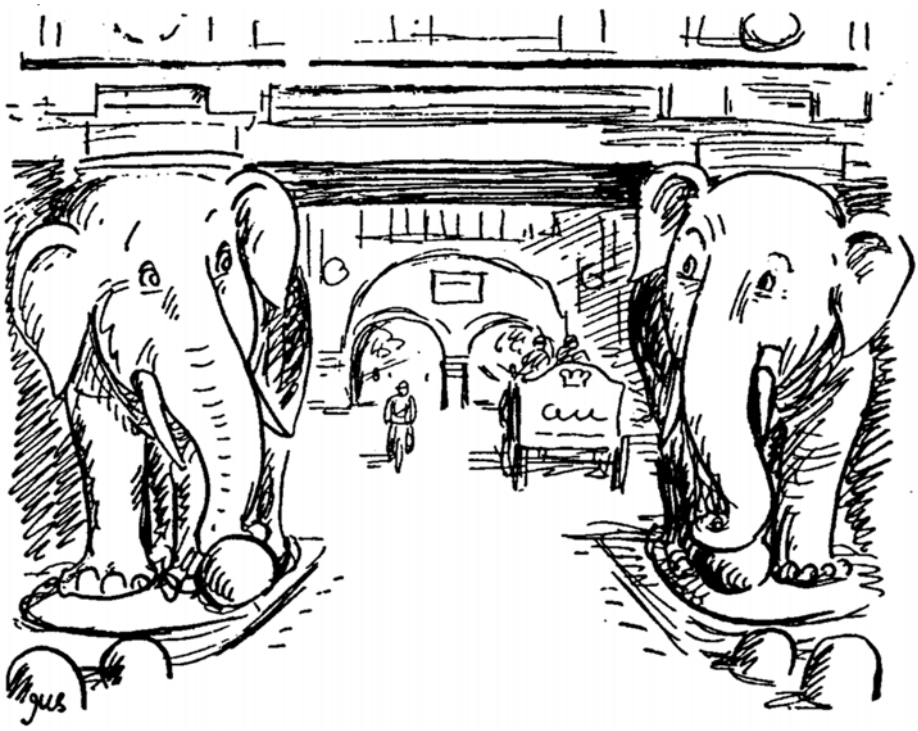

Fig. 14. The Elephant Gate beside Carlsberg Museum. Courtesy of Berlingske Tidende.

- El-muséet (The Danish Museum of Electricity), Bjerringbro, Jutland, covering the physics, technology, and cultural history of electricity (web site <www.elmus.dk>).
- Hauchs Physiske Cabinet, Sorø Academy, Sorø, Zealand, is a remarkable collection of physical instruments first established at the end of the 18th century (web site <www.awhauch.dk>).

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e-mail: nba@nbi.dk
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