

“Route of astronomical observatories” project: Classical observatories from the Renaissance to the rise of astrophysics

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Abstract. Observatories offer a good possibility for serial transnational applications. For example one can choose groups like baroque or neoclassical observatories, solar physics observatories or a group of observatories equipped with the same kind of instruments or made by famous firms. I will discuss what has been achieved and show examples, like the route of astronomical observatories, the transition from classical astronomy to modern astrophysics. I will also discuss why the implementation of the *World Heritage & Astronomy* initiative is difficult and why there are problems to nominate observatories for election in the national tentative lists.

Keywords. history and philosophy of astronomy, observatories, astronomical heritage

1. Introduction

Cultural Heritage of observatories contains (monuments, groups of buildings) sites with historical, aesthetic, archaeological, scientific, etc. value. From the ten criteria for the assessment of *Outstanding Universal Value* (OUV) mainly three (UNESCO criteria ii, iv and vi) are well suitable for classical observatories from Renaissance to 20th century.

We find astronomical observatories not only in Europe but all over the world, cf. Ruggles & Cotte (2011) and here: *Commission C4 on World Heritage and Astronomy* (<http://www2.astronomicalheritage.org/>). But I will not include here the Islamic observatories like Samarkand – important in the Middle Ages – or the five Indian Observatories in Delhi, Ujjain, Mathura, Varanasi and Jaipur (Maharaja Jai Singh II), the last of which is already on the UNESCO World Heritage List since 2010. My emphasis in this contribution is about occidental astronomical heritage but there are not only observatories involved! There are also astronomical clocks, Baroque frescos like Michelangelo’s “Creation of Sun and Moon” in the Sixtin Chapel or ceiling frescos in the *Mathematical Hall* in Prague. One should also mention predecessors of the planetarium like the *Gottorf globe* (Schleswig castle, now in St. Petersburg) or *Eise Eisinga Planetarium* in Franeker. But here I would like to present four groups of examples of observatories from Renaissance to the 20th century, which offer a good possibilities for serial transnational applications. A well-known example for a thematic programme is the Struve arc, already recognized as World Heritage in 2005.

2. Observatories for the Calendar Reform

Nicolaus Copernicus (1473–1543) measured the length of the solar year in the castle in Allenstein/Olsztyn, Poland. Cathedrals were also used as solar observatories – “*beauty and utility*” (Heilbronn (1999)). Here some examples for cathedrals with meridian lines: 67-m-meridian line in San Petronio in Bologna, 1655, made by Jean Dominique Cassini

(1625–1712), Santa Maria del Fiore in Florence, St. Sulpice in Paris, Santa Maria degli Angeli in Rome, *Tower of the Winds* with Meridian Room (1578–1580) in Vatican City for the *Gregorian Calendar Reform* (1582). Meridian lines were also integrated in observatories in Italy and in Breslau/Wrocław.

In the Renaissance and early Baroque time the first real observatories were built. I skip also these observatory buildings of famous astronomers which are no longer existing like Tycho’s or Hevelius’ observatory on Island Hven 1576 to 1599) and in Danzig/Gdansk (1649 to 1679) respectively.

3. Baroque Roof and Tower Observatories, 17th/18th century

In the 17th and 18th century for the Baroque observatories step by step a special architecture was developed, I show some examples (cf. Müller (1978)). The Round Tower (Rundetårn) Copenhagen (1642) was used by the University of Copenhagen until 1861. The prominent Royal observatories of the 17th century like Paris (Claude Perrault, 1667), Greenwich (Sir Christopher Wren, 1675) and Stockholm (Carl Hårleman, 1753) are well-known.

Some examples for roof observatories are the University Observatory (1711–1803) in Altdorf near Nuremberg, the observatory in St. Petersburg on the roof of the Royal Academy (1725), the observatory of Palermo (1791) using the Norman tower of the Royal Palace or the *Mathematical Tower* (1811) – the impressive Breslau (Wrocław) University Observatory.

Many Baroque observatories are tower observing posts, old buildings are re-used and changed for astronomical purpose: *La Specola* in Bologna (1721–1725) – first University Observatory in Italy, built on a fortification tower, and *La Specola*, Osservatorio Astronomico di Padova (1761).

A remarkable group form the observatories in Jesuit colleges (cf. Udías (2003)); they can be found all over the world, for example Beijing (1669), India, Philippines, Middle and South America, and Georgetown Observatory in Washington D. C. (1841–1844) in the USA as well in Europe: Prague the Jesuit College *Clementinum* (1722–1725) with the *Astronomical Tower*. In Mannheim the Jesuit tower observatory (1772/74) was used for astronomy and meteorology; the *Societas Meteorologica Palatina* (1780) had set up the *Mannheim Hours*, a standard until today. Vilnius Observatory, Lithuania, two towers erected on the top of the three-storey university building, is a spectacular Jesuit observatory (1753).

Concerning the group of Baroque monastery observatories I would like to mention the *Csillagász* (observatory) in Eger, Hungary, (1785) with meridian line and with a *Camera Obscura* (1779), for observing the Sun and (today) the town. The most impressive building, the “sky scraper” of the 18th century is the *Specula Cremifanensis*, the *Mathematical Tower* in Kremsmünster (1758).

4. Neoclassical Observatories around 1800 in the shape of the Greek cross – Invention of the Dome

The dome, a new feature – which is now regarded as typical for observatories – came up before 1800; the dome symbolizes the sky. Early examples are Zach’s influential *Seeberg Observatory* Gotha (1788), no longer existing, the Dunsink Observatory of Trinity College in Dublin (1783–1785), Armagh Observatory (1790, restored), and Göttingen Observatory (1802–1816, Georg Heinrich Borheck), designed for Carl Friedrich Gauß (1777–1855), preserved in an excellent way in original condition.

The typical architecture of observatories around 1800 is characterized by observatories in the shape of a greek cross (four wings of equal length) in neoclassical style with a central rotating dome (sometimes still in a cylindrical or conic shape). Many famous architects were involved: Madrid (1790, Juan de Villanueva), Tartu (1810), Naples (1820), Warsaw (1820–1824), Cape Town (1828), Christiania/Oslo (1831, Chr. H. Grosch), Turku/Åbo (1819, Carl Ludwig Engel), Berlin (1835, Karl Friedrich Schinkel, demolished 1915), Bonn (1844, Karl Friedrich Schinkel), Athens (1846, Theophil Hansen) and later the ETH Observatory Zürich (1861–1864, Gottfried Semper). Very striking due to the six “domes” is the *Observatorio Astronomico* in Quito (1873), Ecuador, inspired by Bonn and with the help of the German Father Juan Bautista Menten, built in Victorian style; Quito is the oldest observatory in South America. A final example is the Vienna University Observatory (1883, Ferdinand Fellner and Hermann Helmer), the world’s largest observatory, a “Theatre for Stars” as the director Karl Littrow (1811–1877) called it and he wanted to reside like a prince of science (cf. Schnell (2009), p. 142–149). Very impressive is also the large staircase in the entrance hall like in a theatre or a palace; the hall is covered with a glass roof. But the building was not extremely suitable for astronomical observations.

The architect Carl Ludwig Engel (1778–1840), a friend of Schinkel, designed the Helsinki Observatory (1834); it was among the most modern observatories of its time besides Kazan old observatory (1837, Mikhail P. Korinfsky). The new idea of the 1830s was the three domes facade (in the beginning still cylindrical domes), because more instruments were in use (refractor, heliometer, meridian circle and transit instrument). The good design principles of Helsinki Observatory were adopted in Russia for the design of the Pulkovo Central Observatory in St. Petersburg (1839, Alexander Brüllow), the leading observatory in that field, an outstanding example for classical astronomy; thus Pulkovo became a prototype for the 19th century observatory architecture, cf. Lisbon (1861), Yerkes Observatory, USA (1897), Georgetown College Washington, D. C. (1841–1844) and even the *Astrophysical Observatory* (APO) Potsdam (1874/79) as well as the *Deutsches Museum* München (1925) had this characteristic front.

5. Observatories around 1900 – From classical astronomy to the rise of modern astrophysics

Important features for this serial transnational group of observatories are the following:

- Change of the research field – from classical astronomy to modern astrophysics
- Impressive architecture (well preserved and renovated)
- Ensemble of buildings in a park or a mountain observatory, cf. *Observatoire de la Côte d’Azur*, Nice, France (1888), cf. Le Guet Tully (2009)
- Change of the instrumentation – old: meridian circle, refractor, heliometer – new: astrophotograph, reflector, Schmidt telescope and several astrophysical instruments.

Classical astronomy includes time keeping – providing the official time signal for the city and for navigation; around 160 time-balls existed, about 60 are still existing, many in English speaking countries (cf. Howse (1997)), e. g. time balls in Greenwich (1933), Cape of Good Hope (1836), Washington, D. C. (1845), Liverpool (1845), Edinburgh (1852), San Francisco (1852), Sydney (1858), Lyttelton in New Zealand (1876), New York (1877), and Hong Kong (1885), Danzig/Gdansk (1894), Hamburg (1876 to 1934) and other places in the world; this could be an interesting serial transnational group of observatories.

The other task of classical astronomy is determining stellar positions with meridian circles and compiling star catalogues with the coordinates. Examples for this serial transnational group are the French observatories including Nice and Algier with French instruments and Strasbourg, Munich, the Ukraine observatories Nikolaev (Mykolayiv)

(1821–1829) and Kiev (1845), Rio de Janeiro (1827, new 1913 to 1920) and Hamburg-Bergedorf (1802, 1825 and 1912) equipped with Repsold instruments.

The rise of astrophysics, the “new astronomy”, as Simon Newcomb (1835–1909) called it in 1888, started around 1900: “*that the age of great discoveries in any branch of science had passed by, yet so far as astronomy is concerned, it must be confessed that we do appear to be fast reaching the limits of our knowledge.*” (Newcomb (1888))

The new topics in astrophysics were photometry, astrophotography, spectroscopy / spectralanalysis and solar physics (for a detailed discussion see Wolfschmidt (2009)). Karl Friedrich Zöllner (1834–1882) coined the expression “astrophysics” in 1865 and presented a first instrument for measuring the magnitudes, the wide spread Zöllner photometer (1860). In astrophotography first portrait objectives were used (Max Wolf in Heidelberg, Edward Emerson Barnard in Lick and Chicago observatories). The Frères Henry had an excellent idea to set up the *Carte du Ciel* project (Paris, 1887), this cooperation for 18 zones of the sky with a standard astrograph (34cm, 3,40m, this ratio of 1:10 offered for measuring the plates that 1mm on the plate corresponds to 1' in the sky). But this project turned out to be unsuccessful in the end. In 1964 finally the catalogue was published, the photographic chart of the sky was never completed. But soon around 1900 in Hamburg and in the USA astrographs were used for astrophysics, for spectral surveys of the sky, using an objective lens prism. And with the invention of the Schmidt telescope this photographic map of the sky could be done much quicker and also in different colours, more useful for astrophysics (the “Big Schmidt” did it in seven years with blue and red sensitive plates). The next important step for astrophysics was the introduction of the glass reflecting telescope, important for spectroscopy; in Europe the leading firm became Zeiss of Jena (70-cm-Waltz Reflector Heidelberg 1907 and 1-m-reflector Hamburg 1911). The large reflectors were built in the USA, cf. in Mt. Wilson the 60" = 1.5-m-reflector (1904) and the 100" = 2.5-m-Hooker-Telescope (1917).

Twelve observatories (Algiers, La Plata, Rio de Janeiro, Greenwich, Tartu, Paris-Meudon, Nice, Hamburg, Kodaikanal, Lisbon, Pulkovo, US Naval Obs. Washington D.C.) were chosen in 2008 in discussion with the Conservation Department of Hamburg and with Prof. Dr. Michael Petzet, former president of ICOMOS. One should add the Cape Observatory (cf. Glass (2015)) and the Canadian *Dominion Observatory* (1902 to 1970) in Ottawa for classical astronomy in combination with the *Dominion Astrophysical Observatory* (1918) Victoria, B.C., especially added for astrophysical research. These important observatories contributed remarkably to astronomical science of that time, to our modern view of the world, as well as Mt. Wilson, Einstein Tower, Meudon and Pic du Midi in the field of solar physics.

6. Conclusion

It is not difficult to develop ideas for cooperations, for a serial transnational application. But the realization is very difficult. The observatories have to be acknowledged in the states where the monument protection people mainly come from history of art and prefer castles and churches as cultural heritage. And if you succeed with this, you have to convince the politicians who change every four years. And then you have to restart. And the partner observatories have the same problems.

But in general observatories offer a good possibility for serial transnational applications. A well-known example for a thematic programme is the Struve arc, already recognized as World Heritage. I have shown groups like Renaissance, Baroque or neo-classical observatories, which can be chosen for serial transnational applications. There are other possibilities like solar physics observatories (Wolfschmidt (2005)) or a group of

observatories equipped with the same kind of instruments (meridian circles) or made by famous firms. The group of colonial observatories of Spain, Portugal, France (Algiers (1890), cf. Irbah *et al.* (2001)) and the Netherlands needs to be studied much more.

I have discussed what has been achieved in the route of astronomical observatories project, this group of observatories around 1900 showing the transition from classical astronomy to modern astrophysics (cf. La Plata, Hamburg, Nice, etc.), visible in the architecture, the choice of instruments, and the arrangement of the observatory buildings in an astronomy park. This corresponds to the main categories according to which the “*outstanding universal value*” (UNESCO criteria ii, iv and vi) of the observatories have been evaluated: historic, scientific, and aesthetic. This proposal is based on the criteria of a comparability of the observatories in terms of the urbanistic complex and the architecture, the scientific orientation, equipment of instruments, authenticity and integrity of the preserved state, as well as in terms of historic scientific relations and scientific contributions. This is perhaps the most promising group for a serial transnational UNESCO application.

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