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The Mathematisch-Physikalischer Salon in Dresden: a princely collection of scientific instruments

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Abstract: Since 1728, one of the world's leading collections of historical scientific and philosophical instruments, clocks and watches, and globes is housed in the famous Zwinger Building in Dresden, capital of Saxony. The "Mathematisch-Physikalischer Salon" was founded under August the Strong, Elector of Saxony and King in Poland, and runs back to the 16th century "Kunstkammer" in the residential palace. The exhibits are outstanding examples of finely crafted scientific instruments and devices.

Keywords: Museum, Kunstkammer, Cabinet of Physics, Astronomy, Globes

The Museum, that I present here, the Mathematisch-Physikalischer Salon (MPS), is among 14 other museums part of the Dresden State Art Collections. Dresden is the Capital of the German State of Saxony and was before 1918 the Residence of the Saxon Princes and Kings. And, Dresden has been a twin city of Florence since 1978[1] .

The Mathematisch-Physikalische Salon goes back to 1728, and is the oldest museum in the Zwinger building (Fig. 1). It was founded under Augustus the Strong, Elector in Saxony, as his Cabinet of Mathematical and Physical Instruments. (For a history of the museum see Plassmeyer, 2020, pp. 7-17) Today, the MPS houses one of the world's leading collections of historical scientific instruments, horological instruments, mechanical automatas, astronomical devices, and globes. The exhibits on show are outstanding examples of finely crafted scientific instruments and devices. Their mechanisms and how they work are quite fascinating – yet they can equally be admired for their beauty.
The collected objects are following five main functions:

- The first group are the instruments *to observe*. A gregorian reflecting telescope by Johann Gottlob Rudolph Miltitz, circa 1750 (MPS C I f 8) is an excellent example of this. It was built on an estate near Meissen, its tube is covered with Meissen porcelain.
- *To demonstrate* with Astrolabes, globes, planetaries or oraries are representing such devices.
- *To experiment* means the philosophical instruments in a cabinet of physics.
- Reference standards were stored in it *to compare*. The Dresden Kunstkammer of the 16th and 17th centuries also took the tasks that are now held by the calibration office.
- *To measure* a town, a region, a country, the Earth, and the skies, surveying plays an important role in the MPS's collection. Surveying instruments have been collected since the 16th century and surveying was a core task of the collection until the 19th century.

[1] This text is a written form of my paper given at the conference. He will receive a reduced part of the illustrations shown in the paper. I want to thank Antonella Gasperini and Mauro Gargano for their kind invitation to participate in the Congress in Florence.

Fig. 1: The Zwinger Building in Dresden with the Mathematisch-Physikalischer Salon.

Proof of the importance of MPS-owned objects to articulate the court's intellectual profile is the sumptuous folio volume "Suite des Principes de la Geometrie", (Sächsische Landes- und Universitätsbibliothek SLUB, MSCR. Dresd. C. 38) the sixteen-year-old Prince Karl dedicates to his father, Augustus III. in 1749 as the harvest of his studies, "und partie des fruits de se études". In the most beautiful French handwriting, the prince comments upon drawings explicating the principles of geometry and the application in terrestrial and astronomical surveys – as a result of his exercises. In its construction and function, the crescent-shaped instrument shown in the image corresponds with a semicircular instrument that belongs to our museum. It was made around 1690 by Louis Chapotot in Paris (Fig. 2). (Plassmeyer, 2007, pp. 8-9) More than a century earlier, Christoph Schissler made a surveying instrument, a Quadratum Geometricum, in Augsburg, which is one of the most magnificent scientific instruments of its time. As early as the 16th century, outstanding surveying instruments found their way into Dresden's Kunstkammer. (Dolz, 2020, pp 25-27) The exceptional reliefs on the frame illustrate the instrument's use as a surveying device: right triangles can be mapped in scaled form onto the sides of the square. Christoph Schissler built this instrument in 1569 in Augsburg (Fig. 3). With the help of the laws of similar triangles, the instrument can be used to gauge distances that could not be measured directly – for example, the height of an inaccessible tower or the width of a river.

A copy of this instrument was made by Schissler 10 years later in 1579 for the Imperial Court in Prague. This instrument was sold to England in 1603, and today it is shown on display in the Oxford History of Science Museum. A third instrument was made by Schissler another 10 years later for the Fugger Family in Augsburg. This one doesn't have descriptive reliefs. At the beginning of the 17th century, it was given as a present to the Medici-Family, and it should be on display in Museo Galilei. The Dresden instrument was severely damaged in the bombing night of February 13, 1945, and the manuscript explaining its functions was burned. Fortunately, photographs of the illustrations have been preserved. Surveying and mapping of the Saxon territory was an important task of the Saxon court from the 16th to the 20th century.

Fig. 2: Graphometer, Louis Chapotot, Paris, 1680ca, ©MPS, C III f 10.

Fig. 3: Quadratum Geometricum, Christoph Schissler, Augsburg 1569 (severely damaged in 1945), ©MPS, C I 1.

Fig. 4: Itinerary scroll, ©MPS.

A brass gilt odometer (Christoph Trechsler, Dresden 1584, MPS C III a 4) used in a carriage worked similarly to a milometer in a modern car (Fig. 5). The distance covered was calculated from the number of wheel revolutions multiplied by the circumference of the wheel. The maximum measurable distance was 20 miles=180 kilometres, 1 mile being 2000 rods. It is highly probable that Elector August used

Fig. 5: Exhibition Room with Trexler's odometer and an itinerary scroll in the first case, ©MPS.

this odometer on some of his journeys. With all the collected information, the prince drew two different documentation of his journeys: maps and itinerary scrolls. In 1575, in association with the court painter Friedrich Bercht, Elector August produced an itinerary scroll recording his journey to the Imperial Diet in Regensburg (Fig. 4). It took 13 days to cover the approximately 54 Saxon miles (370 km). The scroll is therefore divided into travelling days, from one overnight encampment to the next. The route is depicted as a straight line. Changes in directions are shown employing compass roses. Along the route the Elector charted villages and towns, woods, rivers and fishponds, mills, and even gallows. The route scroll is 13,4 m long. Not every town and village receives its woodcut, occasionally a print is used several times. More than 150 survey sketches made by Elector August have been preserved, including some of the Pretsch District. They take the form of compass traverses, in which the distances between bends in the path of bounding points are measured with an odometer, and changes of direction with a compass. Elector August (ruled 1553–1586) actively participated in the measurement of his lands as a surveyor and cartographer. This distinguishes him from most other rulers of his time. A large number of sketches and maps drawn in August's own handwriting have been preserved, recording both his territories and his travels. At the same time, he commissioned innovative mechanical odometers. His efforts resulted in sophisticated devices that could automatically record both the distance traveled, and changes in direction. In the inventory of the Dresden Kunstkammer, his surveying method is referred to as "Wagen Messkunst" (The Art of Measurement by Carriage). (Dolz, 2020, pp. 21-27)

Burning lenses and burning mirrors are among the unique selling points of the Cabinet of Physics, which was set up in the Zwinger in the 18th century (Fig. 6). The firing apparatus shown in the picture came from Ehrenfried Walther von Tschirnhaus, who discovered the recipe for Meissen porcelain with his experiments. In the last quarter of the 18th century, an astronomical observatory and the time service for Dresden were added to the cabinet. Other philosophical and astronomical instruments came from a private collection and were placed on princely property. Far away from the Electorical capital of

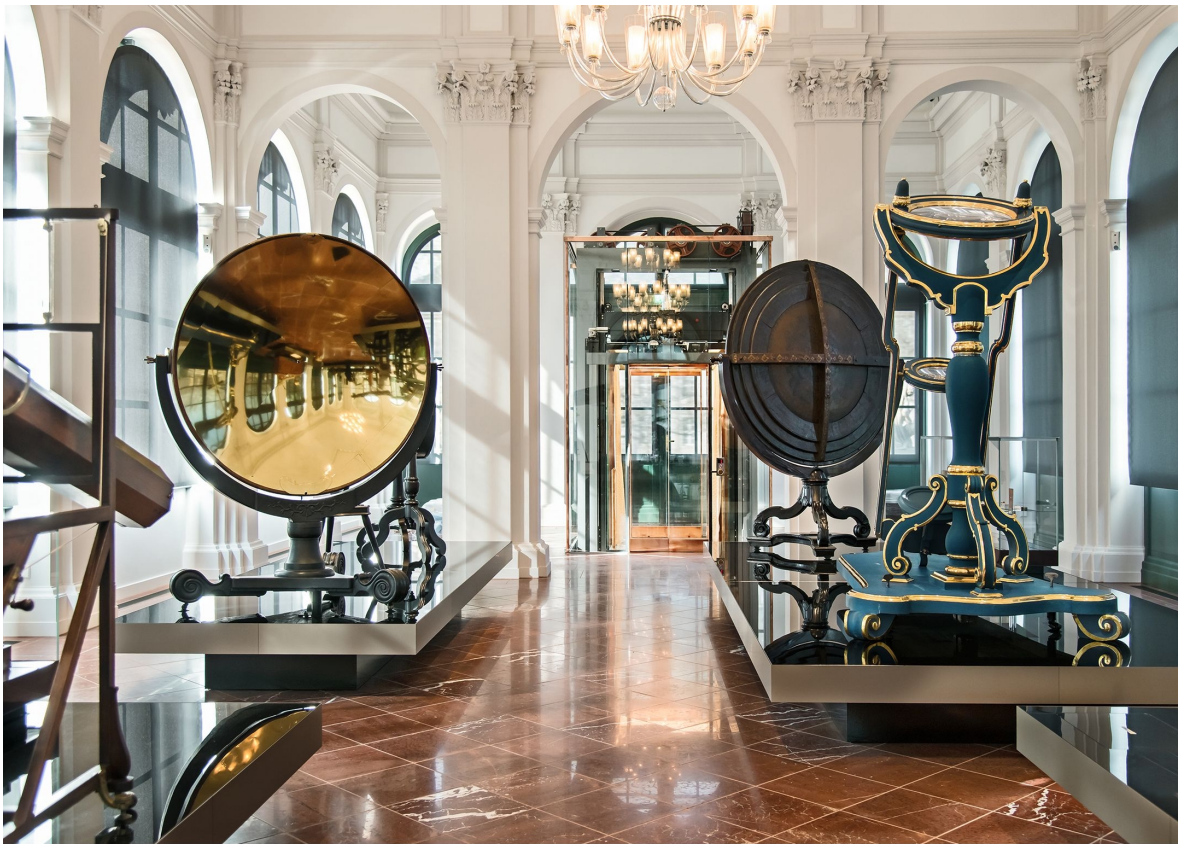

Fig. 6: Exhibition Room with Burning Lenses and Mirrors, ©MPS.

Dresden, a workshop for constructing scientific instruments was established by Imperial Count Hans von Löser (1704–1763) of his estate at Schloss Reinharz. The optical and physical devices manufactured there, mostly for Löser's research investigations, were on a par with the very best contemporary products from London and Paris. Famous scientists even came from abroad to see Löser's instruments, despite the relatively remote location of the estate. (Korey, 2007, pp 21-26) After his death, the workshop was closed down. Most of Löser's instruments were taken to Dresden, where they considerably expanded the existing collection of the Mathematisch-Physikalischer Salon in the Dresden Zwinger palace.

Well-known and often published is the reflecting telescope, made in 1742 (Fig. 7). To better observe the night sky, Löser even ordered that the castle tower be heightened.

Let me come to the outstanding globe collection of our museum.

To comprehend the celestial laws of the stars and planets is among the oldest dreams of humankind. Based on this, astronomers have surveyed the sky, outlining mathematical theories to understand the movements of the stars in the most exact possible manner and attempt to predict them. In order to realistically envision the celestial processes without being compelled to undertake complex calculations, the Saxon electors acquired numerous exquisitely worked celestial machines: Elector August the astronomical clock (Fig. 8), his son Christian the mechanical celestial globe (Fig. 9a). For the princes, these extremely rare machines carried heaven on earth. Moreover, they symbolized something central vis-à-vis their legitimacy as rulers: their proximity to god. In the astronomical clock, constructed by Eberhard Baldewein, the hessian Landgrave Wilhelm publishes his newly determined positions of the stars in the globe on top of his world machine. Reinhold and Roll in Augsburg used for their celestial globes published positions of the stars. Other versions of their globes are today in Vienna, Paris, London, St. Petersburg, and Capodimonte. Of course, we have the most pairs of globes in several sizes published by Blaeu, Doppelmayr, Seutter, Coronelli, and so on in our collection. But we also have some special designs. The oldest instrument in our collection is this celestial globe, made in the late 13th century in

Fig. 7: Exhibition Room with Instruments from Löser's workshop in Reinharz Castle, ©MPS.

Fig. 8: Exhibition Room with Baldewein's Astronomical Clock, ©MPS, D IV d 4.

Persia, and should arrived in Dresden in the Middle of the 16th century.

(a) **(b)**

Fig. 9: (a) Mechanical Celestial Globe, Johannes Reinhold, Georg Roll, Augsburg 1586, ©MPS, E II 2. (b) Hans Moritz von Brühl, Engraving by Samuel William Reynolds, W. Annis after James Northcote, 1803, ©MPS, G I 141.

Ernst Fischers Lunar Globe was made in Dresden in 1875. In the MPS, Johann Gottfried Köhler and Wilhelm Goffhelf Lohrmann began at the end of the 18th century their intense exploration of the Moon's surface. Fischer Globe stands in the same tradition.

In 1882, Giovanni Schiaparelli published a map with the broad Mars "Canals". It served as a template for Dresden's Mars globe. Corresponding with the observation undertaken with an astronomical telescope, the South Pole is located at the top. The globe presents the "red planet" at the end of summer, with extensive northern expanses of snow, during the Mars opposition in 1881/1882.

The central person in the establishment of an astronomical observatory in the MPS in the 1770s was Hans Moritz von Brühl, in the United Kingdom better known as John Maurice, Count Bruhl (Fig. 9b). He was a nephew of the famous Saxon Prime Minister Heinrich von Brühl (1700-1763). From 1764 on he held the office of the Electoral Saxon ambassador in London and from then on lived in England until he died in 1806 (Plassmeyer, 2020b).

In England, the passionate amateur astronomer not only became a member of the Royal Society (1765), but also an important patron of English instrument and chronometer makers (especially Jesse Ramsden, Thomas Mudge, and Josiah Emery). The portrait of John Northcote shown here in an engraving was painted in 1796. It has been hanging in Petworth House in Sussex ever since. We see Brühl sitting with the Order of the White Eagle in front of a red curtain. This is gathered and offers a view of the sea with a ship. On a table, like stately insignia, we see a book, a printed text, a sextant, and a sea chronometer. The spine resembles a marshal's baton or telescope, the chronometer a crown.

Fig. 10: Marine Chronometer “Copie No. 18”, Thomas Mudge et al, London 1796 (MPS D IV b 12)

The manufacturer of the marine chronometer was the watchmaker Thomas Mudge (1715-1794). He was one of the leading masters of his discipline, constructed a lever escapement, as we still find it in many mechanical pocket watches today, and concentrated on the construction of marine chronometers.

In 1714, the English government set up the “Broad of Longitude”, an authority that offered prize money of 20000 pounds to anyone who could accurately determine the longitude at sea. John Harrison (1693 – 1776), an English carpenter and self-taught watchmaker, received half of the prize money for his sea chronometer, known as the “H4”. He received only half because astronomers doubted that several identical timekeepers could be built with equally good measurement results. Therefore, in 1775, the requirements for the price were changed, and from now on two timekeepers of the same design were to be submitted for examination. For these reasons, Thomas Mudge built two identical sea watches between 1776 and 1779, which he refers to distinguish them according to the color of their cases: the “blue” and the “green” chronometer. Both were subjected to various tests in the following years but with unsatisfactory results. Nevertheless, Mudge was awarded 500 pounds for his lever escapement. The invention of the free lever escapement around 1757 and the escapement with constant force are among Thomas Mudge’s outstanding achievements that qualified him for this task. Through the mediation of Brühl, the “Copie No. 18” was delivered to the MPS in 1803 (Fig. 10). The copies were made by Mudge’s son of the same name. In 1794, the lawyer Thomas Mudge Jr. founded a manufactory in London to build marine

chronometers in series for sale according to his father's model. For this purpose, he hired some precision mechanics, who produced about 26 marine chronometers by 1799.

Brühl published Mudge's lever escapement in various writings and became his most important supporter. These writings can also be seen in the portrait. The sextant may have been made by Jesse Ramsden. Ramsden was an instrument maker who was supported by Brühl with considerable financial contributions. The three-masted ship in the background of the portrait could be the admiral ship of John Campbell (1720-1790), who was commissioned to test Mudge "Blue" and "Green" at Brühl's request.

It was not until the end of the 1770s that watchmakers succeeded in further developing the free lever escapement, including Josiah Emery, who was also promoted by Brühl. Last but not least, the network maintained by Brühl offered a helpful sales market for the products of the craftsmen he promoted.

The Marine Chronometer, which was transmitted from Brühl to Dresden, served the time service as a portable watch, with which the time determined in the Dresden Zwinger was delivered to subscribers once a week. However, it also served as a training device for the watchmakers working in the MPS and promoted the quality of the clocks and watches built in Dresden in the long term. This can still be seen today. Ferdinand Adolph Lange, who founded a pocket watch manufactory in Glashütte in 1845, learned his trade in the Dresden Zwinger. The watchmaking tradition he initiated still exists today. Some of the best wristwatches in the world are still built in Saxony.

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