

Wolfschmidt, Gudrun: Booklet of Abstracts.

Timekeeping, Navigation, Surveying – Cultural Astronomy and Instruments.

Conference of the 32th European Society for Astronomy in Culture (SEAC) &
Gesellschaft für Archäoastronomie (GfA), Hamburg, August 25–30, 2025.



Figure 0.1:

Ceiling painting: Starry sky with zodiac
in the Hamburg Planetarium (1930)

(Design for the ceiling painting: Dorothea Maetzel-Johannsen –
Painting by Hinrich Groth of Hamburg)

Gudrun Wolfschmidt

Booklet of Abstracts

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Hamburg, August 25–30, 2025



Ahrensburg: tredition 2025

Wolfschmidt, Gudrun: Booklet of Abstracts. Timekeeping, Navigation, Surveying – Cultural Astronomy and Instruments. Conference of the 32th European Society for Astronomy in Culture (SEAC) & Gesellschaft für Archäoastronomie (GfA), Hamburg, August 25–30, 2025. Ahrensburg: tredition 2025.

Web page of the SEAC conference in Hamburg:
<https://www.fhsev.de/Wolfschmidt/events/SEAC-HH-2025.php>.

Front Cover: Navigation, Timekeeping (Photos: G. Wolfschmidt).

Back Cover: Hamburg Observatory aerial view (Archive Hamburg Observatory).



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<https://www.fhsev.de/Wolfschmidt/GNT/home-wf.htm>.

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Figure 0.2:
Hamburg Coat of Arms and Steamship

(Photo: Gudrun Wolfschmidt)

Programme: Timekeeping, Navigation, Surveying – Cultural Astronomy and Instruments

Conference of the 32th European Society
for Astronomy in Culture (SEAC)
& Gesellschaft für Archäoastronomie (GfA),
Hamburg, August 25–30, 2025



1.0.1 SOC – Scientific Organizing Committee

- Prof. Dr. Gudrun Wolfschmidt – Chair
(GNT, Hamburg Observatory, University of Hamburg)
- Prof. Dr. Rita Gautschy (University of Basel, Switzerland)

1.0.2 LOC – Local Organizing Committee

- Prof. Dr. Gudrun Wolfschmidt
(GNT, Hamburg Observatory, University of Hamburg)

1.0.3 Assistants – Helfer

- Astrid Wokke (Bremen, Germany)
- Dr. Katrin Cura (GNT, Universität Hamburg)
- Dr.cand. Dipl.-Phys. Yang-Hyun Choi (GNT, Universität Hamburg)
- Dipl.-Ing. Jürgen Gottschalk (GNT, Universität Hamburg)

1.0.4 Reviewers

- Prof. Dr. Gudrun Wolfschmidt
(GNT, Hamburg Observatory, University of Hamburg)
- Prof. Dr. Rita Gautschy (University of Basel, Switzerland)
- Dr. Michael Rappenglück (Gilching, Germany)
- Dr. Georg Zotti (Vienna, Austria)
- Prof. Manuela Incerti, PhD (Ferrara, Italy)
- Dr. A. César González-García (Santiago de Compostela, Spain)
- Prof. Marc Frincu, PhD (West University of Timisoara, Romania)
- Prof. Dr. Penka Maglova-Stoeva
(Bulgarian Academy of Sciences, Stara Zagora, Bulgaria)
- Dr. Frank Prendergast (Technological University Dublin, Ireland)
- Prof. Kim Malville, PhD (University of Colorado, USA)
- Dr. Burkard Steinrücken (Recklinghausen, Germany)

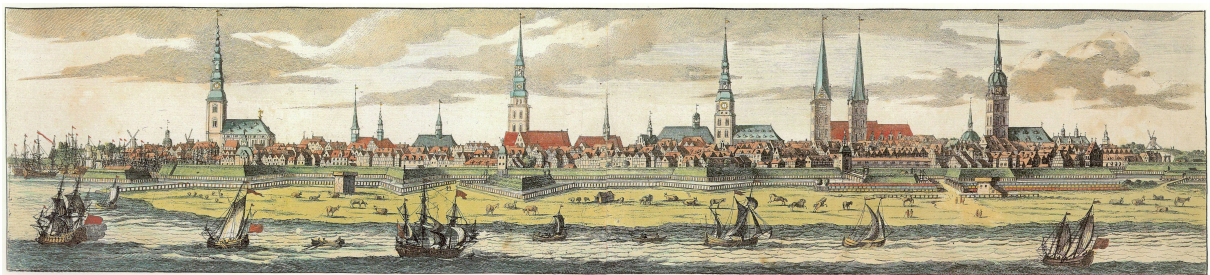


Figure 1.1:
Hamburg (Schenk 1682)

1.1 Welcome to Hamburg – Gateway to the World

1.1.1 Gudrun Wolfschmidt

Hamburg was founded in the time of Charlemagne around 800. and is situated on the rivers Elbe, Alster and Bille. This green city has Hanseatic tradition and an inspiring cosmopolitan atmosphere. Hamburg is called ‘Gateway to the World’.

One can find a mix of culture (museums, music, theatres), gastronomy and nightlife. Landmarks are St. Michaelis Church (8-m-tower clock – the largest in Germany) and the Elbphilharmonie concert hall (Herzog & de Meuron, 2017) – an architectural highlight, as well as the Chile House (a ‘Kontorhaus’ / office building in expressionistic style, Fritz Höger, 1922–1924) with the large Warehouse complex, called ‘Speicherstadt’ (1888) – both Unesco World Heritage, and the modern HafenCity (Port City).

Hamburg has a maritime atmosphere (sailing ship Rickmer Rickmers 1896, cargo vessel Cap San Diego 1961, Light vessel LV13 1952, Light vessel / Feuerschiff “Elbe 3” 1888, Viermastbark “Peking” 1911) with the the third biggest container port in Europe. The old port was at Nikolaifleet (‘Binnenhafen’), used for sailing ships until around 1900, then Landungsbrücken for steamships. The Navigation School was founded in 1749, in 1790 moved to the ‘Baumhaus’.

Astronomy and navigation played a major role: Johann Georg Repsold (1770–1830) founded a private observatory (1802–1812) on the ‘Stintfang’ (smelt fishing) hill at “Landungsbrücken” (landing stages). The “Deutsche Seewarte” (German Maritime Observatory) with Chronometer Testing Institute was built there (1875).

In addition, the Altona Observatory, Palmaille 9, famous for surveying (Danmark, Hamburg, and Kingdom of Hanover), existed from 1821 to 1873 with Heinrich Christian Schumacher (1780–1850) as first director.

The *new* Hamburg Observatory with Navigation School was founded at ‘Millerntor’ (Gate of the Windmills) in 1825. A monument for Repsold (1833) marks the place today. For timekeeping a time ball was erected on the Kaispeicher A (a brick warehouse, now Elbphilharmonie) in 1876, which was in use until 1934. The Millerntor Observatory was replaced by the Museum of Hamburg History, founded in 1908, built by Fritz Schumacher (1869–1947), and opened in 1922. The (new) Hamburg Observatory got an impressive Astronomy Park Ensemble, built by Albert Erbe (1906–1912) in Bergedorf.

The SEAC conference will bring together researchers, scholars, and enthusiasts from around the world. They will explore how astronomy, culture, and instruments intersect in various contexts. The conference will examine historical and modern methods of time-keeping, navigation, and land surveying. These practices have played key roles in shaping societies and their understanding of the cosmos.

1.2 Programme of the SEAC Hamburg 2025 – *Timekeeping, Navigation, Surveying – Cultural Astronomy and Instruments*

1.3 Hamburg, Geomatikum, Monday, August 25, 2025

Geomatikum, Bundesstrasse 55, 20146 Hamburg

Public Transport:

Metro U3 and U2 stop “Schlump”

or Bus 4, 5 and 15 stop Schlump/Bundesstrasse

or Bus X35 stop Zoologisches Museum.

09:30 h – Registration

10:00 h – Lectures

25 min & 5 min discussion

1.3.1 Session 1: Stone Age until the Eneolithic

Chair: **Georg Zotti (VRVis, Vienna, Austria)**

- 10:00 h – Welcome
- 10:15–10:45 h – Michael A. Rappenglück (Gilching, Germany):
Stellar Signposts: Upper Paleolithic Hunter-Gatherers watched the Pleiades – Evidence, Context, and Purpose
- 10:45–11:15 h – A. César González-García (Santiago de Compostela, Spain)
& Francisco Javier Gutiérrez López (Madrid, Spain)
& Raúl Martín Vela (Bernardos, Spain):
The Dolmen of Santa Inés and its illumination phenomena

11:15–11:45 h – Coffee Break

- 11:45–12:15 h – Patrick McCafferty (Chemnitz, Germany):
The Three Gifts of a Charioteer
- Lecture withdrawn:
Claude Maumené (Orange, France):
Beyond salt: a neolithic funerary vessel as a possible astronomical tool?

12:15–14:00 h – Lunch Break

Selfservice Mensa or Bistro, Cafeteria in the Geomatikum

- 14:00–14:30 h – Penka Maglova, Mina Spasova, Ognyan Ognyanov & Alexey Stoev (Sofia, Bulgaria):
Archaeoacoustic studies of the Eneolithic calendar gallery in the Magura cave, Rabisha village, Bulgaria
- 14:30–15:00 h – Alexey Stoev, Hristina Valchanova, Mina Spasova & Penka Maglova (Sofia, Bulgaria):
Dualism in the sacred territories of rock sanctuaries in the Western Rhodopes, related to astronomical practices in the Eneolithic

15:00–15:30 h – Coffee Break



Figure 1.2:

Repsold's Millerntor Observatory (1825) for astronomy and navigation

Schumacher's Observatory Altona (1821) for astronomy and surveying

(Photo: Gudrun Wolfschmidt)

- 15:30 h – City Walk in Hamburg
with an emphasis on Astronomy, Navigation, Timekeeping, and Surveying.
- Evening Dinner proposal:
Blockbräu, St. Pauli Landungsbrücken
Portuguese restaurants near Landungsbrücken
or somewhere in the Hafencity or in Altona

1.4 Hamburg, Geomatikum, Tuesday, August 26, 2025

Geomatikum, Bundesstrasse 55, 20146 Hamburg

1.4.1 Session 2: Ancient Cultures – From Egypt to the Romans

Chair: **Michael A. Rappenglück (Gilching, Germany)**

- 10:00 h–10:30 h – Marianna Ridderstad (Helsinki, Finland):
*Possible Egyptian influences in the orientations
of the Minoan palace of Phaistos*
- 10:30–11:00 h – Konstantin Kokkolis (Kefalonia, Greece):
*Kangelisses – Lakithra: a Winter Solstice Alignment
Leads to a Discovery of a Bronze Age Site in Kefalonia, Greece*

11:00–11:30 h – Coffee Break

- 11:30–12:00 h – Marco V. García Quintela & A. César González García
(Santiago de Compostela, Spain):
Time, society, and vernacular arithmetic in democratic Athens
- 12:00–12:30 h – Romain Ravignot (Sorbonne, Paris, France
& Universidade de Santiago de Compostela, Spain):
*The water clock discovered in the Frankfurt Rhine:
highlighting an entangled temporality*

12:30–14:00 h – Lunch Break

Selfservice Mensa or Bistro, Cafeteria in the Geomatikum

- 14:00–14:30 h – Susanne M. Hoffmann:
Natural Calendars all over the World: All Skies Encyclopaedia

- 14:30–15:00 h – Postersession in Lecture Room (5min each)
 - Göran Henriksson (Uppsala, Sweden):
Early Neolithic Lunar Observations at Stonehenge
 - Chandrashekar Bhupasandra Ugranarsimhaiah
(Bengaluru, Karnataka, India):
The Celestial Mirror of Madurai
 - Romain Ravignot (Sorbonne, Paris, France &
Universidade de Santiago de Compostela, Spain):
*Orientation of sanctuaries and public spaces in the Centre Region
(Turones, Carnutes, and Bituriges) from the Gallic to the Augustan period:
a key to locating the Caesarian Locus Consecratus?*
 - Themis Dallas (University of Thessaly, Volos, Greece) &
Maitane Urrutia-Aparicio (La Orotava, Tenerife, Spain):
*Are any Byzantine churches in Cyprus converted mosques?
An archaeoastronomical approach*
 - Mauro Peppino Zedda (Sardinia, Italy) &
Themis Dallas (University of Thessaly, Volos, Greece):
Further Thoughts on the Accuracy of Online Tools from Sardinia
 - Poster withdrawn:
Karl Albrecht (Kassel, Germany):
Der Diskos von Phaistos (Kreta) – ein Kalender?
 - Poster withdrawn:
Ralph Neuhäuser & Dagmar L. Neuhäuser:
*Pre-telescopic detection of colour on navigation stars
and other celestial objects*
 - Poster withdrawn:
Alessandro Berio (Rio de Janeiro, Brazil):
*The Minoan Sidereal Compass:
Reconstructing Bronze Age Trade Routes through Arcturus*
 - Poster withdrawn:
Harald Gropp (Heidelberg, Germany):
*The European ‘Discovery’ of the ‘Mar del Sur’ –
Early Navigation in and Cartography of the Pacific Ocean*
- 15:00–16:30 h – Postersession and Coffee Break



Figure 1.3:

Planetarium Hamburg with Zeiss Projector, ceiling with constellations

(Photos: Gudrun Wolfschmidt)

- 18.00–21 h – Planetarium Hamburg,
Linnering 1 (Stadtpark), 22299 Hamburg
Metro U3 stop Borgweg (Stadtpark), and a walk of 690 m (11 min)
- 18.00–19.30 h – Visit of the Exhibition *Aby Warburg (1866–1929):
Cultural History of Astronomy and Astrology (Mnemosyne)*,
originally opened in 1930 in the Planetarium Hamburg.

There is also a Bistro in the Planetarium.

- 19.30 h – Public Lecture (Öffentlicher Abendvortrag)
Dr. Michael Rappenglück (Gilching, Germany):
*Humans and the Cosmos: From the World Cave to the Big Bang –
Anthropology, Ecospheres, and Cultural Cosmologies*

1.5 Hamburg Observatory, Wednesday, August 27, 2025

Gojenbergsweg 112, 21029 Hamburg-Bergedorf

Public Transport to Hamburg Observatory in Bergedorf:

Start: S-Bahn S2 – Bahnhof Dammtor/Messe CCH (Gleis 2)

9:03 – 9:26 Bahnhof Bergedorf (Gleis 3)

Gleis 1 – Bus Platform G Bus 135 (Ringlinie) – Bahnhof Bergedorf 9:34 – 9:44

Justus-Brinckmann-Straße (7 min walk)

Bus 332 – Bahnhof Bergedorf 9:46 – 9:57 Sternwarte (Universität)

1.5.1 Session 3: Medieval and Renaissance Culture

Chair: **Rita Gautschy (Basel, Switzerland)**

- 10:00–10:30 h – Maitane Urrutia-Aparicio (La Orotava, Tenerife, Spain) & Marc Frincu (Timisoara, Romania):
Where East meets West: A preliminary analysis of the orientation of historical churches in Romania
- 10:30–11:00 h – Thiago Siqueira dos Reis da Silva, Walmir Thomazi Cardoso (Rio de Janeiro, Brazil) – presenter & Sixto Ramón Giménez Benítez (La Plata, Argentina):
Astronomy, Defense, and Faith: The Astronomical Alignment of Catholic Churches in the Historic Center of Rio de Janeiro

11:00–11:30 h – Coffee Break

- 11:30–12:00 h – Manuela Incerti (Ferrara, Italy):
Geometric Analysis and Advanced Surveying Techniques in the Study of Early Christian Starry Skies

12:00–13:30 h – Lunch Break – Café Stellar



- 12:30–14:00 h – Gudrun Wolfschmidt (Hamburg, Germany):
*Astronomical Clocks and Gottorf Globe –
Astronomical Heritage in the Baltic*
- 14:00–14:30 h – Burkard Steinrücken (Recklinghausen, Germany):
The planets on the old astronomical clock in Münster

14:30–15:00 h – Coffee Break



Figure 1.4:

1-m-Zeiss-Reflecting Telescope and Large Refractor of Hamburg Observatory

(Photos: Gudrun Wolfschmidt)

- 15:00–17:00 h – Guided Tour by Gudrun Wolfschmidt and Matthias Hünsch (Hamburg Observatory):
*The Hamburg Observatory in Bergedorf (built 1906–1912),
a culturally and historically significant ensemble*
- Short Sightseeing in Bergedorf
(you can also get some food)
- 20:00 h Public lecture (German) – Library, Hamburg Observatory
Prof. Dr. Rita Gautschy (Basel, Switzerland):
*Zeit und Zeitmessung im Alten Ägypten
(Time and Timekeeping in Ancient Egypt)*

1.6 Hamburg Observatory, Thursday, August 28, 2025

Gojenbergsweg 112, 21029 Hamburg-Bergedorf

1.6.1 Session 4: Non-European Cultures and Ethnoastronomy

Chair: **A. César González García**

- 10:00 h–10:30 h – Marc Thuillard (St-Blaise, Switzerland):
Searching for the Most Widespread and Old Skylores
- 10:30–11:00 h – Stanisław Iwaniszewski (Mexico City, Mexico):
*Revisiting the Lunar Series on the Tikal Ballgame Marker –
a new Hypothesis*

11:00–11:30 h – Coffee Break

- 11:30–12:00 h – Walmir Thomazi Cardoso & Janecleide Moura de Aguiar (Rio de Janeiro, Brazil):
*The role of historical sources and digital repositories
in Cultural Astronomy studies: a case study*
- 12:00–12:30 h – Yang Hyun Choi (Hamburg, Germany):
*Water clock and sundials from the reign of
King Sejong (1397–1450) of the Joseon Dynasty*

12:30–14:00 h – Lunch Break – Café Stellar



- 14:00–14:30 h – Perry Lange (Hamburg/Kiel, Germany):
*Kosmos in Stein: Archäoastronomische Aspekte
des Anantalisgesvara Mahadeva Tempels in Nepal*
- 14:30–15:30 h – Generalversammlung der
Gesellschaft für Archäoastronomie (GfA)

15:30–16:00 h – Coffee Break

- 16:00–18:00 h – Workshop by Georg Zotti
(VRVis, Vienna, Austria):
“Creation of photo-based landscapes for Stellarium, Part 1”

A well-made photographic panorama from an interesting viewpoint can be used as a reliable proxy to study rising and setting events in past and present skies. In this workshop I will guide the attendants from taking photographs usable for stitching to handling the relevant settings of the Hugin panorama stitcher. We shall also try to properly orient and align the panorama with one created from SRTM data by the Horizon program (or other means).

Participants should use their own laptops which should be reasonably powerful for image processing and running Stellarium. (No “netbooks”!) Preparations (necessary program installations) will be announced later.

- A short visit in Hamburg-Wandsbek is offered:
Bust of Tycho Brahe (1546–1601)
at “Wandsbek Markt” (U1) in Hamburg,
and the site of the Rantzau Castle, Schloßgarten 16–18.
A poem by Matthias Claudius (1740–1815) in 1774
deals with Brahe’s stay at Wandesburg.
- Evening:
Some important Museums in Hamburg
are open on Thursday evening,
cf. Museums in Hamburg: MARKK, MK&G, Art Gallery.

1.7 Hamburg Observatory, Friday, August 29, 2025

Gojenbergsweg 112, 21029 Hamburg-Bergedorf

1.7.1 Session 5: Cultural Astronomy in Early Modern Time until today

Chair: **Gudrun Wolfschmidt (Hamburg, Germany)**

- 10:00 h–10:30 h – Sonja Draxler (Graz, Austria):
Peter Apian – a pioneer in astronomical and geographical instrumentation
- 10:30–11:00 h – Doris Vickers (Vienna, Austria):
The evolution of Schickard's Astroscopium through three generations

11:00–11:30 h – Coffee Break

- 11:30–12:00 h – Anna Paule (Linz, Austria):
Research on James Cook's On-Board Toolkit for Astronavigation

12:00–13:30 h – Lunch Break – Café Stellar



- 13:30–14:00 h – Giangiacomo Gandolfi
(Monte Porzio Catone / Rome, Italy):
*Giovan Domenico Cassini and the Celestial Novelties:
the Resilience of Astral Divination*
- 14:00–14:30 h – Andreas Fuls (TU Berlin, Germany):
Historical Eclipse Records and Earth Rotation Variability

- Lecture withdrawn:
J. Nicolás Balbi (Observatorio de San Miguel, Buenos Aires, Argentina):
The First Stratospheric Ascension Project of the Southern Hemisphere (1938) and the scientists' questions
- Lecture withdrawn:
Barbara Rappenglück (Gilching, Germany):
Close encounters – comets and asteroids in political cartoons 2010–2025

14:30–15:00 h – Coffee Break

- 14:30–16:00 h – General Assembly of the
European Society for Astronomy in Culture (SEAC)
- 16:00–18:00 h – Workshop by Georg Zotti
(VRVis, Vienna, Austria):
“Creation of photo-based landscapes for Stellarium, Part 2”

A well-made photographic panorama from an interesting viewpoint can be used as a reliable proxy to study rising and setting events in past and present skies. In this workshop I will guide the attendants from taking photographs usable for stitching to handling the relevant settings of the Hugin panorama stitcher. We shall also try to properly orient and align the panorama with one created from SRTM data by the Horizon program (or other means).

Participants should use their own laptops which should be reasonably powerful for image processing and running Stellarium. (No “netbooks”!) Preparations (necessary program installations) will be announced later.

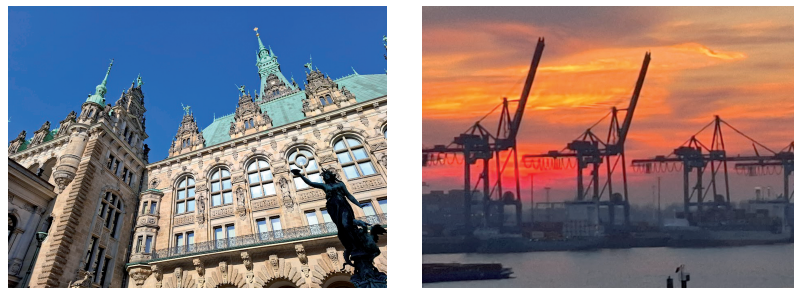


Figure 1.5:
Hamburg City Hall (1897), Hamburg Port (Photos: Gudrun Wolfschmidt)

- 20 h – Dinner

1.8 Excursion, Saturday, August 30, 2025

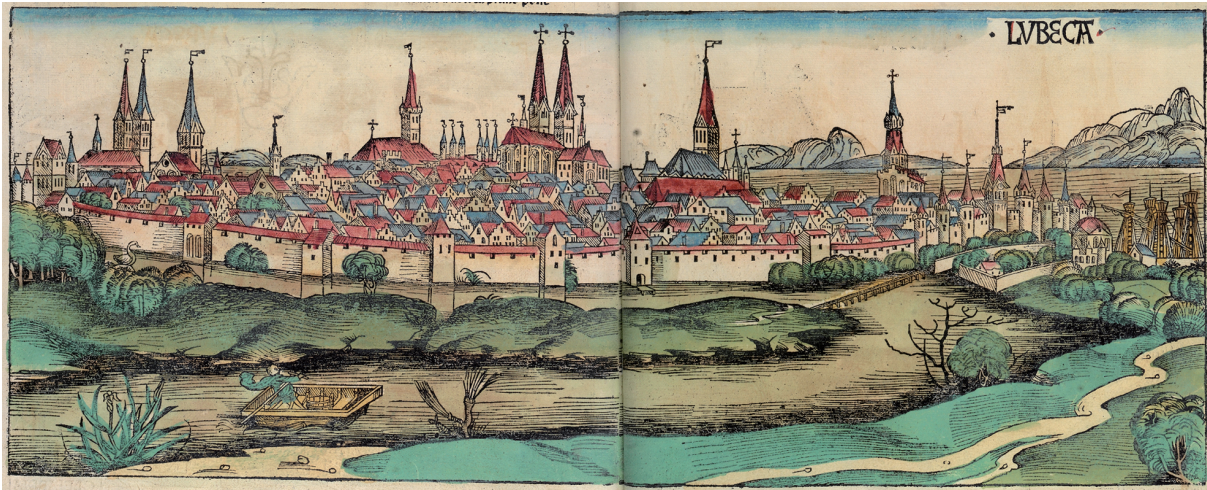


Figure 1.6:

7 Towers of Lübeck (2 Cathedral, Aegidien, Petri, 2 Marien/St. Mary, Jakobi)
and St. Catherine without tower (former Franciscan monastery)

(Nuremberg Schedel Chronicles (1493), f. 265–266)

Train RE 8 (11410): 09:06 h – Hamburg Hauptbahnhof (Central Railway Station)
09:52 h – Lübeck Hauptbahnhof – Platform / Gleis 5 or 6

For the excursion, you need either the Schleswig-Holstein-Ticket or the Deutschlandticket.
Please look at Public transport and Deutschlandticket.

Lübeck: the chief city of the Hanseatic League 1358 – an association of towns for the protection of trading interests. Lübeck, 14 km from the Baltic Sea.

“Liubice” (Old-Lübeck, founded by Slavs in 819); it was re-founded as “Lubeke” by Adolf II Count of Schauenburg and Holstein in 1143,

Transfer of the diocese to Lübeck in 1163 - the first cathedral in Lübeck was consecrated, 1226 Free Imperial City by Frederick II.

The Stecknitz Canal (1398) greatly facilitated the shipping of salt from Lüneburg.

Lübeck was in the 15th century the second largest city (after Cologne) in northern Germany, with 22,000 inhabitants. After the “discovery” of the Americas, Lübeck’s economy declined, and Hamburg with the connection to the North Sea became leading in trade and leading the Hanse.

Highlight: Lübeck, Astronomical Clock (1405/07)
 St. Annen-Museum & Marienkirche/St. Mary's church



Figure 1.7:

Left: Lübeck, Astronomical Clock in St. Mary's church,
 Right: original Astronomical Clock in St. Annen-Museum

(Photos: Gudrun Wolfschmidt)

- Marienkirche/St. Mary's church (*1251),
 (Schüsselbuden 13, 23552 Lübeck)
 the mother church of Brick Gothic style –
 the highest brick vault in the world at 38.5 m, 120 m long,
 and twin towers 124 m high

Astronomical Clock (reconstructed after WWII),

“Dance of Death”, 15th century frescoes.

- St. Annen-Museum:
 here you see the rest of the original Astronomical Clock (1405/07);
 Collections from the Middle Ages and the Early Modern Period

- City Walk: Lübeck, Historical Town
(UNESCO World Heritage-listed Old Town since 1987) –
Holstentor (1478) – “Concordia domi, foris pax” (“Concord at home, peace outside”),
Salt storage buildings in the style of the Brick Renaissance (1579 to 1745)
at the river Obertrave (the salt was transported from Lüneburg, needed for conservation of fish)

Burgkloster/Castle Monastery (1227) and
Castle Gate / Burgtor (1444) – remnants of the medieval fortifications.
Rathaus (city hall), built in Gothic and Renaissance style,
Alleys and courtyards in Lübeck.

1.8.1 Long Night of Museums in Lübeck, 18–24 h

- European Hanseatic Museum Lübeck – 800 years of Hanseatic history
An der Untertrave 1, 23552 Lübeck
- Museum Holstentor – Holsten Gate Museum (1464–1478),
Holstentorplatz, 23552 Lübeck
- St. Catherine’s Church (1300),
church of the former Franciscan monastery
Königstraße, corner of Glockengießerstraße, 23552 Lübeck
- Niederegger Marzipan Salon (history of marzipan)
J. G. Niederegger GmbH & Co. KG,
Breitestrasse 89, 23552 Lübeck
- Museum House – Hanseatic City of Gdansk/Danzig,
Engelsgrube 66, 23552 Lübeck.

Train RE 8 – every half hour
(you can decide, when you want to go home):

21:09 h – Lübeck Hauptbahnhof – Platform / Gleis 7
21:53 h – Hamburg Hauptbahnhof (Central Railway Station)

21:37 – Lübeck Hauptbahnhof - Platform / Gleis 7
22:25 h – Hamburg Hauptbahnhof (Central Railway Station).



Figure 2.1:
Hamburg Observatory: Main Building, Star Gazing with the 1-m-Zeiss-Reflector,
Time Ball, Large Refractor (Repsold/Steinheil)

(Photos: Gudrun Wolfschmidt)

G. Wolschmidt: Booklet of Abstracts –
SEAC Hamburg 2025
*Timekeeping, Navigation, Surveying –
Cultural Astronomy and Instruments*

Session 1: Stone Age until the Eneolithic

2.1 *Stellar Signposts: Upper Paleolithic Hunter-Gatherers Watched the Pleiades – Evidence, Context, and Purpose*

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As early as 1916, the prehistorian Marcel Baudouin speculated that the open star cluster of the Pleiades was depicted in both parietal and mobile art in the Upper Palaeolithic. However, the finds made at the time and the methodology used to analyse them, in particular the dating, were not sufficiently evident. In the nineties of the 20th century, it was then possible to establish with a high degree of probability that part of a cave painting in the Hall of the Bulls, Lascaux Cave (France) depicts the Pleiades. Meanwhile, few similar depictions are known, the oldest dating back to the early Aurignacien. Depictions are found as wall paintings in other caves as well as in mobile art. Of particular interest is the very probable depiction of the Pleiades on the right carpus of a female figurine from the *Hohle Fels* cave, Germany, 35–40 ka cal BP, which shows features of a pregnancy and, with a set of ten engraved lines, visualises its duration in lunar months.

The lecture will begin with a presentation of the finds, including comparisons with similar depictions in cultures from other eras. In particular, the basic forms in which this open star cluster was depicted will be shown. In a further step, the astronomically significant positions of the Pleiades in the seasonal and nocturnal course that match the archaeological dating will be correlated and discussed. The special features (close position to the ecliptic together with the Hyades, occultations by the moon, passage of planets like the bright Venus through the open star cluster, the year of the Pleiades, Pleiades as seasonal signalling device, etc.) that could have led to such early observation by the Palaeolithic hunter-gatherers and the probable significance in their cultures are also discussed.

Keywords: Pleiades, Upper Paleolithic, parietal and mobile art, astronomy, cultural meaning.

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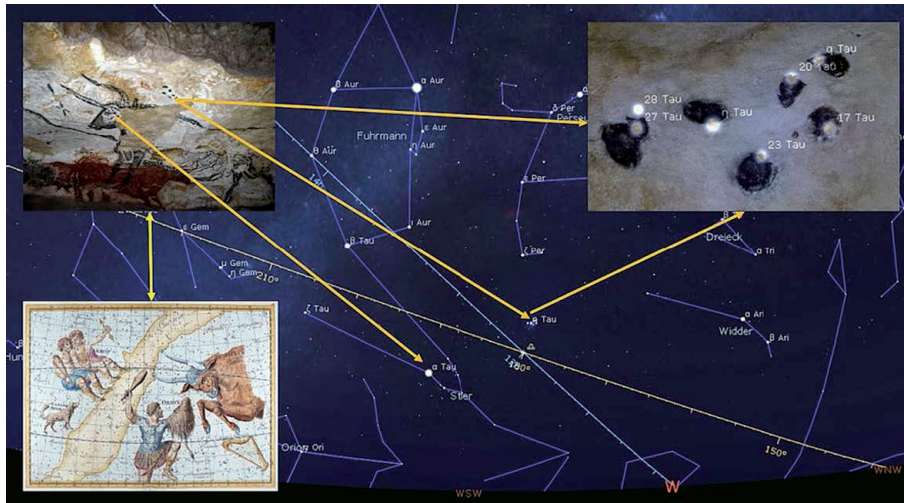


Figure 2.2:

Cave of Lascaux, France. The Aurochs (No. 18) and the group of the six points, Hall of the Bulls: the Pleiades (M 45), 17,300 years ago, were located at the site of the autumnal equinox.

(Graphics/Photos: Michael A. Rappenglück; using Stellarium 24.4 as background)

GARRIDO PIMENTEL, DANIEL; GARCÍA-DIEZ, MARCOS & PITARCH AFRICA: The Technology of the Earliest European Cave Paintings: El Castillo Cave, Spain. In: *Journal of Archaeological Science* **70** (2016).

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2.2 *The Dolmen of Santa Inés and its illumination phenomena*

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The Dolmen de Santa Inés, is a passage grave located in the central parts of Spain at nearly 900 masl. This is the first such tomb to have been excavated in the province of Segovia, Spain. The megalithic structure is composed of seven orthostats forming a chamber, possibly covered by stones or wood (no traces of the original coverage has survived). A passage nearly 16 meters long leads to the chamber from the outside. The whole structure is supported by a massive nearly oval mound composed of medium size boulders.

The corridor has a rather peculiar feature, at nearly its middle part it turns at a given angle, thus providing two orientations for this feature.

It has been argued that this provides evidence that the megalithic structure two construction phases, perhaps during different periods, and it is here argued that this provides a possible explanation for an unusual south-eastward turn to its entrance passage, that makes this a very singular case. This had the effect of changing the structure's orientation from towards sunrise in mid-autumn to sunrise at the winter solstice.

In this presentation we present the reconstruction of the chamber after its excavation, the illumination events in two different seasons, and the 3D reconstruction of the illumination as it could have been witnessed some 5500 years ago. We explain how our analysis confirms the winter solstice orientation, including an illumination effect resulting from the particular positioning of the structure's slate and quartz slabs. We also speculate on the reason for the orientation change, which we hope to validate in future research.

Keywords: Megaliths; orientations; winter solstice; illumination events; winter rituals.

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Figure 2.3:

View of the passage tomb of Santa Inés from the end of the Passage. Note the with quartz boulders at the entrance. The passage and the chamber have an interest interplay of two different materials, quartz and schist that provides interesting interplays with the illumination features and the colours of these stones.

(Photo: Francisco Javier Gutiérrez López)

MARTÍN VELA, RAÚL; DELIBES DE CASTRO, G. & L. MUNICIO: Megalitos al norte de la sierra de Guadarrama – primicias de la excavación del dolmen de Santa Inés de Bernardos, Segovia. In: *CUPAUAM* 47 (2021), 2, p. 11–38.

2.3 *The Three Gifts of a Charioteer*

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In a medieval Irish tale, *Mesca Ulad* (The Intoxication of the Ulstermen), it is said that Cú Chulainn, a legendary Iron Age hero, had ‘the three gifts of a charioteer’ at that time: *immorchor ndelend*, *foscúl ndíriuch*, and *léim dar boilg*. Sayers (1981) interpreted these to mean the use of a charioteer’s wand to sight a straight course; cleaving a path through obstacles; and leaping across a gorge/gap to maintain a level course. These gifts allowed Cú Chulainn to lead his troops *i dtréimdigri na sliged*, ‘in the straightness of the ways’. In the tale, the Ulstermen set out for one destination on the night of Samhain (Hallowe’en) but become hopelessly lost. However, even though their route was indirect, the story seems to refer to a straight path across obstacles in the landscape that can be followed at Samhain.

Warner (2012) subsequently noted that the tale seemed to describe a line on the ground between three important Iron Age sites: Dún Dá Bend, Emain Macha and Tara. Moreover, he showed that the Tech Midchuarta, a pair of parallel banks at Tara, points to Emain Macha, and that cairns along the way could have functioned as sight markers. He argued that any boy scout could have possessed enough ability to take a sightline across the land. He also noted that the distance from Tara to Emain (85.7 km) was practically equal to that from Emain to Dún Dá Bend (85.0 km), and suggested that this would have required ‘either the use of a distance-measuring device – a rod perhaps, or a wheeled odometer (cf. Lewis 2001, 19–22, 134) – or a sophisticated knowledge of trigonometry’.

Extending Warner’s line into the landscape, we encounter a number of significant sites with royal associations, including three provincial capitals: Emain Macha, capital of Ulster; Tara, capital of Meath; and Ferns, capital of Leinster. It would seem that Iron Age people did indeed establish their important sacred sites in line with each other.

Two other authors noted similar phenomena in Ireland. In 2004, Hicks introduced what he called the Lughnasa Triangle (Fig. 2.4), a spatial arrangement of sacred or royal sites in Iron Age Ireland, with a NW to SE line connecting Rathcroghan (Cruachan), Uisneach and Dún Ailinne (Aillend) aligned to the solstices; a SW to NE line between Rathcroghan and Emain Macha connecting to the Celtic festivals of sunsets at Samhain and Imbolc, and sunrise at Bealtaine and Lughnasad. A third line connected Emain Macha in the north to Tailtiu and Dún Ailinne in the South. In 2013, Robb independently noted that there were solstice and meridional connections between the most important Celtic tribal centres across Europe. Extending this work to Britain and Ireland, he produced a diagram that incorporates Hick’s triangle (Fig. 2.5), with Raffin instead of Tailtiu. The implication of this work is that there was an organising principle behind Celtic tribal geography.

Elsewhere, the 5-mountain Belchen system was described by Eichin & Bohnert (1985) and found to mark the solstices, equinoxes and Celtic festivals of Bealtaine and Samhain. The system was further analysed by d’Aujourd’hui (1997), who argued that it also influenced the location of settlements such as Illfurth, Basel Gasfabrik and Augusta Raurica.

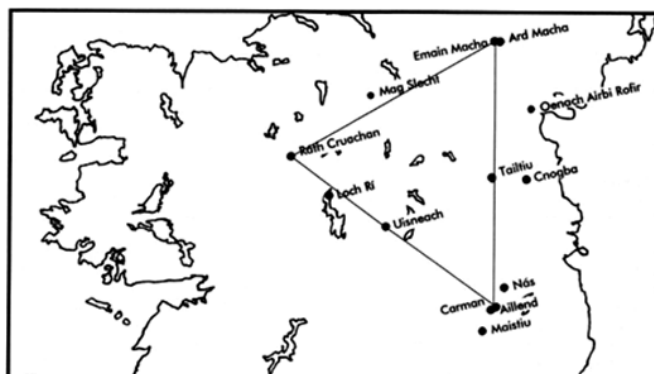


Figure 2.4:
The Lughnasa Triangle
(Hicks 2012–2013, 116)

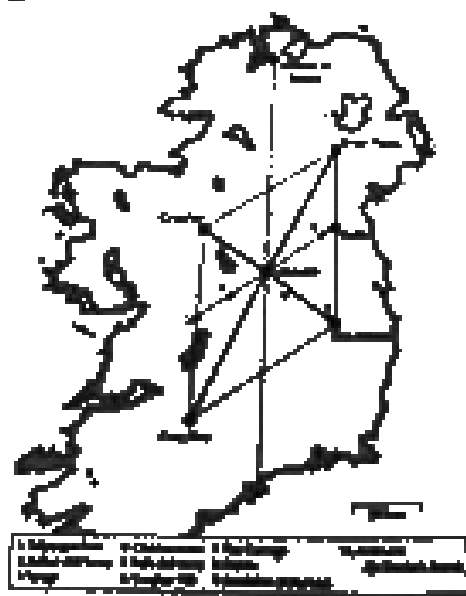


Figure 2.5:
The Irish network
(Robb 2013, 276)

Here, I explore the suggestion that there was a principle of positioning sacred Iron Age sites in line with sunrise or sunset over ‘holy’ mountains on auspicious days. In the tale of Lludd and Llefelys, Britain suffered the scream of a dragon every May Eve. Lludd measured the length and breadth of Britain and found the centre to be in Oxford – a detail that makes little sense until one realises that the centres of Ireland, Wales and Britain were arranged in a straight line aligned to sunset at Bealtaine, hence the story. It is also found that mythical mountains in Ireland such as Croagh Patrick, Ben Bulbin,

Croghan Hill and Slievenamon could be used for surveying the skyscape and landscape. Similar findings are found with the three Holy Mountains of the Franks. Ultimately, by examining a number of sites connected to Der Brocken, it is shown that the technology to survey the landscape was developed as early as the Bronze Age, and can be seen in the Nebra Sky Disc.

Keywords: Ireland, Belchen, Bealtaine, Samhain, surveying, foundations, sacred geography.

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2.4 *Archaeoacoustic studies of the Eneolithic calendar gallery in the Magura cave, Rabisha village, Bulgaria*

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At the end of the 20th century, cult caves with monochrome drawings of a calendar nature were discovered on the territory of Bulgaria, which were used during the Eneolithic as instruments for measuring time. This shows that during the Chalcolithic, real written systems of signs were formed in various places on the Balkan Peninsula, along with the mixed system of meaning formation. They are composed not of letters, but of ideograms, which can also contain conditional signs and are more difficult to understand (Todorova, 1986; Stoychev, 1994). The Chalcolithic semiotic system is built up of images, symbols, signs and forms, combined in various ways in “texts” of an artistic type, reflecting ideas that build the worldview.

One of the most original finds of the Eneolithic writing with a certain content (including astronomical images and calendar records) on the territory of Bulgaria is located in the Magura cave near the village of Rabisha, Belogradchik municipality (Fig. 1).

In the semantic analysis of the actions described through the drawings, we have assumed that they are read from right to left (Maglova, Stoev & Spasova, 2018). This allows for the comparison of symbols and the arrangement of celestial objects and phenomena, human cult actions, cult objects and instruments, logically connected in a common narrative with a calendar composition. The analysis shows that more than 95% of the drawings are symbolic and sometimes one or more of them have a double meaning.

The existence of such a large underground sanctuary with such a number of cult paintings distributed along the branches of the gallery and its separate halls shows its importance for the people. And since a large part of them are related to figures of people in a pose of adoration, the question of how the ceremonies took place and whether they are related to the acoustics of the cave comes to the fore.

There is strong evidence for the importance of human-generated and musical instrument-generated sound in prehistory (Morley, 2013). Many researchers have suggested links between cave paintings, their location, and the creation of sound or music during cult ceremonies. The use of musical instruments by these early societies indicates an appreciation of sound aesthetics and acoustic ecology in what would have been an exclusively oral and auditory culture, long before the invention of writing. The aim of the study was to investigate whether this generation of sound by humans during ceremonies extended to the acoustic response of the spaces with the paintings. In this study, we attempted to find



Figure 2.6:

Solar Hall gallery, Magura cave – monochrome drawings on the walls and ceiling

(Photo: Alexey Stoev)

evidence for a link between the visual motifs (Eneolithic paintings and engravings on the cave walls), the peculiarities of their positioning, and the assessment of the presence of acoustic effects resulting from the interactions of sound with the physical characteristics and morphology of the surrounding cave environment.

During the study, the presence of specific acoustic characteristics in certain halls of the caves, used by the ancients for cult purposes, was noted. This necessitated an analysis of methodological issues related to specific acoustic measurements in closed objects and the ways of determining acoustic characteristics that can be used to support archaeoastronomical hypotheses.

To determine the acoustic characteristics of these spaces, measurements of background noise sound pressure levels, RASTI and reverberation time were carried out. Average values for reverberation times ranging from 1s to 1.9s were obtained, and the average RASTI values showed good intelligibility (0.45 to 0.65). The sound absorption coefficient of the limestone in which these caves were formed was measured with a standing wave apparatus.

It has been hypothesized that the ability to amplify and modify sound is perhaps one of the characteristics that determine the selection of certain locations in the cave for cult purposes. The results show that painted calendar motifs in general and acoustically resonant lines and points in particular are statistically more likely to be found in locations where echo is moderate and where the low-frequency acoustic response has evidence of resonant behavior.

Keywords: Cult caves, astronomical and calendrical records, archaeoacoustics, sound pressure, reverberation time.

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2.5 *Dualism in the sacred territories of rock sanctuaries in the Western Rhodopes,*

related to astronomical practices in the Eneolithic

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The worship of stones and rocks as sacred is characteristic of the prehistoric cultures of the Eastern Mediterranean and Asia Minor. The stone, the rock and the sky become sacred because through them something different from what they actually are is revealed (Eliade, 2002). Rock-cut monuments include various structures such as altars, thrones, chutes, pools and images of solar and lunar disks, anthropomorphic and zoomorphic forms (Naydenova, 1986; Ivanova, 2016). Interdisciplinary studies of rock structures in the Eastern Rhodopes show that in the second half of the 5th millennium BC a network of rock-cut monuments (rock sanctuaries) was formed, located on high rocky peaks, some of which probably served as ancient observatories (Maglova et al., 2007).

The report presents two similar rock-cut sites discovered during field research in the area of the town of Smolyan, Western Rhodopes. They are located on the nearby rocky peaks of St. Iliya (1210 m) and Kraljuv Kamak (1278 m), between which there is a visual connection (Fig. 2.7). The first site is located on the peak of St. Iliya, whose ridge is elliptical, oriented east-west with a length of 68 m and a width of 21 m. The southern end ends with steep cliffs, and the northern is surrounded by a wall of stacked stones. At the southwestern end of the ridge rises a mushroom-shaped rock. Below it, in the natural rock, there is a stone circle cut out with a diameter of 0.96 m and a height of 0.05 m from the south and 0.27 m in other directions. 12 m north of the circle, on the western slope, there is a second circle with a diameter of 0.95 m. and a height of 0.07 m. Next to it is a small chute, and 1.60 m from it is a circular depression, probably a place for offerings or an altar.

Kraljuv Kamak peak has a dissected ridge. The western, higher part is leveled and covered with vegetation, and the eastern part is a lower rocky platform, divided into two parts by a rocky ridge. The eastern half measures 11 m by 3–6 m and has a furnace-shaped niche in its vertical side to the east. The western side is 1.30 m lower than the eastern one and has a slight slope to the south. On an area of 15 m², five circles, two semicircles and two round pits (altars) have been cut, with diameters from 0.80 m to 1 m and depths from 0.03 m to 0.38 m (Fig. 2.8). The surface is eroded or chipped, and traces



Figure 2.7:

Rock sanctuaries in the Western Rhodopes located on the rocky peaks of St. Iliya (1210 m) and Kraljiv Kamak (1278 m) in the area of the town of Smolyan, Bulgaria.

(<https://kade.si>)

of tools are clearly visible. At the foot of the peak, a trapezoidal niche was discovered, cut horizontally, which is a sign of the presence of a cult or sacred center.

Observations on the location and size of the carved rock structures, the sun disks, as well as the 360-degree panorama, indicate that both ritual practices and astronomical observations were carried out on these two peaks. The carved suns and semi-arcs reflect the positions of the Sun relative to the horizon in its daily and annual cycle, and knowledge of this is reflected in the location and size of the circles on the rock terrain. Parallels identify the two sites as sanctuaries of a widespread solar cult during the Eneolithic, part of a broader cultural and religious tradition prevalent in these regions.

Their specific orientation to the west (St. Iliya Peak) and to the east (Kraljiv Kamak Peak) connects them in a duality, complementing the number of possible observational sights within the solar year. This increases the accuracy in determining the moments of the occurrence of the solstices and equinoxes and the division of the solar year into four equal intervals of time, related to the climatic seasons, cult practices and the organization of the society that resided in this territory.

Keywords: Rock-cut monument, rock sanctuary, cult site, prehistoric observatory.

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Figure 2.8:
Sanctuary at the Kraljuv Kamak peak – circles, semicircles and altars

(Photo: Hristina Valchanova)

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Session 2: Ancient Cultures – From Egypt to the Romans

2.6 Possible Egyptian influences in the orientations of the Minoan palace of Phaistos

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The Minoan palatial centre of Phaistos governed the Messara plain in the southern middle part of Crete. From early on, i.e. already in the Middle Minoan IA period ca. 2000 BCE, Phaistos had close ties with Egypt. This is shown e.g. by the manufacturing of the imitations of Egyptian scarabs (see Fitton 2002, 63). It is possible that also the earlier use of Linear A at Phaistos compared to the other main palaces was of Egyptian influence (see Fitton 2002, 88). Moreover, Minoan cultural influences also affected Egyptian religious symbolism and art (e.g., Fitton 2000, 64).

The First Palace of Phaistos was, like other palaces, destroyed, probably by an earthquake, at the end of the Middle Minoan III, ca. 1750 BCE, and was rebuilt. The subsequent period of Late Minoan IA saw the flourishing of the Minoan culture. Also the famous disc of Phaistos, which contains astronomical and calendrical symbolism, dates from this period (see Ridderstad 2020). However, the edge of the ridge the palace was built on was probably already unstable, and it has been suggested that the palace was gradually abandoned, leading to the increase in importance of the lesser centre at the western end of the same ridge, the “villa” of Agia Triada. The final destruction of the palace of Phaistos happened at the end of Late Minoan IB (ca. 1450 BCE), when all palaces except Knossos were abandoned. Both natural disasters and warfare probably were contributing factors to the totality of the destruction (e.g., Fitton 2002, 179). It has been suggested, though, that already before this, Phaistos and other main palaces (Mallia and Zakros; possibly also Chania) may have been under Knossian rule.

It is now well known that the central court of the Second Palace was oriented differently from the old one, with the difference in azimuth being a few degrees. The effect of the axial precession of Earth, which changes the rising and setting positions of stars for about one degree in 70 years, has been suggested as a contributing factor; however, the direction of the change of the orientation seems to contradict this (see Blomberg & Henriksson 2006). The orientations of the palace and its central court were measured with high precision by Blomberg & Henriksson (2006), who presented several possible factors that may have contributed to the change of orientation and came to the conclusion that both solar and stellar factors were contributing to the orientations of the palace. There are also other, later signs of architectural changes in the palace during the Late Minoan period, some of which have raised questions about the precise dating of the last phases of the palace.

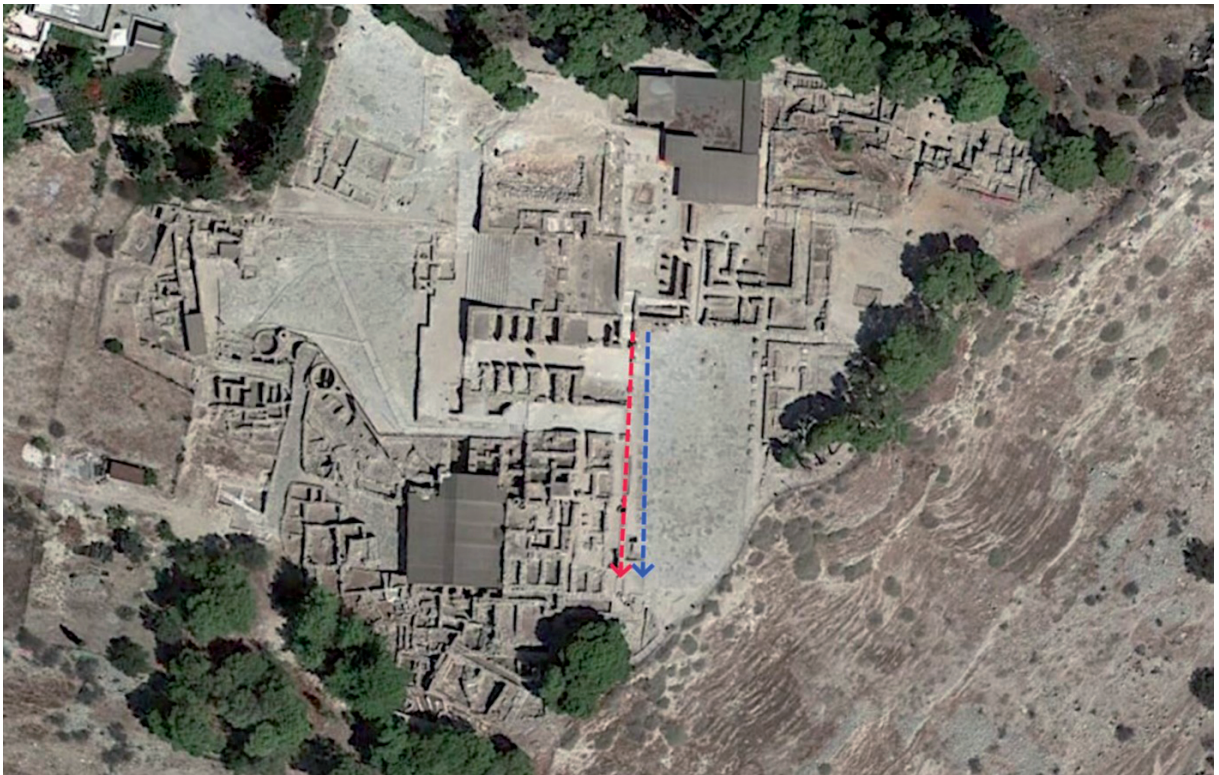


Figure 2.9:
Orientation of the central court of the Old Palace (blue) and the New Palace (red) of Phaistos
(courtesy of Google Earth, © Google Inc., modified by Marianna Ridderstad)

In this study, the possible Egyptian influences to the Minoan astronomical practices are traced and examined. Several possible methods, some of which probably had their origin in Egypt, that may have been used in orienting the palace of Phaistos are presented. The orientations of the Phaistos palace are then compared with the orientations of the corresponding structures in other palatial centres, most importantly, Agia Triada, Knossos and Mallia. Especially, the previous results obtained for the palace of Mallia with 3D modelling are used to evaluate the possible uses suggested for the Minoan Hall of Phaistos (see Ridderstad 2022). It turns out that orienting the Minoan Halls likely were influenced by Egyptian practises, along with indigenous calendrical considerations.

Keywords: Minoan astronomy, Phaistos palace, Minoan Halls.

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2.7 Kangelisses – Lakithra: a Winter Solstice Alignment Leads to a Discovery of a Bronze Age Site in Kefalonia, Greece

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This research analyzes the Kangelisses cemetery with solar alignments in mind. One of the later Late Bronze Age (LBA) tholos tombs at Kangelisses was purposefully built over and into an existing Middle Bronze Age (MBA) cist grave. The cist grave in question seems to be centrally located due to the “radiating” placements of the other cist graves of its time. That central cist grave was also the only one to have a metallic object, a bronze knife, and is oriented east-west. The author decided to use that overlap of tombs to conduct a solar/celestial alignment analysis.

Initially, two computer programs (Google Earth and Stellarium) were used, both independently and in combination. Multiple visits to the site were also conducted during the solstices and equinoxes. The sun was photographed to further confirm the initial hypothesis. Furthermore, measurements with compass and clinometer as well as D-GPS provide more detailed data.

Standing from the central cist grave, the summer solstice sunrise was observed to be aligned with the easternmost cist grave. Standing at the head of the central cist grave during the Equinox sunset, the southern slab of that cist is aligned with the sunset at Equinox. There seem to be additional alignments which require the clearing of vegetation in the future and the possible repositioning of certain fallen slabs from the cist graves.

The southwestern area of the cemetery where the winter solstice sunset could have been marked, was actually clear of any graves or cairns from either the MBA or LBA. Looking to the horizon, the author could see an unusual peak; he subsequently noticed an unusual structure on Google Earth at that peak location and eventually visited the site and observed a ring of boulders encircling a depression, within a likely artificially made mound. An excavation by the local archaeological service ensued early 2023 and a tumulus structure with two wells (or chambers?) came to light. Evidence of ritual was found at the entrances and around the structure. The archaeological service has concluded the structure is LBA, post palatial period.

Based on the computer programs mentioned earlier and confirmed by actual observations, it seems the cemetery at Kangelisses was spatially organized with the sun, cardinal points and other celestial objects in mind. Moreover, the two wells, or chambers of the Lakithra tumulus structure, seem to be oriented similarly to the two tholos tombs at Kangelisses in terms of the cardinal points. It is also important to note that both Kangelisses and the area of the tumulus structure at Lakithra have ramps leading up to the sites and large terraces with abundant pottery sherds dating to the Bronze Age. The very large tumulus structure has two entrances that point in the direction of the winter

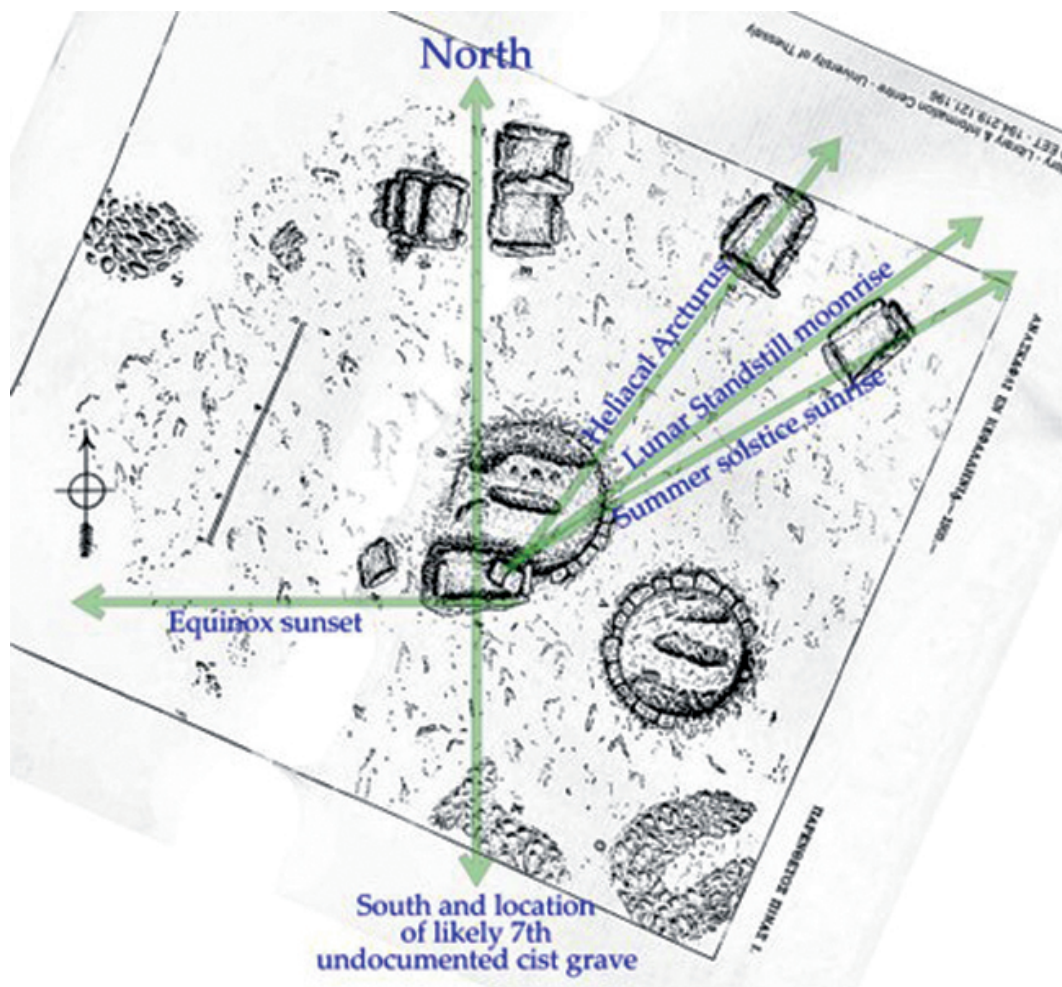


Figure 2.10:
Kavvadias Plan of the Kangelisses MBA/LBA cemetery
(drawing 1912, oriented north)
(Kavvadias 2014)

solstice sunrise and sunset which further adds to the theory it was purposefully located at the winter solstice sunset as viewed from Kangelisses.

This could be the first time an important Greek Bronze Age site has been discovered by following a significant solar alignment on the horizon from another Bronze Age site.

Keywords: Timekeeping, cultural astronomy, archaeoastronomy.

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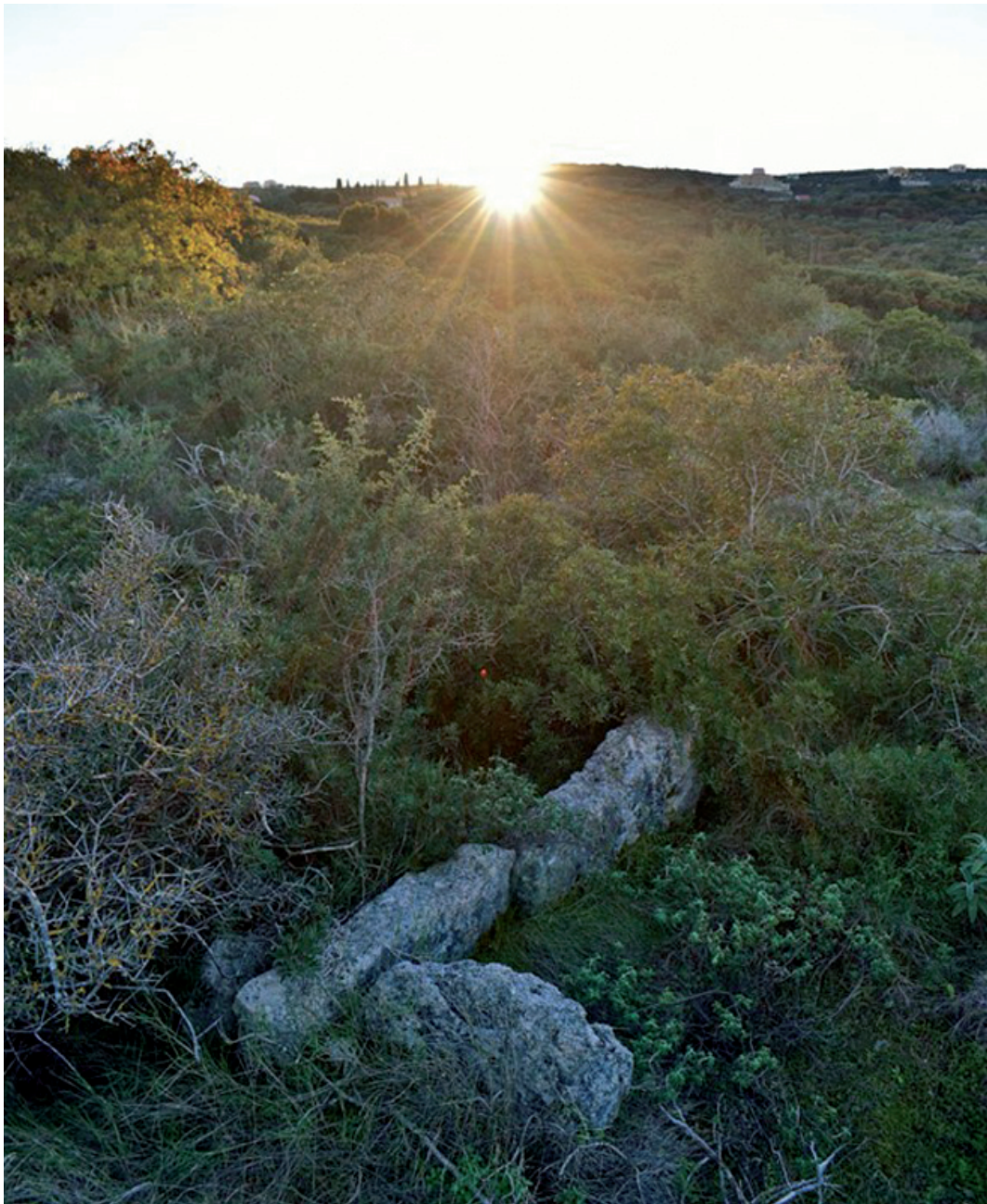


Figure 2.11:

Winter Solstice Sunset viewed from the Kangelisses Cemetery (actual date, 19 December 2021), the central cist grave is in the foreground. Slightly to the left of the sunset, lies the tumulus structure discovered by the author.

(Photo: Konstantin Kokkolis)

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2.8 *Time, society, and vernacular arithmetic in democratic Athens*

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We propose a study of fragment 3 of the *Athenaion Politeia* attributed to Aristotle. This fragment establishes a curious correlation between time and society at a moment in the early history of Athens.

... as Aristotle reports in his *Athenian Constitution*, saying as follows: ‘4 tribes of them were put together, imitating the seasons in the years; each of the tribes was divided into three parts, so that there were altogether twelve parts, like the months in the year, and they were called *trittys* and *phatria*; in the *phatria* thirty gene were arranged, as the days are arranged in the month; and the *genos* was of thirty men.’ [...]

This passage has been approached in different ways in the past, but the equivalence it proposes between social order and temporal order has never been studied in depth.

We propose an analysis considering two aspects. Firstly, its contextualisation and secondly by proposing an explanatory hypothesis of its genesis.

Regarding its context, we examine the calendars that establish years of 360 days in length, allegedly known with different variants in Egypt, Mesopotamia and the Achaemenid Empire. However, it is particularly in the Achaemenid Empire that we find cases in which the number 360 serves to combine social, temporal and spatial order.

In particular, the 360 concubines of the Persian kings and Cyrus’ division of the Gyndes River into 360 channels in 540 BCE will be considered.

These parallels show that the Eastern-inspired ideas of homology between social order and calendrical order may have been known in Athens during the 5th century BCE.

On this basis, it is hypothesised that the homology we read in the fragment of the *Athenaion Politeia* was formulated in the context of the reforms attributed to Ephialtes in 462 BCE. In that year, it is known that the relationship between the Areopagus and the Boule of the 500 was remodelled, and that the tholos was built and began to be used for the 50 Prytans from each of the 10 tribes of Athens to meet during the time of their Prytania. It is also likely that at this time the Prytanic calendar of 10 periods of varying length was introduced to cover the length of the ordinary lunar calendar managed by the archon.

The meaning of the text, according to the hypothesis put forward, would be an option that was not followed and its value will be discussed in relation to the one that was followed (Prytanic periods of unequal duration), and another hypothetical possibility would be the

alteration of the numbers used in the institutional scheme in force (10 tribes, 50 bouleutas per tribe).

Keywords: Time-society; Democratic Athens; Calendrical systems; Time reckoning.

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2.9 *The water clock discovered in the Frankfurt Rhine: highlighting an entangled temporality*

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This study is part of a project conducted with Prof. David Valls-Gabaud (Observatoire de Paris), PhD Romain Ravignot (Sorbonne-Université – Universidade de Santiago de Compostela) and Dr. Carsten Wenzel (Archäologisches Museum Frankfurt). Today, we have no fewer than seven calendars from the Gallo-Roman period (Coligny, Grand, Hambledon, Vindolanda, Frankfurt, Salzburg, and Guidizzolo). While the corpus is expanding, no dialogue has been undertaken between these different objects to discern the indigenous substratum from the Roman contribution; except for Alexander Meyer’s study (2019). Indeed, these calendars are all dated to the 2nd century AD and the application of the Julian solar calendar reform in the territory of Rome. We should therefore observe the application of a homogeneous solar calendar calculation for these objects, which is not the case. These artifacts present singularities that deserve to be questioned and contextualized to establish a more precise categorization of Time during Antiquity.

Among the ancient calendars, the Gallic Calendar of Coligny, discovered in the context of a sanctuary accompanied by a statue of Mars, is often studied because it presents a properly Gallic lunisolar calculation (Duval & Pinault 1985) and a significant number of Gaulish language words (Lambert 1997). Indeed, it is generally accepted that it presents a computation of 5 years, or 60 months plus 2 intercalary months at the beginning of the cycle and at the beginning of the 3rd year. New counting proposals are regularly proposed, making all these theories very hypothetical. Thus, this object has long remained confined to its character as a Gallic unicum.

The study of the water clock discovered in the Rhine by Dagmar Stutzinger in 2001 allows for an initial dialogue allowing for some hypotheses on the understanding of Time in the Roman era, to detect a Gallic heritage and to establish a more detailed “history of astronomy” for Protohistory and European History. This object, dated to the 2nd century AD, is to be linked to a cult context according to Dagmar Stutzinger (2001), like the Coligny Calendar. While the latter presents a lunisolar calculation in Gaulish, the clepsydra uses a Roman Julian calendar but dedicated to a Gaulish God, Borvo. It is the only complete example of a clepsydra known to date in continental Europe, except for the example from Athens and the fragments from Hambledon or Vindolanda. We also have ancient texts such as Lucian, Hippias, or Vitruvius, *De Architectura*, which describe the functioning of such mechanisms. It is within this framework that a study was launched in Paris to examine this object both contextually and functionally.

To this end, this project is being conducted in partnership with the Paris Observatory (SYRTE laboratory – Prof. David Valls-Gabaud), Sorbonne University, and the Archäologisches Museum Frankfurt (Dr. Carsten Wenzel). Photogrammetry of the object and a

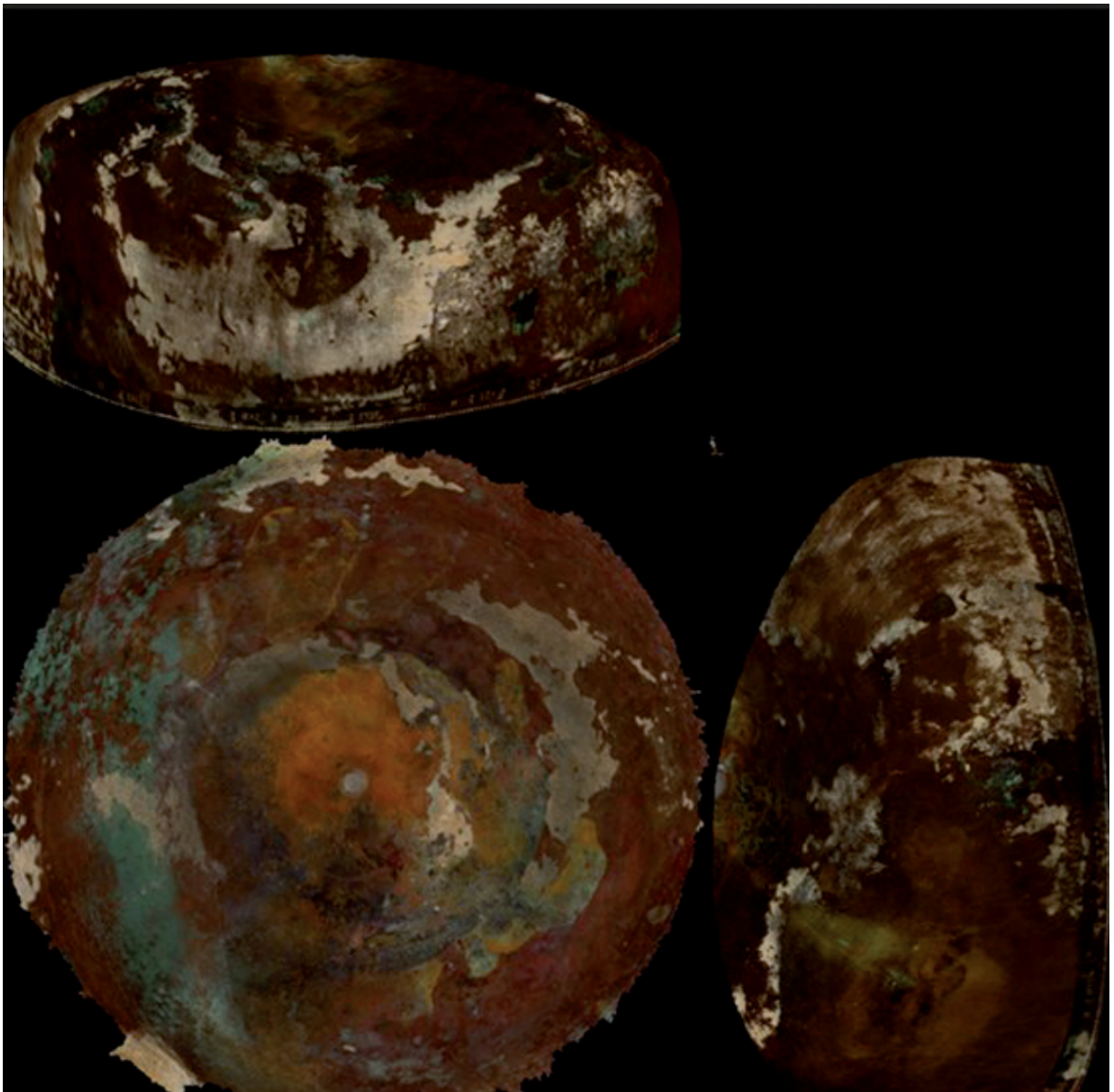


Figure 2.12:
Roman Water clock

(© Archäologisches Museum Frankfurt)

3D model were created before 3D printing. At the end of this phase, an experimental protocol (fluid mechanics) was implemented to refloat the object.

Keywords: Water clock, Clepsydra, Gallic lunisolar calculation, Gallic Calendar of Coligny, Gallic heritage.

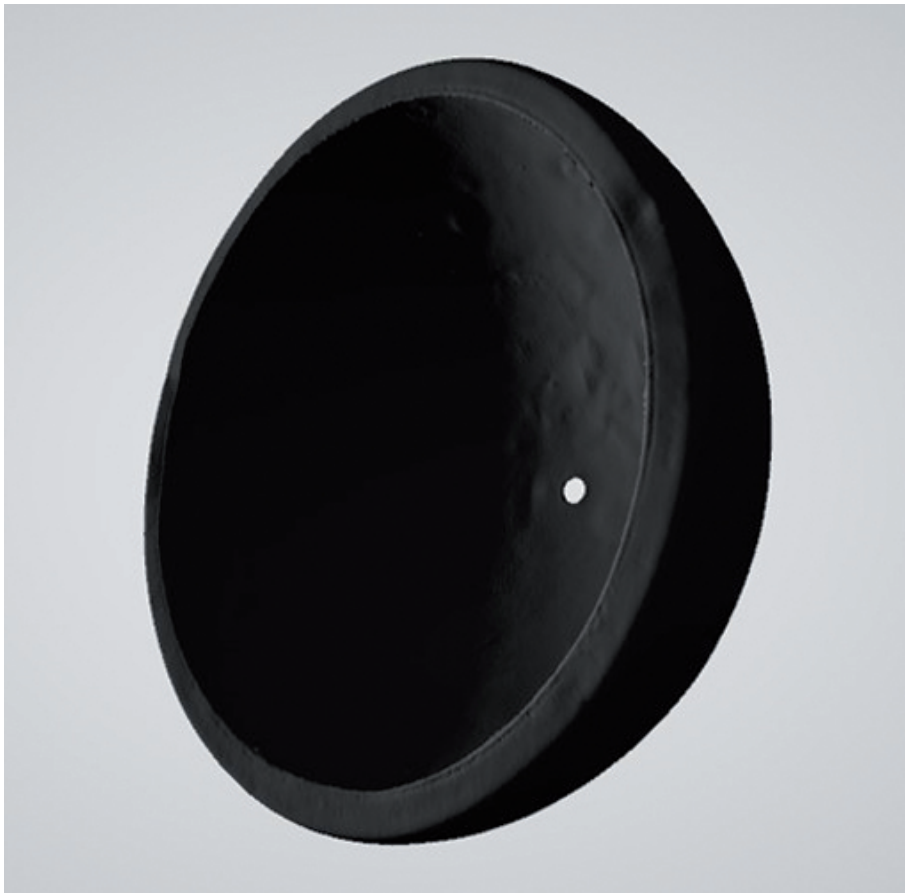


Figure 2.13:
Roman Water clock – Clepsydra
(© Archäologisches Museum Frankfurt)

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2.10 *Natural Calendars all over the World: All Skies Encyclopaedia*

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Background: In epochs of the predominant use of observable lunar calendars, the stars were used to synchronise the calendar with the rhythms of nature, the seasonal weather, climate-related rituals, festivals and other activities. Therefore, the recognisable patterns of stars for timekeeping were named to memorize the seasonal activities with which they were connected. The names of constellations of all cultures, the proper names of bright stars and the figures that were imagined in recognisable patterns were initially made for practical usage.

The so-called Greek constellations, which are the roots of our modern sky culture, are already a multicultural mixture of various influences. For the contemporary Babylonian sky culture, it is commonly known that the zodiac has its roots in the division of the year into twelve months. Still, a millennium earlier, the Mesopotamians used some constellations in the north to determine the seasons (Hoffmann 2024). With this piece of the puzzle, the roots of Babylonian astronomy are recognised on equal footing with many indigenous astronomies worldwide. I would hypothesise that the Babylonians had made the constellations for timekeeping, and the intercultural exchange with the Greeks (and others) led to the weird stories typically told in public. A deity in one culture might not be understood by another one. As the climate in the Aegean Sea deviated from the climate in Mesopotamia, even the seasonal alert functions of asterism did not perfectly match any more. The influence of intercultural misunderstandings and puns has also been studied in the past few years (McHugh 2016, Kechagias & Hoffmann 2022). Data: MUL.APIN (e.g. Hoffmann & Krebernik 2023, Hoffmann & Horowitz 2023, Hoffmann & Hunger 2023, Hoffmann & Wasserman 2024).

From this knowledge, the goal of a comprehensive, global encyclopaedia of all “names in the sky” was derived. Such an encyclopaedia should not only contain a classical dictionary of philology as it has been written for centuries (e.g. Gössmann 1950, Kurtik 2007) but also maps of the sky, which causes a big problem with identification. I launched such a project some years ago for the Greco-Babylonian sky culture(s). As I recently opened it for other historical and indigenous researchers, I will present the first results (an illustrated online encyclopaedia).

Keywords: Babylonian sky culture, Zodiac, Greco-Babylonian sky culture, Greek constellations.

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Postersession

2.11 *Early Neolithic Lunar Observations at Stonehenge*

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An investigation of the ca. 50 post holes, to the north of the Avenue at Stonehenge and about 50–75 m from the centre of the Aubrey circle, has identified them as foresights of lunar observations performed from a point, in this paper called Alpha centre, about 114 m from the A post holes and situated close to the line of symmetry along the Avenue. A nowadays-lost stone has earlier marked its place. The posts raised in these holes have been organised in seven concentric circles to mark the rising of the upper edge of the full moon at the winter solstice. The oldest row consists of the four A-posts raised 4247–4190 BC and are the most distant from the Alpha centre. The next row with posts is called C 1 and were raised between 3875–3769 BC, at a distance of 97 m from the centre, after $372 \text{ years} = 19 \times 19 + 11 \text{ years}$. The rows C 2 – C 6 have had posts on circles with smaller and smaller distances from the Alpha centre. The innermost row, C 6, consists of only 3 posts at a distance of 90 m and was raised 1958, 1939 and 1920 BC. At that time the construction with the huge Sarsen stones had begun and the lunar observations from the Alpha centre had to stop because the large stones prevented free sight to the rising full moon. The astronomical dates fit very well with the archaeological datings.

The first Stone Age farmers appeared on the British Isles around 4300 BC. They had introduced primitive wheat and livestock from the European continent. These farmers made other types of flint and bone tools and mastered the art of pottery making. They are referred to as Early Neolithic People and are known locally as the Windmill Hill Culture.

A similar interest in the luni-solar calendar and its 19-year cycle has been documented in southern Sweden and on the Swedish island of Gotland, in the Baltic Sea, and along the shores of the tributaries of big French rivers Seine and Loire. In all these sites grinding grooves in the bedrock or on big stones has made the documentation permanent. The oldest observation of the full moon at the winter solstice in Sweden was the grinding grooves from 3282 BC. 19 years later, in 3263 BC, the full moon at winter solstice were marked by grinding grooves on several sites in Sweden and at least at one site in France, Pinte de Saint-Martin.

There were parallel observations at Stonehenge and Swedish sites in 3188–3093 BC, 2740–2645 BC and in 2273–2235 BC. However, the most remarkable is that the full moon at the midwinter day, on 27 January in 3294 BC, Gregorian calendar, was marked by a grinding groove on several isolated sites in southern Sweden and on Gotland, but also at Pinte de Saint-Martin in France. One possible explanation to this coincidence may be that the peoples in North Western Europe used the same luni-solar calendar.

The identification of the spherical temple of the Hyperboreans, mentioned by Diodorus of Sicily, with Stonehenge was first suggested by W. J. Harrison (1902). Some lines in

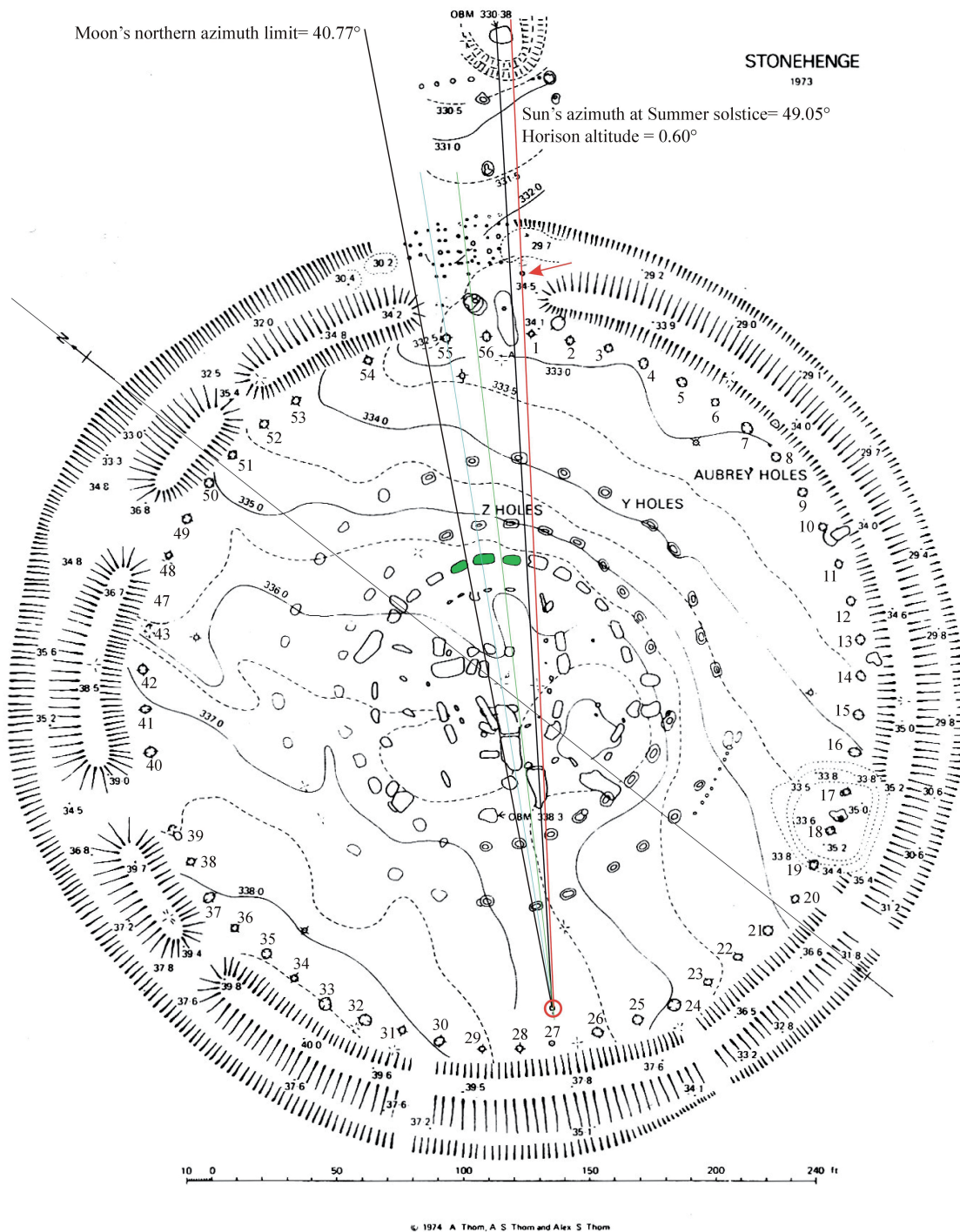


Figure 2.14:

Lunar observations are marked by lines originating from the proposed observing point, the Alpha centre, marked by a red circle, close to Aubrey hole 27. The numbers of the Aubrey holes and the green colour on three Sarsen stones have been added by the author. It is remarkable that the sun at summer solstice, in 4247 BC, rises just to the right of the Heel stone as observed from the Alpha centre, red line. In this year the first observation of the rising full moon at winter solstice was marked by the post A 1.

(Thom et al. (1974), fig. 6)

Diodorus text prompted the question where he tells about the island of the Hyperboreans and how the moon was experienced from there. He mentioned, that the god, probably the moon, “returned to the island every 19 years, the time it takes for the stars to complete their cycle”, and he called this 19-year period the “year of Meton”. Archaeology Professor R. J. C. Atkinson believes that there is insufficient evidence to prove that the land of the Hyperboreans is indeed Britain.

However, the 19-year cycle is dominating in the present investigation of the ca. 50 postholes, to the north of the Avenue at Stonehenge. They are dated to 4247–1920 BC and are organised in seven rows, with the time interval 19 years between them and were oriented towards the rising of upper limb of the full moon on the day of the winter solstice. This result strengthens the arguments for Stonehenge as the spherical temple of the Hyperboreans mentioned by Diodoros.

Keywords: Lunar observations, Early Neolithic, 19-year cycle, Diodorus, Hyperboreans.

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2.12 *The Celestial Mirror of Madurai – An Interdisciplinary Exploration of the Pashupati Seal, Orion’s Constellations, and Tamil Nadu’s Sacred Landscape*

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This paper ventures a speculative mapping of the Pashupati Seal (Indus Valley Civilization, 2500–1900 BCE) onto Madurai’s sacred topography, positing the Minakshi Temple as Orion and its encircling animals—elephant, tiger, rhinoceros, buffalo, deer—as constellations mirrored across the sky: west of Orion to east of Madurai, east of Orion to west. Integrating archaeology, astronomy, and Tamil mythology, we align Yanai Malai (Taurus), the Vaigai River via Theppakulam (Eridanus), Samanar Hills (Monoceros), Pasumalai (Canis Major), and Keeladi (Lepus). Madurai’s Pandya legacy, Minakshi’s three-breast myth tied to Orion’s Belt, the fish flag’s Piscean shift (ca. 100 BCE), and the 3rd/4th-century name Nan-Mada-k-Koodal (Confluence of Four Towers) enrich this theory. The Vaigai emerges as a tigerine river, echoing the seal’s wildness through a Tamil lens. This multidisciplinary synthesis invites exploration of Madurai as an ancient celestial reflection.

Madurai, cradled by the Vaigai River, stands as Tamil Nadu’s enduring heart, its Minakshi Temple a beacon of cultural depth. Far northwest, the Indus Valley Civilization’s Pashupati Seal (Seal No. 420) unveils a horned figure—perhaps a proto-Shiva—amid an elephant, tiger, rhinoceros, buffalo, and deer, suggesting a cosmic tableau (Marshall 1931, Jeyakumar 2022, Chandrashekar). Might Madurai’s landscape mirror this ancient iconography through Orion’s starry frame?

We propose a mirrored alignment: west of Orion (Taurus, Eridanus) to east of Madurai (Yānai Malai, Vaigai/Theppākulam), east of Orion (Monoceros, Canis Major, Lepus) to west (Samanar Hills, Pasumalai), with Keeladi as a southern anchor. This paper weaves Madurai’s Pandya roots, Mīnākshi’s three-to-two breast myth (Orion’s Belt to Betelgeuse-Bellatrix), the fish flag’s Piscean rise, and Nan-Mada-k-Koodal as a celestial confluence. Blending archaeology, astronomy, and mythology, we reimagine Madurai as a Tamil echo of IVC star-lore.

Madurai, with the Mīnākshi Temple as Orion, mirrors the Pashupati Seal’s animals across a flipped starry divide. Yānai Malai, Vaigai/Theppākulam, Samanar Hills, Pasumalai, and Keeladi align with Taurus, Eridanus, Monoceros, Canis Major, and Lepus, enriched by Pandya lore, Mīnākshi’s breast-shift, and the Piscean fish flag. *Nan-Mada-k-Koodal* crowns this as a confluence of towers and stars, the Vaigai a tigerine thread to IVC wildness. This exploration beckons further inquiry—into Madurai’s soil and skies.

Keywords: Indus Valley Civilization, Madurai, Pashupati Seal, Minakshi Temple, Orion, Tamil mythology.



Figure 2.15:

Left: Constellations around Orion;
 Right: Topology of Madurai – Scan QR code for Madurai’s heritage map

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2.13 *Orientation of sanctuaries and public spaces in the Centre Region (Turones, Carnutes, and Bituriges) from the Gallic to the Augustan period: a key to locating the Caesarian Locus Consecratus?*

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With a total of more than 50 structures measured in the Centre Region, encompassing the ancient *civitates* of the Carnutes, Bituriges, and Turones, an initial analytical table can be proposed, allowing us, through a broad chronology (from the Gallic to the Roman period), to address the question of the reorganization of religious and public spaces after the Conquest. Many *fana* or sanctuaries underwent reorientation during and after the Augustan period.

From an epistemological point of view, the interest of this study is to escape from the outdated antagonism between resistance and assimilation to Romanity, preferring instead the analysis of the Gallic substratum and the Roman contribution. This paradigm shift had already been addressed in a previous communication during the study of the cities of *Autricum* (Chartres) and *Avaricum* (Bourges) (Ravignot, to be published). Thus, by broadening the corpus to the spaces present in secondary agglomerations, the hypotheses postulated in this first communication could be verified and confirmed.

They fit perfectly into the logic highlighted by the recent study on the orientation of urban frameworks in Roman Gaul, namely: orientations favouring dates of the beginning of the season linked to the Celtic dates mentioned in Irish texts, equinoctial orientations or around April 21, Roman, because reflecting the imperial cult of Augustus (*Dies Natalis* or his Apotheosis) and the mythical date of the foundation of Rome, and lunar orientations, the growing number of which should allow us to develop interpretative avenues (García Quintela et al., 2022).

The geographical area chosen for this study brings together two important peoples in Gaul: The Bituriges and the Carnutes. The former, whose etymology “the Kings of the World”, recalls their prevalence over other Gallic peoples in the early period and having been the owners of an *omphalos*, a centre of the world (Le Roux 1961). The importance of this central stone echoes Caesar’s words in the *De Bello Gallico* (VI. 13–10) about the annual meeting of the druids in a sacred place (*locus consecratus*) that he placed on the edge of the Carnute country, and which is in the centre of Gaul. Also, some researchers have postulated a transfer of control of this highly sacred place from the Bituriges to the Carnutes.

However, research on this place mentioned by Caesar has become somewhat bogged down since the work of Alain Ferdière (1989) and Bernard Robreau (1997), being limited solely to the study of ancient texts, hagiographies and maps of bishoprics. As already



Figure 2.16:

View of the Saint-Marcel church from the *fana* of Insula A of *Argentomagus*

(© Romain Ravignot)

mentioned for the cathedrals of Chartres and Bourges, the first *ecclesia* were often built on ancient structures, thus stratifying ancient beliefs in a way (Ravignot 2023, Galinié & Zadora-Rio 1996). Also, by correlating the archaeological study of these first buildings with their orientations, it is possible, in certain cases, to reach the Gallic or Roman levels.

The two researchers place the *Locus Consecratus* in three locations, without being able to resolve the issue: Saint-Benoît-sur-Loire, Micy-la-Forêt, and La Chapelle-Saint-Mesmin. They are close to each other, positioned on bends in the Loire River, and gave rise to the founding of important religious communities as early as the Early Middle Ages.

Analysis of the astronomical orientations of these buildings allows us to make connections with the iconography present on numerous architectural blocks, archaeological data, and the hagiography and ancient texts that trace their construction.

Based on this knowledge, we are able to determine that Saint-Benoît-sur-Loire is the most likely Caesarian *locus consecratus*.

Keywords: Gallic period, Augustan period, Augustus *Dies Natalis*, Caesarian Locus Consecratus, Saint-Benoît-sur-Loire.

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Figure 2.17:
View of the apse of the abbey church of Saint-Benoît sur-Loire

(© Romain Ravignot)

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2.14 *Are any Byzantine churches in Cyprus converted mosques?*

An archaeoastronomical approach

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Christian presence in Cyprus has been attested from as early as the 4th century with its church made autocephalous in 431 (Stylianou 1978, 450), and over 70 early Christian basilicas have been excavated on the island (Maguire 2012, II 1 for a map and III for details). The Arabs invaded Cyprus in 649, and after years of conflict, in 688, the Byzantine emperor Justinian II and Umayyad caliph 'Abd al-Malik ibn Marwān reached an unprecedented agreement of joined control of the island (Dikigoropoulos 1979, 354–358; cf. Metcalf 2009, 576). This so-called “condominium” era lasted for three centuries, even amid constant battles between the two empires elsewhere (Dikigoropoulos 1979, 361; cf. Metcalf 2009, 434, 486). The Byzantines regained control in 965, which lasted until Richard the Lionheart landed on Cyprus in 1191 forcing the byzantine governor to flee (Papadopoulos 1979, 301; Metcalf 2009, 566).

Given this period of conquest and cohabitation, we sought to know whether any of the churches built during this period or shortly after might reflect this shared history. To that end, we used remote sensing (Google Earth Pro and Peak Finder) to measure the orientation of Byzantine churches Cyprus dated from the 11th and 12th century, and discuss whether they may have been repurposed mosques. In Spain, for instance, the conquest of Christians after the Muslim domain left examples of churches with orientations that might reflect this repurposing, by rotating the liturgical axis (García-Ortega, 2015). We do know of an Arab-speaking Christian community in Cyprus by the 11th century (Stewart 2008, 285). Thus, suggestions about Muslims and Christians sharing the same sacred spaces for worship (Stewart 2008, 190; Olgun & Zavagno 2019; Foulías 2005; Hatay 2015, 87) may explain why no pre-Latin period mosques have been preserved on the island (Kaffenberger 2020).

In particular, we discuss five churches (see Fig. 2.18) that have orientations that can be associated with the directions of qiblah orientations favored at the time of the Arab presence on the island. However, the typology of these buildings makes it unlikely that they were purposely built mosques, although we can neither confirm nor entirely reject the possibility of Muslims and Christians (especially Arab Christians) shared the same sacred spaces for worship, especially considering their orientations.

Keywords: Byzantine Cyprus, Medieval Cyprus, orientation of churches, qiblah.



Figure 2.18:
Location of churches discussed in the present study
(Google Earth)

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2.15 *Further Thoughts on the Accuracy of Online Tools from Sardinia*

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Figure 2.19:
Church of Santa Maria in Tergu, Sardinia

(Photo: Mauro Peppino Zedda)

In SEAC XXIX the second author presented a paper on the orientation of 47 Sardinian churches (Dallas 2024) using online measuring tools (and 7 also with compass measurements). Unknown to him was that the first author had measured 185 Sardinian churches in situ (Zedda 2012, 70–79). Therefore, it is an opportunity to combine the two and have more results on the accuracy of Google Earth Pro [=GE] which is widely used in archaeoastronomy. Between us, we located and measured approximately 150 churches. In the 7 in situ measurements of Dallas (2024) the mean value of difference was $(+0.2 \pm 0.6)^\circ$.

There is only one church measured in situ both in Dallas (2024) and Zedda (2012) and the difference between the two compass measurements was 1° , in line with Munro & Malville (2010).

We used the history feature of GE to select the best satellite images in each location. These have NIIRS (National Imagery Interpretability Rating Scale) scale of 7 (resolution of 20–40 cm) or 6 (resolution of 40–75 cm). We made sure that we had between 5 and 12 measurements from at least two different GE photos of different parallax and lighting; averaging among them gave the GE measurement of the azimuth of the church, as well as a standard error for each measurement. Our provisional mean error for all the churches is impressively under 0.3° .

This is consistent with previous studies (Romain 2022, and references therein) and demonstrates the usability of GE for archaeoastronomical research. However, we should point out that our study did produce significant outliers, whilst our resulting distribution is not normal.

Keywords: Accuracy of Google Earth Pro; azimuth; Sardinia; orientation of churches.

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Session in Planetarium Hamburg

2.16 *Humans and the Cosmos:*

*From the World Cave to the Big Bang –
Anthropology, Ecospheres, and Cultural Cosmologies*

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For thousands of years, we have looked up to the heavens and asked ourselves: Where did we come from? How did the world (today the gigantic cosmos) come into being? How is it structured? How did it develop? What is its and the human future?

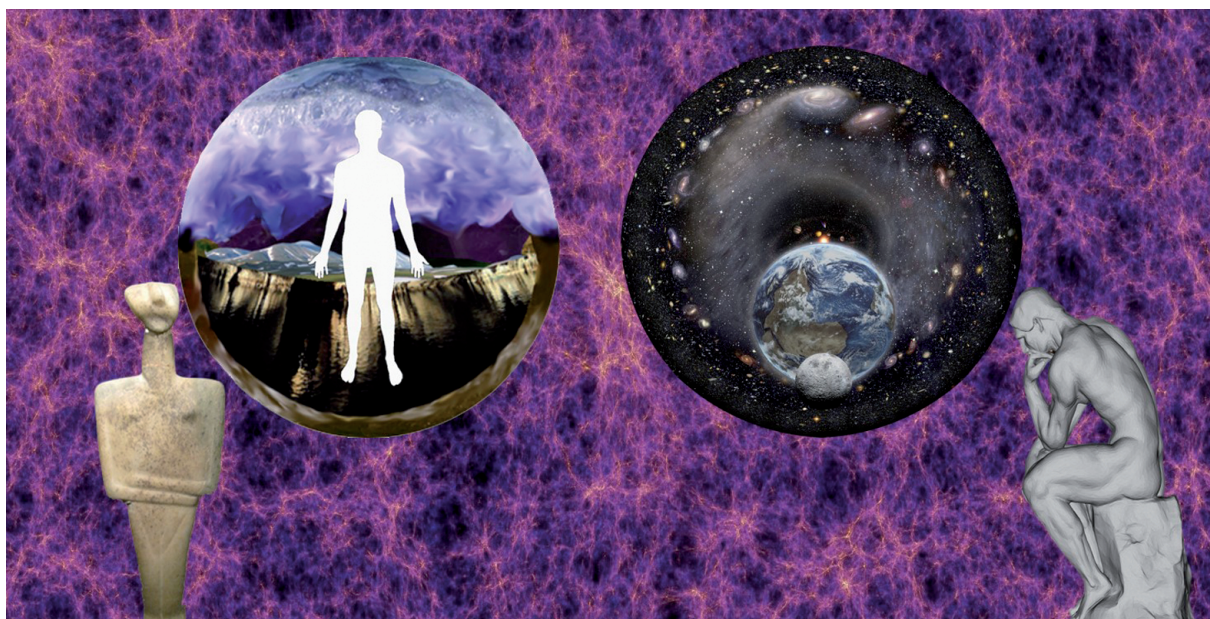


Figure 2.20:

Humans and the Cosmos – From the World Cave to the Big Bang

(Collage consisting largely of image elements (Cycladic figure, human in geode, the thinker is CC), created by the author. The background of the cosmic web is licensed to: Volker Springel (Max Planck Institute for Astrophysics) et al., ESA. Logarithmic overview image: Pablo Carlos Budassi, CC BY-SA 3.0.)

From the first cave paintings and the shadow stick to the latest discoveries of the James Webb Space Telescope – humankind has always tried to understand its existence in the world. Travelling through time shows us how our perspectives have changed. In the

past, myths dominated, filling the sky with divine beings and stories about them. People shaped their relationships with the cosmos in a variety of cultural manifestations. Cosmic phenomena, processes and objects became ‘earthbound’ and tangible: in the landscape, in architectural monuments, on objects, clothing, in the fine arts, in games, in religious, social, political symbols, myths and rituals, partly up to the present day.

Today we use scientific methods to explore the cosmos. The transition from a mythological to a scientific cosmology is a prime example of a paradigm shift that has revolutionised our view of the world. With the James Webb telescope, but also many other instruments, now also supported by AI, we are on the threshold of new insights and paradigmatic upheavals in our world view and our worldviews.

Some of our questions about the deepest mysteries of the cosmos, which have preoccupied us since prehistory, will be answered, but many new ones will be raised. The cosmologies of cultures, as studied by a cultural cosmology, reflect our human possibilities and limitations, our embeddedness in ecospheres and intellectual history. Since Palaeolithic times and still in the age of space travel and modern astronomy the core question of a cultural cosmology is how humans, earth, and cosmos relate to each other. The lecture thematises the connections between anthropology, ecospheres, and cultural cosmologies from prehistory to the present day.

Keywords: World Cave, Anthropology, Ecospheres, Cultural Cosmologies.

Session 3: Medieval and Renaissance Culture

2.17 *Where East meets West: A preliminary analysis of the orientation of historical churches in Romania*

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The East-West Schism in the 11th century split Christianity into the Roman Catholic Church and the Eastern Orthodox Church. This division resulted in significant differences in liturgical practices and architectural styles between the Roman and Byzantine rites. The Roman rite, predominant in the Catholic Church, is characterized by its simplicity and the use of a central altar. In contrast, the Byzantine rite, followed by the Orthodox Church, is distinguished by its elaborate liturgy and the use of an iconostasis – a screen of icons separating the sanctuary from the rest of the church.

Lying between Eastern and Western influences, Romania is characterized by diverse architectural styles and religious practices. Historically, southern and eastern regions were dominated by the Byzantine rite while western regions were split between Roman, Byzantine and Greco Catholic rites. The emphasis on iconography and the use of natural light to highlight religious frescoes and icons are key aspects of Romanian church design (Ivanovici & Sullivan, 2022). Orthodox churches also feature astral symbols, particularly the sun and moon, as decorative motifs. In some churches, zodiac signs and representations of solar systems (see Fig. 2.21) appear on the ceilings-unique elements that may symbolize the passage of time and cosmic order.

In fact, Romania is home to numerous religious UNESCO World Heritage sites, such as the painted Orthodox churches of northern Moldavia (see Fig. 2.22), from the 16th century (Sullivan, 2017), and the wooden, mostly Orthodox with few Greco Catholic, churches of Maramureş, mainly from the 17th and 18th centuries (Ilieş et al., 2016). However, the fortified churches of Transylvania, mostly built between the 13th and 15th centuries by German communities, were originally designed in Romanesque or Gothic styles, thus resembling the western traditions.

The aim of this study was to analyze the orientations of these distinct groups, each forming a homogeneous and representative sample covering various styles, historical periods, regions, and religious communities, with a particular focus on identifying potential differences between Orthodox and Catholic orientation patterns. Our analysis included also less-known wooden Orthodox churches from Banat, dated mostly from the 18th century,



Figure 2.21:

The wooden church of Șurdești in Maramureș,
with a painting of a solar system

(Photo: Maitane Urrutia-Aparicio)

and a few from Salaj County. In total, 143 churches have been measured (34 in Banat, 19 in Bukovina northern Moldavia, 64 in Maramureș and Salaj, 26 in Transylvania).

Similar to other western – catholic – countries, the preliminary results from the wooden churches of Banat and Maramureș have revealed two predominant orientation patterns: towards the sunrise on the equinox and on Easter Sunday. Since Easter is one of Christianity's most significant celebrations, both in the Orthodox and Catholic branches, orienting churches toward the sunrise on this day seems reasonable. Another notable finding is that many of these churches were relocated over time for various reasons, e. g., flooding, Tatar invasions, religious reasons (relocation of Orthodox believers unwilling to switch to the Romanian Church United with Rome, Greek-Catholic). Although the original orientations are unknown, the relocated churches were consistently oriented according to these 'canonical' traditions, suggesting an effort to maintain the symbolic importance of their orientation.

Keywords: Romania, Orientation of churches, Eastern Orthodox.



Figure 2.22:
The Moldovița monastery in Bukovina, built in 1532

(Photo: Maitane Urrutia-Aparicio)

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2.18 *Astronomy, Defense, and Faith: The Astronomical Alignment of Catholic Churches in the Historic Center of Rio de Janeiro*

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This paper is part of a broader study investigating possible astronomical alignments of Catholic churches located in the historic center of Rio de Janeiro.

This study seeks not only to elucidate the technical aspects of the churches' alignments but also to understand how historical, urban, and strategic factors shaped the religious landscape of colonial Rio de Janeiro. The research highlights the need for an interdisciplinary approach to analyzing religious spaces as religious, cultural, and scientific manifestations of the period.

The study was motivated by the existence of similar research in many Western countries, particularly in Europe. The relationship between astronomy and religious architecture has been a scarcely explored topic in the historiography of science and sacred art, even though it has been documented within the rigorous canons of the Catholic faith since its early days. In various historical and geographical contexts, religious temples were designed to reflect astronomical knowledge, often linked to liturgical calendars or sacred representations.

Our research adopted a documentary approach combined with field investigation. The documentary analysis of church construction records, along with on-site measurements, was complemented by studies of city maps associated with transformations in the urban space. Churches built between the 17th and 19th centuries were selected, a period initially marked by the influence of the Portuguese Crown in socio-urban organization. In addition to the axial orientation of the churches concerning the cardinal points and the Sun's position on liturgical dates, we also analyzed the influence of urban layout and projects associated with colonial concerns regarding the city's security against invaders and the positioning of these temples.

The results indicate that there is no single, systematic pattern of astronomical alignment among the studied churches. While some exhibit an approximate eastward orientation, others are aligned according to the street grid and local topography, suggesting that urban

and practical factors played a significant role in construction decisions. Additionally, the analysis of city defense projects suggests that churches may have been considered strategic buildings, reinforcing the hypothesis that the city's defensive function influenced its spatial organization more than astronomical orientation.

These findings contribute to the debate on the transmission of astronomical knowledge during the colonial period and the role of religious orders in shaping the urban space of Rio de Janeiro. Furthermore, the research provides insights into the city's architectural heritage, highlighting the complex interaction between faith, urban planning, and territorial defense. Future steps include expanding the sample of analyzed churches and conducting a more detailed investigation of documentary sources regarding the criteria used for the orientation of religious constructions.

Keywords: Church Alignment, Cultural Astronomy, Archaeoastronomy, History of Astronomy, Rio de Janeiro.

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2.19 *Geometric Analysis and Advanced Surveying Techniques in the Study of Early Christian Starry Skies*

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This abstract presents the results of research conducted on the representations of starry skies in Early Christian architecture in Italy, focusing on the analysis of geometric tracings. The study adopts an innovative approach that combines traditional art-historical methodology with the use of advanced digital surveying tools, allowing for a deeper understanding of the relationships between the mosaic surfaces and the architectural structures that host them. The period studied, spanning from the 4th to the 6th century, is crucial for the development of Christian art and the design of decorative elements, in which geometric and astronomical knowledge played a decisive role.



Figure 2.23:

Mausoleum of Galla Placidia (Ravenna): digital survey

(© Manuela Incerti)

A central aspect of this research is the critical analysis of the geometries underlying the composition of mosaic skies. Advanced surveying techniques, such as laser scanning and photogrammetry, are fundamental in this process, as they allow for the acquisition of

high-precision three-dimensional data, revealing morphologies and textures that are not decodable by the naked eye. The interdisciplinary approach adopted integrates historical, archaeological, and geometric data, providing a comprehensive and detailed view of the studied phenomenon.

The methodologies developed have been applied to several significant case studies, including the Mausoleum of Galla Placidia, Santa Maria di Casaranello (Casarano, Lecce), the Baptistery of San Giovanni in Fonte (Naples), and the Martyrion of Vicenza. Starting from the survey data of the Mausoleum of Galla Placidia (Fig. 2.23), two-dimensional representations were produced that allowed for the analysis of the star distribution on the dome. Initially, the distribution appeared to be organized into concentric circles belonging to horizontal planes, but a more in-depth analysis revealed the presence of non-planar curves, suggesting the existence of a well-defined geometric tracing technique. The presence of such complex geometries in ancient architecture is not surprising, given the interest in similar forms already in classical times.

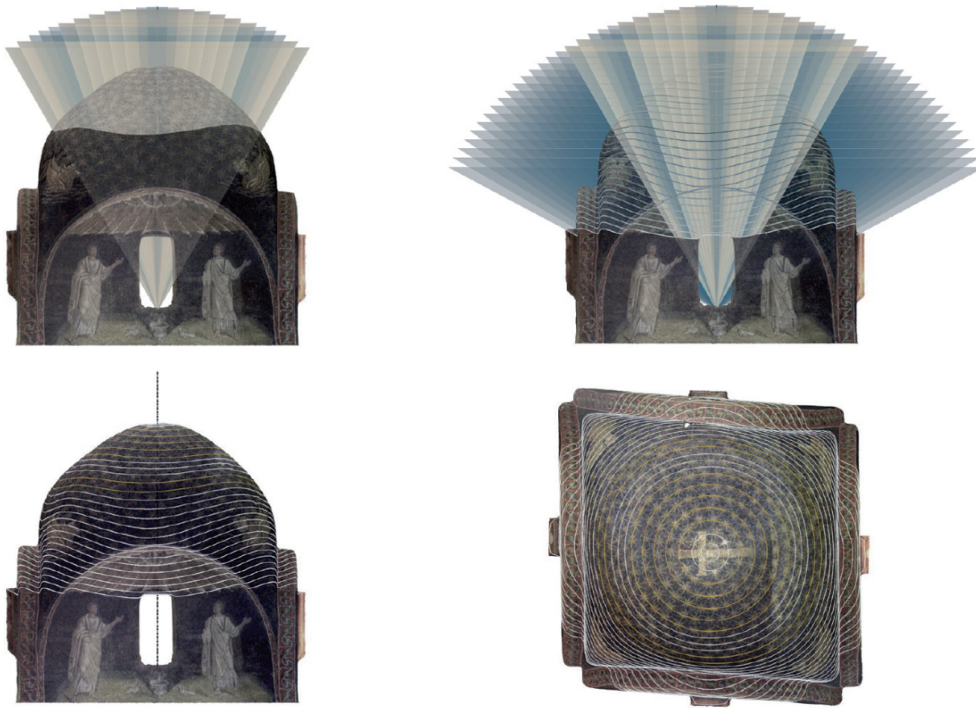


Figure 2.24:
Mausoleum of Galla Placidia (Ravenna): a system of vertical circular cones

(© Manuela Incerti)

In the case of the starry sky of Galla Placidia, the first element analyzed is the surface of the dome itself, whose geometric matrices are not immediately recognizable. The complexity of the surface required the use of advanced techniques for its rigorous documentation. Secondly, a system of vertical circular cones was identified, which allowed the decorative elements to be arranged in an orderly fashion. The analysis showed that the distribution of stars along the surface of the vault was carried out through a process that,

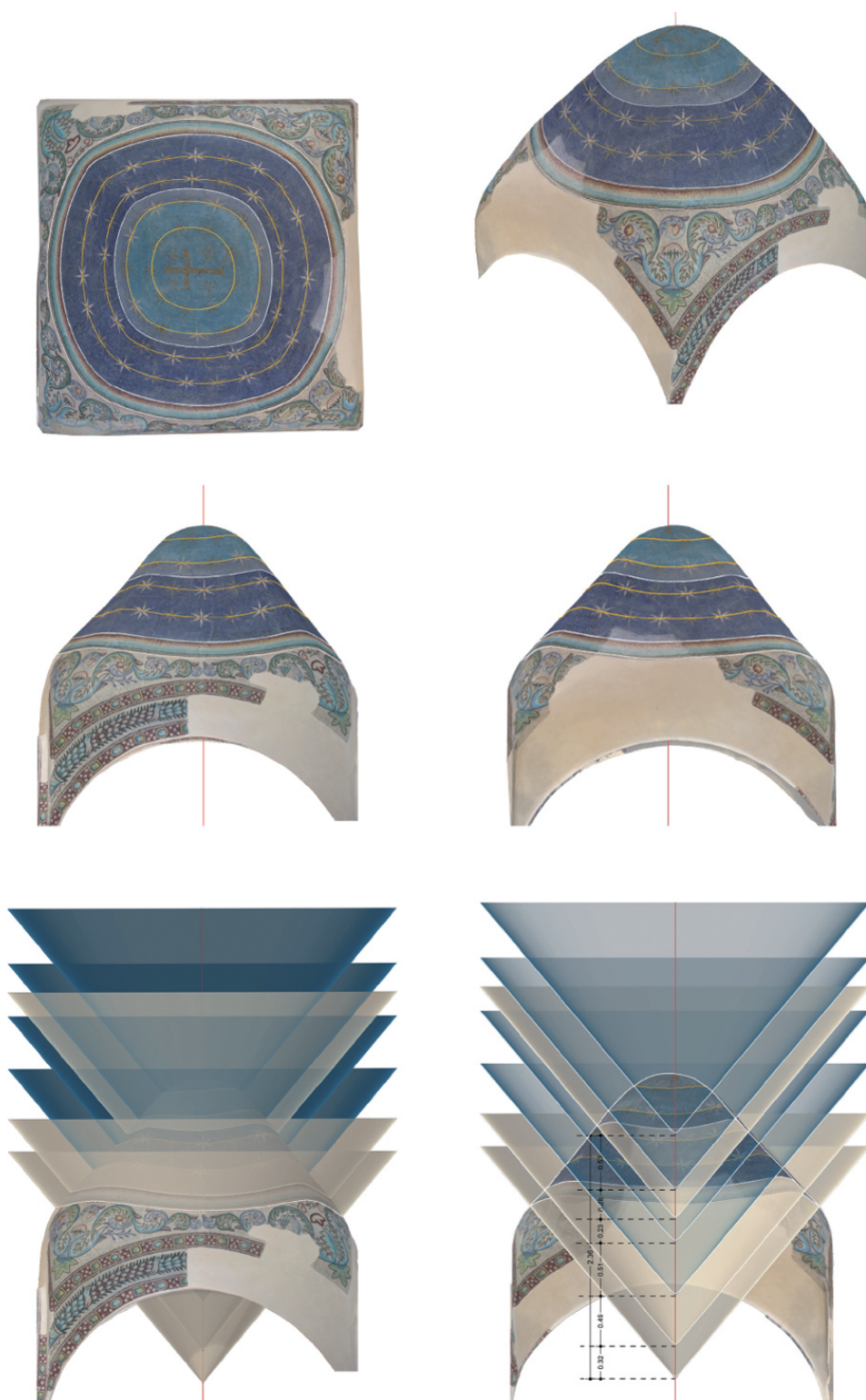


Figure 2.25:
 Santa Maria di Casaranello (Casarano, Lecce):
 a system of vertical circular cones

(© Manuela Incerti)

subsequently, will be codified as central projection. The intersection operation results in a system of distinct curves (non-planar), with increasing lengths and more pronounced trends, which are not perceptible to the naked eye (Fig. 2.24).

This tracing technique (with some variations on the position of the cone's apex) was also applied to the starry skies of Santa Maria di Casaranello (Casarano, Lecce) (Fig. 2.25), the Baptistery of San Giovanni in Fonte (Naples), and the Martyrion of Vicenza. All of these cases confirm the use of a common geometric principle, likely achieved with advanced tools and techniques for the time, such as Ptolemy's Triquetra and the corresponding Table of Chords. Although these tools were simple compared to modern technologies, they allowed for angular measurements and trigonometric calculations with surprising precision.

Keywords: Starry Skies, Architectural Survey, Cultural Astronomy, Digital Modeling, Geometry.

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2.20 *Astronomical Clocks and Gottorf Globe – Astronomical Heritage in the Baltic*

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Astronomical clocks, high tech of the Middle Ages (14th and 15th century), are a valuable astronomical heritage of the Hanseatic League in the Baltic region, representing the clock-work universe, a geocentric world model. Examples can be found in Lübeck (1405, 1566, 1955/67), Bad Doberan (1390), Rostock (1379, 1472), Stralsund (1394), Lund/Sweden (1422, 1923), Danzig/Gdansk (1470, 1997), Stendal/Saxony-Anhalt (1430/35, 1552), and Münster/Westphalia (1408, 1542, 1932). Typical are the two disks – an upper disk, the astrolabe with the temporal and equinoctial hours, the times of sunrise and sunset, lunar phases, lunar nodes (dragon hand), the position of the Sun and Moon, and rarely also of the planets, in the zodiac, and the lower calendar disk showing the date (day, month and year), the saints of the day, the Sunday letters, the Moon cycle / Golden number (important for the Easter calculation). Sometimes they offer also a parade of the Three Magi around Maria or later of the Apostles around Christ, ruling the cosmos, and a carillon. What role does astrology play in astronomical clocks? It is interesting, that changes were made due to the Reformation in this protestantic Baltic region. The astronomical clocks in the former Hanseatic cities form a special group, in contrary to the clocks of the Free Imperial Cities in Southern German states and in Central Europe, but all demonstrate power and knowledge either of the church or of the city.

Frederick III (1597–1659), Duke of Schleswig-Holstein-Gottorf, promoted Baroque science, art and culture, and commissioned the Gottorf Globe. The globe, with a diameter of 3.1-m, was designed by the court scholar and librarian Adam Olearius (1599–1671) and manufactured by the gunsmith Andreas Bösch (fl. 1657) of Limburg. The Gottorf Globe (1650–1664) is extremely interesting in the context of cultural heritage and history. The interior depicted the constellations painted after Willem Janszoon Blaeuw (1571–1638), highlighted by golden stars illuminated by candles. The entire globe could be rotated by hand crank to simulate the daily routine, but was also equipped with a complex water-wheel drive. The globe was presented as a gift to Tsar Peter the Great (1672–1725) in 1715 and can still be admired in St. Petersburg today. In 2004, a modern reconstruction of the globe was made in the Schleswig Castle Park. The Gottorf Globe, the first walk-in planetarium, can be seen as a forerunner of the projection planetarium.

The medieval monumental astronomical clocks in churches in the Hanseatic region represent a valuable astronomical cultural heritage, an ensemble characterized by science, art, craftsmanship, technology, and religion.

Keywords: Astronomical clocks, Gottorf Globe, Timekeeping, Heritage of astronomy, Cultural astronomy.

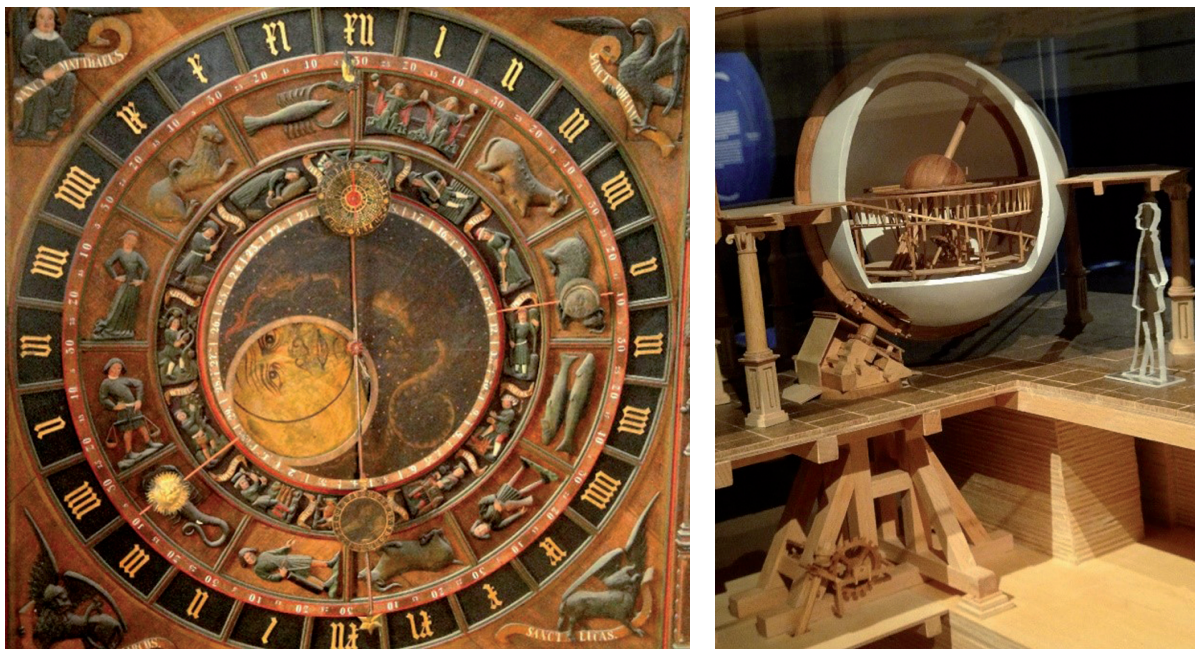


Figure 2.26:
 Left: Astronomical Clock Rostock, St. Mary (1472)
 Right: Gottorf Globe, Scheswig (1664), model

(Photos: Gudrun Wolfschmidt)

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2.21 *The planets on the old astronomical clock in Münster*

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The astrolabe clock in St. Paul's Cathedral in Münster, Westphalia, features the usual elements of astronomical clocks, such as sun and moon displays, a calendar, and the hour rulers, among others. It also features planetary pointers for Venus, Mars, Jupiter, and Saturn, as well as a manually adjustable Mercury pointer. This made it the astronomical clock with the most pointers in Germany and the only one with planetary representations, after the old Lübeck clock in St. Mary's Church was completely destroyed during the bombing of World War II.

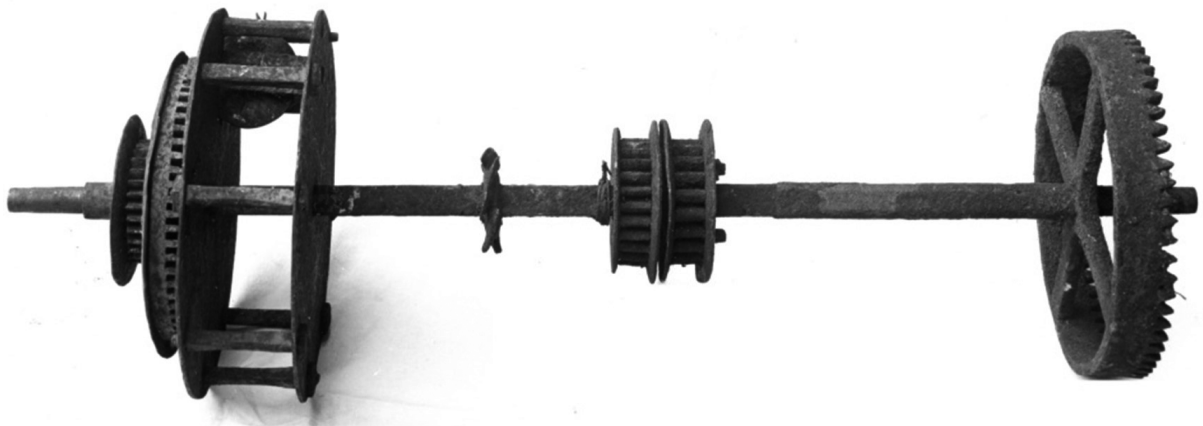


Figure 2.27:

Preserved part of the gear mechanism of the planetarium of the old cathedral clock
(Erhaltenes Teil des Planetariums-Getriebes der alten Domuhr)

(Photo: Sammlung / Collection Claus Peter)

A major renovation project around 1930, which included the replacement of numerous parts with modern components, saved the Münster cathedral clock from decay. However, from a conservation perspective, this renovation involved interventions in the original concept and ancient technology of the late medieval and Renaissance clock that nowadays no longer seem justified. The old planetary gear system has survived only in fragments, and thus the precise knowledge of the original mechanical realization of planetary motion has been almost lost. However, from the surviving scattered remains and a few written records, it is still possible to learn a lot about the curious technical implementation of the planetarium of the old clock and to reconstruct its basic mode of operation.



Figure 2.28:

Front view of the old cathedral clock in Münster (before 1930) (Frontansicht der alten Domuhr in Münster (vor 1930))

(Photo: Sammlung / Collection Bernd Mosel)

German Version: Die Planeten auf der alten astronomischen Uhr in Münster

Die Astrolabiumsuhr im St. Paulus-Dom zu Münster in Westfalen weist neben den für astronomische Großuhren üblichen Elementen wie Sonnen- und Mondanzeige, Kalendarium, Anzeige der Stundenregenten u. a. als Besonderheit auch Planetenzeiger für Venus, Mars, Jupiter und Saturn und einen von Hand verstellbaren Merkurzeiger auf. Damit war und ist sie die zeigerreichste astronomische Uhr Deutschlands und die einzige mit Planetendarstellung, nachdem die alte Lübecker Uhr in der Marienkirche in der Bombenacht im Zweiten Weltkrieg vollständig zerstört wurde.

Durch eine große Renovierungsaktion um 1930 mit dem Austausch zahlreicher Teile durch moderne Komponenten wurde die münsteraner Domuhr vor dem Verfall gerettet. Jedoch erfolgten bei dieser Renovierung aus konservatorischer Sicht heutzutage nicht mehr gerechtfertigt erscheinende Eingriffe in das ursprüngliche Konzept und die alte Technik der spätmittelalterlichen bzw. renaissancezeitlichen Großuhr. Das alte Planetengetriebe ist nur bruchstückhaft erhalten und damit das exakte Wissen um die ursprüngliche mechanische Realisierung der Planetenbewegung fast verloren. Aus den erhaltenen verstreuten Resten und einigen wenigen schriftlichen Aufzeichnungen lässt sich aber noch einiges über die kuriose technische Umsetzung des Planetariums der alten Großuhr ermitteln und die prinzipielle Funktionsweise rekonstruieren.

Keywords: Astronomical clock, St. Paul's Cathedral in Münster, Westphalia, planetary pointers.

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2.22 Zeit und Zeitmessung im Alten Ägypten (Time and Timekeeping in Ancient Egypt)

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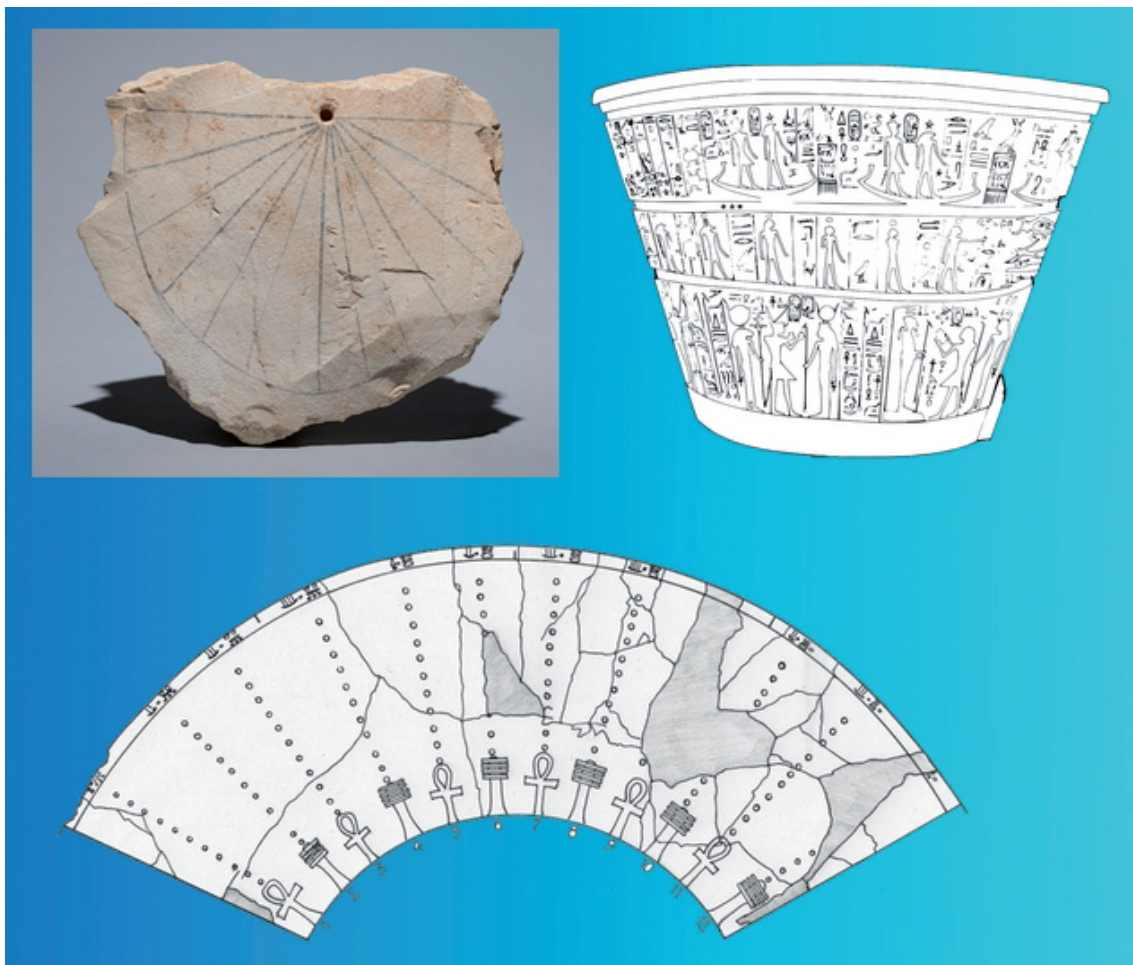


Figure 2.29:

Links oben: Sonnenuhr aus dem Tal der Könige

Rechts oben: Wasseruhr aus der Zeit von Amenhotep III.

Unten: Skalen auf der Innenseite der Wasseruhr aus der Zeit von Amenhotep III.

(Top left: Sundial from the Valley of the Kings, © University of Basel Kings' Valley Project (UBKVP),
Top right: Water clock from the time of Amenhotep III, © Rita Gautschy, Below: Scales on the inside
of the water clock from the time of Amenhotep III, © Rita Gautschy)

Im Alten Ägypten gab es zwei Begriffe für Zeit, die auf der Polarität von Dauer und Zyklus beruhen. Die exakte Bedeutung und deren bestmögliche Übersetzung wird immer noch diskutiert – im ersten Teil des Vortrags soll der Verwendung und Bedeutung dieser Begriffe in den sogenannten Pyramidentexten und Sargtexten nachgegangen werden.

Der zweite Teil wird den ägyptischen Zeitmessinstrumenten gewidmet sein – Sternuhren, Sonnenuhren und Wasseruhren.

Links: <https://www.fhsev.de/Wolfschmidt/GNT/kolloq/ring-ss25.php>,
<https://www.fhsev.de/Wolfschmidt/GNT/kolloq/abstract-pdf/k270825.pdf>.

English Version: *Time and Timekeeping in Ancient Egypt*

In ancient Egypt, there were two concepts for time, based on the polarity of duration and cycle. The exact meaning and their best possible translation are still debated-the first part of the lecture will examine the use and meaning of these terms in the so-called Pyramid Texts and Coffin Texts.

The second part will be devoted to Egyptian timekeeping instruments – star clocks (diagonal star tables), sundials, and water clocks.

Keywords: Timekeeping, Ancient Egypt, star clocks, sundials, water clocks.

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Session 4: Non-European Cultures and Ethnoastronomy

2.23 *Searching for the Most Widespread and Old Skylores*

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Across cultures and continents, skylore motifs provide insight into human cognition, cultural exchanges, and belief systems. Our research focuses on discovering which motifs are most widespread and potentially ancient. Motifs are short narrative elements that can be recombined in various myths, tales, and songs. Several researchers (Witzel, 2012; Berezkin, 2012) suggest that the oldest myths originated in Africa during the Paleolithic, diffused to Sahul (Australia and Papua New Guinea), and later with the first humans to South America. However, reconstructing the transmission of motifs from their recent distribution is inherently challenging, making it difficult to test. Using Berezkin's (2012) database of 2200 motifs across around 1000 traditions, we identified potentially old shared motifs in four isolated regions less susceptible to recent influences: Papua New Guinea, Amazonia-Mato Grosso, Australia, and among African Khoisan speakers. Their isolation is supported by genetic evidence and previous studies on myths (Thuillard, 2024). Of the motifs shared in Africa, New Guinea, and Amazonia-Mato Grosso, 80% are also found in Australia. Half the 20 shared motifs in the four areas are skylores, including the starlore "Pleiades are a group of peoples". Skylores are three times more prevalent in the subset of shared motifs than in the complete database. The skylore motifs can be grouped as follows:

Moon, sun, stars, and Pleiades as people

Ashes on the Milky Way

Spots on the moon

Eclipses, rainbow motifs

Analysis of additional traditions in South America and Melanesia revealed further shared motifs, including "sky close to Earth" and "Orion/Pleiades as male/female". The presence of the latter motif in South America challenges the hypothesis that all widespread motifs arrived with the first people in America. According to the Beringian standstill hypothesis, the first migrants spent a considerable time on the Beringian land bridge, where, due to its latitude, Orion was invisible. If the first migrants had brought this motif, they would unlikely have preserved a story about an unseen constellation. Thus, its presence in America suggests a later arrival, potentially with subsequent migrations or through independent development within the Americas.

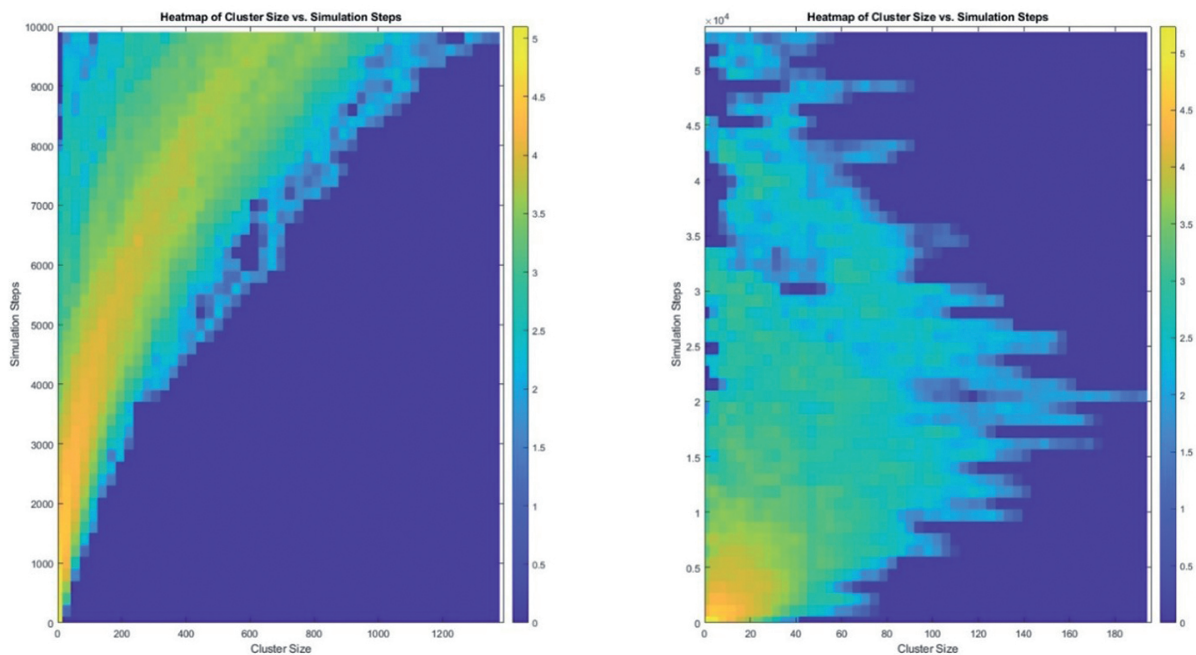


Figure 2.30:

Heatmap relates the number of clusters of some size (x-axis) with simulation steps (y-axis).

Left: Critical regime. Right: regime close to criticality.

This regime best fits the observed size distribution of motifs in the database.

(Simulation: © Marc Thuillard)

We applied a birth-death diffusion model to understand better how motifs spread over time (Thuillard, 2024, SEAC24). Fig. 2.30 shows examples of the two diffusion regimes: the critical regime with exponential growth and a subcritical regime where, ultimately, all motifs disappear. Importantly, the above result holds for a broad class of models. The observed distribution of motifs, with a few widespread and many localized ones, best fits the birth-death diffusion model in a near-critical regime, suggesting that while some skylore motifs have persisted across vast distances, most motifs are prone to rapid disappearance and localized distribution. In this regime, the spatial extent of a motif's presence does not directly correlate with its age and origin, complicating efforts to infer timelines solely from geographic distribution (Fig. 2.30, right panel).

Our simulations suggest rapid loss of origin information for most motifs. While reconstructing the deep past from recently recorded motifs is inherently difficult, our findings highlight the remarkable persistence of certain skylore narratives across vast distances and for some over millennia. The identified widely shared skylores appear to be 'fossil' motifs, likely in a slightly critical regime (Fig. 2.30, left), contrasting with the subcritical regime of most other motifs. Alternatively, some motifs may have arisen independently in multiple regions.

Keywords: Cultural astronomy, Dating skylore, Data analytics.

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2.24 *Revisiting the Lunar Series on the Tikal Ballgame Marker – a new Hypothesis*

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One of the most essential Early Classic texts was found during excavations in Group 6C–XVI at Tikal. The artifact represents a replica of a Teotihuacan-style war banner and contains two medallions: one with the Teotihuacan glyph “Three Tlaloc” and the other depicting an owl with a spearthrower. The object includes an inscription commemorating the conquest of the neighboring city of Uaxactún in 378 CE. The artifact was commissioned by Sihyaj Chan K’awiil II, probably in 416 CE.

The text on the object is also the oldest Maya document containing two dates, with two Lunar Series attached. One refers to 378 CE, and the other to 414 CE..

The hypothesis is that the Lunar Series for 378 was likely calculated backward from the dates 414/416 CE. This conclusion is because, as a result of a lucky twist of fate, the same date (378 CE) with the Lunar Series attached was registered on Stela 5 from Uaxactun and thus reflects what the Maya recorded on that day. The information on Stela 5 gives a different Lunar Series.

Furthermore, both lunar series also show changes in the way information about the phases of the moon was recorded. Compared to the second and later dates, the first or older Lunar Series does not include information about the length of the lunar month (29 or 30 days), but this notation was not known in the era to which it refers. The text on the ball game marker reflects the changes that occurred in the encoding of information about the phases of the moon.

What is fascinating, however, is that the order of the three lunar semesters at Tikal may have been different than at other Maya centers. This paper raises a hypothesis regarding a different sequence of lunar semesters at Tikal by the end of the 4th century CE.

Keywords: Maya Astronomy, Tikal, Lunar Series, Lunar Calendars.

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Figure 2.31:
Ballgame Marker

(© Museo Nacional de Antropología y Etnología, Ciudad de Guatemala)

2.25 *The role of historical sources and digital repositories in Cultural Astronomy studies: a case study*

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In this work, we aim to highlight the need to expand the foundation of historical sources within the field of cultural astronomy, emphasizing and detailing methodological processes related to digital repositories by researchers in the field. Based on a case study related to two works by the German ethnologist and explorer Theodor Koch-Grünberg (1872–1924), we seek to recognize the potential of integrating traditional bibliographic research with materials found in digital repositories. Such an approach is particularly valuable as it enables remote access to often rare databases, expanding their content, analysis, and interpretation.

In general terms, the foundational pillars of cultural astronomy are rooted in the history of science, particularly the history of astronomy, as well as in ethnoastronomy and archaeoastronomy. Additionally, socioastronomy, along with communication and language studies, provides complementary perspectives. The interdisciplinary nature of cultural astronomy and the vast availability of relevant materials in diverse formats – such as reports, field notebooks, photographs, films, diaries, and correspondence are an additional challenge for researchers. Prior experience may offer an analytical advantage; however, theoretical and methodological approaches do not always succeed in unraveling the complexity of sky-earth relationships, particularly due to their evident intersections with other disciplines. In addition to traditional physical sources found in libraries and archives, there is a growing number of digital repositories comprising digitized texts and iconographic materials, including maps and photographic records.

In this research, we present a case study that demonstrates the potential of digital repositories, particularly for research involving historical sources in cultural astronomy focused on South America. The northern and northwestern regions of the Amazon have been more extensively explored since the late 19th century, particularly by European colonizers and their American descendants. By the early decades of the 20th century, explorers, missionaries, ethnographers, and military personnel had produced a wide range of records, especially regarding the Indigenous ethnic groups that had inhabited these regions for thousands of years.

To illustrate the potential of digital repositories for historical documentation research in cultural astronomy, we selected an emblematic case associated with the theme of cultural



Figure 2.32:

Koch-Grünberg, Theodor: *Zwei Jahre bei den Indianern Nordwest-Brasiliens* (1921). *Vom Roroima zum Orinoco: Ergebnisse einer Reise in Nordbrasilien und Venezuela in den Jahren 1911–1913. Band II: Mythen und Legenden der Taulipang- und Arekuna-Indianer* (1924).

(Koch-Grünberg, Theodor, 1921,1924)

astronomy in South America. This study is based on two works by the German ethnologist and explorer Theodor Koch-Grünberg, who focused primarily on the Indigenous Pemon peoples (Arekuna and Taulipang) living between Venezuela, Guyana, and Brazil in the early 20th century. His research influenced later scholars who conducted studies on dozens of ethnic groups across a significant portion of the Amazonian territory. Additionally, Koch-Grünberg was a pioneer in using photography as an ethnographic document.

One of his works, *Vom Roroima zum Orinoco: Ergebnisse einer Reise in Nordbrasilien und Venezuela in den Jahren 1911–1913* (From Roraima to the Orinoco: Results of a Journey in Northern Brazil and Venezuela in the Years 1911–1913), significantly influenced Brazilian Modernist writer and intellectual Mário de Andrade in writing a classic of Brazilian literature, *Macunaíma – o herói sem nenhum caráter* (1928). This work became a landmark in Latin American literature and was based on myths described by Koch-Grünberg in his book. In addition to myths associated with asterisms corresponding to Western constellations-such as Orion, Taurus (including the Pleiades and Hyades clusters), Centaurus, and the Southern Cross-*Vom Roroima zum Orinoco* presents a comprehensive cosmological vision of the extensive area visited by its author. The book's rich photographic archive also serves as documentation that complements the textual information.

In another book, *Anfänge der Kunst im Urwald: Indianer-Handzeichnungen auf seinen Reisen in Brasilien, gesammelt von Dr. Theodor Koch-Grünberg* (The Beginnings of Art in the Jungle: Indigenous Hand-Drawings Collected by Dr. Theodor Koch-Grünberg. During His Travels in Brazil), explicit references appear to the asterisms Kobéua and Miriti-Tapuia, respectively from the Cuduiary River and the Tiquié River, which are associated with Western constellations, as reproduced in a celestial chart by Koch-Grünberg.

Although printed translations of these works have been published recently, access to the original editions remains crucial for comparative research on content and translation accuracy. In the field of the history of science, remote access to authors and original works via digital repositories represents a methodological approach that deserves further recognition.

In summary, although some documents are well-known and have been extensively analyzed for their core content, it is essential to recognize their value as historical sources for both the history of astronomy and cultural astronomy. Written records such as reports, field diaries, and correspondence available in digital repositories constitute and represent significant historical sources of information and knowledge.

Keywords: Ethnoastronomy, Digital Repositories, Indigenous Peoples, Koch-Grünberg, Cultural Astronomy.

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2.26 *Water clock and sundials from the reign of King Sejong (1397–1450) of the Joseon Dynasty*

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Korea officially has a long history, starting in 2333 BC. Until the Joseon Dynasty, the last dynasty, the rulers and kings of that time not only worshipped the sky because they believed that their power came from the sky, but also did not neglect observing the sky because they thought that changes in astronomical phenomena in the sky were changes in their ruling power. Although celestial observation had an astrological aspect, it contributed significantly to the development of astronomy, which corresponds to celestial observation today. *Samguksagi* (Chronicle of the Three Kingdoms), for example, contain numerous observational data, such as changes in the Sun and Moon, solar eclipses, auroras, meteors, comets, and guest stars. Unfortunately, all observational instruments used at that time have disappeared, but numerous Chronicles contain detailed records of observational data and methods of making and using the observational instruments used at that time.

Geographically, Korea borders China and has therefore been heavily influenced by China in various areas. Especially since the Three Kingdoms period (*Goguryeo* (37 BC – 668 AD), *Baekje* (18 BC – 660 AD), and *Silla* (57 BC – 935 AD)), the calendar used in China has been used. Accordingly, the time used in China, although the latitude and longitude are different, was inconvenient in many ways because it uses the same time as China. King Sejong, the 4th king of the *Joseon* Dynasty (1392–1910), improved these inconveniences and, in particular, by using the time and calendar appropriate to the *Joseon* Dynasty, increased productivity through precise timing of agriculture, which was the basis of the country at that time, and encouraged people to use precise time, thus achieving the status of a sovereign and independent nation.

Since celestial observation was related to the ruler's power, all observations were conducted within the palace. Appropriate observation facilities and instruments were also created within the palace. Experts were permitted to conduct systematic observations, centered on *Seowoon-gwan* (書雲觀), a special government office for astronomy.

Sundials include the simple gnomon *Gyupyo* (圭表), the portable equatorial sundials *Hyeonjuilgu* (懸珠日晷), *Cheonpyeongilgu* (天平日晷), the hollow sphere sundial *Angbuilgu* (仰釜日晷), and *Jeongnamilgu* (定南日晷), a sundial in the shape of an armillary sphere that displays time as a point of light. There is also the *Ilseong Jeongsi-ui* (일성정시의), a disc aligned with Polaris, for measuring day and night time.

Particularly interesting is the sundial *Angbuilgu*, which was made by Jang Yeong-Sil, I Cheon and Kim Jo in the 16th year of King Sejong's reign (1434), characterized by a concave hemispherical shape. In addition to the time indication, it depicts the Sun's course in the sky through the twelve signs of the zodiac. It is a representative sundial of the *Joseon* Dynasty and is a valuable scientific cultural heritage.



Figure 2.33:

Left: *Angbuilgu* (hemispherical sundial) in the National Palace Museum
 Right: Automatic Water Clock *Jagyeongnu* In the National Palace Museum of Korea

(© Astronomy and Space Science Institute)

The water clock was *Jagyeongnu* (自擊漏), a system of outlet water clocks that automatically displayed and audibly displayed the time through a rolling ball with bells, gongs and drums, depending on the water level in a pipe. Jang Yeong-Sil, the best instrument maker during the reign of King Sejong, also completed *Jagyeongnu*, a water clock with an automatic time signal, in 1434 (the 16th year of King Sejong's reign). *Jagyeongnu* incorporates Islamic engineering elements through its use of an iron ball and a signaling device. This instrument was likely developed by the brilliant Islamic engineer Ismail al-Jazari (12th /13th century) to automatically indicate time using iron balls. It is believed that the principle of the water clock was probably introduced to Korea via the Silk Road during the *Joseon* Dynasty.

This conference will focus on the sundials, *Angbuilgu* and water clocks, *Jagyeongnu*, which were built during the reign of King Sejong in the *Joseon* Dynasty.

Keywords: Timekeeping, Astronomical Instruments, Sundials, Water Clock, Korea, Heritage of astronomy, Cultural astronomy.

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2.27 *Kosmos in Stein: Archäoastronomische Aspekte des Anantalingeśvara Mahādeva Tempels in Nepal*

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Der Anantalingeśvara Mahādeva Tempel in Dhadhikoṭa in Bhaktapur, Nepal, zählt zu den ältesten kontinuierlich genutzten Tempelanlagen Südasiens. Im Rahmen des “Nepal Temple Project” wurde die Tempelanlage umfassend archäologisch untersucht, dokumentiert und digitalisiert. Ziel dieser Arbeit ist es, die enge Verbindung zwischen Architektur, Raumordnung und klassischer indischer Astronomie herauszuarbeiten – insbesondere im Hinblick auf kosmologische Konzepte der späten Licchavi-Periode (ca. 5.–7. Jh. n. Chr.).



Figure 2.34:

Left: Isometrische Draufsicht des Grabungsareales vor der westlichen Ziegelmauer I & II W001
(Isometric top view of the excavation area in front of the western brick wall I & II W001)

Right: Quadrocopter im Einsatz für das Structure-from-Motion Verfahren
(Quadrocopter in use for the structure-from-motion process)

(© Perry Lange)

Die präzise Ost-West-Ausrichtung des Haupttempels, der Aufbau der Anlage nach cardinalen Richtungen sowie ikonographische Elemente (z. B. Darstellung des Śiva-Liṅga im Zentrum als Axis Mundi) legen nahe, dass astronomisches Wissen maßgeblich die Gestaltung und Funktion des sakralen Raumes bestimmte. Besonderes Augenmerk gilt der Untersuchung der Orientierung des Tempels anhand geodätischer Vermessungen (UTM 45 / WGS 84) und der Interpretation epigraphischer Quellen mit astronomischen Bezügen,

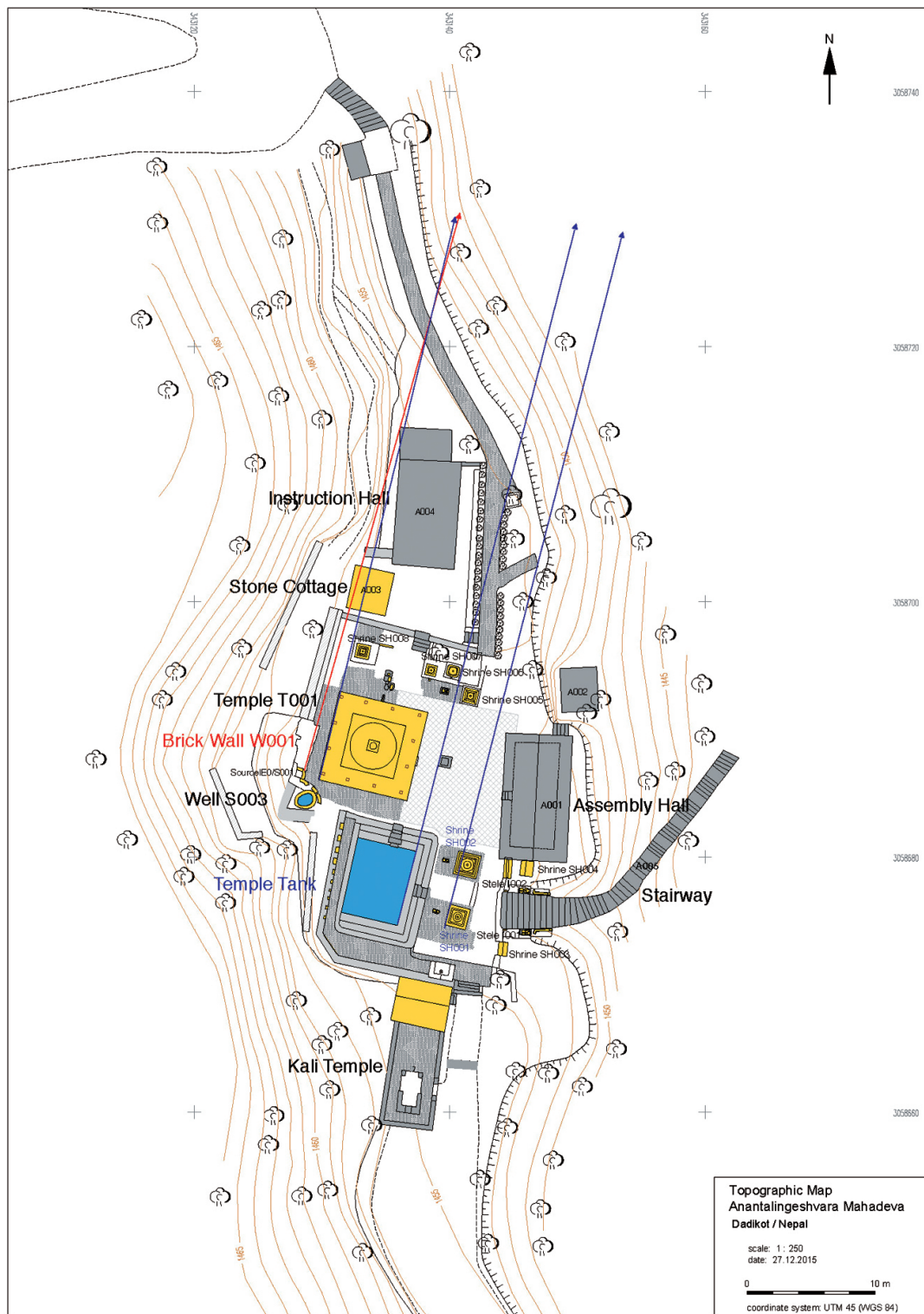


Figure 2.35:

Topographischer Plan des Tempelgeländes mit Gebäudeausrichtungen
 (Topographical plan of the temple site showing the orientation of the buildings)

(© Perry Lange)

darunter die Datierung nach der samvat-Zeitrechnung und Hinweise auf rituelle Kalendrierung.

Diese Studie betont die Rolle archaischer Tempelarchitektur als Medium der kulturellen Astronomie. Sie zeigt, wie durch Bauformen, Ausrichtung und rituelle Nutzung eine symbolische Verbindung zwischen Makrokosmos und Mikrokosmos geschaffen wurde – ein zentrales Motiv der klassischen indischen Astronomie, das in architektonischen Manifestationen greifbar wird.

English Version: *Cosmos in Stone: Archaeoastronomical Aspects of the Anantalingeśvara Mahādeva Temple in Nepal*

The Anantalingeśvara Mahādeva Temple at Dhadhikoṭa in Bhaktapur, Nepal, is one of the oldest continuously used temple complexes in South Asia. As part of the Nepal Temple Project, the temple complex was comprehensively archaeologically investigated, documented, and digitized. The aim of this work is to explore the close connection between architecture, spatial planning, and classical Indian astronomy-particularly with regard to cosmological concepts of the late Licchavi period (ca. 5th–7th century AD).

The precise east-west orientation of the main temple, the layout of the complex according to cardinal directions, and iconographic elements (e. g., the depiction of the Śiva-Liṅga in the center as the Axis Mundi) suggest that astronomical knowledge significantly influenced the design and function of the sacred space. Particular attention is paid to the study of the temple's orientation based on geodetic surveys (UTM 45 / WGS 84) and the interpretation of epigraphic sources with astronomical references, including dating according to the Samvat calendar and indications of ritual calendaring.

This study emphasizes the role of archaic temple architecture as a medium of cultural astronomy. It shows how building forms, orientation, and ritual use created a symbolic connection between the macrocosm and the microcosm-a central motif of classical Indian astronomy that is tangible in architectural manifestations.

Keywords: Classical Indian astronomy, orientation, archaeoastronomy, temple architecture, Nepal, Licchavi period.

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Session 5: Cultural Astronomy in Early Modern Time until today

2.28 *Peter Apian – a pioneer in astronomical and geographical instrumentation*

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Peter Apian was a German humanist and famous for his works in mathematics, astronomy and cartography. He studied mathematics and astronomy in Leipzig, in 1519 he went to Vienna to continue with his studies with Georg Tannstetter. Vienna at this time was one of the leading universities in mathematics and geography. When the plague broke out in Vienna in 1521 Apian moved back to Germany. In 1525 the University of Ingolstadt appointed him as a mathematician. In the same year together with his brother Georg he started a print shop which was supported by the University of Ingolstadt.

Apian's print shop was very successful and well-known for high quality editions of geographic and cartographic works. In 1533 Apian published his *Instrument Buch*, where he discussed in German language a variety of instruments such as the quadrant or the Jacob's staff. These instruments could be used for surveying, navigating, and timekeeping.

His most famous work is the *Astronomicum Caesareum* (1540), dedicated to Emperor Charles V and his brother King Ferdinand I. Its special feature is the 36 full-page woodcuts, 21 of which are provided with rotating paper discs, so-called volvelles. They reproduce the Ptolemaic system and serve as calculating discs that make it possible to determine the position of the planets. Particular attention is paid to the description of comet observations in the years 1531 to 1539. Here Apian documents for the first time the fact that the comet's tail always points away from the sun. Manuscript 124 in Rein Abbey near Graz offers an interesting counterpart to the printed copies. It contains the pictures and volvelles of the *Astronomicum Caesareum* as coloured pen and ink drawings, without any text.

Apian's books were extremely influential in his time, with numerous editions in multiple languages being published until 1609. His view of the world is geocentric and purely geometric and kinematic: the movement of the celestial bodies is described by the rolling of spheres on top of each other, without questioning the nature of these spheres and the causes of their movement.

The aim of this presentation is to analyse the significance of Apian for the improvement and practical application of astronomical instruments, which have been in use since the Middle Ages. Furthermore, it will be shown that also Kepler was influenced by the work of Peter Apian. 'Who will now give me a fountain of tears to mourn the pitiable diligence of Apian after his merit.' In his *Astronomia nova*, Johannes Kepler thus laments the fact



Figure 2.36:

Apian, Petrus: *Instrument Buch*. Ingolstadt 1533.

(Staatsbibliothek Bamberg)



Figure 2.37:

Apian, Petrus: *Astronomicum Caesareum*. Ingolstadt 1540.

(Library of the University of Graz)

that Peter Apian remained attached to the Ptolemaic system despite the ‘*divine gifts of his highly perceptive mind*’, even though he had become aware of Copernicus’ approach at least through Rheticus, if not already from the *Commentariolus*. Kepler’s sentences are often interpreted as disdain for Apian, but probably wrongly. Rather, it seems that Appian’s works were firmly anchored in Kepler’s thinking and exerted no small influence on him, even if he opened completely different paths of thought than his older colleague had taken.

Keywords: Peter Apian, astronomical instrumentation, volvelles.

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2.29 *The evolution of Schickard's Astroscopium through three generations*

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Wilhelm Schickard's *Astroscopium*, first published in 1623, offered a novel approach to a fundamental observational challenge: traditional celestial globes showed the stars as if viewed from outside the celestial sphere, but this was the opposite of how people observed them from Earth. Schickard's solution was a conical device with constellation maps that users could assemble, bound into an accompanying booklet, democratising astronomical observation. In keeping with contemporary German practices, these early charts featured Christianised constellations, reflecting the period's broader tendency to integrate religious elements into scientific instruments.

Spanning three generations of the Schickard family, the ingenious instrument underwent significant evolution through several editions. Each iteration brought new refinements and adaptations that reflected both practical needs and advancing astronomical knowledge. Following Wilhelm Schickard's untimely death from plague in 1635, his brother Lucas carried the project forward, producing two refined versions, notably removing the Christianised constellations. Lucas Schickard focused on enhancing the device's practical utility through improved size and legibility, marking a shift toward more secular astronomical representation. More editions came from Wilhelm's nephew (also named Wilhelm), who introduced substantial technical improvements including sophisticated ecliptic markings and more precise stellar magnitude representations. He also decided to reintroduce the Christianised constellations.

Through careful analysis of surviving copies, we can trace how the *Astroscopium* evolved from Wilhelm's initial concept through subsequent publications. Its multi-generational development reveals fascinating patterns of knowledge transmission within early modern German scientific families. Rather than representing a single inventor's isolated achievement, the *Astroscopium* exemplifies a family enterprise that continuously adapted to incorporate advancing astronomical understanding. The instrument's evolution demonstrates both the collaborative nature of 17th century astronomical instrument making and how scientific innovation operated within familial networks.

The progressive refinement of the *Astroscopium* – from its original design addressing the observational paradox, through Lucas's and the younger Wilhelm's improvements – illustrates how scientific instruments in this period were not static inventions but dynamic projects that evolved alongside astronomical knowledge.

The editions of the *Astroscopium*, spanning almost a century, provide a unique window into the evolution of astronomical instrumentation during a crucial period in the history of science. The development also reflects broader trends in 17th century scientific practice. The shift from Christianised to secular constellation representations mirrors the gradual separation of religious and scientific spheres during this period. Similarly, the



Figure 2.38:
The northern hemisphere of the 1623 edition of the *Astroscopium*.

(© Linda Hall Library, Kansas City, Mo, USA)

improvements in technical precision and usability demonstrate the increasing emphasis on accurate observation and measurement in astronomical practice. The family's commitment to refining and republishing the instrument over multiple decades shows how scientific knowledge was preserved and transmitted through personal networks before the establishment of formal scientific institutions.

Keywords: Early modern astronomical instruments, scientific families, knowledge transmission, Christianised constellations, instrument evolution.

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2.30 *Research on James Cook's On-Board Toolkit for Astronavigation*

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Improving methods for determining longitude at sea was one of the greatest intellectual challenges of the 18th century. As is well known from both scientific and popular scientific literature, the advocates of two newly developed methods competed with each other; attacking other methods as technically impossible or cumbersome to use. This particularly applies to the astronomical-mathematical method, which is also referred to as lunar distance method, and another method based on the use of first marine timekeepers or chronometers to record the time of a reference point on land. This scenario implies, however, that no clocks were available aboard ocean-going vessels in the second half of the eighteenth century. Despite the difficulties in making seaworthy horological instruments during this period, it becomes evident from an examination of historical inventory lists that a certain number of high-quality clocks were present on board eighteenth-century vessels. These clocks may have been used to measure short-term time intervals on board, such as needed in lunar distance observations, or to measure time ashore.

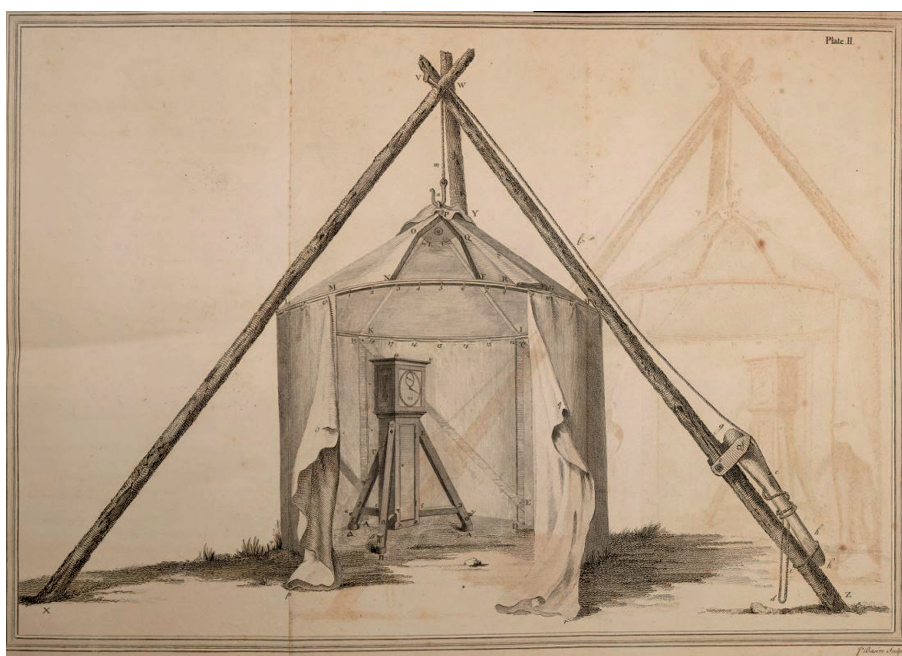


Figure 2.39:

Long-case regulator (clock) in tent observatory. Drawing by James Basire (1730–1802)

(Wales & Bayly 1777, pl. II.)

Striking examples can be identified among the navigational instruments supplied to Captain James Cook, renowned British cartographer, explorer, and navigator (1728–1779), and the astronomers who boarded the vessels under his command on his three scientific expeditions to the Pacific Ocean. Charles Green (1734–1771), Assistant at the Royal Observatory, Greenwich, was first to serve as an astronomer along with Cook during his first expedition aboard HMS Endeavour (1768–1771). He assisted not only in documenting the transit of Venus across the Sun at the Pacific island of Tahiti in 1769, but also in testing data obtained using either the lunar distance method or John Harrison’s H4 chronometer during a previous expedition to Barbados in 1763. The astronomers William Wales (1734–1798) and William Bayly (1737–1810) came to support Cook’s second expedition to the Pacific Ocean, serving aboard HMS Resolution and Adventure, respectively (1772–1775). Wales was employed as a human computer at the Royal Observatory, Greenwich, thus calculated ephemerides tables that were published in a newly launched series of manuals for the British Admiralty (i. e., *The Nautical Almanac and Astronomical Ephemeris and the Tables Requisite to Be Used with The Nautical Ephemeris*; first published in 1767). In 1769, he participated in one of the scientific expeditions of the Royal Society and was sent to Hudson Bay, Canada, to observe the transit of Venus, while Bayly, Assistant at the Royal Observatory, Greenwich, was sent to the North Cape, Norway, for the same purpose. During the third and last of Cook’s expeditions to the Pacific Ocean, William Bayly and the British Royal Navy officer James King (1750–1784) served as astronomers aboard HMS Resolution and Discovery (1776–1780).

With this in mind, the present paper briefly outlines the historical development of navigational methods before mapping out the existing research on navigational instruments available on board during Cook’s expeditions to the Pacific Ocean. For that purpose, this paper draws not only on modern research literature, but also on a broad range of original records related to or created by the above-mentioned navigators and astronomers. Special benefit comes from the consultation of online archives and collections that are available for research purposes, offering insight into historical inventory lists and scientific instruments that would otherwise be difficult to access. In particular, the re-examination of historical inventory lists allows to deepen previous research results on different strategies for position finding at sea and other scientific tasks on board and ashore.

Apart from navigational instruments for position finding and chart work that were provided by the official authorities or were privately owned by the scientific crew members, these inventory lists also include references to celestial charts and computational aids for performing numerical calculations. In addition to scientific aspects, certain artistic and design-related aspects are also discussed, with the aim of rectifying the comparatively limited attention given to eighteenth-century artisanship and scientific instrument making. Finally, the present paper provides some novel insights into eighteenth-century navigational skills and the navigational instruments available on board, with the aim to make a small but genuine contribution to this field of research.

Keywords: Eighteenth-century navigation, history of science, navigational instruments, timekeeping, James Cook’s expeditions.



Figure 2.40:

Long-case regulator (clock) made by John Shelton (1712–1777). This clock accompanied Captain James Cook on his second and third expeditions to the Pacific Ocean.

(Image no. RS. 8470, © The Royal Society)

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2.31 *Giovan Domenico Cassini and the Celestial Novelties: the Resilience of Astral Divination*

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*“Ne l’anno primo di Clemente o quanti
Nuovi apparir veggiam astri nel Cielo!
Tosto rassembra a l’occhio nostro un velo
Onde scoprir possiam prodigii tanti.”*

In his unpublished Poetical Cosmography (*Frammenti di Cosmografia in versi italiani*), astronomy lessons in verse probably written in Rome and Bologna between 1664 and 1668, Giovan Domenico Cassini dedicates a long section of the poem to the ever-changing sky of the fixed stars. Here he describes at length and in detail the discovery and study of *Mira Ceti* and other enigmatic variable stars, which conveys the renewed “frisson” of another age of celestial novelties after the original one at the turn of the 17th century.

I will briefly summarize the incredible sequence of discoveries in the field and the debates in which he was involved (dubious comets, fleeting nebulae, moving stars in Andromeda, presumed novae), reviving the excitement of those years also through a little-known baroque painting of the cycle of the History of Astronomy in Palazzo Montoro in Rome, whose protagonists are indeed Cassini, Hevelius and Ismael Bouillau. But the most surprising element is the unscrupulous use by the astronomer from Perinaldo of one of the new stars – the so-called “Astro Olorino” (P Cygni) – as a celestial prophecy regarding the ascension to the papacy of Clement IX. The same prediction, extracted from the “De Summis Pontificibus” of the 12th-century Saint-Archbishop Malachy, probably a forgery, published in Venice in 1596, was widely circulating in those year and was insistently used in the celebrations for the enthronement of Giulio Rospigliosi, cited again in the introduction to the *Ephemerides Bononienses* (1668) and explained and commented in *Vita, Gesta e Predittioni circa i Sommi Pontefici Romani del Glorioso Padre S. Malachia* by Reverend Giovanni Germano (1670).

The rise of astral divination in the 15th century was the occasion for a massive introduction of astrology at the pontifical court: as other contemporary texts also show, Cassini’s laudatory and courtly gesture makes it clear that, even during the apparent decline of the *Science of the Judgments of the Stars* two centuries later, the prophetic component remained one of the strong driving forces behind the papal interest in the starry sky, even in the aftermath of the Scientific Revolution.

Keywords: Giovan Domenico Cassini; Variable Stars; Novae; Prophecy; Astrology.



Figure 2.41:

Anonymous (c. 1700): The 17th century Cycle of the History of Astronomy
Palazzo Patrizi-Montoro, Roma

(Photo: Gianluca Masi and Giangiacomo Gandolfi)

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- NERLI, FRANCESCO: *Relatione delle festiue dimostrazioni fatte in Bologna nella creatione e coronatione della Santita' di N. S. P. Clemente IX*. Bologna 1667.

2.32 *Historical Eclipse Records and Earth Rotation Variability*

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Astronomical dating is one of the most precise methods to establish chronologies of ancient cultures. This often includes records of historical eclipses and star occultations by the Moon. Eclipses were noted above all in Babylonian cuneiform tablets, Chinese and Greek sources, in Ptolemy's book of the *Almagest*, and in Arabic and European medieval scripts. The usability of historical eclipse records, however, requires the knowledge of Earth rotation parameters such as the Ephemeris time correction and obliquity of the ecliptic to determine their path of visibility on the surface of the Earth.

Lunar eclipses can be used to verify chronologies, but not for calculation of Ephemeris time correction because of their broad visibility on Earth. For this reason, solar eclipse records are the best choice, especially if the daytime of its visibility and the magnitude are also recorded. The calculation of Earth rotation parameter is, therefore, based on well dated solar eclipses that were observed and properly recorded.

The dating of solar eclipse records, however, requires a firm chronology to convert ancient calendrical statements into a common time frame (Julian Day Number, JDN). Ambiguities and discrepancies between astronomical records, historical data and other dating methods often result into divergent chronologies proposed by different archaeologists. For example, various chronologies have been proposed for Mesopotamia and the year of Babylon's fall, ranging between 1651 BC (Long Chronology) and 1499 BC (Ultra-Low Chronology). Each of these chronologies is based on different historical data and their interpretations, including historical eclipses. However, whether and when these eclipses were observable in the respective region also depends on the Earth's rotation.

The interaction and dependency between three fields of research, Earth parameter modeling, historical eclipse records, and the chronology of ancient cultures creates a conceptual problem with the danger of circular reasoning that will be discussed in the paper. Astronomers rely on the correct dating of historical eclipse records. By using hundreds of pieces of data, they hope to obtain an accurate average value when modeling the variation of the Earth rotation and to eliminate gross errors in the historical data. When archaeologists and historians base their dating on solar eclipse observations, the calculations are based on known Earth rotation parameters. Since there is a direct dependency between the two methods, historical data and the earth rotation model should be evaluated together. An iterative process of continuous improvement seems to be a reasonable approach here but at the same time it often uses the assumption of a steady change in the Earth's rotation without large discontinuities. Another assumption is the invariability of the shape of the coast and thus the tidal friction of the Moon and Sun and the decrease in the Earth's rotation. Historical eclipse reports coming from different cultures seem

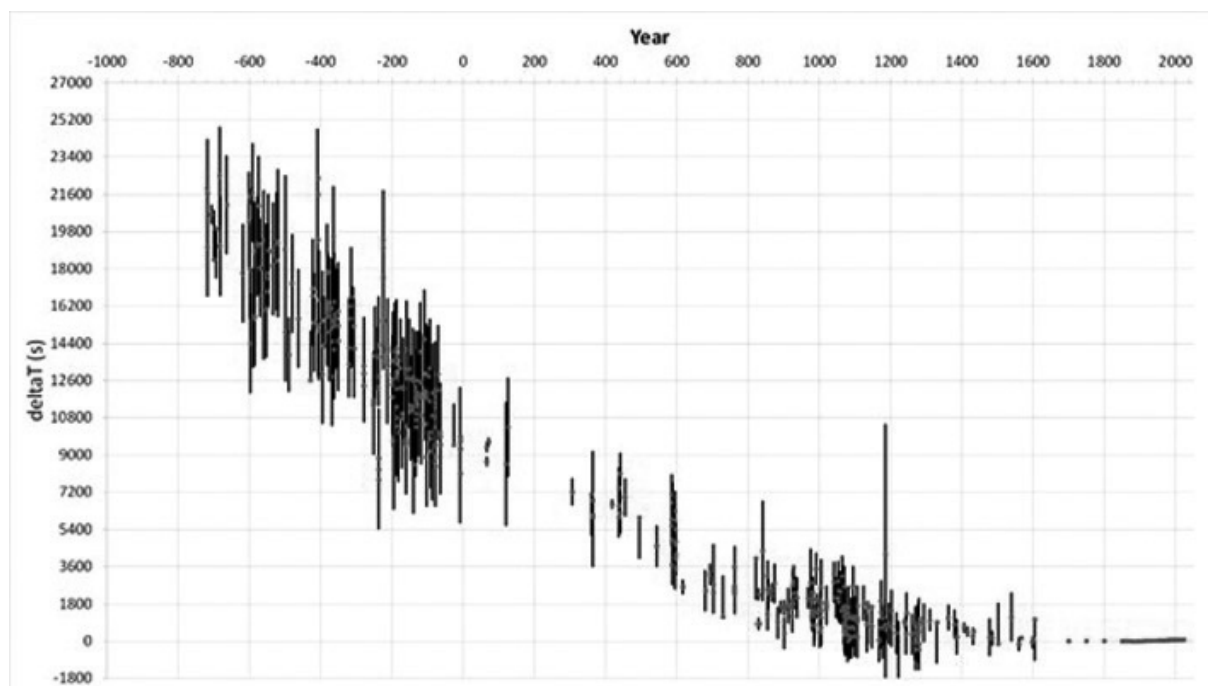


Figure 2.42:

Time diagram of ΔT (s) based on historical eclipses, lunar occultations of stars (1625–2015), and modern geodetic methods since 1965.

(Graphics: Andreas Fuls)

to rule out errors in chronological models, but only if the chronologies were developed independently of each other.

The paper discusses the data and methods, their quality and usability to model the Earth rotation. The establishment of a database and the spatio-temporal analysis of historical eclipses will be proposed to improve our understanding of the Earth's rotation variability and its effect on the visibility of historical eclipses, their dating and the establishment of the chronology of ancient cultures.

Keywords: Eclipses, chronologies, Earth rotation, Ephemeris Time Correction.

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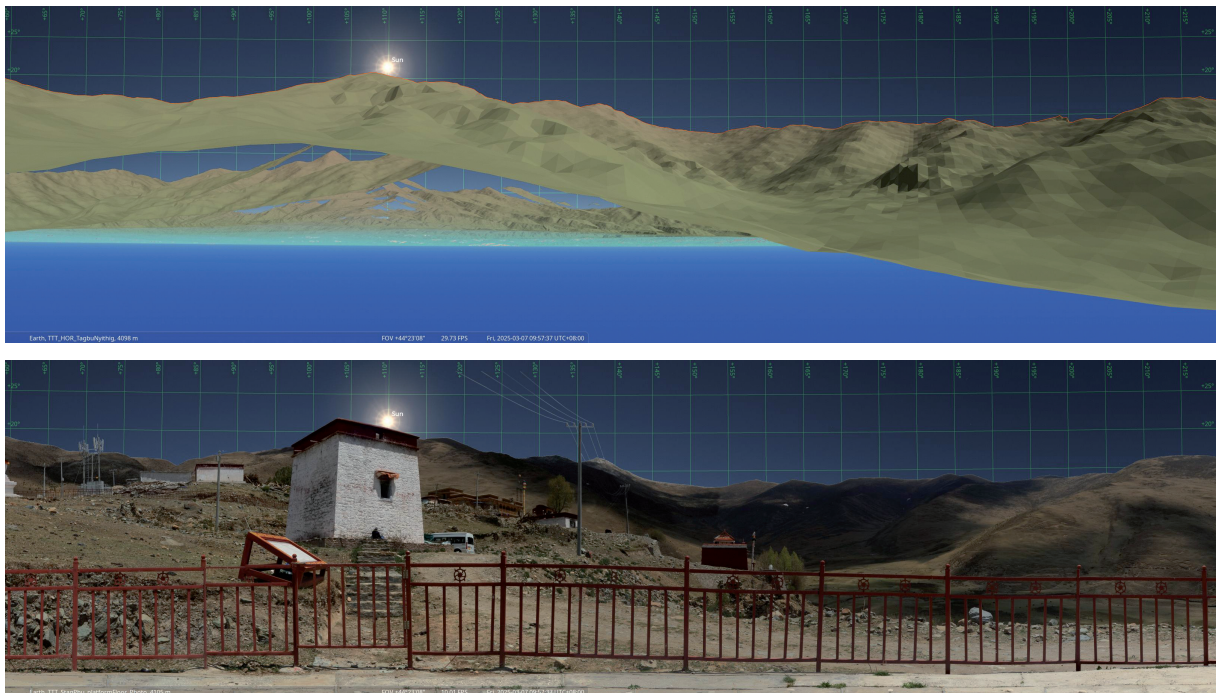


Figure 2.43:

Above: Preliminary panorama of Stag Phu Nyi Thig, created with Horizon
Below: Photo-based panorama at the same site, used in Stellarium

(Zotti et al., 2024)

Workshop: Creation of photo-based landscapes for Stellarium

2.33 *Creation of photo-based landscapes for Stellarium*

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A well-made photographic panorama (cf. Fig. 2.43) from an interesting viewpoint can be used as a reliable proxy to study rising and setting events in past and present skies. In this workshop I will guide the attendants from taking photographs usable for stitching to handling the relevant settings of the Hugin panorama stitcher. We shall also try to properly orient and align the panorama with one created from SRTM data by the Horizon program (or other means).

Participants should use their own laptops which should be reasonably powerful for image processing and running Stellarium. (No “netbooks”!) Preparations (necessary program installations) will be announced later.

Keywords: Stellarium, Hugin panorama stitcher, Horizon program.

References

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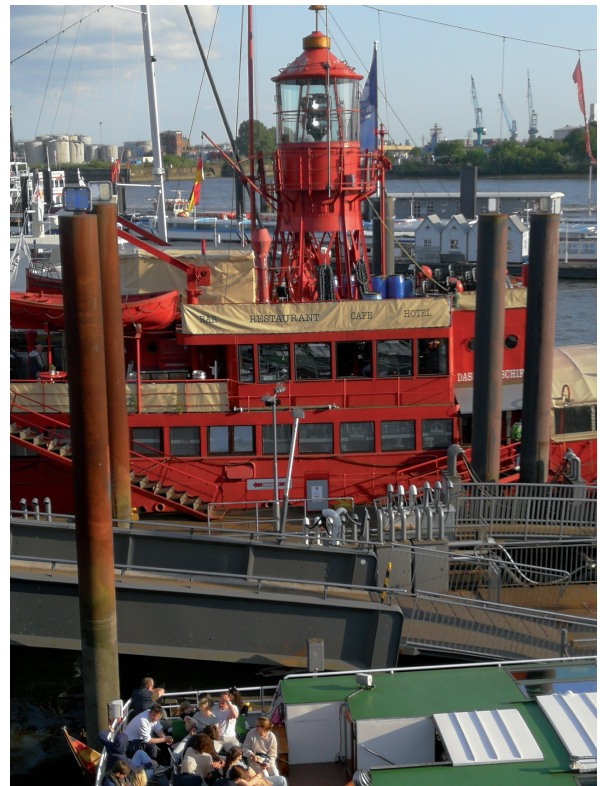


Figure 3.1:
Hamburg Impressions: Elbphilharmonie, Landungsbrücken – Hamburg Port, Light Vessel

(Photos: Gudrun Wolfschmidt)

Appendix: General Information

3.1 Links

- Centre for History of Science and Technology
(<https://www.fhsev.de/Wolfschmidt/GNT/home-wf.htm>),
Hamburg Observatory, University of Hamburg
Bundesstrasse 55 Geomatikum, 20146 Hamburg
Homepage Gudrun Wolfschmidt (<https://www.fhsev.de/Wolfschmidt/>),
Organisation of Conferences – Wolfschmidt
(<https://www.fhsev.de/Wolfschmidt/tagung.php>)
- Hamburg Observatory in Bergedorf
(<https://www.physik.uni-hamburg.de/en/hs.html>),
Department of Physics, MIN-Faculty, University of Hamburg
Gojenbergsweg 112, 21029 Hamburg
- Förderverein Hamburger Sternwarte e.V. (FHS)
(<https://www.fhsev.de/>),
(Association for Promoting Hamburg Observatory) & Events 2025
(<https://www.fhsev.de/fhs-v25.php>)
- European Society for Astronomy in Culture (SEAC)
(<https://www.archaeoastronomy.org/>)
- Gesellschaft für Archäoastronomie (Association for Archaeoastronomy)
(<https://archaeoastronomie.org/>)
- SEAC Astronomical Heritage Chat/Blog
(<https://www.archaeoastronomy.org/content/about-seac/glass-plates.html>)
- Heritage Working Group (HER WG)
(<https://www.coimbra-group.eu/working-group/heritage/>)
- Working Group for the History of Astronomy in the Astronomical Society
(https://www.astronomische-gesellschaft.de/en/working-groups/history-of-astronomy?set_language=en. Cf. Astrophotography – From the Beginnings (1839) to CCD and Detectors
(<https://www.fhsev.de/Wolfschmidt/events/akag-goerlitz-2025.php>),
Colloquium of the Working Group History of Astronomy in the Astronomical Society, Görlitz, 19.–21. September 2025.
- Nuncius Hamburgensis – Beiträge zur Geschichte der Naturwissenschaften
(<https://www.fhsev.de/Wolfschmidt/GNT/research/nuncius.php>)

3.2 Museums and Collections in Hamburg University and in Hamburg

3.2.1 Museums and Collections in Hamburg University

- Museums and Collections of Hamburg University
(<https://www.uni-hamburg.de/en/museen-sammlungen.html>)
- FUNDus! - Database / Research Portal of Hamburg University Collections
(<https://www.fundus.uni-hamburg.de/en>)
- FUNDus! - Database / Research Portal of MIN Faculty:
(<https://www.fundus.uni-hamburg.de/en/divisions/min>)
 - History of science and technology
(https://www.fundus.uni-hamburg.de/en/collections/science_tec_history)
 - Hamburg Observatory
(https://www.fundus.uni-hamburg.de/en/sub_divisions/astronomy)
 - Schmidt Museum of Hamburg Observatory
(https://www.fundus.uni-hamburg.de/en/collections/schmidt_museum)
- Museums and Collections of Hamburg Observatory Scientific Instruments, Archive, and Schmidt Museum
(https://www.fhsev.de/Wolfschmidt/events/Sammlungen_HS.php)
(Sammlungen der Hamburger Sternwarte – Wissenschaftliche Instrumente, Archiv und Schmidt Museum)
- FUNDus! – Telescopes of Hamburg Observatory Library & Archives The Online Digital Archives of Hamburg Observatory:
(https://fundus.uni-hamburg.de/de/collections/large_instruments)
 - Photographic Plate-Archive
 - Image Archive
 - Bernhard Schmidt Archive
- Collections of Scientific Instruments and Models – History of Science and Technology
(https://www.fhsev.de/Wolfschmidt/events/Sammlungen_IGN.php) (Sammlungen von wissenschaftlichen Instrumenten und Modellen – Geschichte der Naturwissenschaft und Technik)
- Museum of Nature – Palaeontology and Geology of Hamburg University
(<https://hamburg.leibniz-lib.de/ausstellungen/museum-palaeontologie.html>)
- Mineralogical Museum
(<https://hamburg.leibniz-lib.de/ausstellungen/museum-mineralogie.html>)

- Förderverein Hamburger Sternwarte:
 - Exhibitions (<https://www.fhsev.de/Ausstellungen.php>), cf. Weltbild im Wandel – Von Copernicus bis zur modernen Kosmologie (Our changing World View – From Copernicus to Modern Cosmology) (<https://www.fhsev.de/Weltbild.php>)
 - Restoration (Restaurierung, Sanierung) (<https://www.fhsev.de/restaur.php>).



Figure 3.2:

Exhibition *Our changing World View* (Flammarion 1888), (© Maria Thrun, MK&G)
 Melkeveien (Milky Way), Frida Hansen, Oslo (1898)
 Creation, Hamburg Master Francke (fl. 1424–1434) (Photo: G. Wolfschmidt)

3.2.2 Museums in Hamburg

- Archaeological Museum Hamburg – Helms-Museum (<https://amh.de/>)

Museumsplatz 2, 21073 Hamburg-Harburg,
200,000 years of the region's history.
Tue – Sun 10:00 – 17:00 h.

- MARKK – Museum am Rothenbaum – World Cultures and Arts
(<https://markk-hamburg.de/en/>),
Rothenbaumchaussee 64, 20148 Hamburg,
Museum of Ethnology (1879), Africa, Asia, Oceania, the Americas and Europe,
especially Ancient Egypt; Inca Gallery.
Tue – Sun 10:00 – 18:00 h, Thursday 10 – 21 h.
- International Maritime Museum
(<https://www.imm-hamburg.de/international/en/>), Kaispeicher B, Koreastrasse
1, 20457 Hamburg,
Maritime treasures from 3000 years of shipping and naval history.
Mon – Sun 10:00 – 18:00 h.
- Museum für Kunst und Gewerbe Hamburg (MK&G)
(<https://www.imm-hamburg.de/international/en/>),
Museumsplatz 2, 21073 Hamburg
(Art and Crafts Museum) – Ancient Art and Antiquities
(<https://www.mkg-hamburg.de/en/collection/ancient-art-and-antiquities>),
'Mirror Canteen' (1969) by Verner Panton,
the Art Nouveau ensemble 'Pariser Saal' (1900).
Tue – Sun 10:00 – 18:00 h, Thursday 10 – 21 h.
- Kunsthalle (Art Gallery) Hamburg (1846)
(<https://www.hamburger-kunsthalle.de/en>),
Glockengießerwall 5, 20095 Hamburg.
Three buildings show art through eight centuries:
brick structure from 1869, neo-classical annex with dome from 1919,
and the modern white cube of the "Galerie der Gegenwart" (Gallery of the present)
by the architect Oswald Mathias Ungers (1997).
Tue – Sun 10:00 – 18:00 h, Thursday 10 – 21 h.
- Altona Museum in Hamburg
(<https://www.shmh.de/en/altona-museum/>),
Museumstr. 23, 22765 Hamburg-Altona.
Art and cultural history of the Elbe region from Schleswig Holstein
and the coastal area from the North Sea to the Baltic Sea.
Wednesday to Friday 10–17 h, Saturday and Sunday 10–18 h.
- Museum of Hamburg History (MHG, 1908)
(<https://www.shmh.de/en/museum-of-hamburg-history/>),
Holstenwall 24, 20355 Hamburg.
From piracy in Hamburg and its development into a modern Metropolis.
Temporarily closed due to modernisation.
- Museums & Exhibitions in Hamburg
(<https://www.hamburg-travel.com/booking/tickets/museums-exhibitions/>).

3.3 Public Transport (ÖPNV) and Deutschlandticket

3.3.1 Public Transport in Hamburg

- Public Transport in Hamburg (<https://www.hvv.de/en>)
Connections / Departures: (<https://www.hvv.de/en/timetables/all-departures>)
- Public Transport in Hamburg during the SEAC 5 days and the excursion to Lübeck:
(8 days – one day before and after the conference to the airport)
 $5 \times 7.80 + 32 = 71$ Euro – cf. Deutschlandticket 58.- Euro.
- Day Tickets for the Public Transport Hamburg (HVV) –
(<https://www.hvv.de/en/tickets/single-day-tickets>)
Day Ticket (Tageskarte) 7.80 Euro (1–2 Rings) A Single Ticket is already 3.90 Euro, so the Day Ticket is better. The Day Ticket (1–2 Rings) includes the travelling to the airport and the observatory.
You can buy the tickets in ticket machines in metro stations or in the railway stations, but you get no tickets in buses (!).
- Maps for Public Transport in Hamburg (Metro / elevated train Hochbahn, S-Bahn, Buses, Ferry boats)
(<https://www.hvv.de/en/plans>)

3.3.2 Deutschlandticket

- Deutschlandticket DB
(https://int.bahn.de/en/offers/regional/deutschland-ticket?dbkanal_007=teaserBlock_2-1_link_DeutschlandticketINT)
or here: Deutschlandticket HVV
(<https://www.hvv-deutschlandticket.de/en/>)
(58.- Euro for HVV in Hamburg during the whole conference and for the Excursion: local trains and the public transport in Lübeck.
- The Deutschlandticket is valid in whole Germany (!), when you want to visit more in Germany earlier in August.
- But you have to book the Deutschlandticket electronically already in July, and you have to cancel it by the 10th of August latest.
Then it is valid the whole month of August.

3.3.3 Schleswig-Holstein Ticket

- Schleswig-Holstein Ticket (regional day ticket) for one day – 32.- Euro
(<https://www.bahn.de/angebot/regio/laender-tickets/schleswig-holstein-ticket>,
<https://www.nah.sh/en/tickets/sh-tariff-tickets/>),
starting at 9 h – (including Hamburg and Lübeck public transportation, https://www.fhsev.de/Wolfschmidt/events/pdf/HVV-ringe_a-h_Luebeck.pdf)



Public Transport in Hamburg – HVV map

(<https://www.hvv.de/en>)