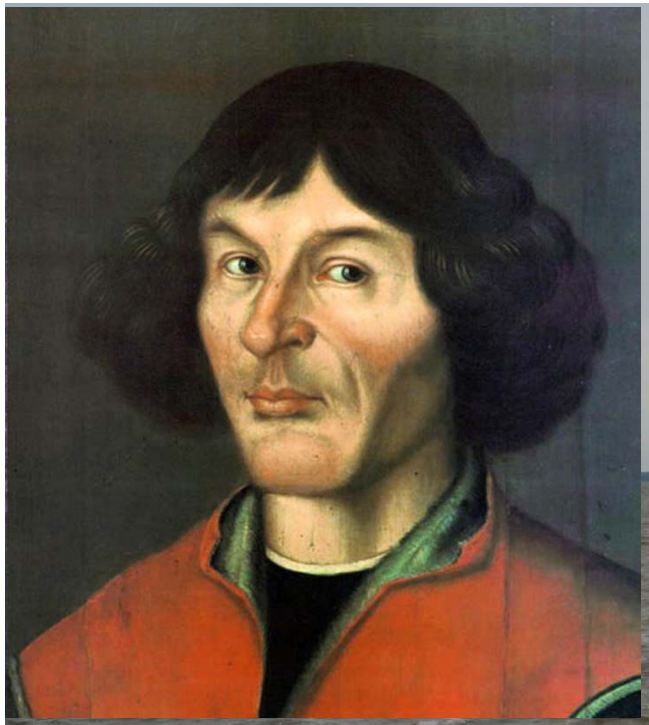


Nicolaus Copernicus

– 500 years of experimental science

The Vistula Lagoon
seen from Frombork

Roman Marks
University of Szczecin, Faculty of Earth Sciences,
A. Mickiewicza 18, 70-383 Szczecin, Poland

Copernicus conducted several experimental observations and measurements, which lead to the „Copernican Revolution”

Before settling in Frombork Copernicus studied: regular law, cannon law and medicine.

But first of all He was dedicated to astronomy.

He collected astronomy books and instruments.

Some of the measuring units Copernicus even constructed himself.

Replica of the armillary sphere

Location of Frombork was important

- Low cloudiness over Frombork allowed longer and more precise observations of the planets motion
- Thanks to sailors visiting Frombork there was communication and exchange of knowledge
- Sailors in Copernicus times were on regular basis watching the height of the Sun or a given star for navigation purposes
- Sailing ships (some?) were equipped with astrolabe

Navigation instruments exposed at the Museum in Frombork

In Frombork Copernicus build his own observatory

It was placed in Stanislav's canonry, where Copernicus resided. The observatory was equipped with

Pavimentum (precisely elevated platform)

allowing to arrange instruments as:

Quadrant, Triguetum, Armillary Sphere

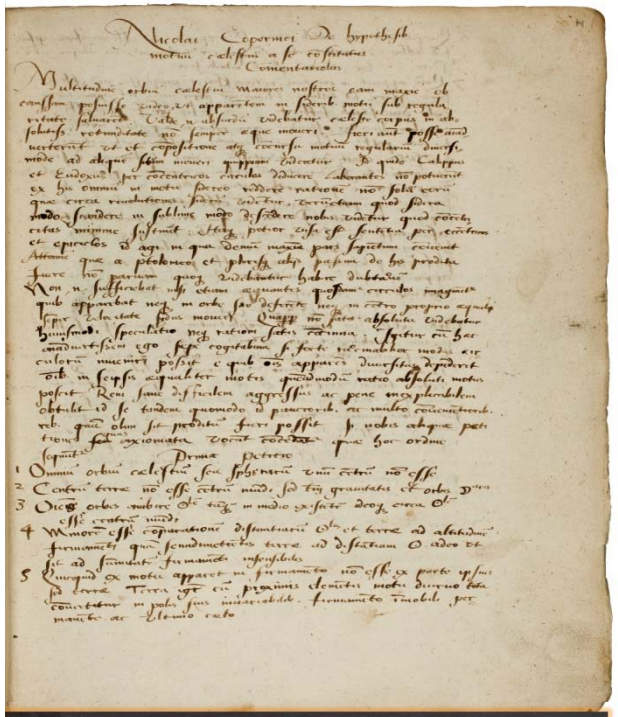
and conduct repeatable, comparable and consistent to each other observations, collected during more than 30 years.

Copernicus Museum in Frombork

Replicas of the Quadrant, Triguetum and Armillary sphere used by Copernicus during astronomical observations

First results were written before 1514 in "Commentariolus"

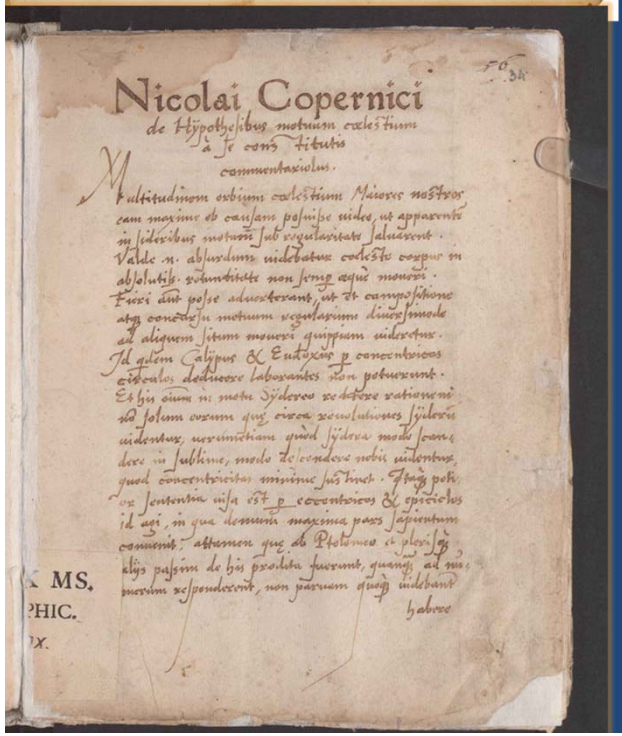
there are three known hand written manuscripts



Nicolai Copernici
de Hypothesibus motuum coelestium
a se constitutis
commentariolus.

Multitudinem orbium coelestium Maiores nostros
eam maxime ob causam posuisse uides, ut apparentis
in sideribus motuum sub regularitate saluarent.
Valde n. absurdum uidebatur coeleste corpus in
absolutiss. uolubilitate non semp aequè moueri.
Fieri aut posse aduerterant, ut de compositione
atq; concursu motuum regularium diuersimode
ad aliquem situm moueri quippiam uideretur.
Id quidem Calippus & Eudoxus p concentricos
circulos deducere laborantes non potuerunt.
Et his cum ni motu Sydereo reddere rationem
sed solum eorum qui circa reuolutiones Syderei
uidentur, uerumtiam quod Sydera modo scandere
in sublime, modo descendere nobis uidentur,
quod concentricis minime sustinet. Itaq; potior
est sententia ipsa est p eccentricos & epicyclos
id agi, in qua demum maxima pars sapientum
conuenit, attamen quę ab Ptolomeo et pleris q;
aliis passim de his prodita fuerunt, quanq; ad nos
merito respondeant, non parum quoq; uidebant
habere

First page of the Aberdeen copy



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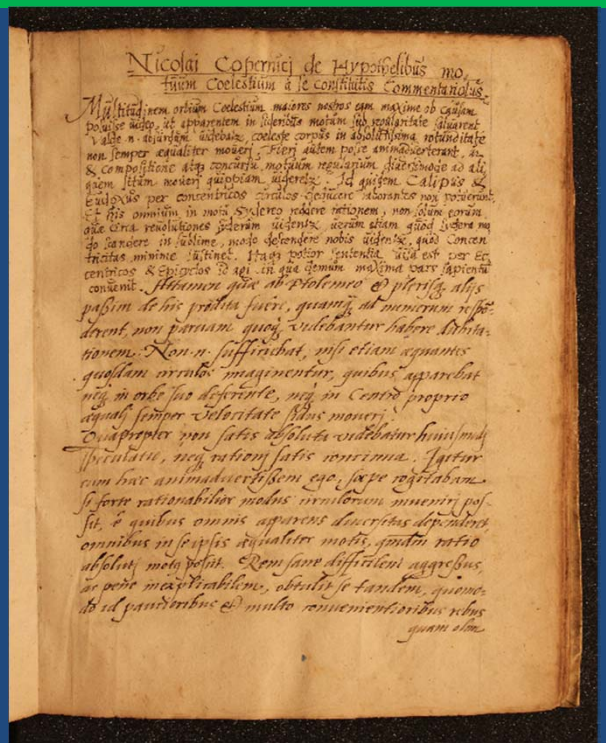
conuenit, attamen quę ab Ptolomeo et pleris q;
aliis passim de his prodita fuerunt, quanq; ad nos
merito respondeant, non parum quoq; uidebant
habere

MS.
PHIC.
IX.

First page of the Vienna copy



Nicolai Copernici de hypothesibus mo
tuum Coelestium à se constitutis Commentariolus.

Multitudinem orbium Coelestium maiores nostros eam maxime ob causam
posuisse uides, ut apparentem in sideribus motum sub regularitate saluarent.
Valde n. absurdum uidebatur, coeleste corpus in absolutissima rotunditate
non semper aequaliter moueri. Fieri autem posse animaduerterant, in
compositione atq; concursu motuum regularium, siderumque ad ali
quem situm mouari quippiam uiderētur. Id quidem Calippus &
Eudoxus per concentricos circulos deducere laborantes non potuerunt.
Et his omnium in motu Sydereo reddere rationem, non solum eorum
quę circa reuolutiones syderum uidentur, uerum etiam quod Sydera mo
do scandere in sublime, modo descendere nobis uidentur, quod Concen
tricis minime sustinet. Itaq; potior sententia, ipsa est per ec
centricos & Epicyclos id agi, in qua demum maxima pars sapientū
conuenit. Attamen quę ab Ptolomeo & pleris q; aliis
passim de his prodita fuere, quanq; ad meritum respō
derent, non parcum quoq; uidebantur habere scibila
tionem. Non n. sufferebat, nisi etiam aequantes
quosdam irregulos imaginentur, quibus apparebat
neq; in orbe sue deferentie, neq; in Centro proprio
aequali semper velocitate situs manere.
Quapropter non satis absoluta uidebatur hui[illegible]
speculatio, neq; rationem satis sonantia. Igitur
cum hec animaduerterem ego, sepe reputabam
si forte rationabilior modus inueniri pos
sit, è quibus omnia apparens diuersitas deprehendi
omnibus in seipsis absolutior motis, simili ratio
absolutis moti possit. Rem sane difficilem aggressus,
ac pene inexplicabilem, obtulit se tandem, quem
ad paucissimos & multo reuolutionibus rebus
quam olim

First page of the Stockholm copy

A first official reference to the "Commentariolus" is contained in a library catalogue in Kraków, dated 1 May 1514,

of a 16th-century historian, Matthew of Miechów, so it must have begun circulating in Europe before that date (Koyré, 1973, p. 85; Gingerich, 2004, p. 32). Thoren (1990 p. 99) gives the length of the manuscript as 40 pages.

Five of seven Copernicus postulates are very precise

1. Celestial bodies do not all revolve around a single point;
2. The centre of Earth is the centre of the lunar sphere—the orbit of the moon around the Earth;
3. All the spheres rotate around the Sun, which is near the centre of the Universe;
4. The distance between the Earth and the Sun is an insignificant fraction of the distance from the Earth and Sun to the stars, so parallax is not observed in the stars;
5. The stars are immovable; their apparent daily motion is caused by the daily rotation of the Earth;
6. Earth is moved in a sphere around the Sun, causing the apparent annual migration of the Sun; the Earth has more than one motion;
7. Earth's orbital motion around the Sun causes the seeming reverse in direction of the motions of the planets.

Thanks to Copernicus the ancient hypothesis of Greek astronomers – Aristotle (384–322 B.C.) and Aristarchus of Samos (310–230 B.C.) that the Earth is orbiting around the Sun and is rotating around its own axis has been proved.

The rotational principles of the Solar System configuration and the rotational principles of all objects dispersed in the Universe have been described in detail.

The theory of the stationary and centric location of the Earth in the Universe that stopped the development in sciences for almost 2000 years was finally rejected.

Frombork,
Copernicus Tower

As a result, it becomes apparent that all natural processes on the Earth are coherent with Copernicus postulates.

At the same time the attempts to restructure the religious interpretations of the natural processes were undertaken.

In consequence, tensions and divergences were noticed between Copernicus cosmology and formal orders, that were shaped by dogmata, constituted by the Catholic Church, at that time.

In the first phase, the Catholic Church was interested in the new Copernicus theory

However soon afterwards hierarches, turned to indisputability of the centric location of the Earth.

It resulted in persecution of all who grasped the meaning of Copernicus findings.

The case of Giordano Bruno sentenced to death and burned in 17 February 1600 is an example.

Copernicus methodological matrix as an universal tool in science

The scrupulous experimental measurements and the verification of results are of great importance.

In the final phase, after an apprehensive perception of the phenomenon's features comes the stage of the mathematical description of the phenomenon.

Experimental verification of new theories and concepts ought to be the essence of development in modern science, which is the Copernicus way of doing science.

Knowledge originates from the sighting phenomenon's correctness or perception of the inaccuracy in commonly accepted theories. Then, comes the long process of data collection and experimental proof.

Copernicus observations were in circulation in Europe

The news was shared with other astronomers and probably disseminated via net of sailors connecting the cities of Gdańsk Frombork, Elbląg with all other trade centers in Europe.

The Great geographical discoveries in XVI centaury have been inspired by famous astronomers of those times.

For example the Ferdinand Magellan voyage around the globe in 1519-1522 was supported by the astronomer Ruy Faleiro, who possibly knew about Copernicus findings.

In turn however probably also Copernicus was inspired by the sailors' discoveries confirming the spherical shape of the Earth thus supporting Copernicus vision.

Port in Frombork

The Solar System rotational configuration

The Solar System (one of many gravity systems in our Galaxy) is moving around the center of the Galaxy with orbital relative speed of about **268 km/sec.**
8 planets are orbiting in the gravity of the Sun.

Configuration of the Earth

- the fifth planet in term of size,
- third in term of the distance from the Sun,
- mass is only (1 / 330000) of the Sun,
- orbital motion around the Sun ranges from **29.292 km/sec. up to 30.287 km/sec.**
- rotation at Equator with speed **0.465 km/sec.**

City of Gdańsk

Canon House nearby
the Mariacka Cathedral

Mariacka street
Anna Schilling house in Mariacka 1


Anna Schilling house
in Gdańsk, Mariacka 1

Entering into the new millennium,

500 years after the "Commentariolus" was written by Nicolaus Copernicus is a good time to reflect on our civilization and to ask the following question:

1) How important is the experimental proof in sciences and in determining goals of our civilization?

2) How to overcome the centric ideologies that still shape some leaders of our societies?

3) Why the centric (egocentric) philosophies are still accepted by humans and even by some scientists?

Let us hope that in a new millennium,
especially Europeans will follow at least the first Copernicus postulates, written exactly 500 years ago as following:
"Celestial bodies do not all revolve around a single point"
and old hierarchical – geocentric oriented doctrines (still firmly settled)
will be reexamined and replaced by more solidarity oriented principles.

Contemporary science

It is worth underlining that **experimental proof** should be a standard for present and future science and civilization. Thus the Copernicus system of experimental multiple-proof, should be **the universal methodological model in science.**

„Astronomer Copernicus" or „Conversations with God" painting by Jan Matejko

Concluding remarks

The Copernican Revolution, which originated at the Baltic Sea coast, is the most important achievement of our civilization.

500 years after Copernican Revolution we understood the Universe and the Earth systems better thus

we live in a better world.

Development in science (including "Climate change" research) base on improving experimental approaches and instruments, allowing more precise, comparable and long term, thus more trustful observations.

Maybe Europeans should grant a new European Research Units and place it along the Baltic Sea including Frombork,

to continue the Copernicus tradition in the Baltic Earth.

In 2043 it will be the 500 years anniversary of publishing „De revolutionibus orbium coelestium” „On the Revolutions of the Heavenly Spheres”.

NICOLAI CO
PERNICI TORINENSIS
DE REVOLVTIONIBVS ORBI-
um cœleſtium, Libri VI.

Habes in hoc opere iam recens nato, & ædito, ſtudioſe lector, Motus ſtellarum, tam fixarum, quàm erraticarum, cum ex ueteribus, tum etiam ex recentibus obſeruationibus reſtitutos: & nouis inſuper ac admirabilibus hypotheſibus ornatos. Habes etiam Tabulas expeditiſsimas, ex quibus eoſdem ad quoduis tempus quàm facilli me calculare poteris. Igitur eme, lege, fruere.

Ἀγεωμέτρητος μηδεὶς εἰσίτω.

Norimbergæ apud Ioh. Petreium,
Anno M. D. XLIII.

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Thank you