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The road from good software engineering

to good science

...is a two way street...

Three Themes :

Philosophy

Interlude on Goodness

Lessons from Science

Philosophy

Good

Good as in Quality

Fundamental Premise

Our community needs to think more about science, and about being able to reproduce results, and formulate theories that let us make predictions about language

The key to making that happen is making our software and data more usable, more available, and making such acts of sharing more central to our field

If we do that, our software engineering is pretty good

Science

Develop theories or models that let us make predictions about the world

Our world is language...

Good Science

… are those methods that result in experimental findings that an independent observer can reproduce

Good Software Engineering

...are those methods that result in software that anyone can use, anytime, anywhere...

...to reproduce our results...

Experimental results that you publish are the test cases for your ideas

...and your software...

Can't discount
the role of software

...although many try...

“It's really the ideas that count...”

“Well, the algorithm
is described in the paper...”

“It's really just a prototype...”

“Well, I got a new computer and I don't think the software made it to the new one...”

“Ummm ... my student left and I don't quite know how he did all this...”

Unacceptable

I did this experiment on X

Here are the results...

Accept them

No, the software isn't available

Neither is the data

I simply assume
you have 8 months available
to reinvent my method

And that you can do that from an incomplete description

Cheers!

That's many things ...

It's not science

Empiricism is Not a Matter of Faith

Computational Linguistics

September 2008

Software and NLP

Good Software

Should Work

Anytime

Anywhere

For Anyone

...and it should certainly work for you 6 months in the future

...or 5 years from now...

... it should work
for others today,
and 5 years from now ...

...even if you've moved on,
aren't answering email,
and the project is over

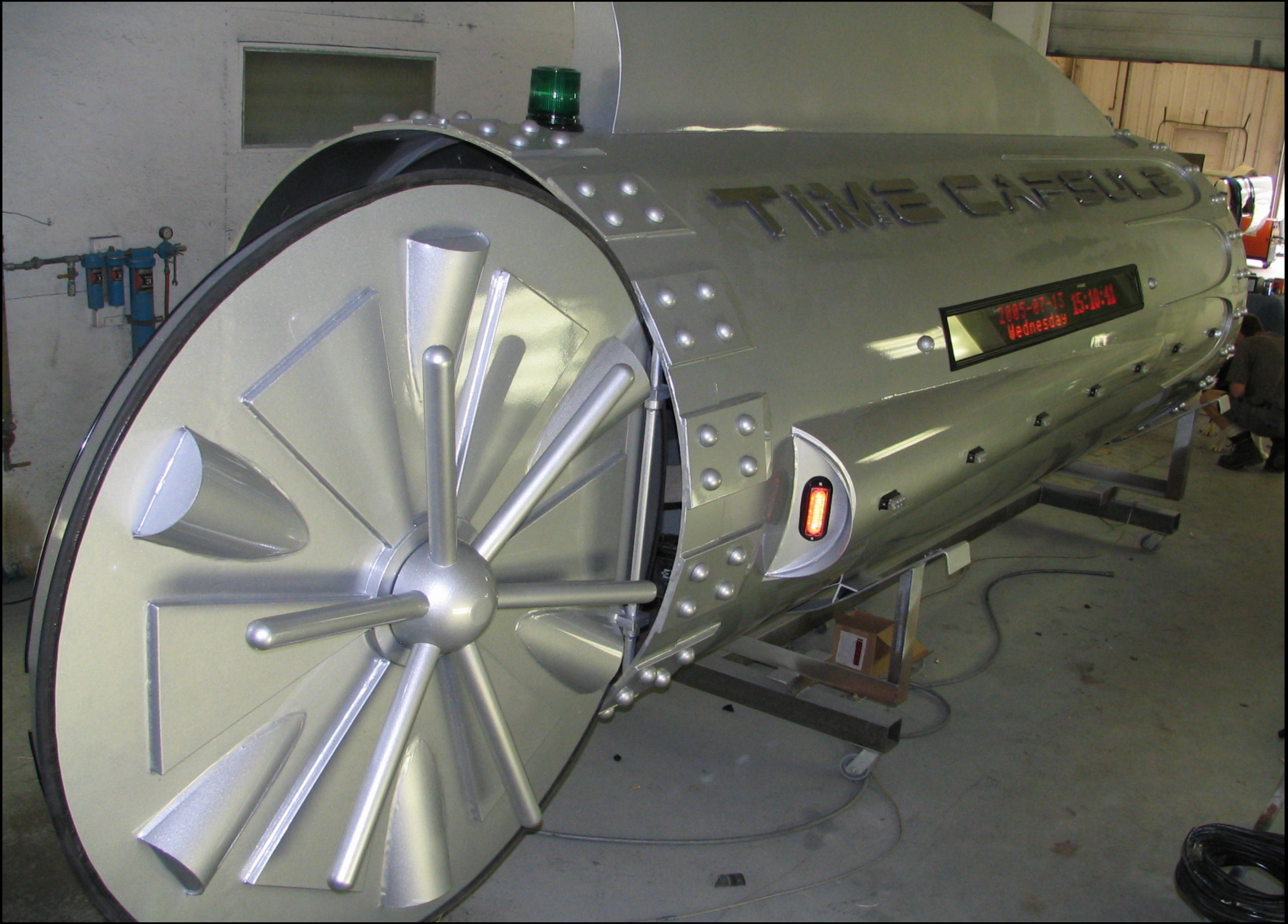
If your software can do that, it's pretty well engineered

Will your software
work in 40 years?

You should hope so ...

Make choices that
make that at least possible

Think of your software
as a time capsule


TIME CAPSULE
2005-07-13 15:10:41
Wednesday

Think of it as your chance for immortality

How many hours have you spent away from loved ones, friends, adventure, nature, romance, and life ...

… to create, test,
and use software?

At least make it last...

Let someone 100 years from now unpack your code and data, and be able to read it, understand it, run it, and modify it

Let yourself be able to do the same thing in 10 years

If your software can do that, it's pretty well engineered

Will the Linux Kernel
be available and running
in X years?

There's a good chance

Company won't
go out of business

ANSI C will be around
for a long time

Virtualization will keep architectures alive even when hardware is gone

Make choices that give your code (and your legacy) a chance too

Don't rely on the newest priceiest weirdest goofball proprietary bleeding edge hardware and software

NeXTCUBE

The NeXTcube is a versatile, easy-to-use workstation that can be utilized as a desktop monochrome system, true color 32-bit-per-pixel color/video workstation or file server system, all featuring NeXT's object-oriented operating and development environment.

Whether used with the NeXTdimension™ board as a standalone workstation incorporating 32-bit-per-pixel color/video, or as server on a network, the NeXTcube™ computer offers a tremendous amount of flexibility and performance in a single, one-foot-square magnesium cube. The system is built around the Motorola 25-megahertz 68040 CPU with integrated memory management and floating-point units, and includes the Motorola 56001 Digital Signal Processor for superior sound handling.

The NeXTcube may be equipped with 16 to 64 megabytes of main memory, and offers a variety of storage options—ranging from a 2.88-megabyte floppy disk drive to hard drives with capacities from 400 megabytes to 2.8 gigabytes. In addition, there are three available NeXTbus™ slots, so additional functionality can be added to the NeXTcube via NeXTbus expansion cards from third-party vendors or from NeXT, making the NeXTcube an extremely versatile workstation.

Symmetry 2000 Family

Don't hoard

Take advantage of public repositories which likely endure and proliferate

Think about who is included in your definition of “anyone”

...with $200?

...with $20,000

...with a PhD
in Computer Science?

...and a staff of 10?

...with 4 weeks
available to debug?

...and another 6 months
to reimplement?

Interlude on Goodness

No matter how well engineered our software is ...

Life will be hard and a bit cruel for many ...

So be a little humble

Appreciate your good fortune

And push yourself
a little harder

Think about what you can give back to the scientific community

Think about the people who fund your work

… and I don't mean government project managers, legislators, or corporate titans

WAL-MART
$14.82
$4.50

Appreciate our good fortune

Live up to the trust
that is given us almost without
question

And make sure we end up making some progress

Good Science

Produce theories
that make reliable predictions
about the world

Experiments are described in such a way that the results can be conveniently and reliably reproduced

Anytime

Anywhere

By Anyone

Gravity

A Good Theory

Works now

Will work in 10 years

Works here

Works on the moon

Works for me

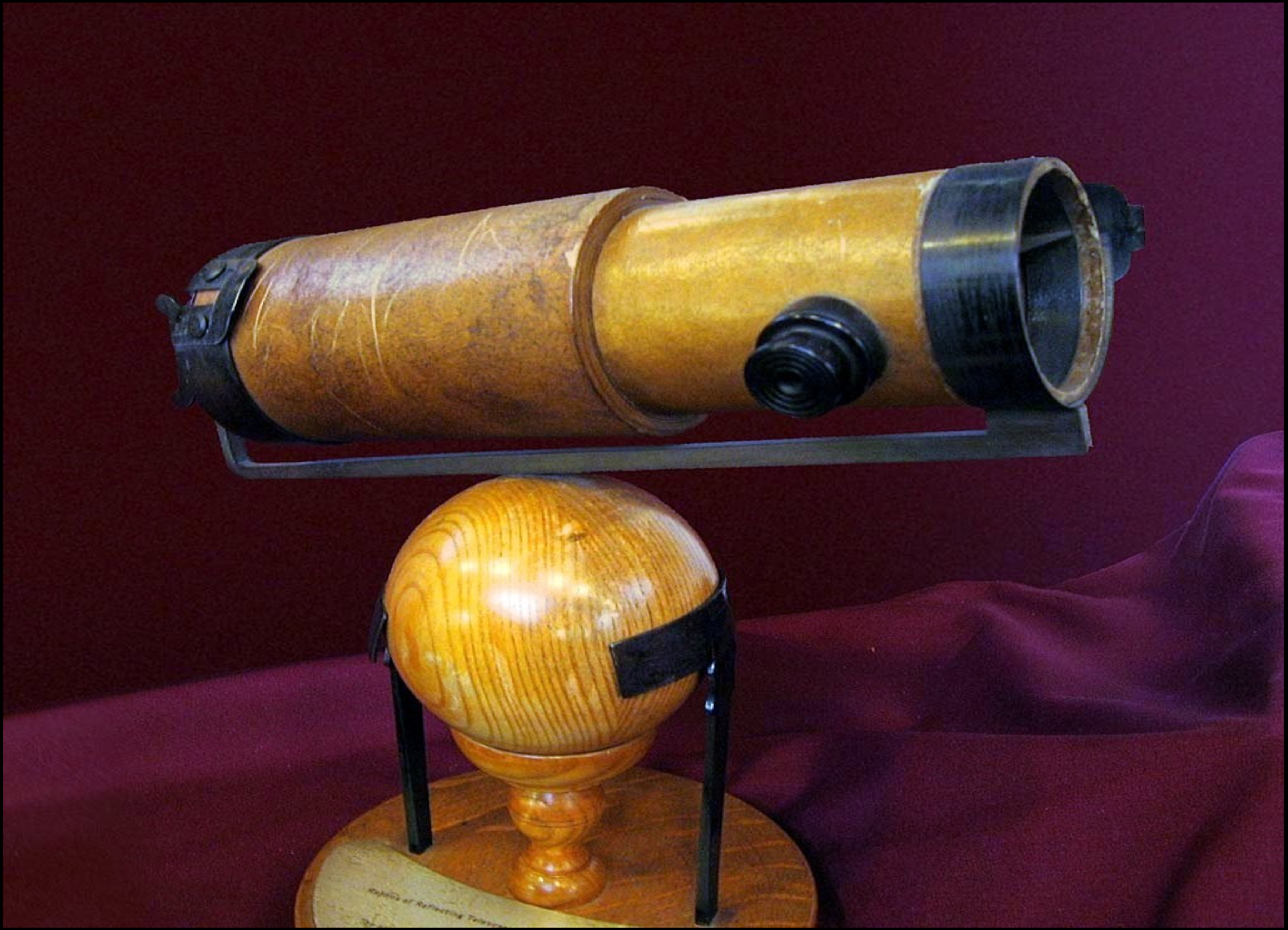
Works for you

Gravity is a force,
not an artifact

Telescope

Works anytime,
anywhere,
for anyone

The old ones still work


Replica of Reflecting Telesco

We share the big ones...

If we have access to the
same resources,
we can reproduce
each other's results

We need to work a lot harder (and engineer systems a lot better) to make that happen

Not convinced?

Conduct the following experiment

Randomly select
1 of your papers

Reproduce your results

If you can't...

Do you think
anyone else can?

What if nobody could have reproduced Galileo's falling objects experimental results? Would we simply believe?

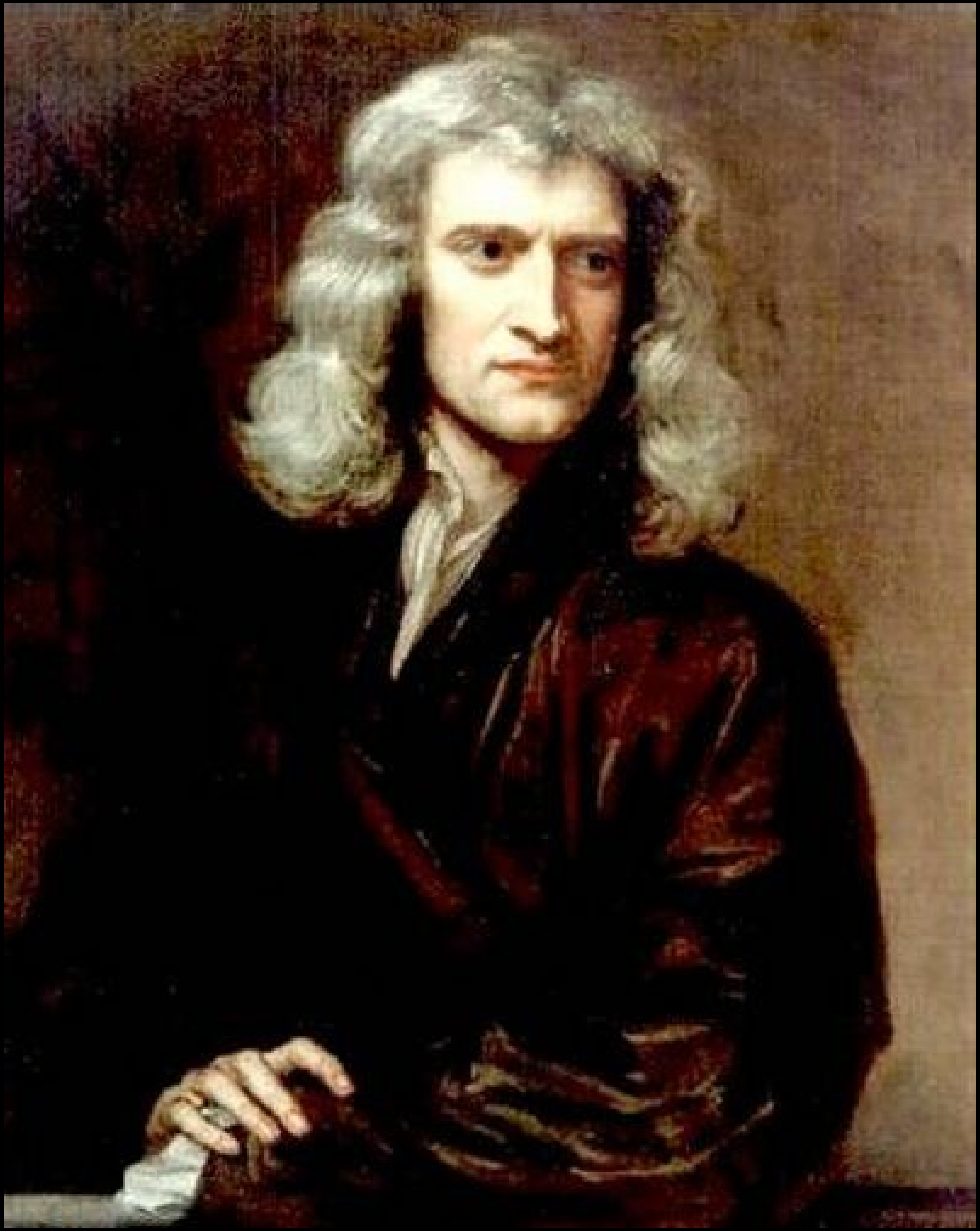
They barely believed him at the time

If your software can
reproduce your results,
its pretty well engineered

Lessons from Science

We don't get it right
the first time

If I have seen further
it is only by standing
on the shoulders of giants



(who were mostly wrong)

"Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns -- the ones we don't know we don't know."

We don't get it right
the first time

Aristotle
(384 – 322 BC)

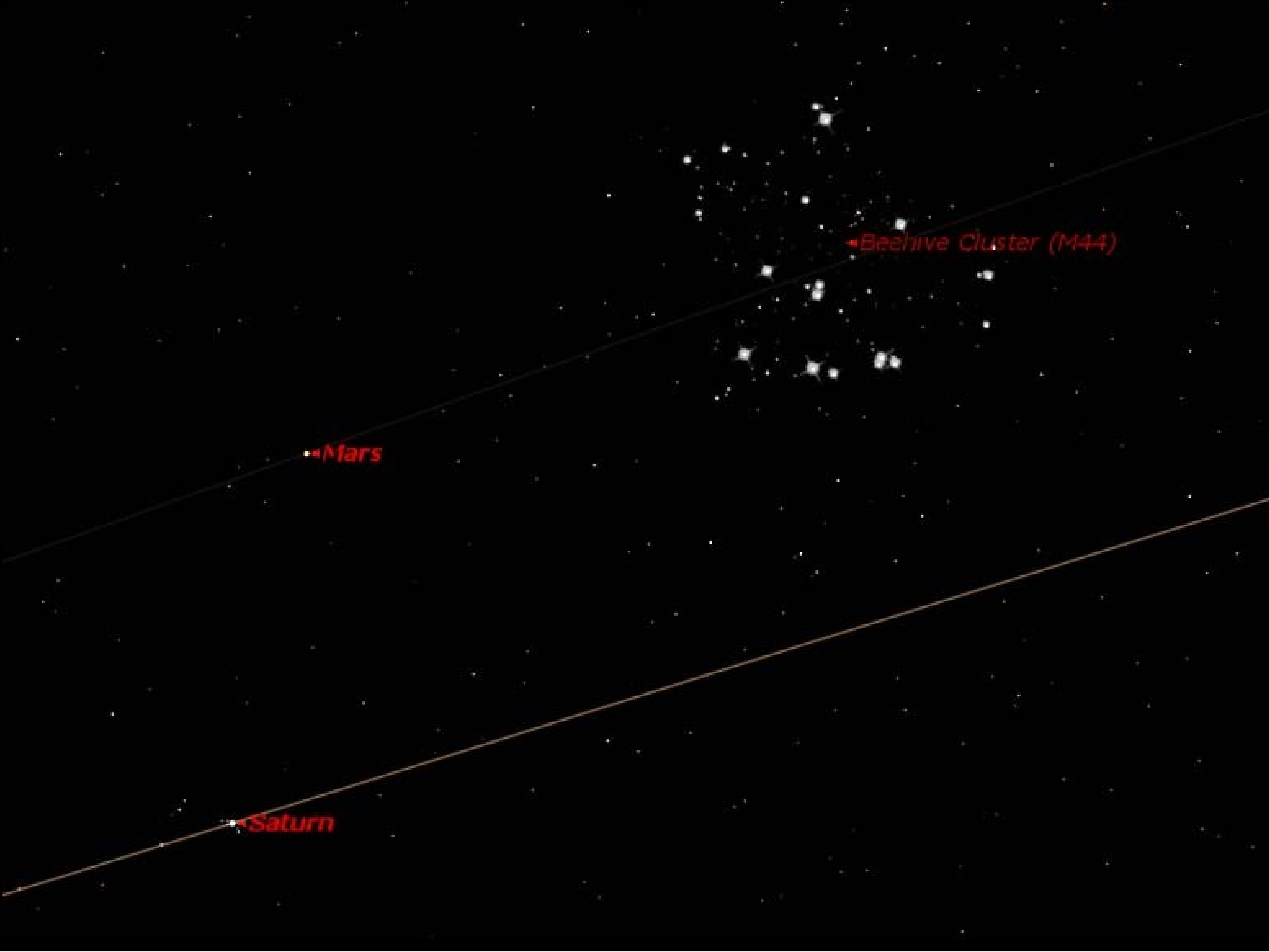
There are 4 elements

The heavens are different

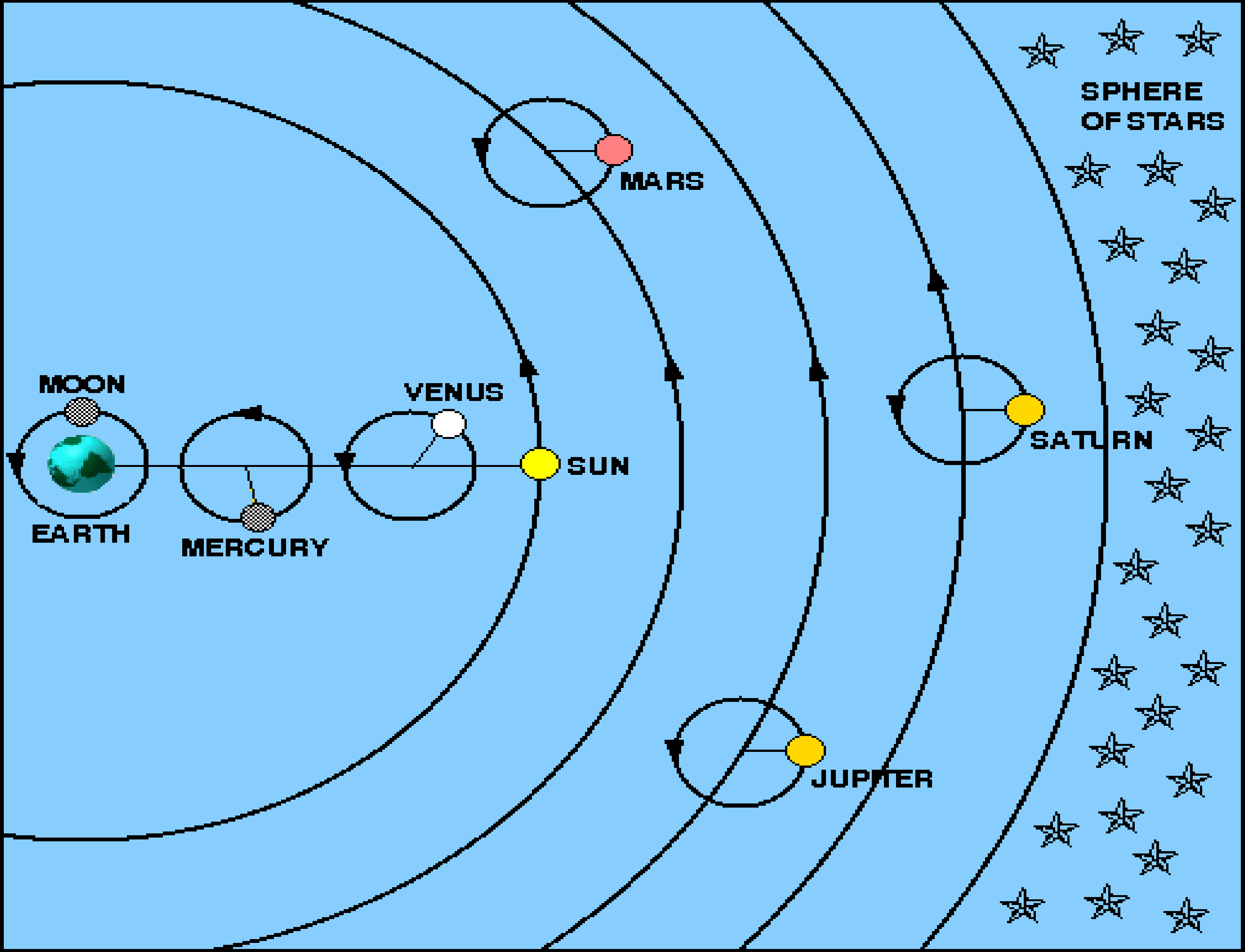
Different rules apply

Before the telescope, the heavens really were different

Other planets were balls of fire, like the stars, like the sun


Beehive Cluster (M44)
Mars
Saturn

Ptolemy
(90 – 168)


SPHERE OF STARS
MARS
MOON
VENUS
SUN
SATURN
EARTH
MERCURY
JUPITER

Crazy?

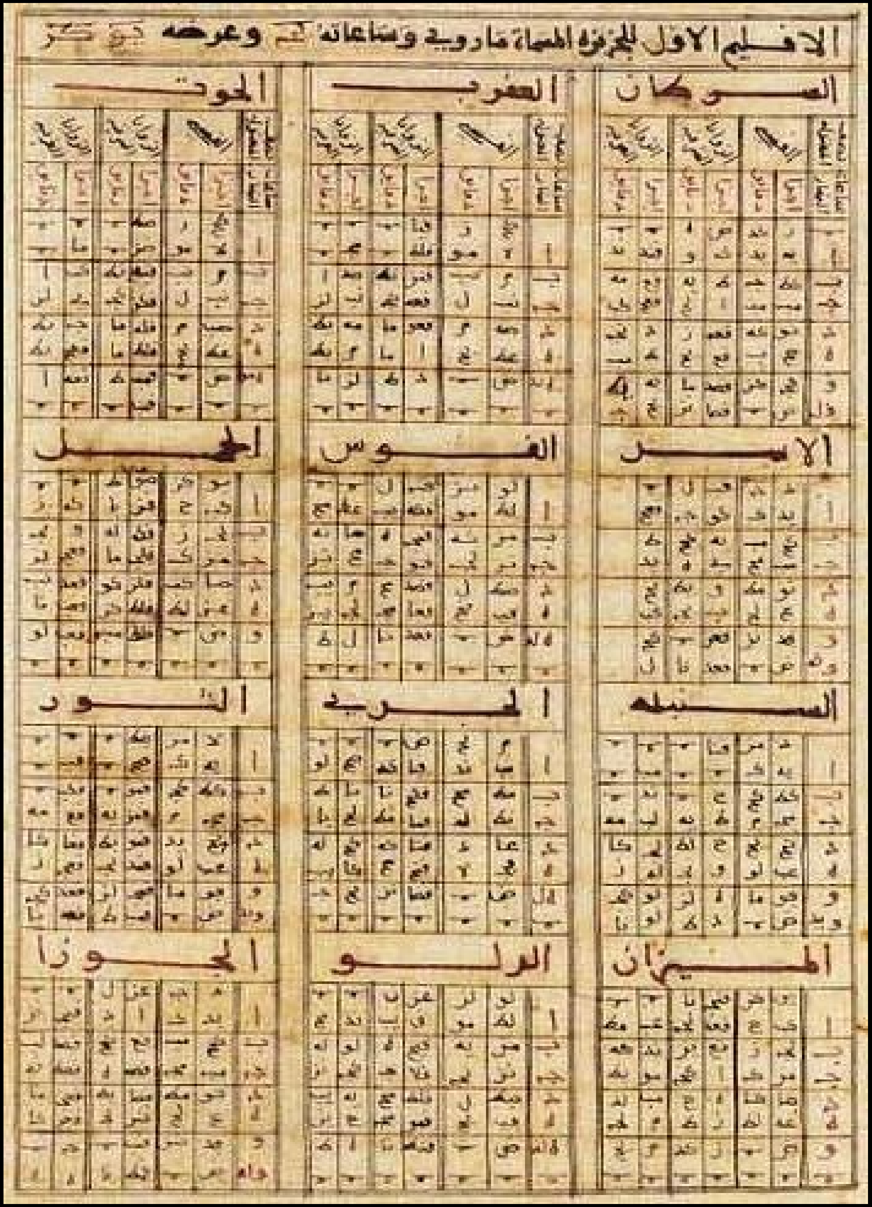
Very reliably predicts
the movement of
heavenly bodies

Instrumentalist

A theory that reliably explains and predicts the existing data

Realistic

A theory that describes things as they “really” are



الاقليم الاول للجزيرة المسماة ماروية وساعاته يج وعرضه يو كز

السرطان

العقرب

الحوت

الاسد

القوس

الحمل

السنبلة

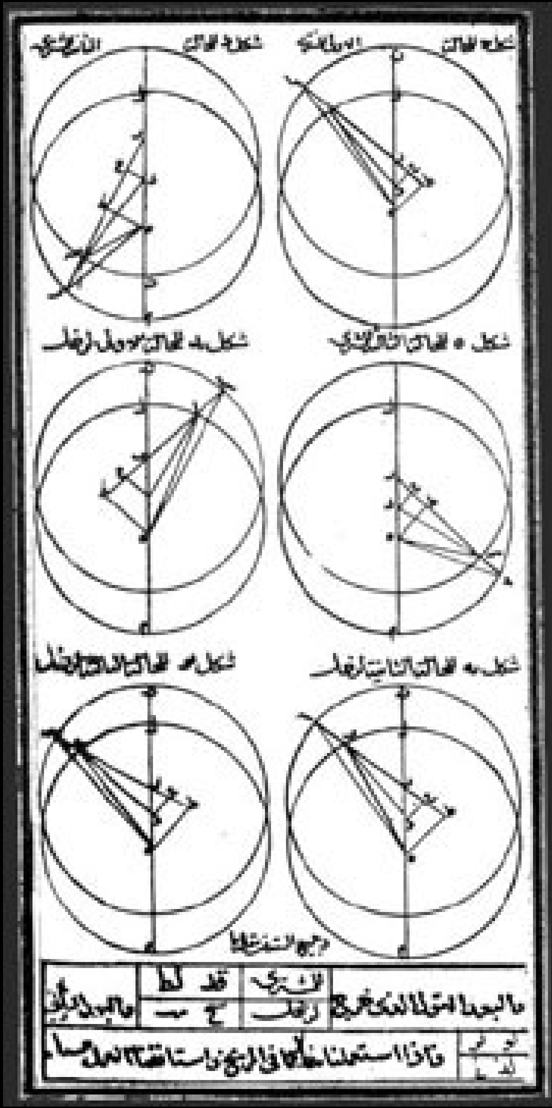
الجدي

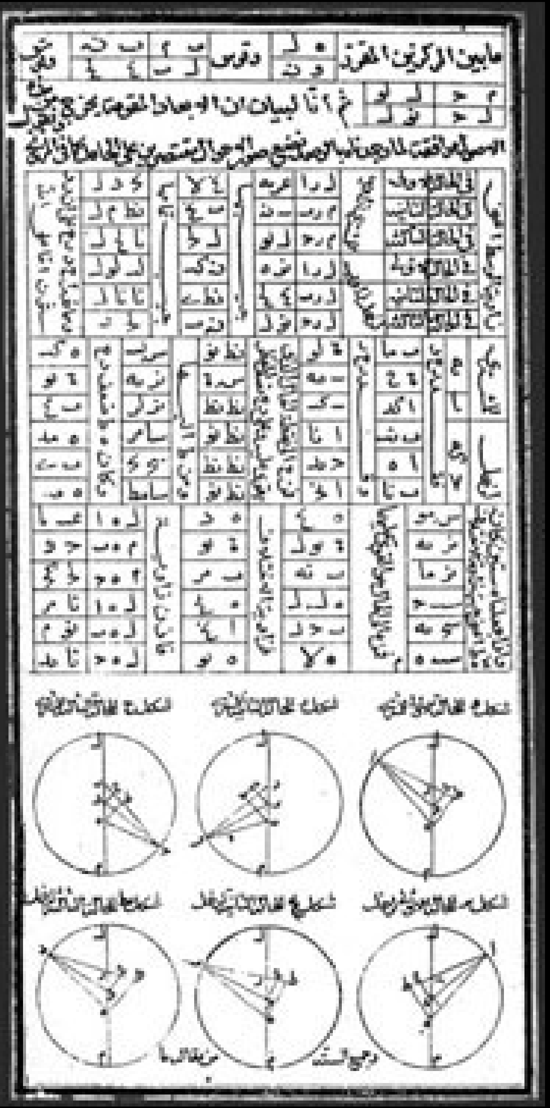
الثور

الميزان

الدلو

الجوزا





Copernicus (1473 - 1543)

Nicolas Copernic
Célébre Astronome, Mathematicien,
Philosophè et Médecin, né à Thorn Ville de
la Prusse Royale, mort en 1543. agé de
70 ans

A Paris chez Daumont.

Copernic s'élevant au dessus du Vulgaire,
Presente à l'univers une nouvelle Sphére,
Et par un effort sans pareil
Rend la Terre mobile et fixe le soleil.

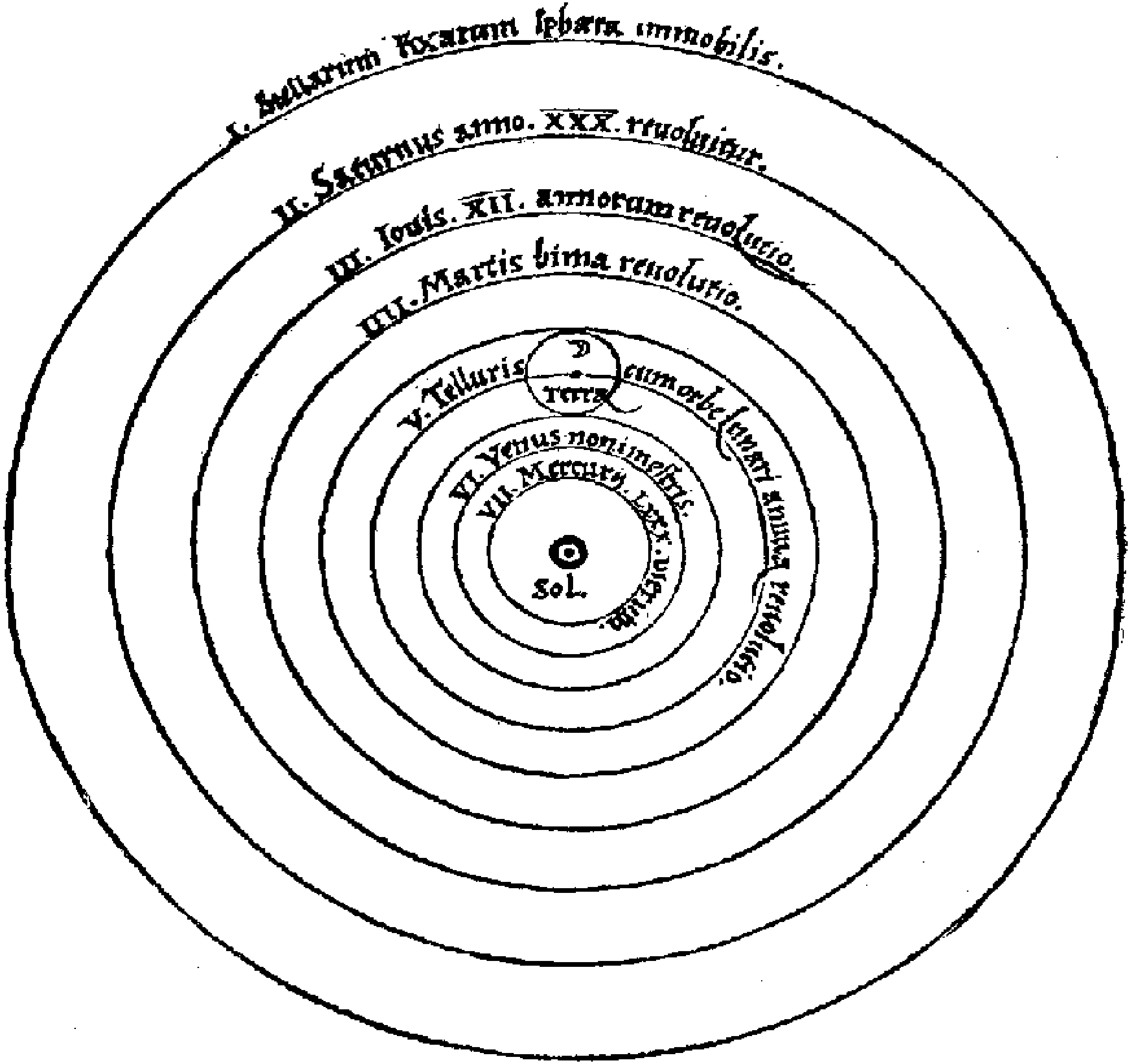
Wasn't much of an observer

Found Ptolmey's model overly complicated

Wanted a simpler explanation

...that was more heavenly

Came up with another model that was consistent with Ptolmey's data

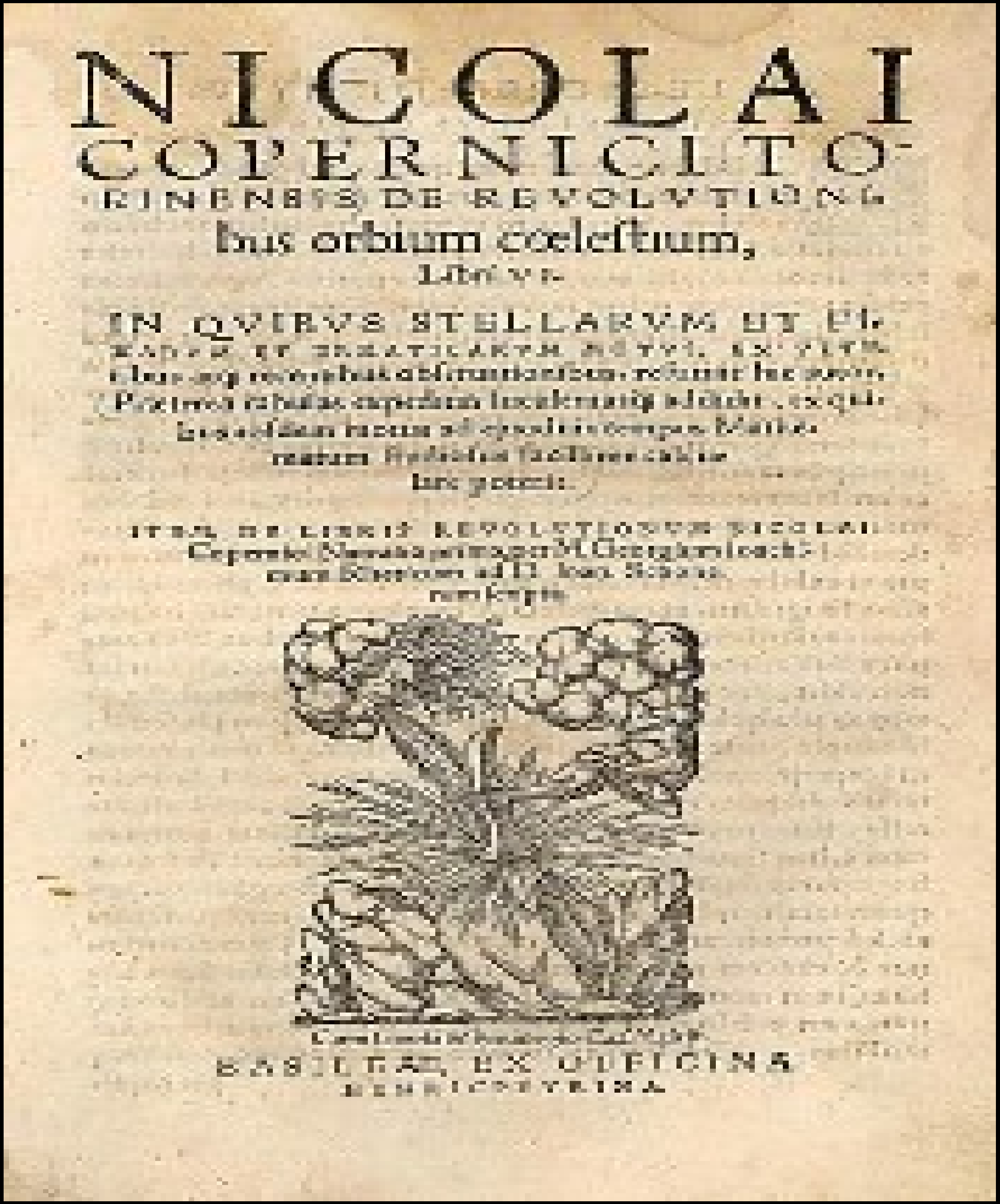

I. Stellarum Fixarum ſphaera immobilis.
II. Saturnus anno. XXX. revolvitur.
III. Iovis. XII. annorum revolutio.
IIII. Martis bima revolutio.
V. Telluris cum orbe lunari annua revolutio.
terra
VI. Venus nonimeſtris.
VII. Mercurij. LXXX. dierum.
Sol.

Great!

(Well, better)

Uniform Motion

Perfect circles



NICOLAI
COPERNICI TO-
RINENSIS DE REVOLVTIONI-
bus orbium coeleſtium,
Libri VI.

IN QVIBVS STELLARVM ET FI-
XARVM ET ERRATICARVM MOTVS, EX VETE-
ribus atque recentibus obſeruationibus, reſtituit hic autor.
Praeterea tabulas expeditas luculentasque addidit, ex qui-
bus eoſdem motus ad quoduis tempus Mathe-
matum ſtudioſus facillimè calcu-
lare poterit.

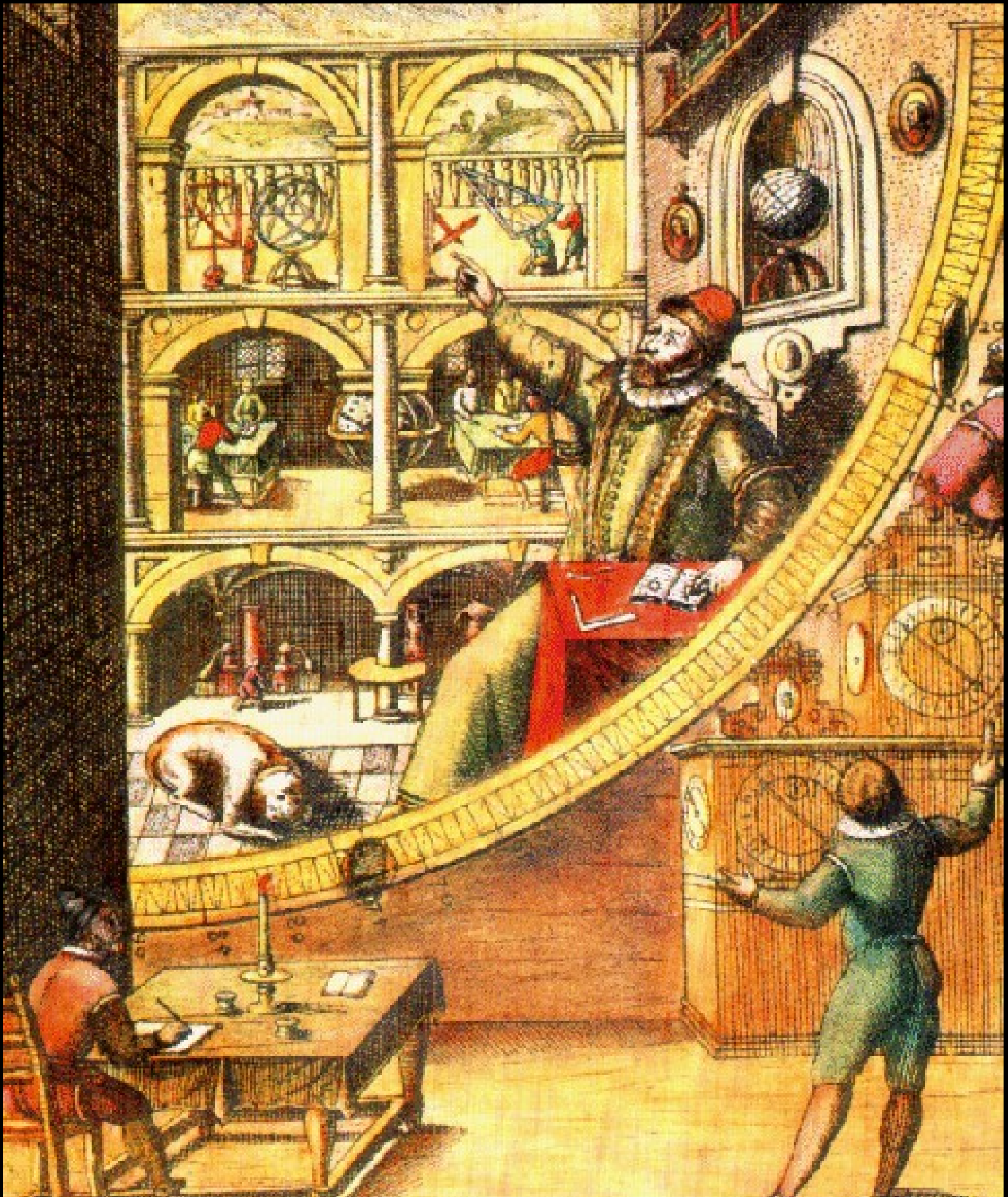
ITEM, DE LIBRIS REVOLVTIONVM NICOLAI
Copernici Narratio prima, per M. Georgium Ioachi-
mum Rheticum ad D. Ioan. Schone-
rum ſcripta.

Cum Gratia & Priuilegio Caeſ. Maieſt.

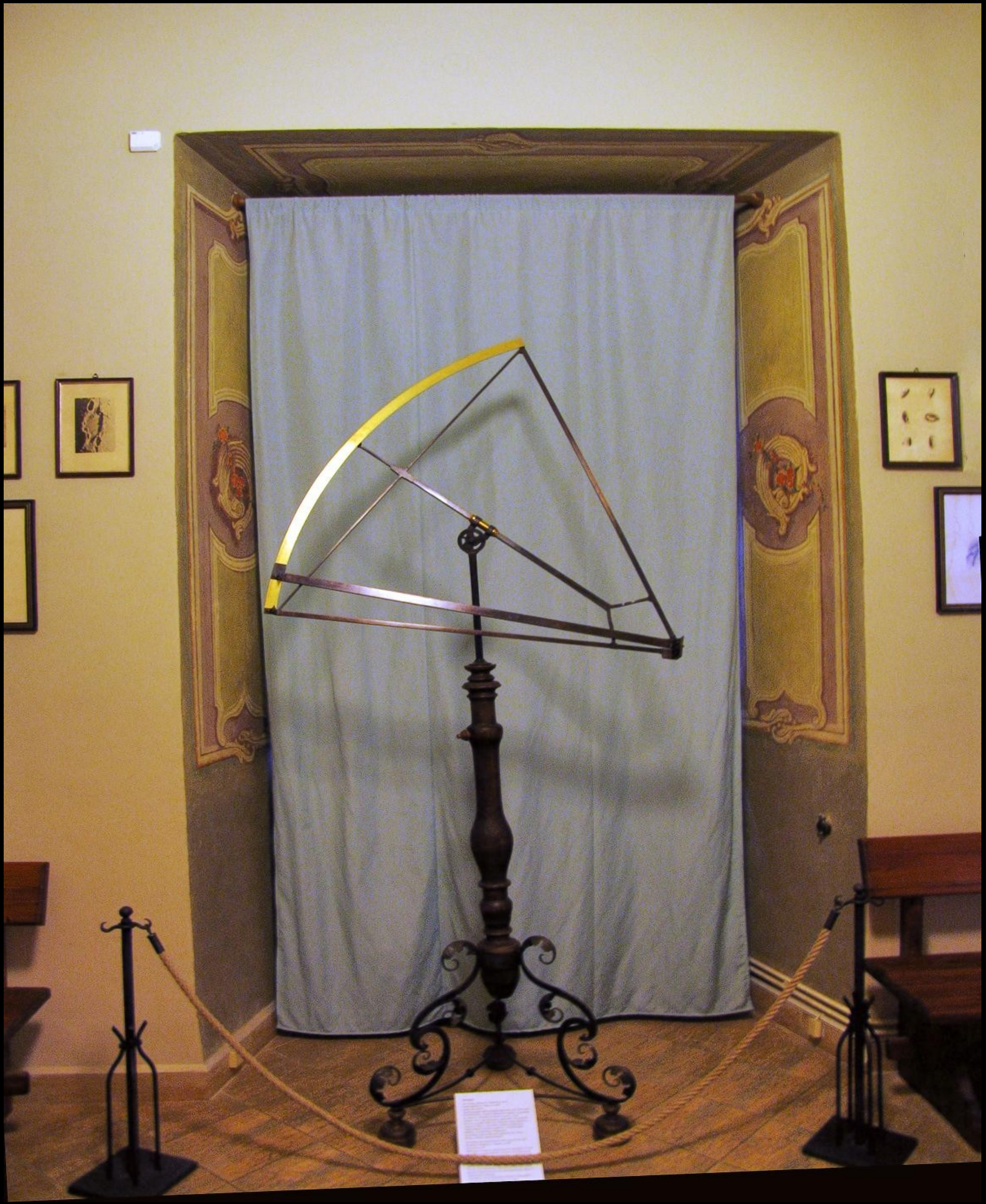
BASILEAE, EX OFFICINA
HENRICPETRINA.

Copernicus de Revolutionibus

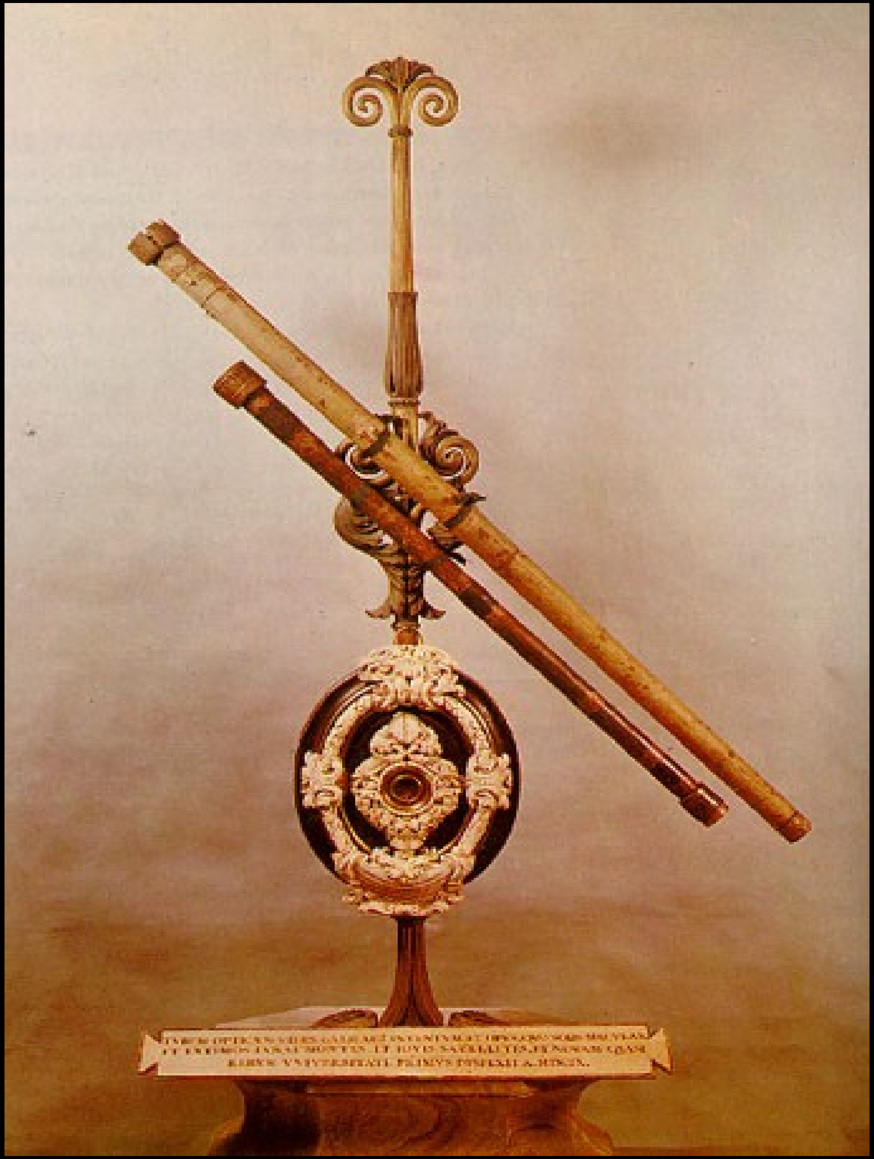
Tycho Brahe (1546 - 1601)



A great observational astronomer, the last naked eye astronomer



Galileo
(1564 - 1642)



1609 Telescope

1610

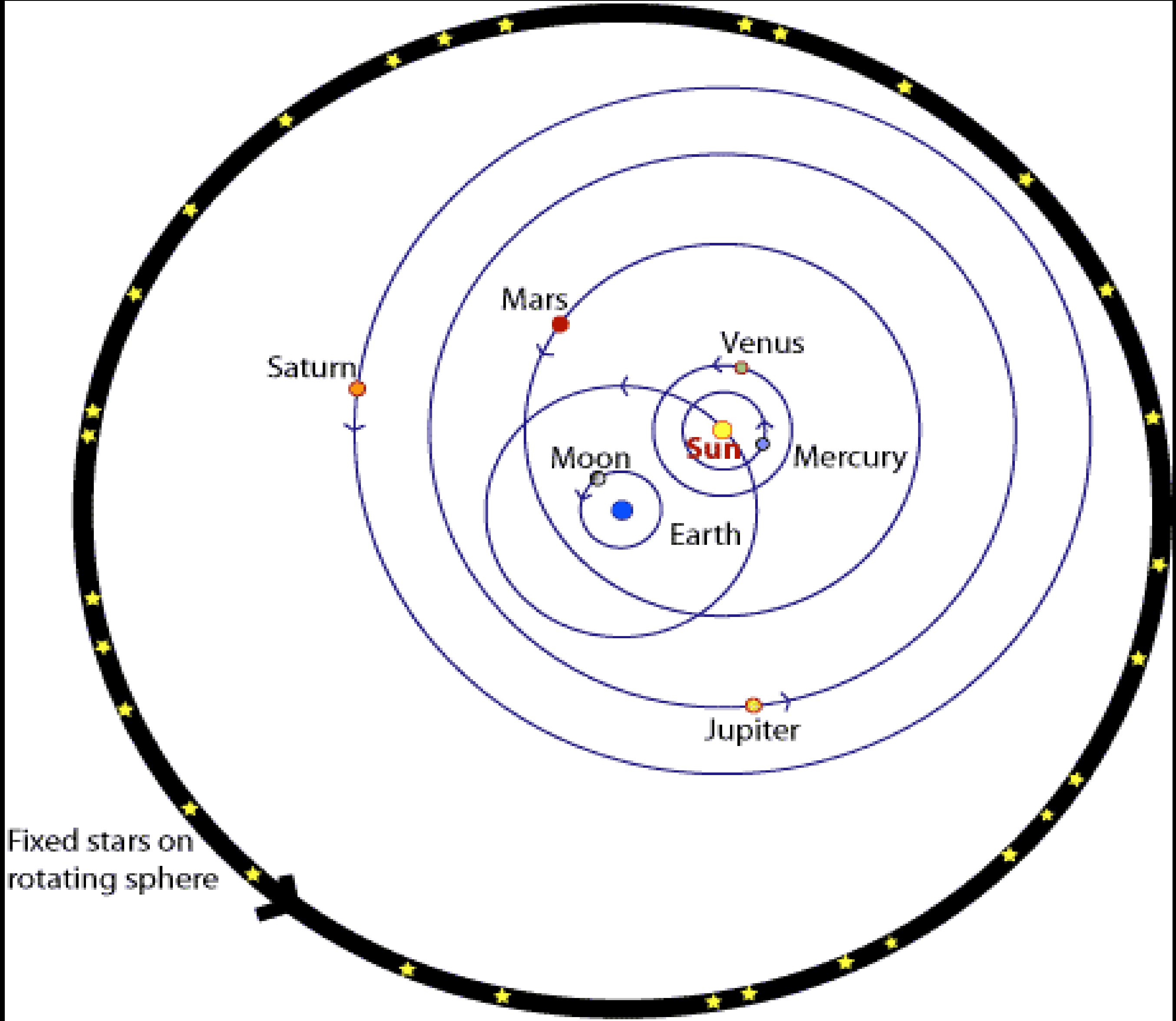
Observed 4 moons of Jupiter

Back to Tycho

Made remarkably accurate observations for 20 years

Knew about Copernicus

Arrived at his own theory



The Tychonic Model

A hybrid model

Fits and predicts the observed data

Data Sharing

TYCHO BRAHE
JOHANNES KEPLER

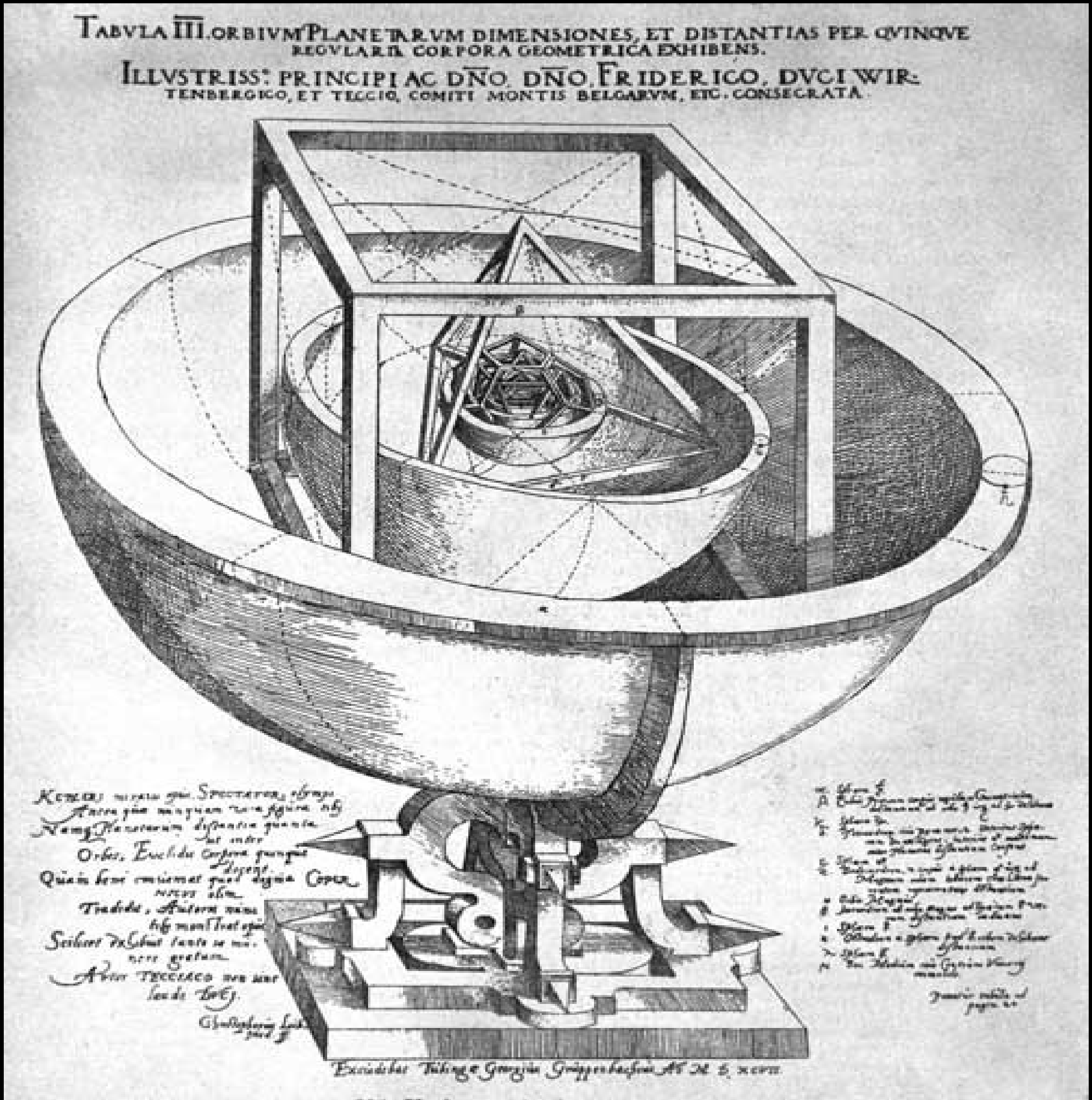
Kepler
(1571 - 1630)

ÆTATIS SUÆ
1610

Why are there 6 planets?

Why are they so positioned?

Geometry and Perfect Solids



TABVLA III. ORBIVM PLANETARVM DIMENSIONES, ET DISTANTIAS PER QVINQVE REGVLARIA CORPORA GEOMETRICA EXHIBENS.
ILLVSTRISS: PRINCIPI AC DNO. DNO. FRIDERICO, DVCI WIRTENBERGICO, ET TECCIO, COMITI MONTIS BELGARVM, ETC. CONSECRATA.
Orbes, Euclidis Corpora quinque
Quàm bene conveniant quod digna Copernicus olim
Tradidit, Autoris nunc
Scilicet
aere gratum
Autor TECCIACO
laude
Excudebat Tubingæ Georgius Gruppenbachius A° M. D. XCVII

295. Kepler. 1596. (Greatly reduced.)

In 1601 Tycho bequeathed his data...

Kepler's Laws of Planetary Motion

Varying velocity

Elliptical Orbits

...around the Sun

It was left to Newton to work out what held the planets in place and made them move...

History of Science?

We are wrong many many times before we are right

Progress happens
when people leave their
data and instruments behind

Ptolemy (90 - 168)
Copernicus (1473 - 1543)
Tycho (1546 – 1601)
Galileo (1564 - 1642)
Kepler (1571 - 1630)
Newton (1642 - 1727)

Good science and
good software assume you
don't get it right at first

Leave your software (and your data) behind for your successors to build on

And if they can,
you've done some
good software engineering,
and some good science

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