OLD BOOKS BRING NEW LIFE TO THE BRICK AND MORTAR LIBRARY

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Abstract. If all the library books and journals can be viewed on your desk top, why come to the physical library? The USNO Library tried to bring the patrons inside the library. One method was to rotate rare book displays each month. As the library holds a fabulous collection of ancient astronomy books, including Copernicus, Kepler, Galileo, and Newton, we have abundant resources. The presentation will highlight the varied displays and offer a Rare Books 101 explanation of paper, printing, binding and a behind-the-scenes look at how old books are maintained and preserved.

Old Books Bring New Life to the Brick and Mortar Library

The US Naval Observatory library started in 1843 when Lt. James M. Gilliss was given $800 and a ticket to Europe to purchase important astronomy books. It is a sanctuary for some. For me, it is a lonely place and I wanted more people to come to the library. I started hosting monthly gatherings to show off our changing rare book exhibits. I offered cake and people came! Some days we have few people. Some days we have tours. Some days we have lectures. Some days we have ceremonies. Just as long as they keep coming to the library, we are happy.

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If all the library books and journals can be viewed on your desk top, why come to the physical library? The USNO Library tried to bring the patrons inside the library. One method was to rotate rare book displays each month. As the library holds a fabulous collection of ancient astronomy books, including Copernicus, Kepler, Galileo, and Newton, we have abundant resources. The presentation will highlight the varied displays and offer a Rare Books 101 explanation of paper, printing, binding and a behind-the-scenes look at how old books are maintained and preserved.

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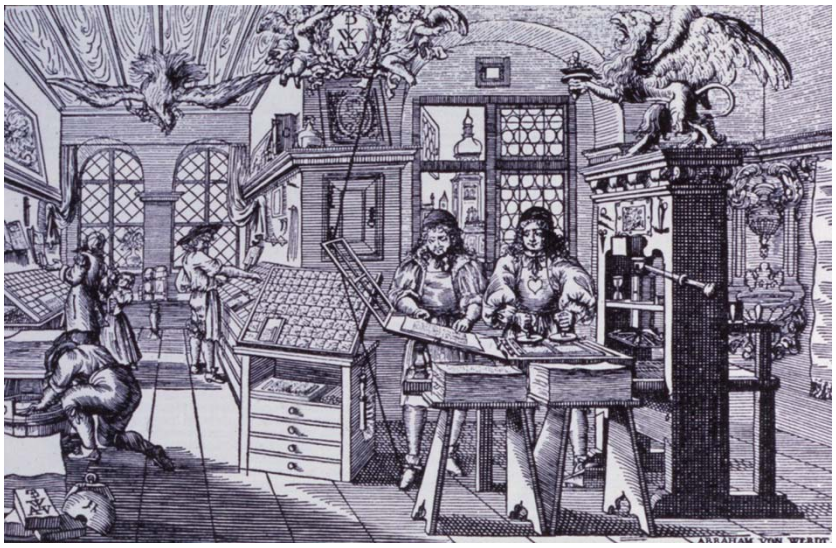
Gilliss did a great job with his $800 collecting all the important rare books in astronomy. We no longer buy books like these but we're happy he did!

I'm going to show you some of our fabulous books but first I want to point out to you my basic philosophy about rare books. They are books. People wrote them to be read and used and appreciated by readers. Even though our copy of Copernicus is worth millions, it is first and foremost – not a museum object -- but a book; a book to be enjoyed by people like you and me. We will also look at some of the art associated with old books. Book illustration in the European renaissance was art.

My goals for you today are to learn a little bit about the history of the printing press. You will learn that bookbinding was a separate job. You will see how paper was made. You will see pictures of old books by some of the great names in astronomy. You will see some of the constellations from four major celestial atlases. You will find out a little about the history of scientific societies. You will see some of our monthly rare book displays. Also, you will get to see what a rare book vault looks like.



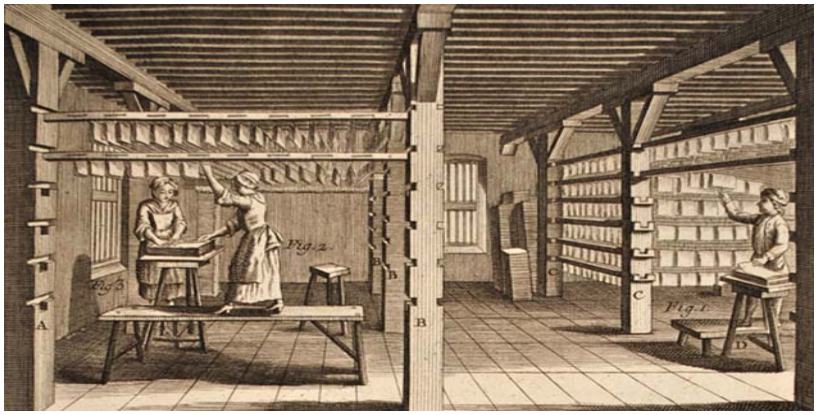
All of the Naval Observatory books are post Gutenberg – think of machine printing flourishing in the mid-1400s. In the olden times, printing a book involved two different vocations – that of the printer who actually had a press and a book binder. Gutenberg was the first European to use movable type printing, around 1439 in Mainz, Germany. Among his many contributions to printing are: the invention of a process for mass-producing movable type; the use of oil-based ink; and the use of a wooden printing press similar to the agricultural screw presses of the period. His historical gift was the combination of these three elements into a practical system which allowed the mass production of printed books that was economically viable for printers and readers alike.

You also need a book binder. When you purchased a book from the printer you would take all those sheets of paper to your book binder to insure that it looked like all of your other books. This is a picture of a book binder from Weigel's Book of Trades, published in 1698. This man is sewing the sheets of paper together with the leather binding on top. The man in the back is putting leather over a wooden board to make the cover.

You need to have paper – and this was by far and away the most expensive part of the whole printing process. The ladies below are rag sorters and they will make rag paper – linen, cotton any old clothes sorted by color and made into a slurry. A machine beats the slurry of rags, water and sour milk to soften and bleach the fibers.

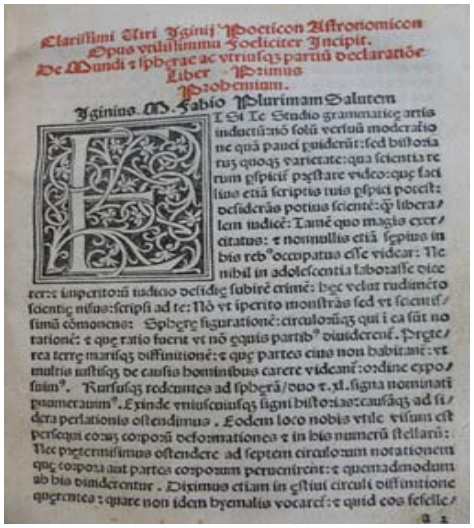
The slurry is taken from the vats and screened. The sheets are pressed to remove excess moisture.

The sheets of paper are hung to dry. Now we have the paper, the printer and the book binder ready to make our first book.



Hyginus

Our first book is our oldest, Hyginus's Astronomy published in 1482 in Venice, Italy. Printing was thirty years old – it was an established mechanical technique by 1482. Here is the title page. It is fancier and more expensive to add another color to the printing – that means the paper has to be run through the press twice with two different inks. This is the only page in the entire book with red color added.



Clarissimi Viri Iginij Poeticon Astronomicon
Opus vtilissima Feliciter Incipit.
De Mundi z sphera ac vtriusq3 partiū declaratiōe
Liber Primus
Prohemium.
Iginius M. Fabio Plurimam Salutem
Si Te Studio grammatice artis
inductū:nō solū versuū moderatio
ne quā pauci gaudent:sed historia
rum quoq3 varietate:qua scientia re
rum gspicit pstare video:eque faci
lius etiā scriptis tuis gspici potest:
desideras potius scientē:op libera
lem iudicē: Tamē quo magis exer
citatus: z nonnullis etiā sępius in
bis reb9 occupatus esse videar: Ne
nihil in adolescentia laborasse dice
rer: imperitorū iudicio delicte subirē crimē: hec velut rudimēto
scientię misi:scripsi ad te: Nō vt iperito monstrās sed vt scientis
simū cōmonens: Sphere figurationē:circulorūq3 qui i ea sūt no
tationē: z que ratio fuerit vt nō equis partib9 diuiderent. Prete
rea terre marisq3 diffinitionē: z que partes eius non habitant: vt
multis iustisq3 de causis hominibus carere videam:ordine expo
suim9. Rursusq3 redeuntes ad sphērā/duo z.xl. signa nominati
puameruum9. Exinde vtilitatisq3 signi historiam:causāq3 ad si
dera perlationis ostendimus. Eodem loco nobis vtile visum est
persequi eorū corpoꝝ deformationes z in his numerū stellarū:
Nec pretermisimus ostendere ad septem circulorum notationem
que corpora aut partes corporum perueniret: z quemadmodum
ab his dimicrentur. Diximus etiam in estiui circuli diffinitione
quęrentes: quare non idem hyemalis vocaret: z quid eos seiecit

The printer, Erhard Ratdolt commissioned a series of woodcuts depicting the constellations to accompany Hyginus' text. The initial letters were also made with wood blocks but printing from blocks of wood was cumbersome and slow. The text describes the forty eight Ptolemaic

constellations, centering primarily on the Greek and Roman mythology surrounding the constellations. As with star atlases that would follow it, the positions of the stars are overlaid on the image of each constellation. However, the positions of the stars in the woodcuts bear little resemblance to the actual positions of the stars in the sky. As a result of the inaccuracy of the star positions and the fact that the constellations are not shown in any context where they are in the sky, the book is not particularly useful. However, the illustrations commissioned by Ratdolt served as a template for future sky atlas illustrations and the text is an important source, and occasionally the only source, for some of the more obscure Greek myths.

So who was Hydra and why is he always shown with a crow and a cup in a laurel tree? The Greek myth says Apollo asked the crow to get him a cup of water. The crow returned with a cup with water and a snake in it; Apollo was disgusted, and angrily threw the crow, cup, and snake, into a tree in the sky.

This book is 530 years old. The paper looks like it was made yesterday. Rag paper is a very stable product – unlike our wood pulp paper today which is inherently acidic.

Abu Masar

Another old book, published in 1488 is by Abu Masarsh: De Magnis Coniunctionibus, Annorum Revolutionibus. He was the leading astrologer in the Muslim world who lived in the 9th century. It was also printed by Erhart Radolt; the same man who printed our Hyginus. His innovative layout of mixing type and woodcuts influenced future printers. He produced the first known printer's type broadsheet displaying the fonts available.

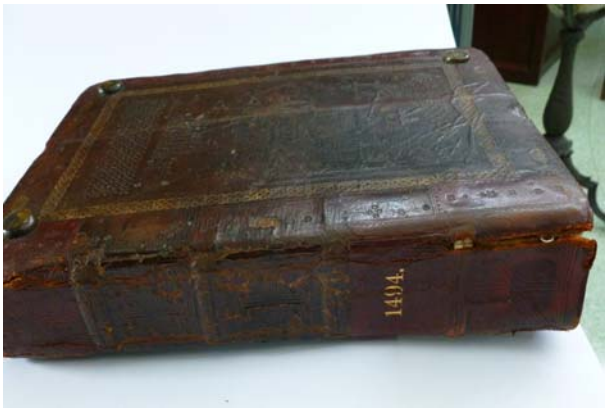
Abu Masar taught "mathematics" which included not only arithmetic, but astronomy and astrology. I show you this book because of the beautiful illustrations from 524 years ago.

Pacioli

The Summa de Arithmetica by Lucia Pacioli, published in 1494 was a textbook for the schools of Northern Italy. It was a compilation of the mathematical knowledge of the time and contained the first printed work on algebra and a method of bookkeeping that Venetian merchants used during the Italian Renaissance, double-entry. The system is just like the accounting cycle today with journals and ledgers, warning you not to go to sleep at night until the debits equaled the credits.

Pacioli was born in 1445. He was a mathematician, scholar and Franciscan monk. A famous man in his lifetime, he was friends with Leonardo da Vinci who illustrated his second book. He was the first to translate Euclid's works into Latin. This portrait of him is from the Naples National Museum. The open book before him is Euclid. His book is off to the side in the red binding, closed with clasps. The man looking over his shoulder is believed to be his sponsor, The Duke of Urbino.

The cover binding is an armorial binding – meaning it shows the family crest – with a gold tooled strap work border. The more gold leaf on your books; the more you can impress your friends with your wealth. The binding is leather over a wooden board. This is not the original 1494 binding – because in 1494 they would not have put the date on the back so prominently – but it is from the early 1700's.



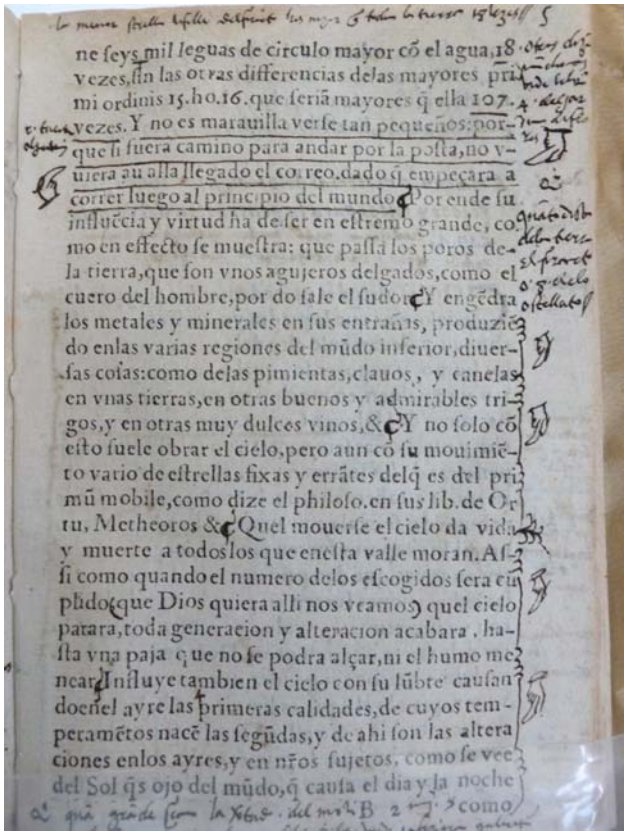
After the sack of Mainz in 1462, Guttenberg's students were scattered throughout Europe. Venice became one of the chief locations. During the first part of the 1500s one fourth of all books printed came from Venice. So, for a book to be produced in 1494 in Venice, its subject must have been so important that it was chosen to be one of the first ones published. European commerce radiated from Venice. So it is logical that a book keeping book would come from this area. The owner of the book, Carlo Camucio wrote on the last page on Feb 11, 1726. He lived in Italy and wrote a book called (in Italian) Through the Eye of the World: Two Pilgrims in the Holy Land of the Eighteenth Century. So Camucio owned a 232 year old book and bound the book with his family crest.

This book has had a hard life: Someone cut pages from this book and wrote on it. It got wet along the edges. Once the paper was wet – a mouse ate it. After a mouse, a book worm ate through a section. It is always fun to have annotations and notes in a book – not to mention drawings of little men.

Mico

Now we make an 80 year leap forward to a book published in Spain: Micos' Comet of 1578. This is a homemade binding of animal skin with ties to hold it together. The book written in Spanish is about comets and was written the year after the great comet of 1577. This is the only book Mico wrote. We don't know anything about him.

This book is fun because someone actually read it and annotated it! Since they did not have a yellow highlighter, the book owner drew a picture of a finger pointing to the important passages or a drawing of a centipede. The annotations end about half way through the book.



ne seys mil leguas de circulo mayor cõ el agua, 18
vezes, sin las otras differencias delas mayores pri-
mi ordinis 15. ho. 16. que seriã mayores q̃ ella 107.
vezes. Y no es marauilla verse tan pequeños: por-
que si fuera camino para andar por la posta, no y-
uiera au alla llegado el correo, dado q̃ empeçara a
correr luego al principio del mundo. Por ende su
influccia y virtud ha de ser en estremo grande, co-
mo en effecto se muestra: que passa los poros de-
la tierra, que son vnos agujeros delgados, como el
cuero del hombre, por do sale el sudor. Y engẽdra
los metales y minerales en sus entrañas, produzie-
do enlas varias regiones del mũdo inferior, diuer-
sas cosas: como delas pimientas, clauos, y canelas
en vnas tierras, en otras buenos y admirables tri-
gos, y en otras muy dulces vinos, &. Y no solo cõ
esto suele obrar el cielo, pero aun cõ su mouimiẽ-
to vario de estrellas fixas y errãtes delq̃ es del pri
mũ mobile, como dize el philoso. en sus lib. de Or
tu, Metheoros &. Quel mouerse el cielo da vida
y muerte a todos los que en esta valle moran. As-
si como quando el numero delos escogidos sera cũ
plido (que Dios quiera alli nos veamos) quel cielo
patara, toda generacion y alteracion acabara. ha-
sta vna paja q̃ no se podra alçar, ni el humo me-
near. Influye tambien el cielo con su lũbre causan
doen el ayre las primeras calidades, de cuyos tem-
peramẽtos nacẽ las segũdas, y de ahi son las altera
ciones enlos ayres, y en nros sujetos, como se vee
del Sol q̃s ojo del mũdo, q̃ causa el dia y la noche

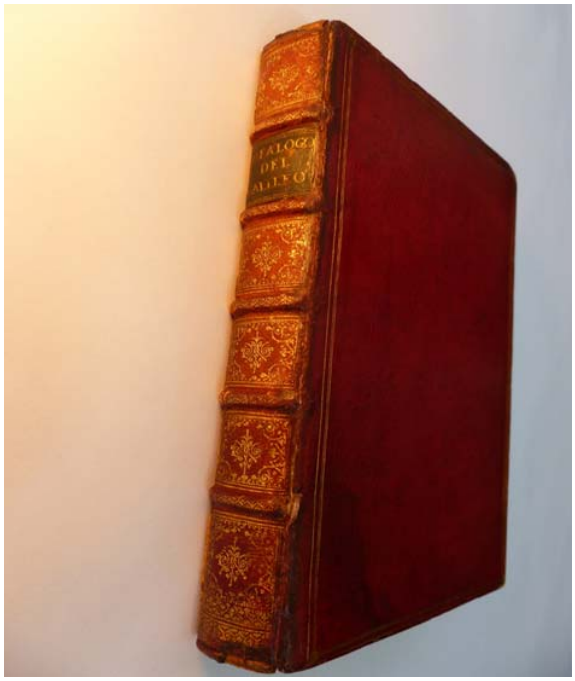
Copernicus

We have a second edition of Copernicus' De Revolutionibus Orbium Coelestium from 1578. Copernicus was a Renaissance astronomer and the first person to formulate a comprehensive heliocentric cosmology which displaced the Earth from the center of the universe. The book is the starting point of modern astronomy and began the scientific revolution. Despite urging by his closest friends, Copernicus resisted publishing his views during his lifetime, not wishing—as he said—to risk the scorn "to which he would expose himself on account of the novelty and incomprehensibility of his theses." Legend has it that the first printed copy of his book was placed in his hands on the very day that he died.

His heliocentric model, with the Sun at the center of the universe, demonstrated that the observed motions of celestial objects can be explained without putting Earth at rest in the center of the universe. This is the iconic image from the book.

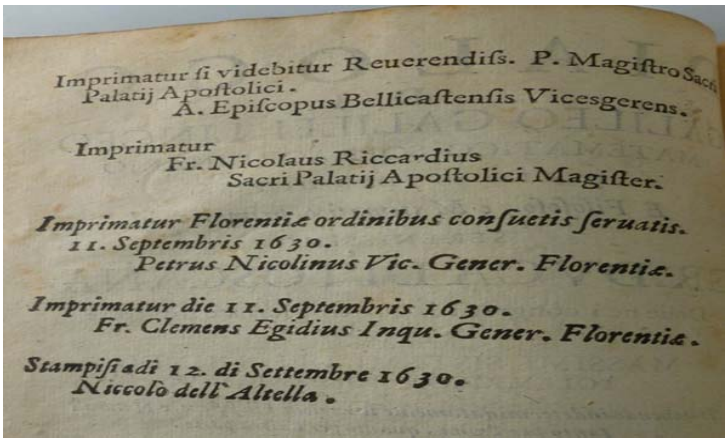
Galileo

The Dialogue Concerning the Two Chief World Systems (Ptolemaic & Copernican) was published in Florence in Italian in 1632. This has a beautiful red leather binding with a lot of stamped gold leaf. So much so they even gilded the edges of the covers.



Galileo presents his book as a hypothetical look at this newfangled Copernican theory. The Dialogue was an immense success upon publication and by the time Galileo's enemies succeeded in banning it 5 months later, there was scarcely a copy to be found with the book sellers.

This is on the back of the title page – these are all the people who had to approve it to be printed (the word “imprimatur” meant “Let it be printed”). The book was officially sanctioned by the Church and allowed to be published. The second name is listed as the “master of the sacred apostolic palace.” After all these people said it was ok to print, it was still contested!


Imprimatur ſi videbitur Reuerendiſs. P. Magiſtro Sacri
Palatij Apoſtolici.
A. Epiſcopus Bellicaſtenſis Vicesgerens.

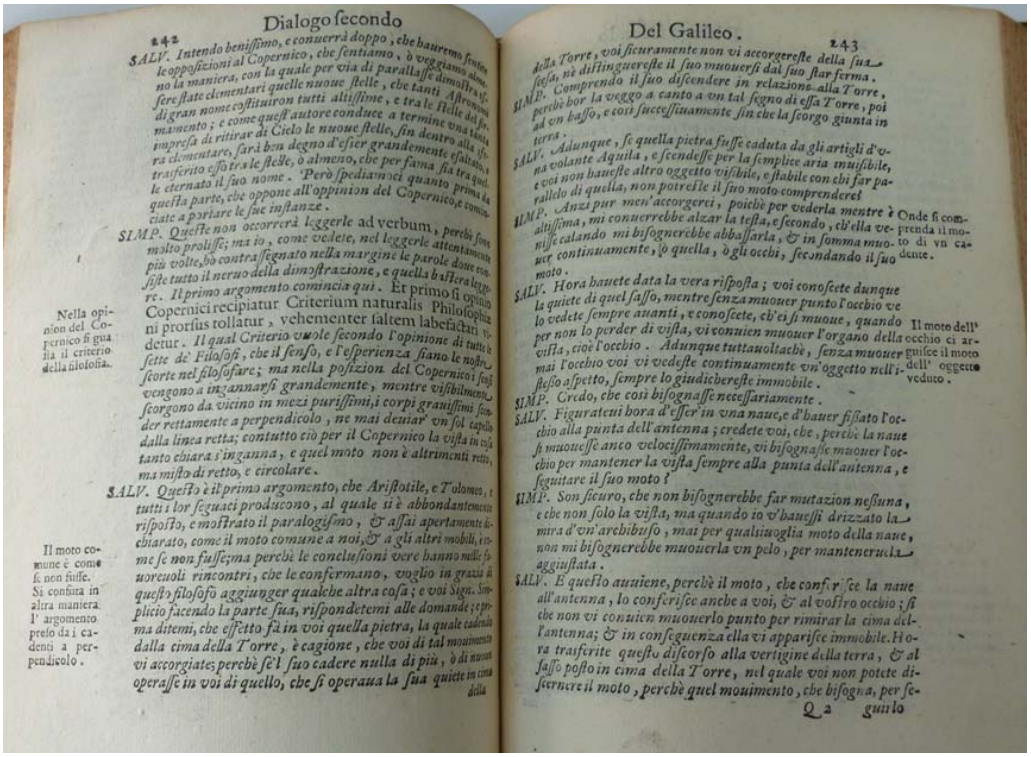
Imprimatur
Fr. Nicolaus Riccardius
Sacri Palatij Apoſtolici Magiſter.

Imprimatur Florentiæ ordinibus conſuetis ſeruatis.
11. Septembris 1630.
Petrus Nicolinus Vic. Gener. Florentiæ.

Imprimatur die 11. Septembris 1630.
Fr. Clemens Egidius Inqu. Gener. Florentiæ.

Stampiſi adi 12. di Settembre 1630.
Niccolò dell'Altella.

This page illustrates the conversational aspect of the book. There are three people speaking. The first, Salviati argues for the Copernican position. Second, Sagredo is an intelligent layman who is neutral. Simplicio presents the traditional views of Aristotle and gives arguments against the Copernican position. He is named after a sixth century commentator of Aristotle, Simplicius of Cilicia but it was suspected the name was a pun on the Italian word for simple minded.



Dialogo secondo 242

SALV. Intendo benissimo, e conuerrà doppo, che hauremo fruste le opposizioni al Copernico, che sentiamo, ò veggiamo alcuno la maniera, con la quale per via di parallasse dimostra vi sere state elementari quelle nuoue stelle, che tanti Astronomi di gran nome costituiron tutti altissime, e tra le Stelle del firmamento; e come quest'autore conduce a termine vna tanta impresa di ritirar di Cielo le nuoue stelle, sin dentro alla sfera elementare, sarà ben degno d'esser grandemente esaltato, e trasferito esso tra le stelle, ò almeno, che per fama sia tra quelle eternata il suo nome. Però spediamoci quanto prima da questa parte, che oppone all'oppinion del Copernico, e cominciate a portare le sue instanze.

SIMP. Queste non occorrerà leggerle ad verbum, perchè sono molto prolisse; ma io, come vedete, nel leggerle attentamente più volte, ho contrassegnato nella margine le parole donde consiste tutto il nerbo della dimostrazione, e quella basterà leggere. Il primo argomento comincia qui. Et primo si opponi Copernici recipiatur Criterium naturalis Philosophiæ ni prorsus tollatur, vehementer saltem labefactari videtur. Il qual Criterio vuole secondo l'opinione di tutte le sette de' Filosofi, che il senso, e l'esperienza siano le nostre scorte nel filosofare; ma nella posizion del Copernico si vengono a ingannarsi grandemente, mentre visibilmente scorgono da vicino in mezi purissimi, i corpi grauissimi scender rettamente a perpendicolo, ne mai deuiar vn sol capello dalla linea retta; contutto cio per il Copernico la vista in cosa tanto chiara s'inganna, e quel moto non è altrimenti retto, ma misto di retto, e circolare.

Nella opinion del Copernico si guasta il criterio della filosofia.

SALV. Questo è il primo argomento, che Aristotile, e Tolomeo, e tutti i lor seguaci producono, al quale si è abbondantemente risposto, e mostrato il paralogismo, & assai apertamente dichiarato, come il moto comune a noi, & a gli altri mobili, come se non fusse; ma perchè le conclusioni vere hanno nelle fauoreuoli rincontri, che le confermano, voglio in grazia di questo filosofo aggiunger qualche altra cosa; e voi Sign. Simplicio facendo la parte sua, rispondetemi alle domande; e prima ditemi, che effetto fà in voi quella pietra, la quale cadendo dalla cima della Torre, è cagione, che voi di tal mouimento vi accorgiate; perchè s'el suo cadere nulla di più, ò di nuouo operasse in voi di quello, che si operaua la sua quiete in cima della

Il moto comune è come se non fusse. Si confuta in altra maniera l'argomento preso da i cadenti a perpendicolo.

Del Galileo. 243

della Torre, voi sicuramente non vi accorgereste della sua fessa, nè distinguereste il suo muouersi dal suo star ferma.

SIMP. Comprendo il suo discendere in relazione alla Torre, perchè hor la veggo a canto a un tal segno di essa Torre, poi ad vn basso, e così successiuamente sin che la scorgo giunta in terra.

SALV. Adunque, se quella pietra fusse caduta da gli artigli d'vna volante Aquila, e scendesse per la semplice aria inuisibile, e voi non hauesse altro oggetto visibile, e stabile con chi far parallelo di quella, non potreste il suo moto comprendere?

SIMP. Anzi pur men'accorgerei, poichè per vederla mentre è altissima, mi conuerrebbe alzar la testa, e secondo, ch'ella venisse calando mi bisognerebbe abbassarla, & in somma muouer continuamente, ò quella, ò gli occhi, secondando il suo moto.

Onde si comprenda il moto di vn cadente.

SALV. Hora hauete data la vera risposta; voi conoscete dunque la quiete di quel sasso, mentre senza muouer punto l'occhio vedete sempre auanti, e conoscete, ch'ei si muoue, quando per non lo perder di vista, vi conuien muouer l'organo della vista, cioè l'occhio. Adunque tuttauoltachè, senza muouer mai l'occhio voi vi vedeste continuamente vn'oggetto nell'istesso aspetto, sempre lo giudichereste immobile.

Il moto dell'occhio ci arguisce il moto dell'oggetto veduto.

SIMP. Credo, che così bisognasse necessariamente.

SALV. Figuratevi hora d'esser in vna naue, e d'hauer fissato l'occhio alla punta dell'antenna; credete voi, che, perchè la naue si muouesse anco velocissimamente, vi bisognasse muouer l'occhio per mantener la vista sempre alla punta dell'antenna, e seguitare il suo moto?

SIMP. Son sicuro, che non bisognerebbe far mutazion nessuna, e che non solo la vista, ma quando io v'hauessi drizzato la mira d'vn'archibuso, mai per qualsiuoglia moto della naue, non mi bisognerebbe muouerla vn pelo, per mantenerucla aggiustata.

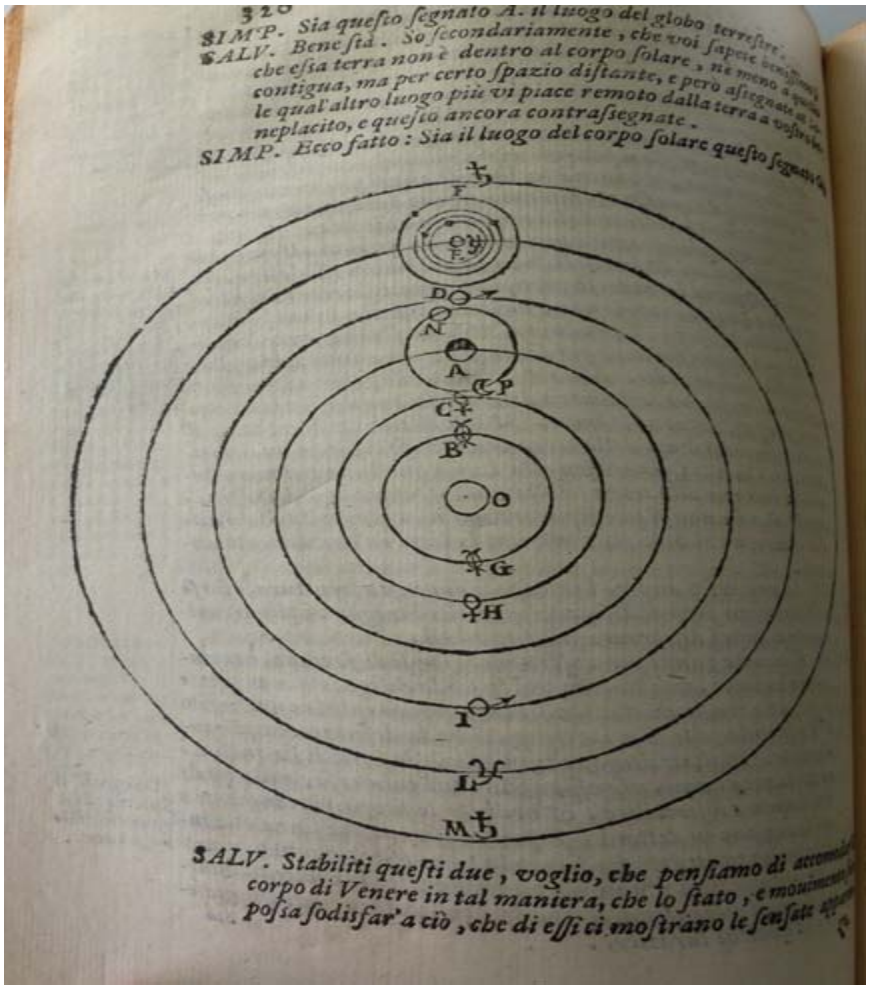
SALV. E questo auuiene, perchè il moto, che conferisce la naue all'antenna, lo conferisce anche a voi, & al vostro occhio; sì che non vi conuien muouerlo punto per rimirar la cima dell'antenna; & in conseguenza ella vi apparisce immobile. Hora trasferite questo discorso alla vertigine della terra, & al sasso posto in cima della Torre, nel quale voi non potete discernere il moto, perchè quel mouimento, che bisogna, per se-

Q 2 guirlo

The dialogue takes place over three days. On the first day Salviati starts out saying. “We agreed to meet today to discuss as clearly and with as much detail as possible the character of the laws of nature which have been put forth by the supporters of the Aristotle and Ptolemy position on the one hand and by the followers of the Copernican systems on the other. Since Copernicus places the earth among the moveable heavenly bodies, making it a globe like a planet, we may well begin our discussion by arguing the impossibility of that hypothesis.”

Here is an illustration from the third day. Salviati asks Simplico to make a mark in a diagram where the earth is located. They agree on place marked A. Salviati responds “all right, I know

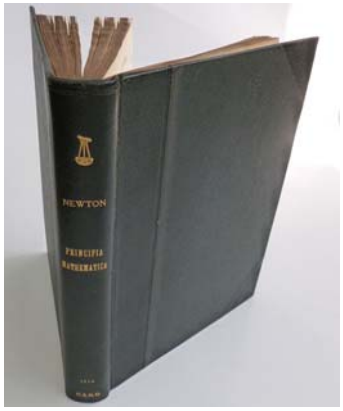
that you are aware that this earth is not inside the body of the sun, nor even contiguous to it, but it is distant from it by a certain space. Therefore, assign the sun some other place of your choosing as far from earth as you like and designate that as the letter O."



And although Galileo received all the correct approvals before the book was published, once people read the printed book they felt that it wasn't a hypothetical discussion of the two systems – but one that put forth the Copernican system in the best light. Galileo was brought before the Court of the Inquisition and found guilty of heresy. He was made to recant and was put under house arrest for the remaining 8 years of his life.

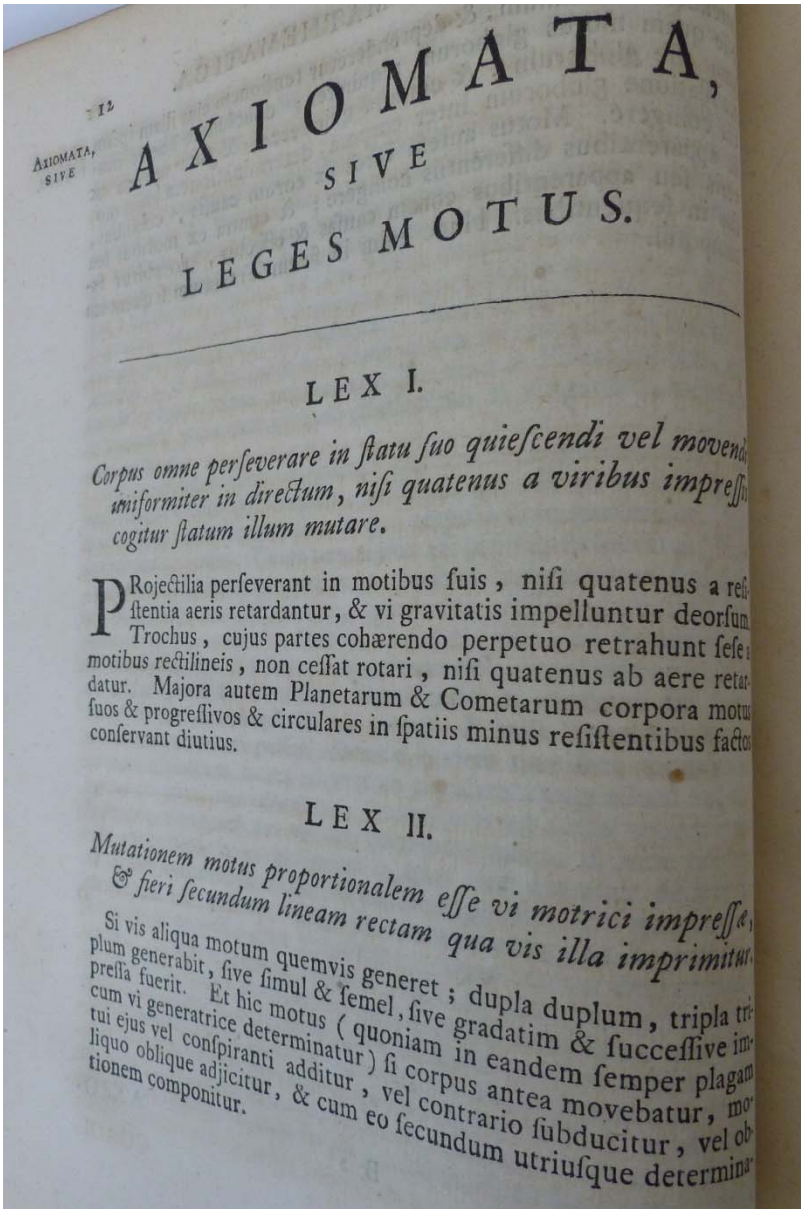
Newton

Next we come to Newton’s Philosophiae Naturalis Principia Mathematica.



Newton was reluctant to publish in 1687. Edmund Halley agreed to edit the manuscript and pay all printing fees. It was a small edition, about 250 copies, and was soon sold out. The second edition was published 26 years later in Cambridge. This copy is the Amsterdam reprint of the second edition. Bear in mind, that in the 1700s when an author published a book he lost all ownership of it. Anyone could purchase the book and republish it without paying the writer.

“Mathematical Principles of Natural Philosophy” is often referred to as simply Principia. Newton observes in his preface that “we offer this work as mathematical principles of philosophy. By the propositions mathematically demonstrated in the first book we then derive from the celestial phenomena the forces of gravity. Then from these forces, we deduce the motions of the planets, the comets, the moon and the sea.” The Principia states Newton's laws of motion, law of universal gravitation, and a derivation of Kepler's laws of planetary motion. The Principia is regarded as one of the most important works in the history of science.



12

Axiomata, sive

AXIOMATA, SIVE LEGES MOTUS.

LEX I.

Corpus omne perſeverare in ſtatu ſuo quieſcendi vel movendi uniformiter in directum, niſi quatenus a viribus impreſſis cogitur ſtatum illum mutare.

Projectilia perſeverant in motibus ſuis, niſi quatenus a reſiſtentia aeris retardantur, & vi gravitatis impelluntur deorſum. Trochus, cujus partes cohærendo perpetuo retrahunt ſeſe a motibus rectilineis, non ceſſat rotari, niſi quatenus ab aere retardatur. Majora autem Planetarum & Cometarum corpora motus ſuos & progreſſivos & circulares in ſpatiis minus reſiſtentibus factos conſervant diutius.

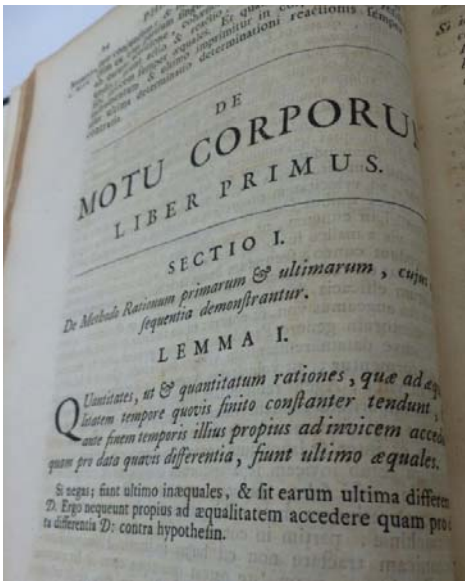
LEX II.

Mutationem motus proportionalem eſſe vi motrici impreſſæ, & fieri ſecundum lineam rectam qua vis illa imprimitur.

Si vis aliqua motum quemvis generet; dupla duplum, tripla triplum generabit, ſive ſimul & ſemel, ſive gradatim & ſucceſſive impreſſa fuerit. Et hic motus (quoniam in eandem ſemper plagam cum vi generatrice determinatur) ſi corpus antea movebatur, motui ejus vel conſpiranti additur, vel contrario ſubducitur, vel obliquo oblique adjicitur, & cum eo ſecundum utriuſque determinationem componitur.

Laws of motion: An object at rest will remain at rest.

The motion of bodies and the method of first and last ratios of quantities:



DE
MOTU CORPORU
LIBER PRIMUS.

SECTIO I.

De Methodo Rationum primarum & ultimarum, cujus sequentia demonstrantur.

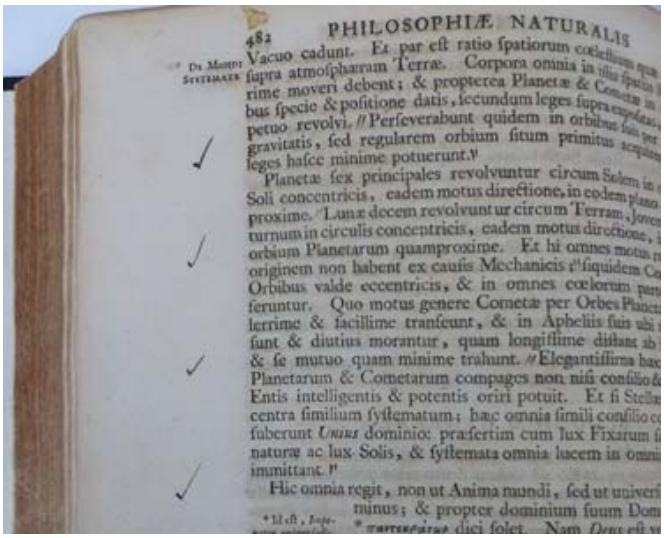
LEMMA I.

Quantitates, ut & quantitatum rationes, quæ ad æqualitatem tempore quovis finito constanter tendunt, ante finem temporis illius propius ad invicem accedunt quam pro data quavis differentia, fiunt ultimo æquales.

Si negas; fiant ultimo inæquales, & sit earum ultima differentia D. Ergo nequeunt propius ad æqualitatem accedere quam pro data differentia D: contra hypothesin.

Section 3 (On the system of the world) is an explanation of the consequences of universal gravitation, especially for astronomy. Newton lists the astronomical observations on which he relies and establishes that the inverse square law of mutual gravitation applies to solar system bodies. He promotes the theory of the motions of comets and offers the first theory of the precession of the equinoxes.

Like so many of our books, this looks like a book nobody read – but on page 482 someone checked four important sections. This is the only marking in the entire book.



482 PHILOSOPHIÆ NATURALIS

De Mundi Systemate

Vacuo cadunt. Et par est ratio spatiorum cœlestium supra atmosphæram Terræ. Corpora omnia in illis spatiis rime moveri debent; & propterea Planetæ & Cometæ in bus specie & positione datis, secundum leges supra expositas petuo revolvi. // Perseverabunt quidem in orbibus suis per gravitatis, sed regularem orbium situm primitus acquisitum leges hasce minime potuerunt.//

Planetæ sex principales revolvuntur circum Solem in Soli concentricis, eadem motus directione, in eodem plano proxime. // Lunæ decem revolvuntur circum Terram, Jovem turnum in circulis concentricis, eadem motus directione, orbium Planetarum quamproxime. Et hi omnes motus originem non habent ex causis Mechanicis (siquidem Co Orbibus valde eccentricis, & in omnes cœlorum partes feruntur. Quo motus genere Cometæ per Orbes Planetarum lerrime & facillime transeunt, & in Apheliis suis ubi sunt & diutius morantur, quam longissime distant ab & se mutuo quam minime trahunt. // Elegantissima hæc Planetarum & Cometarum compages non nisi consilio & Entis intelligentis & potentis oriri potuit. Et si Stellæ centra similium systematum; hæc omnia simili consilio c suberunt *Unius* dominio: præsertim cum lux Fixarum s naturæ ac lux Solis, & systemata omnia lucem in omnia immittant. //

Hic omnia regit, non ut Anima mundi, sed ut universi minus; & propter dominium suum Dominus

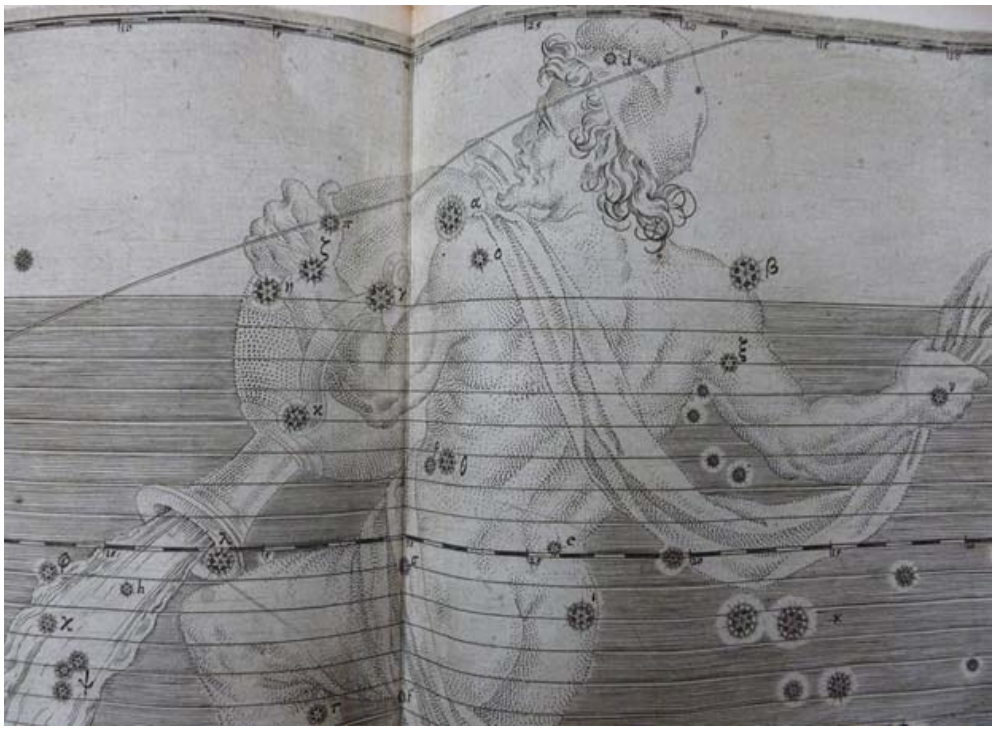
Celestial atlases

An exhibit of celestial atlases requires little justification. These are among the most beautiful scientific books ever published, capturing the sweeping grandeur of the heavens -- superimposed with constellations figures in a grand and monumental manner.

We will look at several of these atlases – starting with the most illustrious of all celestial atlases, Bayer's Uranometria. This was the forerunner of all-star atlases and contains star charts for each of the traditional 48 Ptolemaic constellations.

But the most important feature of the Bayer is that is as an atlas – a collection of maps rather than just pictures like Hyginus.

These are copper engravings, rather than wood cuts and quite large. The images shown here demonstrate one notable feature of this atlas: the sheer beauty of the plates. Many of Bayer's constellations figures have no known prototype.



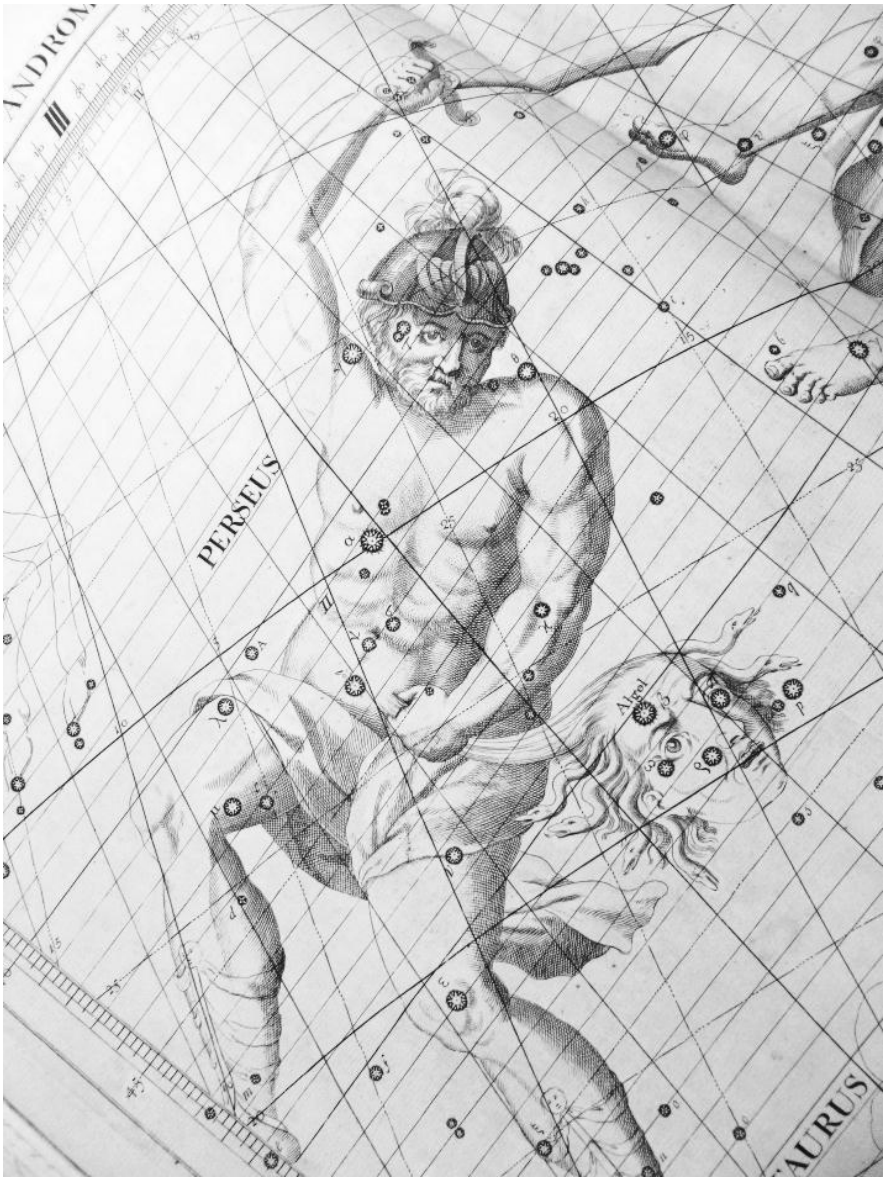
Another important feature of this atlas was the introduction of a new system of stellar nomenclature. Bayer assigned Greek letters to the brighter starts, with alpha being the brightest. These letters were placed on the charts themselves. So just a few years before the invention of the telescope enormously increased the number of visible stars, Bayer produced a star naming system still used today. One of the odd features of Uranometria is that Bayer chose to show the human constellations from the back. This has the unfortunate result of making traditional star descriptions obsolete, since the star on the right shoulder of Aquarius now becomes a star on his left shoulder.

Bayer's atlas was very popular and went through several editions.

Flamsteed

James Flamsteed was the first Royal astronomer of England and presided over the building of Greenwich Observatory. Flamsteed carefully made and checked his star measurements over the years refusing to publish his findings until he was completely satisfied with them. Edmond Halley and Isaac Newton pressured him to print and he sent them a draft copy of his catalogue. They published this as a completed catalogue and Flamsteed was furious. He subsequently found and burned 300 of the remaining 400 copies that had been printed.

His "British" catalogue of stars published by his wife after his death brought astronomy to a new level. One of Flamsteed's principle motives in publishing the atlas was to correct what Flamsteed felt were serious errors in Bayer's depiction of the constellations. All of Flamsteed's figures were seen from the front.



In 1776, the French published a new smaller edition with improvements to the illustrations, making them more graceful.

Flamsteed's was the first major celestial atlas to use maps that emphasized the newer equatorial grid system that was centered on the projection of the earth's equator into the sky. This more practical system corresponded to the apparent rotation of the heavens as seen from the Earth and it could be used with greater ease with meridian circle telescopes.

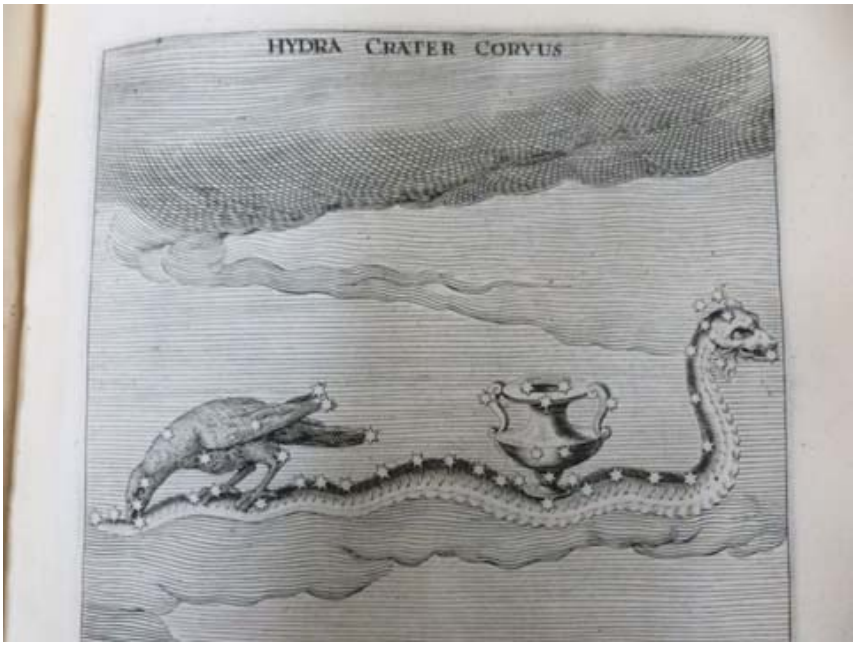
Jamieson

Alexander Jamieson was both author and artist for his Celestial Atlas which appeared in London in February 1822. For all the fame that the Atlas achieved, its author remains little known. He evidently had a wide knowledge of science for he wrote a number of text books on subjects as diverse as cartography, logic and algebra.

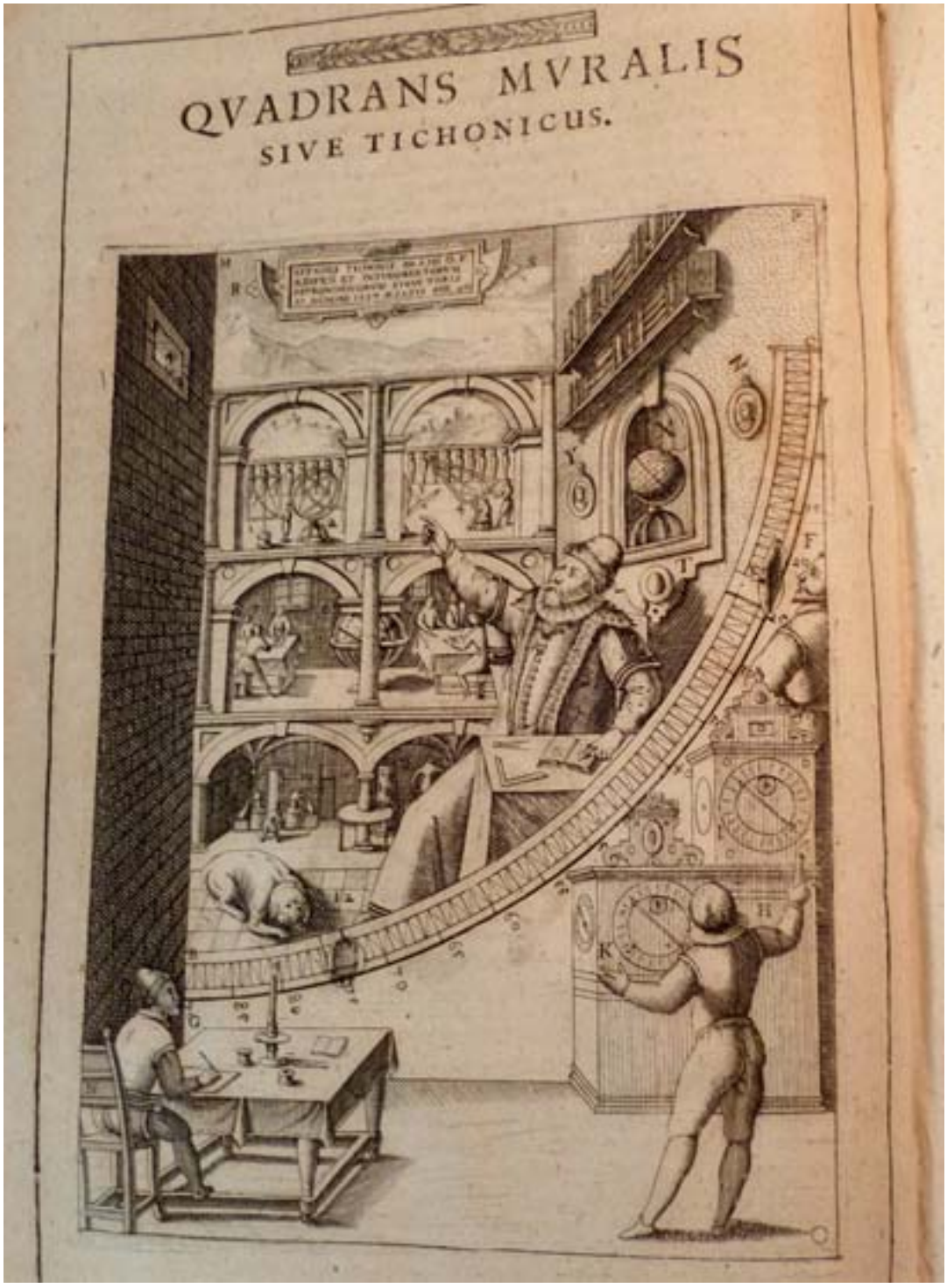
Here is Jamieson's Aquarius; His charts differed most noticeably from previous ones in his modeling of the constellation figures. Whereas others closely followed the depictions in Flamsteed's Atlas Coelestis, Jamieson allowed himself greater artistic freedom. His figures were more realistically drawn. Below is his depiction of Orion:

Brahe

Tycho Brahe's book, Astronomiae Instauratae Mechanica was published in 1602 on Brahe's own printing press at Uraniborg and printed on paper made at the observatory – I like to think that he really had something to do with the publication of this actual book. His book isn't really an atlas but I wanted to show you his version of Hydra with the cup.



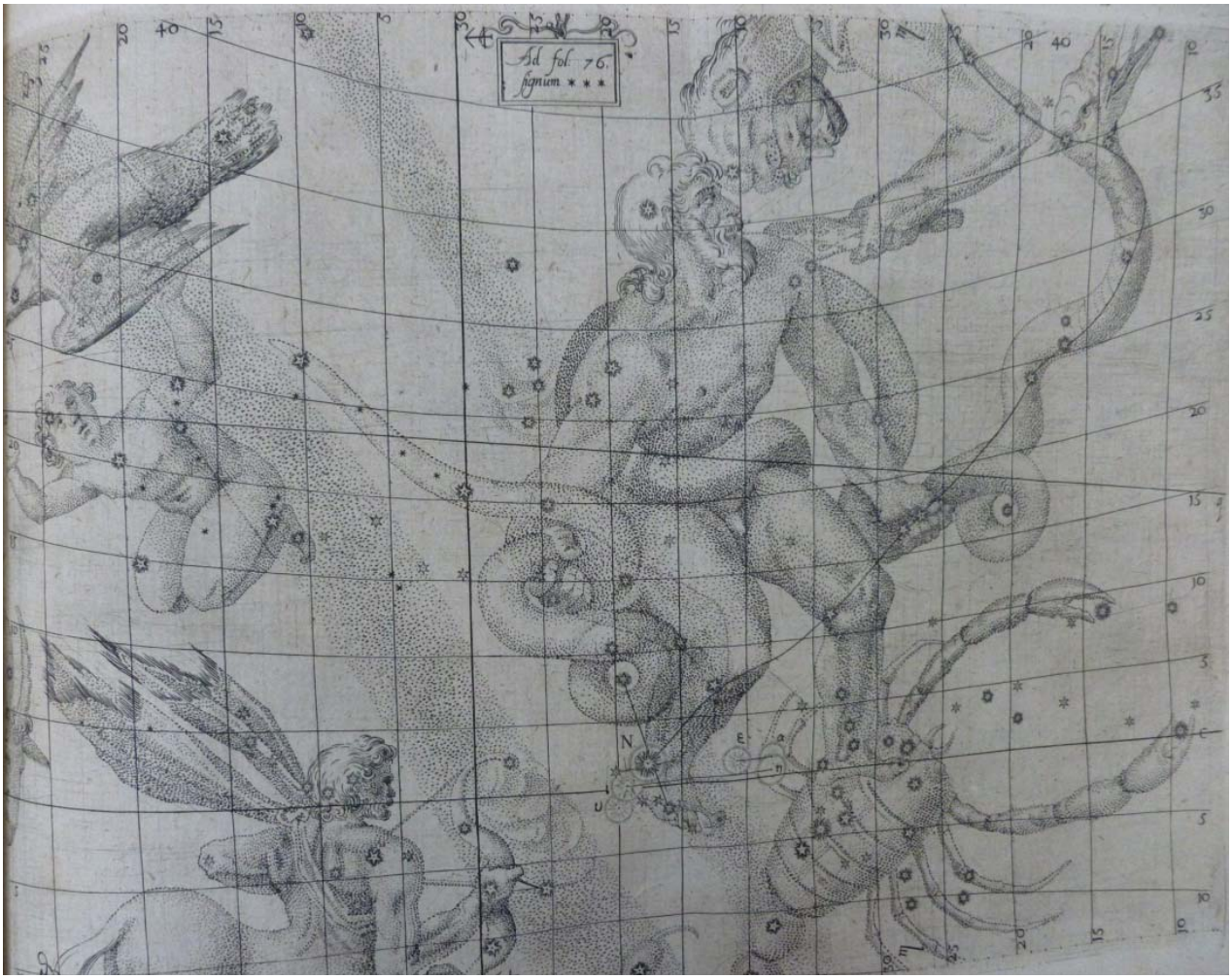
Tycho's book is justifiably famous for its beautiful illustrations . It contains the celebrated account of Brahe's instruments as they were at Uraniborg together with his chief discoveries. And here is the iconic picture of Tycho with his instruments. His mural quadrant, the largest instrument erected in his observatory, was made of brass. The instrument was used to measure the elevation of stars above the horizon as they passed by due to the earth's rotation. Corresponding longitudes were determined by noting their times of passage.


QVADRANS MVRALIS
SIVE TICHONICUS.

Kepler

We get our first glimpse of a Bayer chart in action in Kepler's book about the new star, De Stella Nova in Serpentarii, that appeared in 1604 in the foot of the serpent bearer. Kepler was greatly impressed by the appearance of the new star because it coincided with the triple conjunction of Mars, Jupiter and Saturn.

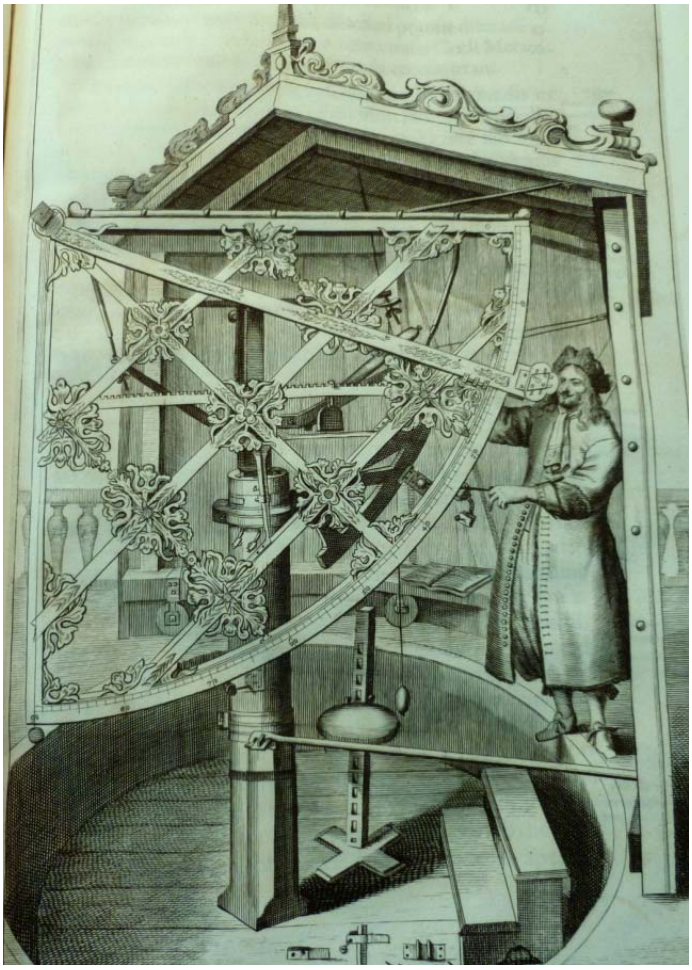
The chart that Kepler published of the serpent bearer shows both the nova (marked with the N) and the positions of the planets at two separate times.



Hevelius

The first volume of Hevelius' wonderful book Machina Coelestis was published in 1673 and contained a description of his instruments with many gorgeous illustrations.

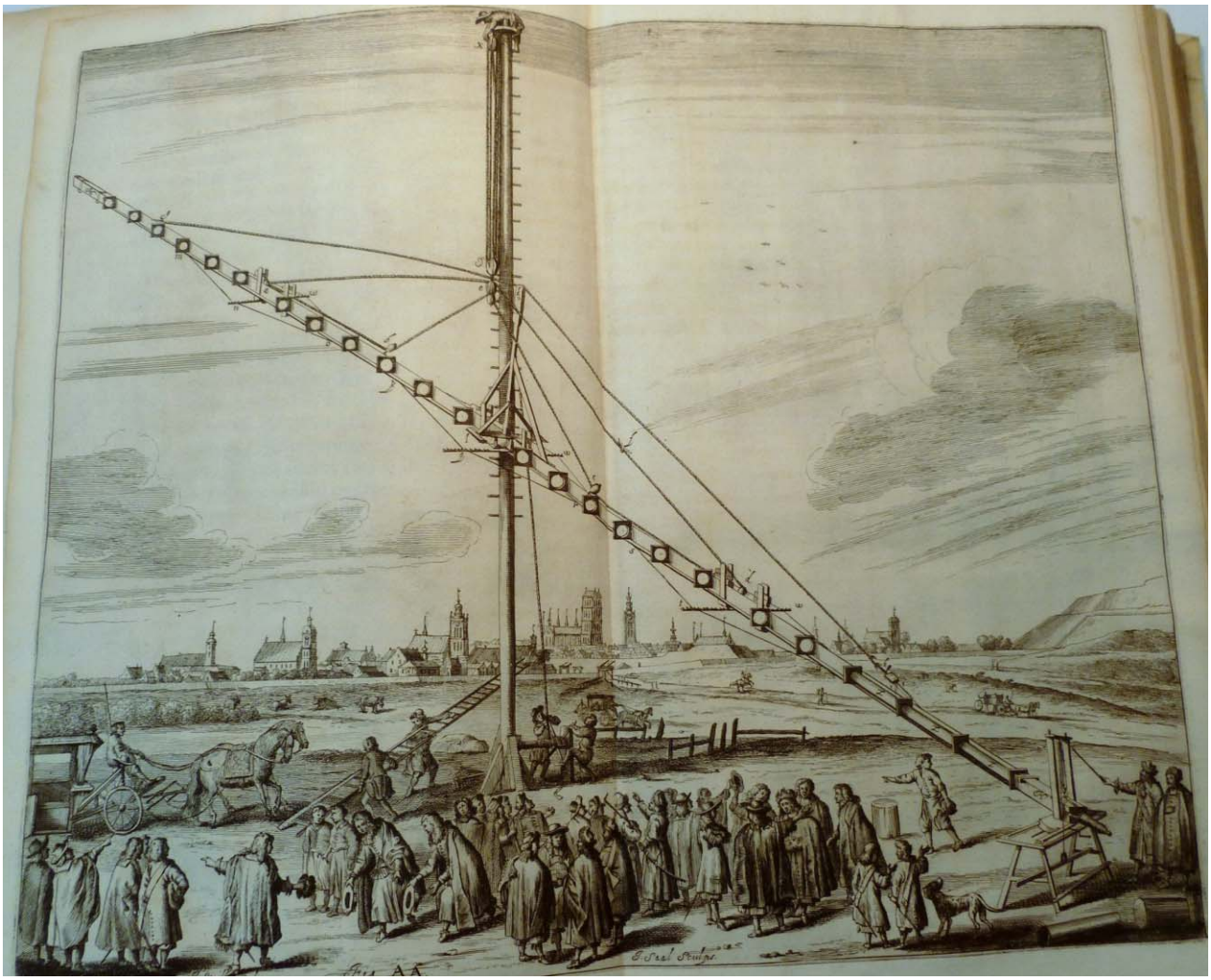
Hevelius is shown lining up the sight rule through small holes at either end of a rule, with his left hand he is positioning it by means of a counterbalanced weight



The frontispiece shows Copernicus with his book in hand and Tycho Brahe looking down at the ancient astronomers Ptolemy and Hipparchus as they study the celestial globe with Hydra and the cup on the lower part! The publication of the book triggered a controversy that was to shake

European astronomy for the next decade; Robert Hooke was unhappy with Hevelius's comments about the value of telescopic versus plain sight viewing and wrote a criticism. Hevelius wrote to the Royal Society in London where both he and Hooke were members. The Royal Society asked one of their younger members, Edmond Halley to go to Danzig to examine Hevelius's instruments and the observations made using them. Halley arrived with telescopes and they began their work comparing the two. Halley left written testimony on his views and experiences with his host. Halley said Hevelius could see with his plain sight as well as he could with the telescope. Hevelius was vindicated! This illustration shows the new form of engraving.

In 1641 he built an observatory, equipping it with splendid instruments, including a large Keplerian telescope of 45 m focal length, with a wood and wire tube. Here it is shown against the Danzig skyline.

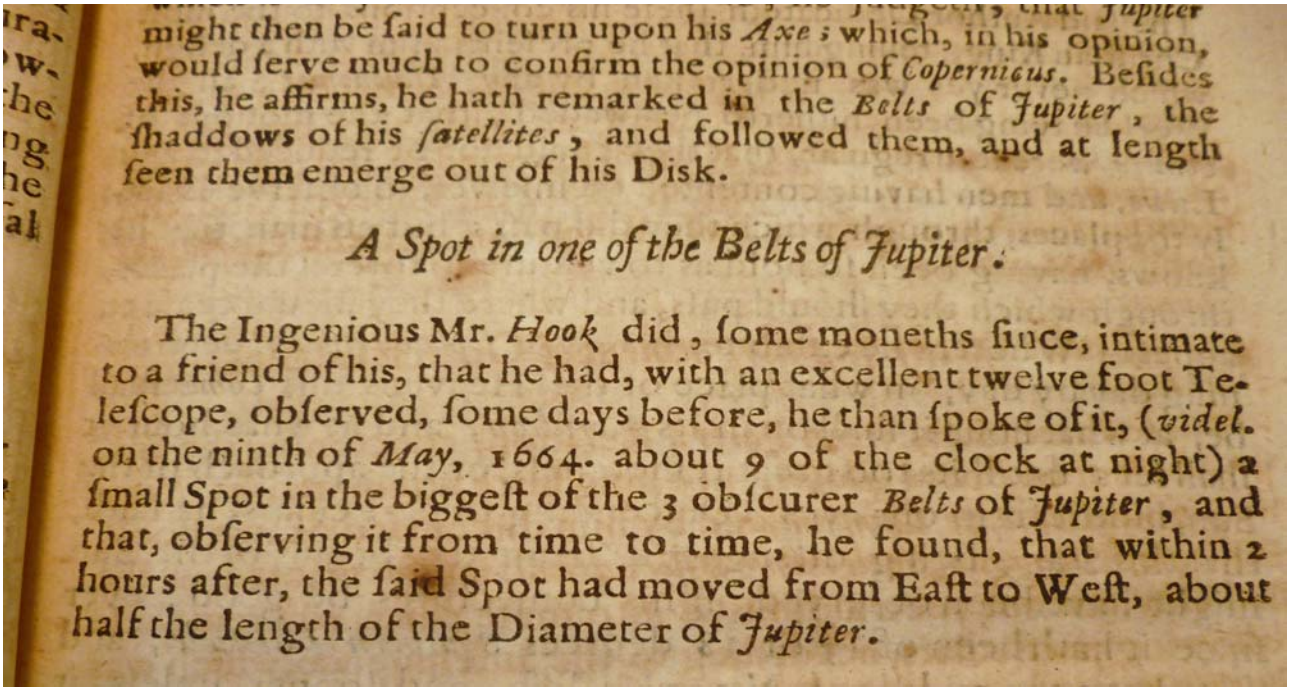


Journals

We have a collection of old journals to complement our rare books. We have the Philosophical Transactions of the Royal Society from the first volume in 1665. After a lecture given by Christopher Wren, a professor of astronomy at Gresham College, 12 prominent men decided that they would meet weekly to discuss science. It was the beginning of the Royal Society. They

wanted to “assist and promote the accumulation of useful knowledge.” Nobody had ever done anything quite like this before. The Royal Society invented scientific publishing and peer review. It made English the primary language of scientific discourse in place of Latin. It promoted clarity of expression in place of high flown rhetoric. It was truly international. The title expressly says “in many considerable parts of the world”. The first editor was German. The Transactions brought together the best thinking from all over the world. It was an early version of the internet. It created modern science.

Here’s a note from Robert Hooke about the belts of Jupiter from 1665.

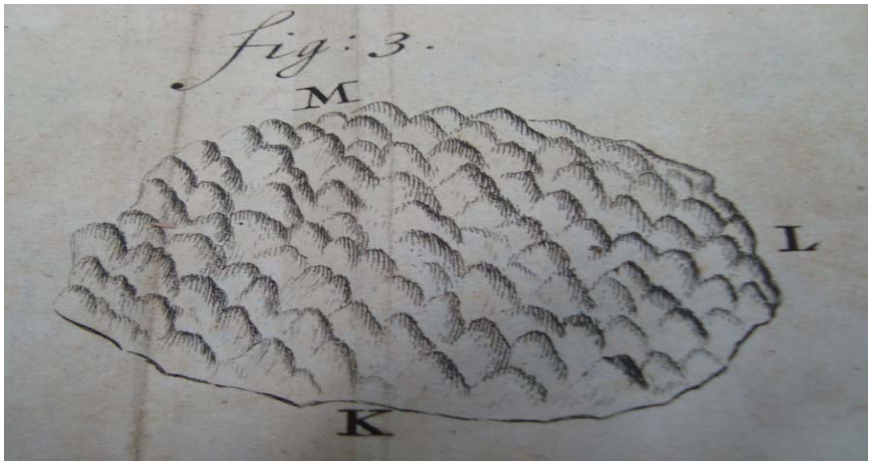


might then be ſaid to turn upon his *Axe*; which, in his opinion, would ſerve much to confirm the opinion of *Copernicus*. Beſides this, he affirms, he hath remarked in the *Belts* of *Jupiter*, the ſhaddows of his *ſatellites*, and followed them, and at length ſeen them emerge out of his Disk.

A Spot in one of the Belts of Jupiter.

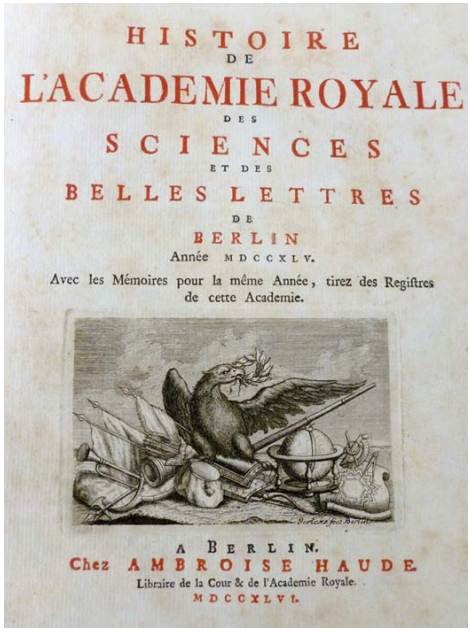
The Ingenious Mr. *Hook* did, ſome moneths ſince, intimate to a friend of his, that he had, with an excellent twelve foot Teleſcope, obſerved, ſome days before, he than ſpoke of it, (*videl.* on the ninth of *May*, 1664. about 9 of the clock at night) a ſmall Spot in the biggeſt of the 3 obſcurer *Belts* of *Jupiter*, and that, obſerving it from time to time, he found, that within 2 hours after, the ſaid Spot had moved from Eaſt to Weſt, about half the length of the Diameter of *Jupiter*.

Another unique characteristic was that one did not have to be from the upper class to be a member. Being scientifically conscientious and experimentally clever was far more important. Take for example a dry goods merchant from Delft named Leuwenhoek. Over 50 years, he submitted 200 papers all accompanied by drawings of things he found by looking in his hand made microscope. Leuwenhoek had practically no education. He sent his reports in low Dutch because he knew no Latin or English; what mattered was that he was a genius. Here is his image from the June 1708 volume called “microscopic observations of a tongue”.



We also have the journal from the French Académie des Sciences, founded in Paris in 1666 by Colbert, with the approval of Louis XIV. Their publication is called the Mémoires de l'Académie des Sciences. Here is their frontispiece with France holding the portrait of Louis 14.

The Berlin academy of science started in 1700. We have copies of all the volumes of these journals from their inception.


HISTOIRE
DE
L'ACADEMIE ROYALE
DES
SCIENCES
ET DES
BELLES LETTRES
DE
BERLIN
Année MDCCXLV.
Avec les Mémoires pour la même Année, tirez des Registres de cette Academie.
A BERLIN.
Chez AMBROISE HAUDE.
Libraire de la Cour & de l'Academie Royale.
MDCCXLVI.

Monthly Rare Books Displays

Every month I do a different rare book display using our fabulous books and old journals. Last month we had an exhibit on Henri Poincare, to commemorate the 100 year anniversary of his death. Modern books and journal articles are put beside the display for the astronomers who want to learn more.

Rare Book Vault

All of our books are kept in a climate controlled vault which was built for this purpose in 1893. The temperature is kept at 66 F and 34% humidity year round. The floor is tile and shelving is metal – the only thing that could burn is the books. We have a waterless fire suppression system called FM 200 which will put out a fire without damaging the books – or the librarian. “FM-200® systems reach extinguishing levels in 10 seconds, stopping ordinary combustible, electrical, and flammable liquid fires before they cause significant damage” (DuPont, 2012). Unlike a dry chemical, it is a colorless, odorless gas that leaves no residue to clean up. Unlike water, it is an electrically nonconductive agent that will not short-out electronic equipment. And unlike the very cold discharge of carbon dioxide, FM-200 will not thermally shock delicate books. Our extensive holdings are kept safe in here.

There is a second floor where the old journals are kept.

We have a sign in system to keep statistics on the temperature and use of the vault. At the end of the day we want to insure that the wonderful rare books that Gilliss bought in 1843 are kept safe.

Recap

I explained a little bit about the history of the printing press. You learned that bookbinding was a separate job. You saw pictures of how paper is made from rags. I showed you pictures of great books by Hyginus**,** Abu Masar, Pacioli, Mico, Copernicus, Galileo, Newton, Brahe, Kepler and Hevelius. You saw images of constellations from 4 major celestial atlases. You got an idea of the breadth of our holdings of old scientific society journals. You saw pictures of one of our monthly rare book displays.

Now my final word is my commercial. The mission of the U.S. Naval Observatory is to determine positions and motions of celestial bodies, Earth's motion/orientation and precise time; to disseminate astrometry and timing data to the U.S. Navy and the American Department of Defense for navigation, targeting, weapons guidance, and communications to other agencies and the public, and to conduct research to improve these services, using the USNO Library. Thank you for your attention and enjoyment of our fabulous rare astronomy book collection.

References

DuPont (2012). "DuPont™ FM-200® Waterless Fire Suppression Systems," Retrieved from http://www2.dupont.com/FE/en_US/products/FM200.html