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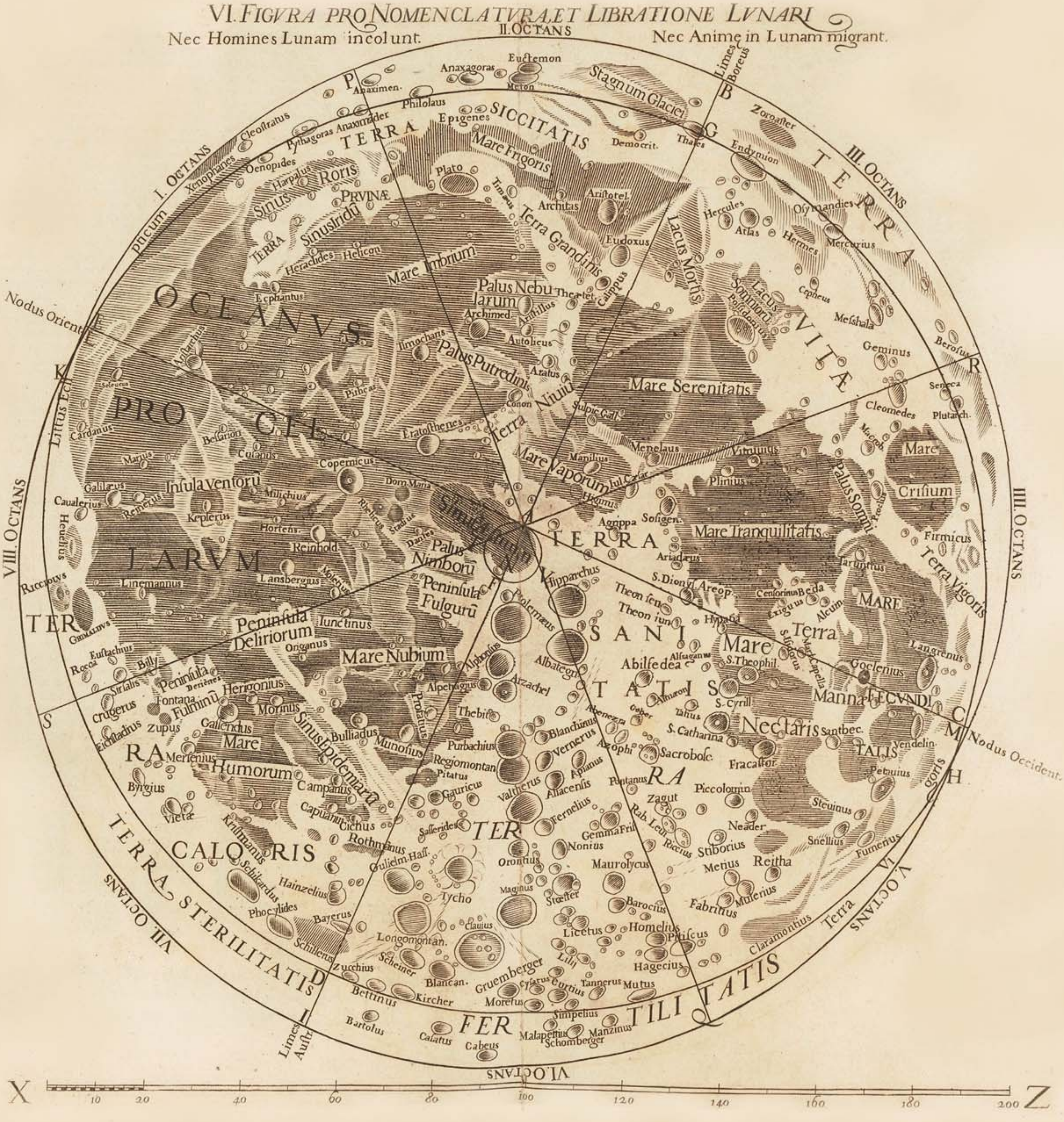
VI. FIGVRA PRO NOMENCLATVRA, ET LIBRATIONE LVNARI
Nec Homines Lunam incolunt.
Nec Animæ in Lunam migrant.
II. OCTANS
I. OCTANS
III. OCTANS
IIII. OCTANS
V. OCTANS
VI. OCTANS
VII. OCTANS
VIII. OCTANS
Nodus Orient.
Nodus Occident.
Limes Boreus
Limes Austr.
OCEANVS PROCELLARVM
TERRA SICCITATIS
Mare Frigoris
Stagnum Glaciei
Sinus Roris
PRVINÆ
Sinus Iridu
Mare Imbrium
Palus Nebularum
Palus Putredinis
Terra Grandinis
Lacus Mortis
Lacus Somniorum
TERRA VITÆ
Mare Serenitatis
Terra Niuis
Mare Vaporum
Insula ventoru
Sinus Medii
TERRA SANITATIS
Mare Tranquillitatis
Palus Somnii
Mare Crisium
Terra Vigoris
MARE FECVNDITATIS
Mare Nectaris
Palus Nimboru
Peninsula Fulguru
Peninsula Deliriorum
Mare Nubium
Peninsula Fulminu
Mare Humorum
Sinus Epidemiaru
TERRA CALORIS
TERRA STERILITATIS
TERRA FERTILITATIS
Plato
Aristotel.
Eudoxus
Archimed.
Copernicus
Eratosthenes
Keplerus
Tycho
Clauius
Hipparchus
Ptolemæus
Cleomedes
Langrenus
Petauius
Stevinus
Grimaldus
Riccioli
Schikardus
Longomontan.
Blancan.
Gruemberger
Cabeus
Bettinus
Kircher
Zucchius
Manzinus
Schomberger
Malapertius
Calatus
Bartolus
X
Z
10
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180
200

The Man Who Put the Names on the Moon

Giambattista Riccioli had a grander plan than meets the eye — and perhaps a secret agenda.

Andrew Livingston

One benefit of binoculars is their big-picture view. Take the Moon. Looking at it with only 8 or 10 power makes you focus on larger issues, such as why did the second-quarter (waxing gibbous) Moon get the oceans with the ominous names? And what's that gulag of ancient Greek astronomers doing, shivering on the shores of the Sea of Cold? Why are the crater names beginning with *Al-* so concentrated in the south? And why was the great Galileo assigned such an insignificant little out-of-the-way crater that you need 20× to spot it?

The man to ask, the man with the plan, the man who named all the major features on the Moon, was the Italian Jesuit astronomer Giambattista Riccioli (1598–1671).

Riccioli published his landmark Moon map in 1651, just 42 years after Galileo first turned a telescope to the heavens and saw that the Moon was rough and mountainous — and 18 years after the Inquisition sentenced him for advocating the Copernican system of the Earth and planets revolving around the Sun. Riccioli's map of the Moon was the best one yet. Its detail and accuracy are impressive considering the small, primitive, hard-to-use telescopes of the time.

And all those features on the map needed names.

NAMING OF PARTS Riccioli's Moon map, from his *Almagestum Novum* (1651). The subhead says, "Men neither live on the Moon. Nor do their souls go there." Riccioli's rebuke of those popular fancies is ironic — thanks to him the Moon is full of famous men. And a few women.

ALMAGESTUM NOVUM

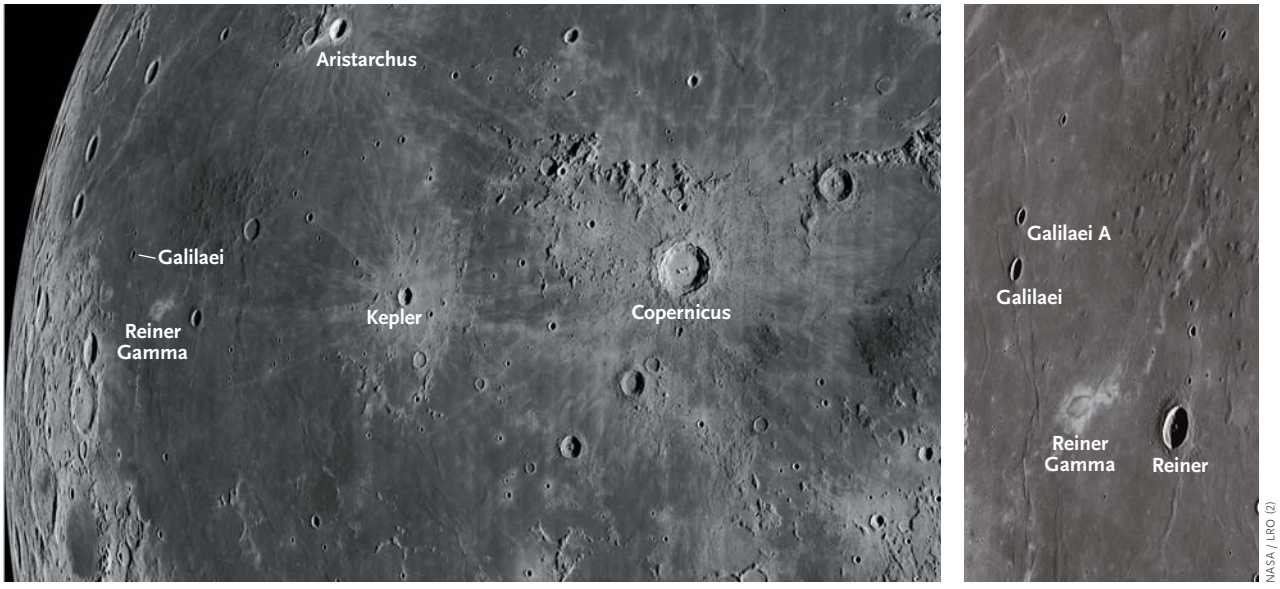
Look at the Moon's celestial eastern limb (on the left) just south of the equator — there Riccioli named a modest crater for himself, giving him the easternmost ringside seat on his handiwork. Next to him is his assistant Francesco Grimaldi, who drew the map. Then comes the Polish astronomer Johannes Hevelius, who had recently published his own Moon map, in 1647, featuring a grab bag of royals, religious figures, scientists, and explorers. Finally, on the opposite side sits Langrenus, whose earlier (1645) map had used neutral but head-scratchingly obscure names from Greek and Latin geographies. Riccioli left him in his own chosen place on the shores of Mare Fecunditatis. There they are, the three pioneers of selenography, except it was pretty much winner-take-all for Riccioli.

What made his names such a success? Why do we use most of them today?

The Moon's Eight Octants

Riccioli divided the Moon into eight slices like a pizza, drawn on his map and labeled around the edges as seen on the facing page. They start in the celestial northeast with "I Octans": upper left on the map and on the Moon as seen with the naked eye. An odd place to start? Watch what happens. Working around clockwise in a historical timeline, Riccioli sprinkles the Moon with ancient Greeks, followed by Romans and early Christians, then medieval scholars both Christian and Muslim, to end with a grand finale of his fellow moderns in VIII Octans, the easternmost and last to be well revealed as the Moon waxes to full.

Riccioli didn't always follow this design strictly. Some eras spill out of their octants, and along the southern



NASA / LRO (2)

THE COPERNICANS Aristarchus, "the Greek Copernicus," is placed above Galileo, Kepler, and prominent Copernicus himself. *Right*: Riccioli didn't intend Galileo to end up with the tiny crater so named today. He applied the name to what's now called Reiner Gamma: an odd, flat, light marking, part of a streamer with unusual magnetism that may have been left by a comet's ion tail.

limb from Langrenus onward are more of Riccioli's contemporaries — new authorities taking their seats opposite the ancients.

Hold the Latin!

Sorry, not an option. In Riccioli's day, scientists not only published in Latin (Galileo was an exception) but were usually known by Latinized names. Which gives the moderns on the Moon a deceptively antique flavor. Regiomontanus in VI Octans, for example, was born Johannes Müller von Königsberg ("Regent's Mount") in 1436. A Johnny-come-lately by lunar standards, he was the assistant of Purbachius, the crater above. After Purbachius's sudden death in 1461, Regiomontanus found himself finishing off his master's update of Ptolemy's *Almagest*. They had been in Italy, invited by the scholar Cardinal Bessarion, who'd gotten his hands on an *Almagest* in the original Greek; you'll find Bessarion north of Kepler (note that Riccioli often used the obsolete long *s*, which looks almost like an *f*). Regiomontanus ended up in Nuremberg, a scientific center where the wealthy Bernhard Walther helped him build the first scientific printing press. Valtherus, now Walter, is positioned just below Regiomontanus as if to support him. Walther's house, later bought by Albrecht Dürer, is a Nuremberg landmark to this day.

A Quick Tour of the Octants

I and II Octans: Ancient Astronomers On Ice. The north polar region glitters with ancient Greeks. Plato, Aristoteles, Archimedes, and Eratosthenes are the leading lights, but who outshines them all? For Riccioli it was evidently Aristarchus of Samos (circa 310–230 BC), Copernicus's predecessor who first proposed a Sun-centered solar system with the planets in the right order and the stars far away. Riccioli assigned him the brightest marking on the Moon. After he had been ignored in favor of Aristotle and Ptolemy for almost two thousand years, Riccioli's map brings things literally full circle — Aristarchus's neighbors to the south at the end of the timeline are the Copernican astronomers of VIII Octans.

But here Riccioli, a Jesuit priest, was treading on politically risky ground — just 18 years after Galileo had been forced to denounce Copernicanism and was dealt a life sentence of house arrest. Elsewhere, in public, Riccioli was quite the orthodox anti-Copernican, as displayed on his book's frontispiece (see page 31). But did he harbor secret Copernican sympathies? More on this later.

III Octans, outer: Sunset Myth. Shortly after new Moon, when the crescent hangs in the west after sunset, the legendary Greek strongmen Hercules and Atlas stand boldly on the terminator. Hercules's second-to-last labor was to retrieve the Golden Apples of the Sun, apples that gave you immortality. Guarded by a serpent, they grew in the Garden of the Hesperides, the Sunset goddesses, at the western end of the world where Atlas stood holding up the heavens. Since the Hesperides were Atlas's daughters, he agreed to fetch the apples if Hercules relieved him of his burden. Note how Hercules, of mixed birth, gets the smaller crater while Atlas, the 100% god with the full-time job, gets the larger.

III Octans (inner) and IIII: Rome. Julius Caesar earns his place here thanks to the Julian calendar, which brought the dates back in line with the seasons for

centuries to come. (When the calendar needed another tune-up by 1582, Pope Gregory turned to Aloysius Lilius and Christopher Clavius, duly cratered in VI Octans.) Manilius is next door for his epic poem *Astronomica*. Agrippa to his south wasn't the famous martial son-in-law of Augustus, but a later Greco-Roman astronomer about whom we know next to nothing except that Ptolemy mentioned him observing an occultation of the Pleiades in AD 92.

IIII Octans raises the question: What's a Sea of Crises (Mare Crisium) doing among the serene, tranquil seas of the first quarter? Riccioli followed a separate scheme for naming the maria; they seem to follow contemporary popular ideas about the influence of the Moon's phases on moods and weather. New Moon, for instance, was a time of changes — times of crises. But there may be a Roman connection here too. Perhaps Riccioli was referring to the persecution of the early Christians by ruthless emperors such as Nero, who was quite unimproved by the philosopher Seneca being his tutor. Seneca, held in high regard by the Church, got a crater for his efforts.

Later we move down to Firmicus, astrologer-polemicist to the first Christian emperor, Constantine. The now defunct Terra Mannae, Land of Manna, is populated by early Catholic scholars such as Dionysius Exiguus, the 6th-century monk who devised our AD chronology of years, and Abbot Alcuin of York, advisor to Charlemagne. Alcuin's gone from modern maps; his dubious astronomical credentials got him swapped out for a more recent Englishman, Sir John Lubbock.

V Octans: Christianity Triumphant. The prominent crater trio Theophilus, Cyrillus, and Catharina lived in Alexandria, which got them seaside locations on Mare Nectaris. Fourth-century Alexandria was the New York of its time, and Saint Theophilus was its crusading bishop. His destruction of the famous temple of Serapis symbolized the final triumph of Christianity over paganism. His nephew Saint Cyrillus followed in his footsteps by banishing the Jews.

Hypatia, above them, is the only astronomer here, with a crater nearby for her father, Theon Junior. (His neighboring senior namesake lived three centuries earlier.) The pagan Hypatia, a remarkable scholar, Neoplatonist philosopher, and mathematician, came to a sticky end thanks to Saint Cyrillus. Her gruesome death at the hands of Cyrillus's agents in AD 415 could be said to mark the end of the classical world.

Saint Catherine's martyrdom parallels Hypatia's; she is said to have been a brilliant Christian philosopher condemned to death by the last pagan emperor, Maxentius, who didn't appreciate her attempt to convert him. No record of her exists until 500 years later; some historians believe she was invented to be a counter-martyr to Hypatia. Both are among the very few women on the Moon.

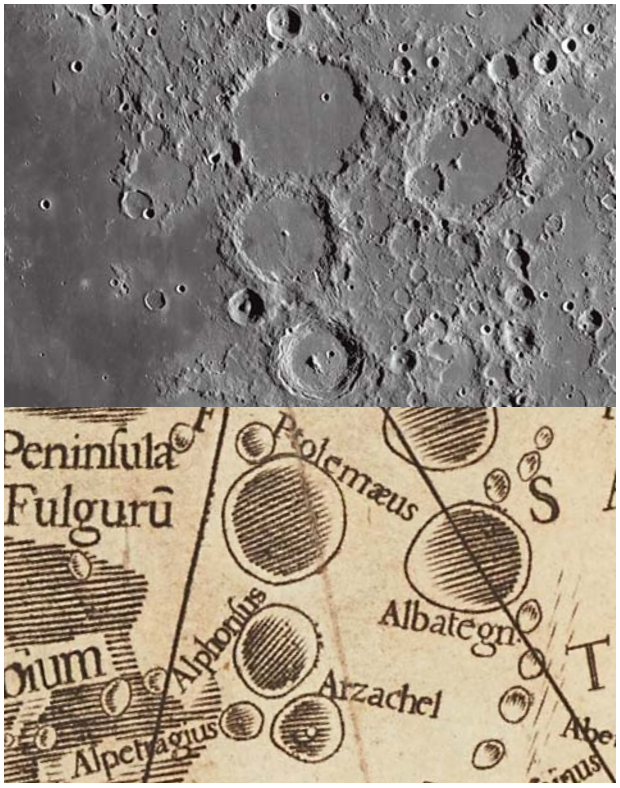
And how does astronomy fit into this business? Hardly at all. Saint Catherine was highly venerated in the Middle Ages; let's guess that Riccioli, with an eye to any criticism that might come for including the Copernicans on the other side of the Moon, was banking a few points with the Church.

VI Octans. Arab Astronomy Takes a Bow. European astronomers knew how indebted they were to the Arab world. The highlight of the terminator at half Moon is the grand Ptolemaeus-Albategnius-Alphonsus-Arzachel group, with Hipparchus, the greatest of the ancient observers, presiding. Ptolemaeus (Claudius Ptolemy,

NASA / LRO

FOCUS FEATURES / NEWMARKET FILMS

OPPOSITE MARTYRS **The prominent twin craters of the Mare Nectaris region went to the Christians of the Hypatia episode; Hypatia just received a little one. What's interesting is that she's here at all. She and Catharina, two of the Moon's very few women, both died for their beliefs and were placed on opposite sides of Theophilus and Cyrillus. *Right*: Mathematician or witch? Rachel Weisz played Hypatia in the movie *Agora* (2009). Two centuries after Hypatia's death, the Coptic bishop John of Nikiû described her as a pagan "devoted at all times to magic, astrolabes, and instruments of music, and she beguiled many people through her Satanic wiles."**



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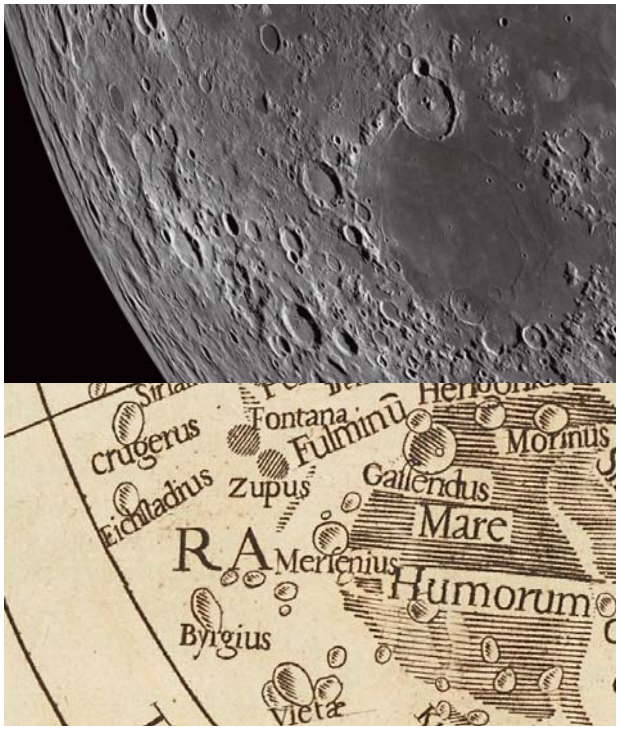
SHOULDERS OF GIANTS Ptolemy got pride of place with a grand walled plain near the Moon's center. Below him gather some of his astronomical descendants, the Arabs who laid the foundation for European astronomy.



NASA / LRO

NAME-DROPPING Riccioli honored some of his own contemporaries in the final octants of his map, no doubt helping to ensure its acceptance.

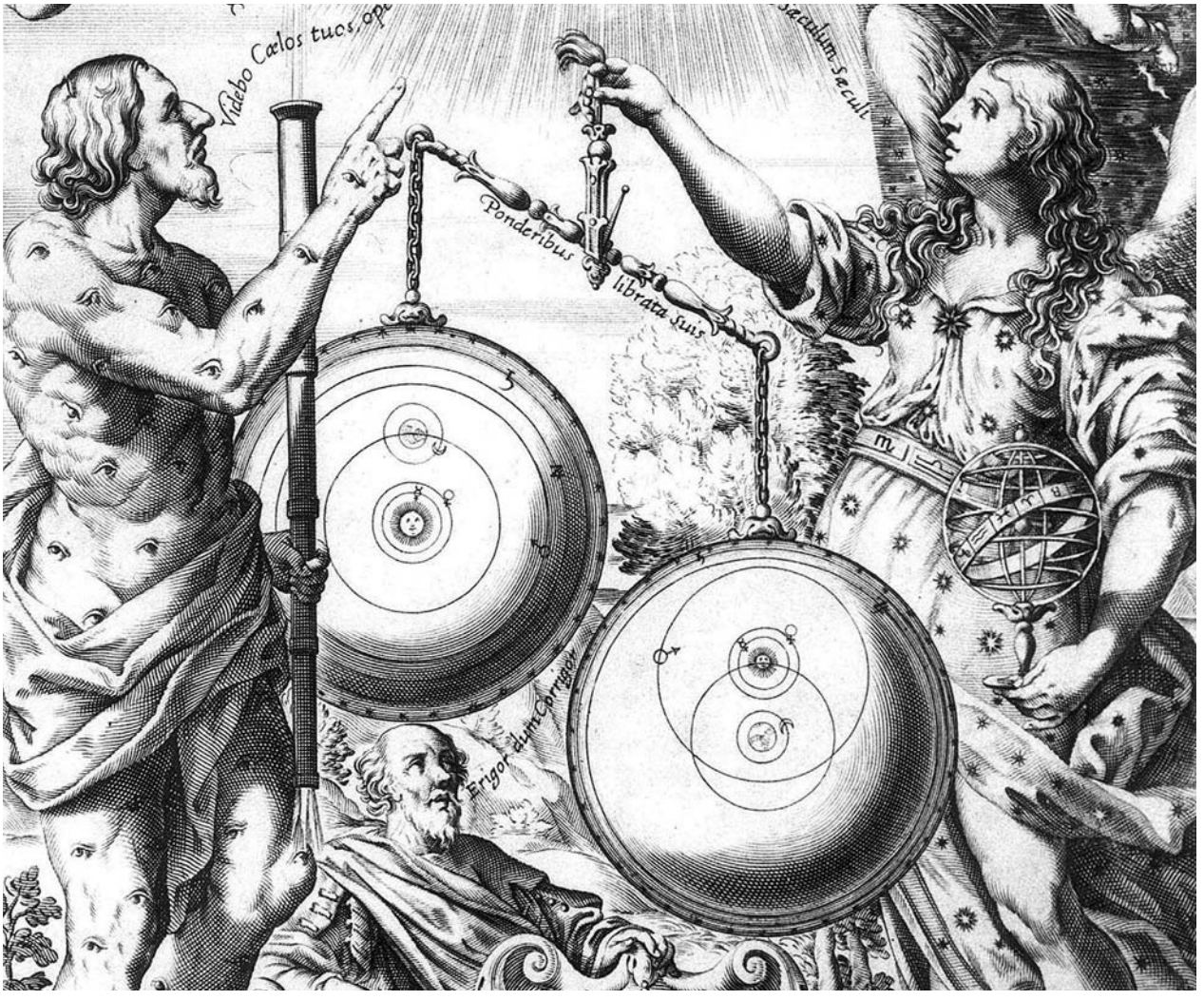
an Alexandrian Greek c. AD 90–160) gets the biggest crater. Throughout the Middle Ages his *Almagest* (from *al-majisti,* "Great Treatise") was *the* astronomy textbook. (Thebit, aka Thabit ibn Qurra of Harran and Baghdad, was a notable translator). Ptolemy's heliocentric model of the solar system, with its awkward circling circles, did a respectable job of predicting the motions of the planets. Albategnius was the 9th-century Syrian al-Battani, whose extremely accurate trigonometry tables were used by Copernicus and Tycho. Alphonsus (Alfonso X "the Wise," King of Castile, 1221–1284) bankrolled the Alfonsine Tables of planetary positions based on the calculations of Arzachel (al-Zarqali, "the Engraver") in Muslim Spain. Arzachel (1029–1087) was a leading astronomer and instrument maker, and perfector of that medieval multi-tool, the astrolabe.

VII Octans. Sunrise on European Science. Philosopher-priest Pierre Gassendi (1592–1655, France) gets the top spot on Mare Humorum, perhaps for being the first to observe a transit of Mercury in 1631, perhaps for trying to reconcile religious belief with a skeptical, scientific outlook, a problem that never goes away. His seaside neighbor Mersenius (Marin Mersenne, 1588–1648, France) was a sort of Jesuit Robert Hooke, who in addition to his own research — he was a forerunner of Cassegrain in reflecting-telescope optics — acted as a clearinghouse for all the latest developments.

Byrgius (Jost Bürgi, 1552–1632) was a super-skillful Swiss instrument maker and unlettered genius who invented logarithms, though by the time Kepler convinced him to publish (Bürgi didn't know Latin), he had been scooped by the Scot John Napier.

Viete (François Viète, 1540–1603), lawyer and mathematician, was involved in the reform of the calendar until he had a falling out with Clavius, Pope Gregory's scientific advisor. And finally there's Peter Cruger (1580–1639, Germany and Poland), who published many scientific papers and was Hevelius's teacher, appealing to him from his deathbed to pursue astronomy. Which Hevelius did in a big way, using fantastically long-focus telescopes. These were a solution to the severe chromatic aberration of the increasingly large single-element lenses that astronomers were trying to use. Hevelius's beer brewery, which no doubt financed such projects, went out of business only recently.

VIII Octans. Galileo, what were you thinking?! Galileo Galilei (Italy, 1564–1642) is still a delight to read (try *The Starry Messenger*), and not just for his scorched-earth rebuttals of other scientists, many of whom were unfortunately Jesuits. With *Dialogue Concerning the Two Chief World Systems* he really burned his bridges with the Church. Comparing Copernicus's model of the solar system with Ptolemy's, he couldn't resist giving the name Simplicio to the hapless defender of the geocentric camp. The name was supposedly "after Simplicius



ALMAGESTUM NOVUM

ANTI-COPERNICUS **On the frontispiece of his great *Almagestum Novum*, Riccioli displays the Muse of Astronomy judging Copernicus's Sun-centered solar system against Tycho's Earth-centered version. The balance beam says, "Their weights assessed." Tycho wins and Copernicus loses, the only safe way Riccioli could rule on the question nine years after the passing of Galileo. Below, old Ptolemy says "I stand corrected."**

the Aristotelian" of the 6th century, called by some the last great philosopher of pagan antiquity and perhaps a suitable representative for Aristotelianism. But was anybody fooled? The word can also mean "dunce." Into Simplicio's mouth Galileo put the arguments of his old friend Cardinal Barberini, now the Pope! The trial of 1633 followed shortly.

This made things awkward for Riccioli when it came to putting Galileo on the Moon. The Church was not in a forgiving mood; the ban on Galileo's books wouldn't be lifted until the next century. So what was Riccioli to do?

He had already assigned Copernicus, Tycho, and Kepler to the splashiest craters, which luckily were all on the waxing-gibbous quarter, the side popularly associated with storms, damp, and misery. Tycho on the Southern Highlands was happily high and dry — Tycho's geo-heliocentric model, with the Sun and Moon orbiting the Earth while the other planets orbited the Sun, did not contradict the Bible.

But Copernicus and Kepler? They were tossed on the Sea of Storms (Oceanus Procellarum), with marshes of fogs and putrefaction to the north (Palus Nebularum and Palus Putredinis), twin threats of disease and insanity to the south (Palus Epidemiarum and Peninsula Deliriorum), and a thunder-and-lightning battering from peninsulas Fulminum and Fulgurum to top things off.

Gothic excess? Not for an audience with fresh memories of the Thirty Years' War. A religious war turned political, it had drawn in mercenary armies from across Europe and killed a quarter to a third of the population of the German states. The German Kepler had danced around disaster while he lived; not so his grave, destroyed by the Swedes in the sack of Regensburg. If

"THE MONSTROUS BEAST OF WAR," detail from a typical flysheet of the time, shows the Thirty Years' War laying waste to the land, pillaging churches and towns, and slaughtering their inhabitants. Were Riccioli's grim waxing-gibbous names a reflection?

Riccioli was using hellish surroundings to launder the Copernicans, perhaps he'd be less likely to get called out for memorializing them so prominently.

Riccioli a Closet Copernican?

Next up in the Tycho-Copernicus-Kepler progression was Galileo. But try to spot Galileo's pinprick of a crater! It's invisible in most binoculars unless you catch it, and its later-named satellite Galilaei A, as twin sparks of light on the terminator.

So what happened? Don't blame Riccioli; only later was Galileo relocated to the insignificant crater that bears the name today. (Beer and Mädler's 1836 map seems to be the culprit.) Riccioli gave Galileo's name to the last bright splash left in VIII Octans: the flat albedo feature Reiner Gamma, which Grimaldi had mistakenly drawn as a largish crater.

Riccioli published his Moon map in his great encyclopedic work the *Almagestum Novum,* a book "no serious seventeenth century astronomer could do without," as John Flamsteed, England's first Astronomer Royal, put it around the 17th century's end. As its frontispiece illustrates dramatically (see previous page), Riccioli held in public that the Copernicans got it wrong. He discusses 77 objections to a moving Earth. Most were variations on "where's the big wind?", but a couple he thought were legitimate. Where were the Coriolis effects if Earth was spinning? Falling objects and flying cannonballs didn't seem to be deflected. And if the Earth circled the Sun without the stars showing parallax motion, the stars would have to be extremely far away. But the small telescopes of his day showed them as little disks (now known to be illusory diffraction disks), which at such a distance would make the stars huge beyond belief.

As for the first objection, and as the Jesuit in Riccioli might have suspected, absence of evidence was not evidence of absence. Coriolis effects are significant only on large scales, because Earth is large; they would be demonstrated in the 19th century. So would the stars' parallaxes. Against these objections was the Copernican system's seductive simplicity. So did Riccioli have his doubts? We'll never know, but it's telling that he gave Aristarchus, the Greek Copernicus, such a blazing beacon unifying the ancient and modern octants, and Copernicus himself a crater second only to Tycho.

The practical purpose for mapping the Moon — so that terminator timings could be used to determine longitude on ocean voyages — turned out to be impractical. But that didn't stop Riccioli's map from becoming a hit with astronomers from Rome to Greenwich. Who could argue with a Hall of Fame, especially if it included them? And hats off to the way Riccioli handled the Copernicans. But the map's enduring appeal was poetic. The Moon, its gaze fixed upon Earth, had seen a lot of history. Riccioli made it bear witness to all those centuries of observation, speculation and calculation.

As for Galileo getting short-changed, there's a postscript. In the far-off future, a spacecraft orbiting the Moon would discover something unusual — that the Reiner Gamma marking is a magnetic anomaly whose mini-magnetosphere may be shielding it from the darkening effect of the solar wind. Left where Riccioli put him, Galileo would have kept his name in lights, and in binoculars, for millennia to come. ✦

In all his years in advertising, ***Andrew Livingston*** *has never seen such an action-packed layout as Riccioli's map of the Moon. As for Galileo, when binoculars show the Sun rising on his crater, he gets an honorary visit with a 13-inch Dob.*

Further Reading

- Antonín Rükl's indispensable *Lunar Atlas* (edited by *S&T*'s Gary Seronik) is a labor of love deserving a crater of its own. It includes a wealth of lunar information as well as a who's who on our side of the Moon.
- Ewan Whitaker, *Mapping and Naming the Moon.* This is the Almagest on the topic, by someone who had a hand in directing the International Astronomical Union's lunar nomenclature and in preparing the map used by the Apollo missions.
- C. M. Graney, *Teaching Galileo? Get To Know Riccioli!,* available at arxiv.org/abs/1107.3483.
- Also by Graney: *Giovanni Battista Riccioli's Seventy-Seven Arguments Against the Motion of the Earth,* arxiv.org/abs/1011.3778.