LINDA HALL LIBRARY

HEDGEHOG

NUMBER 69 • 2024

TABLE OF CONTENTS

THE LINDA HALL LIBRARY HEDGEHOG

In 1992, Bruce Bradley and Bill Ashworth were tasked with finding an image to use on the Library's first postcard. They settled on the impish hedgehog that was included as a hand-colored woodcut in the Library's beautiful copy of Conrad Gessner's *History of Animals* (1551) because it is charming and makes people smile.

The postcard, a popular give-away, was reprinted two years later around the time that the Library decided to create the first issue of its newsletter. Because the popularity of the postcard had made the hedgehog the unofficial mascot of the Library, it was decided that the newsletter should be named for it. In ensuing years, other historic hedgehog images from the Library's History of Science Collection were allowed to rotate in as icons, but the original image from Gessner remains the standard, the Mona Lisa of the spiny mammals.

Cover Image: "The Transept, Kaibab Division, Grand Cañon," chromolithograph after painting by Thomas Moran, in *Tertiary History of the Grand Cañon District*, by Clarence Dutton, *Atlas*, pl. XVIII, 1882.

PRESIDENT'S MESSAGE

As I embrace my first year as President, I am thrilled to introduce the 2024 edition of the *Hedgehog*, marking a period rich with transformation and innovation.

Linda Hall Library, with its vast collections and dedication to science and technology, invites a diverse audience of scholars, students, and the public to explore the breadth of human knowledge. Our programming, from exhibitions to lectures, is designed to inspire curiosity and foster a deeper understanding of the complex world around us. In this issue, you'll get a fascinating cross-section of topics that reflect the interplay between culture and science.

Featured on the cover, Bill Ashworth's "Perspectives on the Grand Canyon: William Henry Holmes" offers a historical vista into one of nature's geological marvels, while my own piece, "From Frescoes to Field Guides: A Journey through the History of Bird Illustration," explores the evolution of avian art. These highlights exemplify our diverse approach to engaging with the natural world.

A standout feature of this issue is an in-depth look, by Jason W. Dean, Vice President of Collections and Public Services, at the recent major acquisition of Galileo's *Sidereus nuncius*, a seminal work that has revolutionized our understanding of the universe. This acquisition puts the Linda Hall at the worldwide center of scholarship of Galileo and Early Modern cosmology. This is complemented by another article, "The World's Fabric," on Renaissance cosmology by Finch Collins, Assistant Curator of Rare Books.

Not to be missed is the interview with NEH Fellow Roger Hart on quantum computing, which bridges the gap between contemporary science and its historical roots, illustrating the forward-thinking nature of our work.

This year's *Hedgehog* embodies the dynamic intersection of cultural engagement and scientific exploration. It is a testament to the diversity and depth of the subjects that fascinate us and a sneak peek into the compelling world we are privileged to explore.

As we move forward, I am excited about the journey ahead and the stories we will share. Here's to a future filled with discovery, innovation, and the rich dialogue between our past and what's to come. Welcome to an exciting new chapter in the *Hedgehog*.

Warmly,

Eric Dorfman, President

Photograph by Spencer Selover

PERSPECTIVES ON THE GRAND CANYON:

WILLIAM HENRY HOLMES

William B. Ashworth, Jr.
Consultant for the History of Science

When geologist Clarence Durtton headed back to the Grand Canyon in 1880, under the auspices of the newly established U.S. Geological Survey (USGS), he had in his entourage two of the finest geological artists in the country. Thomas Moran had painted at Yellowstone, the Tetons, and the Green Mountains, and his *Grand Canyon of the Yellowstone* was hanging in the halls of Congress. William Henry Holmes was a talented draftsman, some nine years younger than Moran (and six than Dutton), and also a geologist, which Moran would never have claimed to be.

Holmes was just back from a year's study in Munich when he was sent, in July of 1880, to join Dutton and Moran and the rest of their party on the border between Utah and Arizona, along the Colorado River. He arrived in short order (thanks to the rapidly expanding transcontinental railroad), and soon began to sketch views of the Grand Canyon (or Cañon, as they called it) from North Rim vantage points such as the Kaibab Plateau, the Toroweap (the only vantage point from which you can see the Colorado River at the bottom of the canyon), and a site that Holmes would soon make famous, Point

"View from Point Sublime, Looking South," chromolithograph after drawing by William Henry Holmes, in *Tertiary History of the Grand Cañon District*, by Clarence Dutton, *Atlas*, pl. XVI, 1882.

Sublime. Moran painted as well, but the two men had very different ideas on how to paint the landscapes of the American West. Moran sought grandeur and spectacle, and he was not at all averse to moving the landscape around to achieve the effect he desired. He had no interest in being a cartographer or stratigrapher.

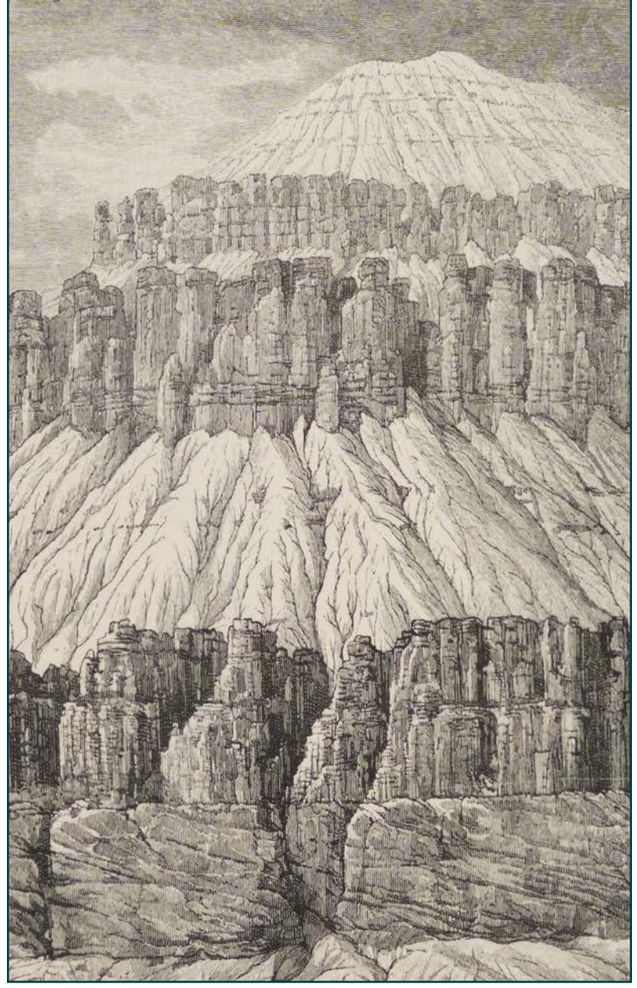
Holmes, on the other hand, wanted his sketches to be of use to geologists. His drawings of strata were exact and accurate, which in the case of the Grand Canyon, required delineating thousands of strata as precisely as possible. And because he was an artist, he had a way of doing this in a manner unfamiliar to geologists, which is to say,

"View from Point Sublime, Looking East," chromolithograph after drawing by William Henry Holmes, in *Tertiary History of the Grand Cañon District*, by Clarence Dutton, *Atlas*, pl. XV, 1882.

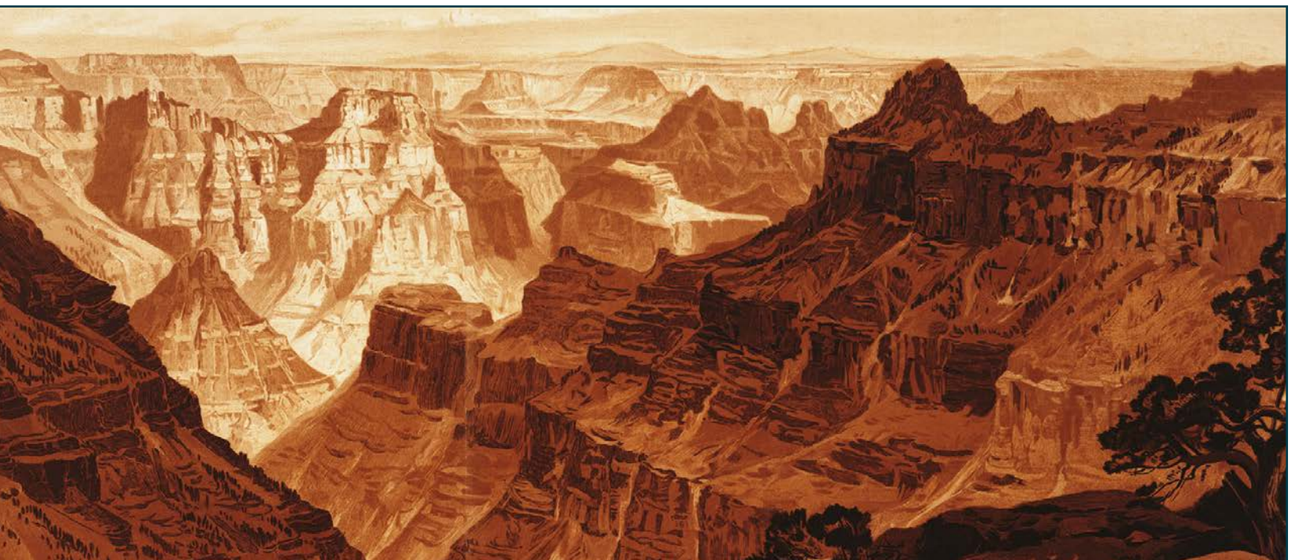
"View from Point Sublime, Looking West," chromolithograph after drawing by William Henry Holmes, in *Tertiary History of the Grand Cañon District,*
by Clarence Dutton, *Atlas*, pl. XVII, 1882.

stylishly. Holmes wanted his compositions to be as balanced and harmonious as possible, but he preferred to move his own viewpoint to improve the composition – he never resorted to moving landforms or even trees from one place to another.

The result of the collaboration was the most beautiful book ever published by the USGS, the *Tertiary History of the Grand Cañon District* (1882), consisting of a quarto text volume, written by Dutton and copiously illustrated with wood engravings derived from artwork by Holmes and Moran, and a folio *Atlas* of 22 large double-page lithographed plates, mostly based on drawings by Holmes. The views in the *Text* volume, being smaller and mostly uncolored, tend to show individual landforms such as "A Gable with Pinnacles," depicting a structure on the Toroweap, and "Vishnu Temple," a cap formation that, to Dutton (who named it) resembled a Hindu shrine. Both images were pen drawings by Holmes that were converted to wood engravings or photo-engravings for printing.



"A Gable with Pinnacles – the Toroweap," wood engraving after pen drawing by William Henry Holmes, in *Tertiary History of the Grand Cañon District*, by Clarence Dutton, *Text* vol., plate 16, p. 84, 1882.



"The Transept, Kaibab Division, Grand Cañon," chromolithograph after painting by Thomas Moran, in *Tertiary History of the Grand Cañon District*, by Clarence Dutton, *Atlas*, pl. XVIII, 1882.

"Vishnu's Temple," photo-engraving after pen drawing by William Henry Holmes, in *Tertiary History of the Grand Cañon District*, by Clarence Dutton, *Text* vol., plate 34, p. 176, 1882.

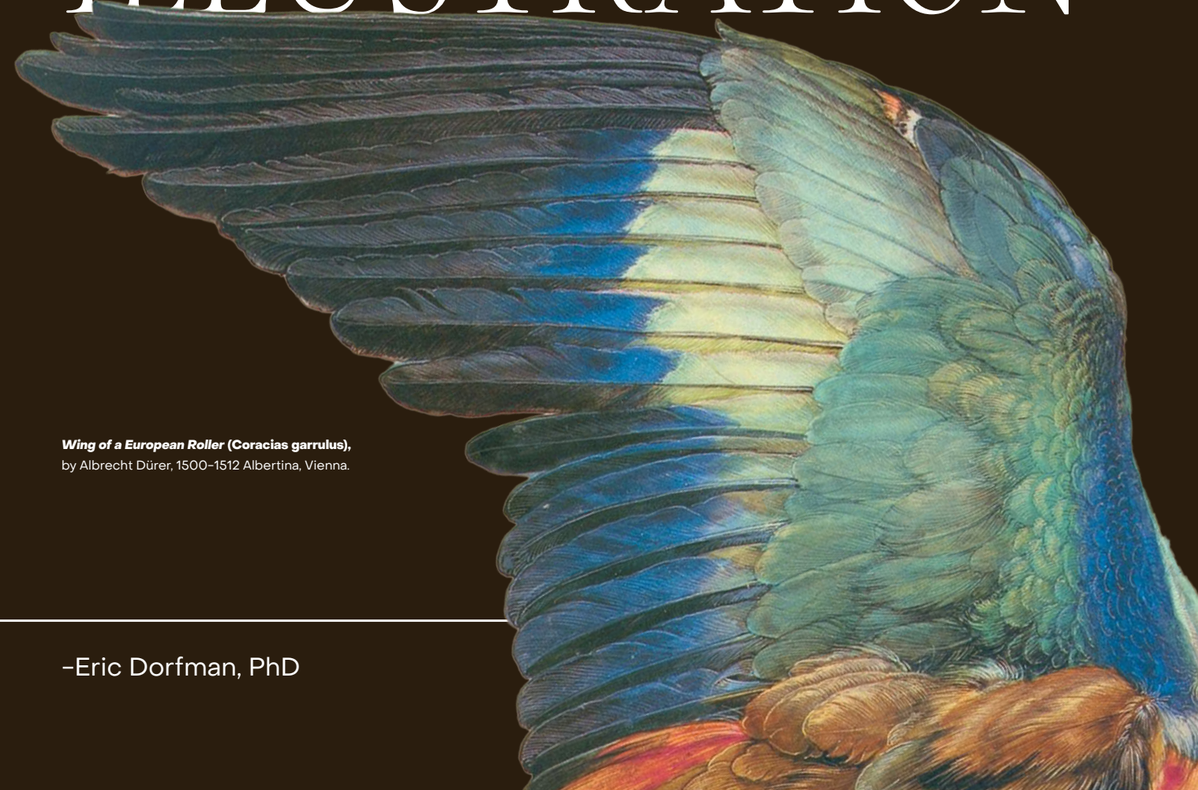
Most of the plates in the *Atlas* are tinted lithographs, meaning they were printed from several stones, each adding a different earthtone color. The most arresting section of the *Atlas* is undoubtedly a three-part sequence called *Panorama from Point Sublime*, where Holmes provided three views of the Grand Canyon, looking east, south, and west, from a single vantage point on the North Rim. The three lithographs form a continuous panorama, should you remove them from their binding and place them side by side. In the first of these, "Looking East" (see detail), Holmes contrived to put himself and Dutton into the picture, a clever way of indicating that the *Atlas* was very much a collaborative effort.

There is only one painting by Moran in the *Atlas*, "The Transept – Kaibab Division," and most viewers really like it and prefer it to the less dramatic renderings of canyon walls by Holmes. It is indeed a lovely work of art; however, it is easy to see how a geologist like Dutton would find it useless in helping him understand the history of the Grand Canyon, for there is no reliable detail in it. Masterful though it might be, Moran's "Transept" is still just an artist's impression of an awesome vista, meant to stir the heart, but not the mind. Holmes sought to educate and inform first, but he still managed to bring out the awe in all of us. ✲

Edward Lear's Rainbow Lorikeet illustration for English ornithologist Prideaux John Selby's *Natural History of Parrots*, 1836.

FROM FRESCOES TO FIELD GUIDES:

A JOURNEY THROUGH THE HISTORY OF BIRD ILLUSTRATION



***Wing of a European Roller* (Coracias garrulus),** by Albrecht Dürer, 1500–1512 Albertina, Vienna.

-Eric Dorfman, PhD

An Eye for Birds

I have, unashamedly, a deep fascination with birds. Some of my appreciation was developed while studying the behavioral ecology of waterbirds in remote areas of Australia and South Africa. I have been fortunate to spend time in some dramatically beautiful places, environments teeming with cormorants, ducks, swans, pelicans, towered over by gangly storks and punctuated by colorful little gallinules and jacanas darting here and there after their food. Never mind the plentiful crocodiles, these are truly paradises.

But my attraction to birds doesn't end with field study. I am also a huge fan of the garden variety birds that end up in our feeder, migratory warblers and the American Goldfinch. Brown-headed Nuthatches spreading their wings to ward off bluebirds who pile onto the platform, their scruffy offspring in tow. And then there is that Pileated Woodpecker who stares at the cat through the living room window. I have blogged about the species in our former garden in North Carolina and am eagerly awaiting the spring migration to see what arrives at the Linda Hall Arboretum. In all this, my scientific background doesn't afford me any special birding credentials. I am in a truly enormous crowd of bird enthusiasts. In fact, Cornell University's bird lab reported at the beginning of this year that, according to a nationwide survey, fully a third of American adults, or 96 million people, are active birdwatchers.

...FULLY A THIRD OF AMERICAN ADULTS, 96 MILLION PEOPLE, ARE ACTIVE BIRDWATCHERS.

A Century of Birds from the Himalaya Mountains,
by John Gould, 1832.

While this current number is eye-wateringly large, birds have been a source of fascination for a long time, intertwining with many aspects of our lives. Aside from the wonder with which so many of us observe these modern-day dinosaurs, we incorporate them into our diets with great enthusiasm (mostly chickens—34.4 billion worldwide in 2023). We keep them as pets (an estimated 800,000 wild-caught birds are imported annually into the US to be sold as pets). They even accompany us to sleep, their down filling our pillows (270 metric tons of duck down are produced every year, mostly in Europe and Asia). However, these functional statistics belie the enduring allure that has captured people's imagination and reverence, especially in times long past.

Artistic Portrayals of Birds

During the 2023-24 season at the Library, we have shared some of these insights in the exhibition *Chained to the Sky: The Science of Birds, Past and Present*, developed in partnership with Chicago's Field Museum. It is a chronicle of our changing relationship with birds from prehistoric times through the modern day, to the future of bird conservation in our own backyards. At every step, the science is accompanied by illustrations. From the ancient cave paintings through the detailed Victorian-era illustrations by Edward Lear, to the contemporary field guides by David Sibley, these artistic portrayals of birds do more than capture their beauty; they provide visual evidence of an evolving relationship. In this article, we celebrate a few of the outstanding people who observed birds and documented those observations to view and ponder.

From Lascaux Caves in France, this image of the "Bird Man" is the earliest known depiction of a bird. Darryl Wheye and Donald Kennedy. *Humans, Nature, and Birds: Science Art from Cave Walls to Computer Screens*, New Haven, 2008.

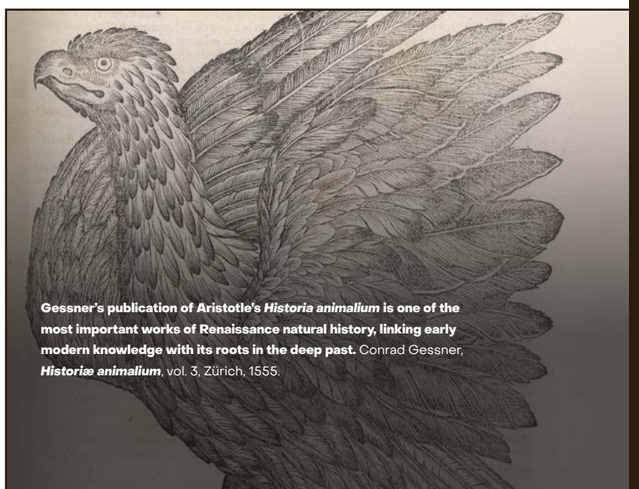
The Ancient World

Bird illustration as we think of it today was a fairly recent development, although we've been capturing images of birds for a very long time. The earliest depiction of a bird by a human is the "Bird Man" of Lascaux, dating back 17,000 years. At first glance, he looks almost comical, arms outstretched with an enormous bird head perched on his shoulders. He is presumed to be a shaman blessing a hunt, as evidenced by a dead bison in front of him. Was this a literal depiction of a man wearing a mask, or a figurative image of somebody drawing power from the sky? On the other side of him, its purpose also unclear, is a pole with a bird on top. We will probably never know the answers; however, these humble yet important beginnings produced a proliferation of beauty and inspiration. From those very early days, it seems, birds have carried a sense of mysticism about them.

The Renaissance

You need to move forward in time to uncover named artists drawing birds for illustrative purposes. In 1512, Albrecht Dürer, a master of the Northern Renaissance, meticulously captured the beauty and detail of the natural world in his artwork, of which his hare is probably the most famous. Among these remarkable studies, the drawing of the wing of a European Roller (*Coracias garrulus;* pictured on the title page of this article) stands out for its precision and depth, exemplifying Dürer's skill in rendering the intricate textures and patterns of feathers with almost photographic realism. He, like Leonardo da Vinci, whose manuscripts contain over 500 sketches of birds, bird flight, and machines for human flight, probably drew birds or parts of birds from direct observation, in the same sense we know illustrations today. This was, however, rare for the time.

The Renaissance generally is marked by a broader embrace of scientific inquiry and rediscovery of classical knowledge. For instance, the earliest surviving illustrated treatment of Aristotle's *Historia animalium* was published in four volumes in Zurich between 1551 and 1558 by the prolific Conrad Gesner, a Swiss naturalist and physician with a fifth volume published posthumously in 1587. A copy of volume three is displayed in *Chained to the Sky.*



Gessner's publication of Aristotle's *Historia animalium* is one of the most important works of Renaissance natural history, linking early modern knowledge with its roots in the deep past. Conrad Gessner, ***Historiæ animalium***, vol. 3, Zürich, 1555.

Although the illustrator of this eagle is unnamed, Ulisse Aldrovandi used many of the most important artists of his time to illustrate his seminal works on natural history. Ulisse Aldrovandi, *Ornithologiae: hoc est de avibus historiae libri XII*, vol. 1, Bologna, 1599.

Conrad Gessner (1516–1565)
Conrad Gessner, a Swiss naturalist and physician, mentioned earlier for his publication of Aristotle, is often regarded as the progenitor of modern zoology. His seminal work, *Historiae animalium*, is considered one of the first modern works in zoology and includes extensive descriptions and illustrations of birds. Gessner's approach combined careful observation with information drawn from classical sources, making his work a comprehensive reference for European natural history in the sixteenth century.

Ulisse Aldrovandi (1522–1605)
An Italian naturalist, Aldrovandi is a pivotal figure in the history of natural history, including ornithology. Aldrovandi's emphasis on mixing empirical observation with traditional historical accounts, along with his extensive collection of natural specimens, greatly influenced the development of natural history generally. His works, particularly *Ornithologiae,* were among the first to focus exclusively on birds and included rich visuals, which were commissioned from some of the region's greatest artists, including Giuseppe Arcimboldo, Jacopo Ligozzi, Joris Hoefnagel, and Daniel Fröschl.

Much of his extensive collection of specimens is still together and on display at the Palazzo Poggi in Bologna, making it the longest continuously-running natural history collection in the world. The palace is part of the University of Bologna, and the collection is curated and preserved as both a historical and scientific resource. The Palazzo Poggi Museum displays many of Aldrovandi's original specimens, reflecting his vastly varied interests. In the *Chained to the Sky* exhibition, we feature this image of an Eagle from *Ornithologiae.*

The Enlightenment
During the Enlightenment, the study and illustration of birds flourished under the era's burgeoning zeal for scientific exploration and categorization. This period was characterized by a significant expansion in ornithological knowledge, driven by increased exploration and the collection of specimens from the newly-founded colonies of wealthy European nations. Enlightenment thinkers and artists sought a deeper understanding of the natural world, moving beyond mere observation to a systematic study of birds' anatomy, behavior, and habitat. This shift is exemplified by works of naturalists like Carl Linnaeus, who developed the binomial nomenclature system, and illustrators like Mark Catesby and George Edwards, who brought the exotic avian species of the New World to European audiences. Birds, in the context of the Enlightenment, were no longer just subjects of artistic representation or religious symbolism; they became integral to scientific discourse, contributing to the broader Enlightenment objectives of knowledge, reason, and the pursuit of understanding the natural order of the world.

Alexander Wilson (1766-1813)
Alexander Wilson was a pioneer in the study and illustration of North American birds. Born in Scotland in 1766 and immigrating to America in 1794, he authored the groundbreaking *American Ornithology,* published in nine volumes between 1808 and 1814. His extensive travels across America for field observations set new standards for ornithological study. Wilson's realistic and detailed bird illustrations were influential, laying the groundwork for future ornithologists, including John James Audubon. Despite passing away in 1813 before completing his work, Wilson's contributions significantly advanced the scientific understanding and appreciation of birds in North America.

Wilson's paintings, like these Cardinals and Tanagers, laid the groundwork for many ornithologists and illustrators that followed.
Alexander Wilson, *American Ornithology,* vol. 1, Philadelphia, 1808.

John James Audubon (1785–1851)
John James Audubon, a Franco-American naturalist and artist, remains one of the most renowned figures in ornithology, primarily for his monumental work *The Birds of America,* published on double-elephant paper between 1827 and 1838. This work contained life-sized, hand-colored illustrations of a wide variety of American birds, depicted in their natural habitats. Audubon's combination of artistic skill and meticulous scientific observation set a new standard in ornithological illustration and profoundly influenced the field of natural history illustration.

Unlike his predecessors, whose portrayals often appeared static, Audubon brought an unparalleled vitality to his subjects, portraying them as living, breathing entities within their natural habitats. This approach, in an era before photography, enabled a deeper public appreciation and understanding of birds, fostering a connection with these species. While acknowledging the problematic aspects of Audubon's history, including his treatment of Indigenous peoples and environmental ethics, his artistic legacy remains significant, bridging the human-avian divide and reshaping our perception of the natural world through art.

Modern Times
From the Victorian era to the present day, the representation and study of birds has seen a remarkable evolution, paralleling the rapid advancements in both science and art. The Victorian era, with its fascination for collecting and classifying the natural world, saw the production of elaborate and detailed bird illustrations in works like John James Audubon's *The Birds of America*, which combined artistic splendor with scientific accuracy. This period also witnessed the integration of bird study into the burgeoning field of evolutionary biology. Moving into the twentieth and twenty-first centuries, considerable focus has shifted towards conservation and ecology, reflecting growing concerns about habitat loss and species extinction. Modern bird illustrations, while continuing the tradition of detailed depiction, have increasingly served a practical purpose in field guides and ornithological research, as seen in the works of Roger Tory Peterson and David Sibley.

We feature a number of Audubon images in the exhibition, including the Carolina Parakeet, North America's only native parrot, which was sent extinct by humans in 1939. John James Audubon, *The Birds of America*, vol. 4, New York and Philadelphia, 1842.

Edward Lear (1812-1888)
Lear was an English artist, illustrator, musician, author, and poet, now most widely known for his literary nonsense in poetry and prose, especially his limericks, a form he popularized.

There was an Old Man with a beard,
Who said, "It is just as I feared!—
Two Owls and a Hen,
Four Larks and a Wren,
Have all built their nests in my beard."

-Edward Lear

He was also a highly respected travel illustrator and bird painter, of which the Rainbow Lorikeet *Trichoglossus moluccanus* in the front of this article (and on display in *Chained to the Sky*) shows extremely well. Lear's illustration was part of a series created for Prideaux John Selby's *Natural History of Parrots,* which was published as part of William Jardine's *Naturalist's Library* series in 1836. I am particularly fond of Rainbow Lorikeets, having lived for many years in Sydney. They are ubiquitous, raucously invading every suburb and – to me at least – add something distinctive to the character of the city.

David Allen Sibley is a preeminent figure in modern ornithology and bird illustration. His *Sibley Guide to Birds*, first published in 2000, has become a standard reference in bird identification in North America. Sibley's work, characterized by its detailed and accurate illustrations of birds in various poses and plumages, combines scientific rigor with artistic finesse. His guides have made the study and appreciation of birds accessible to a wide audience, continuing the tradition of blending art and science in ornithology. Each illustrator, and the many others we did not have space to cover, has contributed uniquely to our understanding and enjoyment of birds, reflecting the changing ways in which these creatures have been viewed and appreciated through time. It is our hope that, by celebrating birds, and the artists who painstakingly captured their anatomy and behavior, we all journey closer to protecting them for future generations.

We warmly welcome you to see *Chained to the Sky: The Science of Birds, Past and Future,* offering a distinctive look at the world of birds through historical literature, illustrations, and photography. With bird populations facing significant challenges globally, this exhibition aims to educate and inspire visitors to make a difference. So, beyond the celebration of their beauty, we provide practical advice on bird conservation in your own home and garden. Looking forward to seeing you there. ✲

Pictured: David Sibley and Eric Dorfman viewing *Chained to the Sky*.

SIDEREUS NUNCIUS

Jason W. Dean, Vice President for Collections and Public Services

One of a Kind
The Linda Hall Library is the only place in the world where researchers and patrons can read, use, and examine all three "versions" of Galileo's seminal work on telescopic observations: the *Sidereus nuncius* of 1610. In late 2023, the Library acquired an ordinary paper copy of the Venice edition of this book which has been hand corrected by Galileo himself, the most significant acquisition in the Library's recent history.

Sidereus nuncius is one of the most famous books in the history of science. Even in translation, the book is entertaining, readable, and engaging over 400 years after its initial publication. Over the course of 60 pages, Galileo shared his observations that transformed how we view our solar system, universe, and our place in the stars. The book can be roughly broken down into seven sections: the dedication to Cosimo II de' Medici, the introduction, Galileo's discussion of the telescope, his narrative and illustrations of his observations of the moon, his observations of fixed stars, his observations of the moons of Jupiter, and finally, the conclusion.

Galileo's discussion of the telescope describes how he first learned of the telescope and how he worked to improve its magnifying power and clarity to make it suitable for astronomical observations. It bears remarking that Galileo did not claim to invent the telescope, only that he improved considerably upon it. These observations include his etchings and description of the moon. They further reveal that the surface of the moon was rough, indicating mountains and valleys on its surface. Eschewing the traditional view that the moon was a flat disk in the sky, he argued that the moon was a sphere and addressed the problems of silhouette and earthshine.

Galileo's 44 observations of the moons of Jupiter, which he initially describes as "wandering stars," occurred between January 7 and March 2, 1610. He ultimately concludes that those objects are not stars but rather moons orbiting Jupiter. In honor of his patron, Cosimo II de' Medici, he names them the Medicean Stars. His observations are among the earliest data that supported the heliocentric model of our solar system; however, his revelations caused a great furor in learned circles throughout Europe.

Two editions, two issues:
The three *Siderei nuncii* now in the Library's collection are, to be more specific, two issues and two editions of the book. The first edition of 550 copies of the book was printed in Venice under the name of Tomasso Baglioni in 1610 and appeared in two issues: one printed on fine paper and one printed on ordinary paper. The Venice edition sold out shortly

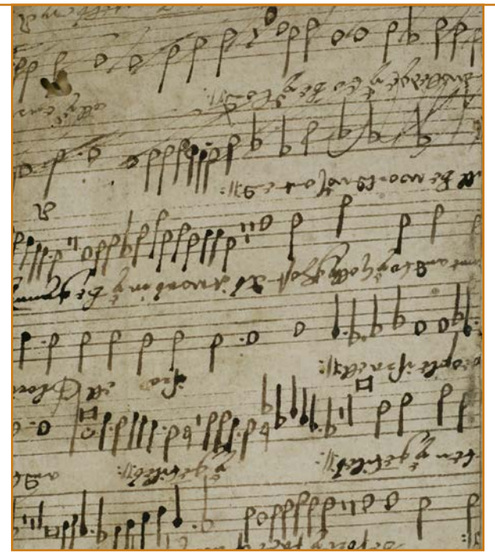
Quòd tertio loco à nobis fuit obſeruatum, eſt ipſiuſmet LACTEI Circuli eſſentia, ſeu materies, quam Perſpicilli beneficio adeò ad ſenſum licet intueri, vt & altercationes omnes, quæ per tot ſæcula Philoſophos excruciarunt ab oculata certitudine dirimantur, nosque à verboſis diſputationibus liberemur. Eſt enim GALAXYA nihil aliud, quam innumerarum Stellarum coaceruatim conſitarum congeries; in quamcunq; enim regionem illius Perſpicillum dirigas, ſtatim Stellarum ingens frequentia ſe ſe in conſpectum profert, quarum complures ſatis magnæ, ac valde conſpicuæ videntur; ſed exiguarum multitudo prorſus inexplorabilis eſt.

At cum non tantum in GALAXYA lacteus ille candor, veluti albicantis nubis ſpectetur, ſed complures conſimilis coloris areolæ ſparſim per æthera ſubfulgeant, ſi in illarum quamlibet Specillum conuertas Stellarum conſtipatarum

cœtum

Foldout showing full asterism field on the verso of D5 and the recto of D6, and partial deckled edge, ordinary paper issue.

Printed binding waste at rear of Frankfurt edition of *Sidereus*, with the printed text that identified a likely early English owner.



Manuscript binding waste, of the "nunc dimittis," drawn from the 1549 Book of Common Prayer.

after its appearance in the marketplace. Those two issues comprise the first edition of the book. The second edition was printed in Frankfurt in the same year, in a single known issue.

The Library's first copy of *Sidereus*, a Frankfurt edition, was acquired by the Library's first Director Joe Shipman from the British bookseller Quaritch in 1976. As a result of the intense interest in the Venice edition, Zacharias Palthenius printed the second edition of the book in Frankfurt, with two obvious alterations – the book was printed in the less expensive octavo format, and the black on white asterism woodcuts were printed white on black, a likely time and cost saving measure. The Frankfurt edition lacks much of the clarity and resolution of the images in the Venice edition and is today the rarest edition of the book from 1610.

[1] Though Thomas Baglioni's name appears as the printer, the book was in fact printed by Polo and Meietti. For more information, see Wilding, *Galileo's Idol*, p. 101–116.

The Library's copy of this edition is bound in limp vellum and has both printed and manuscript waste, which provides tantalizing clues as to the early ownership of this copy. One of the front free endpapers is manuscript waste, which appears to be in English, sourced from the 1549 Book of Common Prayer, indicating that the book was likely bound in England.

The Library's second copy of *Sidereus,* a fine paper issue of the Venice edition, was acquired by Bruce Bradley and Bill Ashworth in 1988 from an auction at Sotheby's. Further examination uncovered the significance of this copy of the book and its identification as being one of the few known copies in the fine paper issue.

The Venice edition was produced in great haste; only 15 weeks elapsed between Galileo's first observation to the completion of printing by Niccolò Polo and Roberto Meietti.[1] Galileo's extraordinary rush came from his well-founded fear that he might not be the first to publish his observations. Indeed, Thomas Hariot's lunar observations predate Galileo's by three months. Printing of *Sidereus* began January 30, 1610, and was completed by March 12, with Galileo's late additions (his observations of the fixed stars) finalized on March 8. In mid-March of 1610, and after the printing of the ordinary paper copies, Galileo received approximately 30 copies of *Sidereus* printed on fine paper, all intended to be presentation gifts to the good and great in Galileo's circles. Presentation copies were sent to the most powerful families in Italy, including Cosimo II.

In 2009, the Library lent their (at that time) only Venice edition of the book to an exhibition at the Franklin Institute. This loan coincided with Paul Needham's work on a census of existing copies of *Sidereus,*

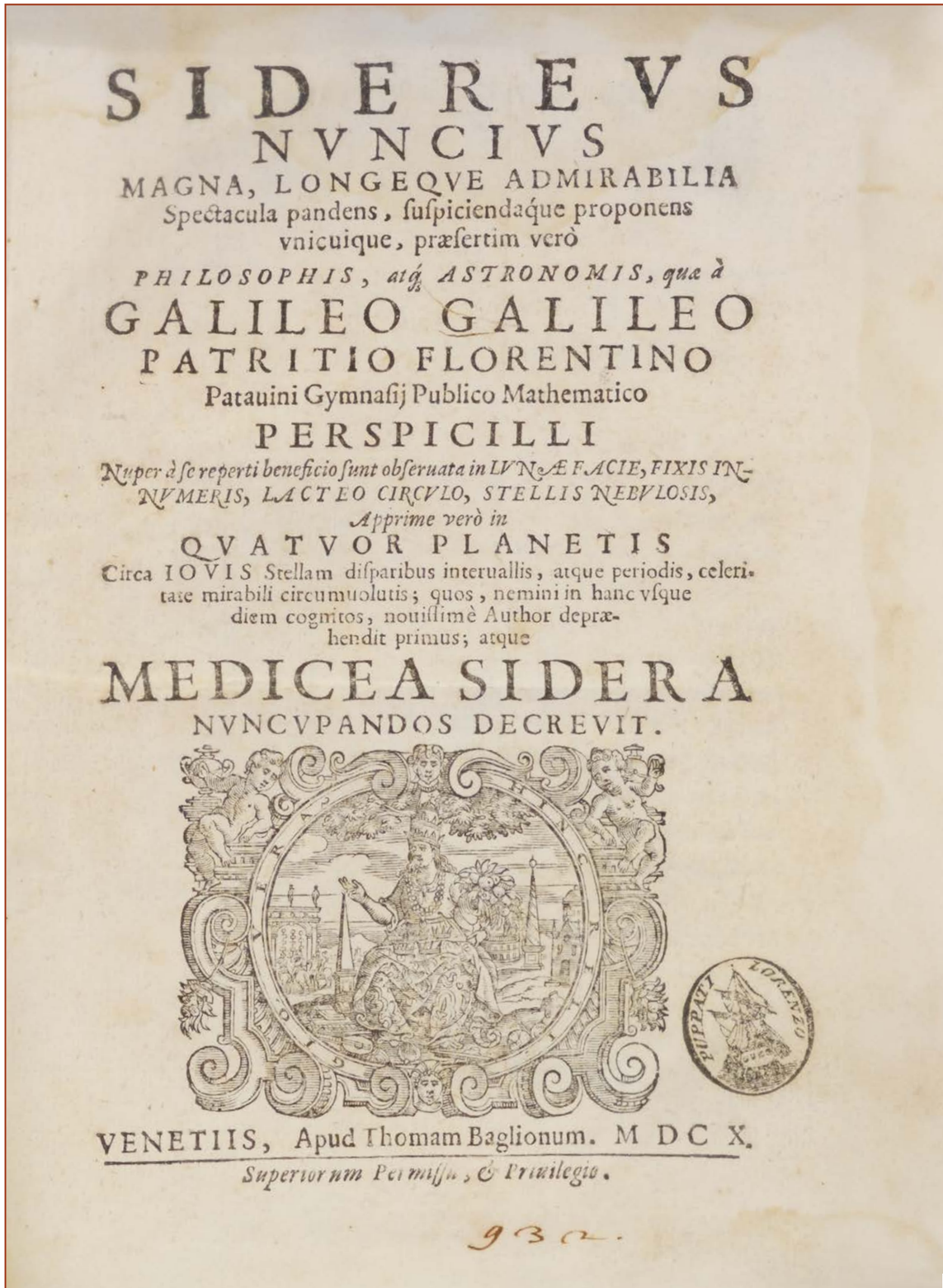
titled *Galileo Makes a Book.* Dr. Needham closely examined this copy, and thanks to his examination of all known copies, concluded that the Library's copy was one of nine extant copies printed on fine paper. The paper is noticeably thick and bright. Close examination of the watermarks and chain lines indicates that the paper was manufactured by the Fabriano mill, a logical choice for Galileo thanks to its relative proximity to both Venice and Florence. Needham's work also revealed that all fine paper copies have between two and seven corrections to the printed text in Galileo's hand. The Library's copy has three corrections, as well as the Medicea cancel slip pasted over the incorrect printed word "Cosmica."

The Library's third copy of *Sidereus,* from the ordinary paper issue, was acquired by Jason W. Dean in late 2023 from the Danish bookseller Christian Westergaard of Sophia Rare Books. This copy is bound with two other titles, introduced later. The titles in the volume all are linked to Galileo's observations described in *Sidereus*. The Library drew upon the Ringle Fund, established through the generosity of Dr. David Ringle and Mrs. Stata Norton Ringle in 2012, for this acquisition. This sammelband[2] acquisition is one of the most important acquisitions in the Library's history.

This copy of *Sidereus* is from the group of roughly 520 copies printed on ordinary paper. Of those 520, approximately 80 survive. Needham identified several paper stocks used for this issue, some of which are seen in the Library's copy.[3] However, elevating this copy from the 80 others is that it has five corrections to the printed text in Galileo's hand, two more than the Library's fine paper copy. The five corrections are the maximum known outside of Galileo's own copy, now at Brown University, and the fine paper copy at the University of Strasbourg. These edits correct unintentional mistakes introduced either by the printer or from Galileo's own fair copy sent to the printer. In addition to the three corrections found in the fine paper copy, this copy has two Galilean corrections on the verso of E1v (the back of leaf 17): "exitare" corrected to "haesitare," and "caepit" corrected to "caepi." Having two Galilean corrected copies allows for direct comparison of handwriting, inks, and correction methods, an opportunity unique in the world.

Beyond the Galilean corrections, three material aspects of this copy are of significant interest. First, that it includes an asterism not found in the Library's fine paper copy but seen in the untrimmed copy at the Library of Congress. The edges of this leaf still are deckled, meaning that they are the untrimmed edges of a whole sheet of paper, likely super-median sized (38 x 52 cm unfolded).[4] Second, this copy bears evidence of folding, which indicates its likely initial distribution through diplomatic mail systems. These folds are most evident in the final signature of the book (G) and become less evident through to the titlepage. Third, signature C, rather than being from a single sheet of paper, is two half sheets. This signature includes the bulk of the etchings of the moon, literally 3/4 of the lunar images. Needham points out that there is a strong possibility that the etchings were printed later than the rest of the book, which would have been required by the method of printing etchings using a cylinder press.[5] Galileo notes in a letter dated March 13, 1610 that he had yet to receive the printed moon etchings for the copies that were due to him. Books

Right: Title page of ordinary paper issue, with ownership stamp of Lorenzo Puppati in lower right.



[2] "From the German words sammeln (to collect)… and Band (volume). In one sense, the word means an anthology, but it is more used for a volume made up of parts, collected or brought together."–Sid Berger, *Dictionary of the Book,* p. 230.
[3] Title page of ordinary paper issue, with ownership stamp of Lorenzo Puppati in lower right.
[4] Needham, *Galileo Makes a Book*, p. 28–29.
[5] Ibid, p. 199.

destined for the Frankfurt fair likely received their plates first, and then Galileo's copies were completed. The presence of these two half sheets provides another avenue for further research.

Christian Westergaard asked two leading experts to examine the sammelband – Nick Wilding and Nicholas Pickwoad. Their work was essential for authentication, and Dr. Pickwoad's work in particular revealed two significant clues. First, Pickwoad identified that the volume was bound early in the seventeenth century, likely just after the publication of the final title. More significantly, he identified that the binding structure is not Germanic, and is likely Italian, thanks to the method of binding. Second, he identified the remnants of the original binding not in the structure – strands of blue thread which appear in the gutter between the verso of D2 and the recto of D3. He notes that the book was re-bound, not altering the binding structure, in the nineteenth century.

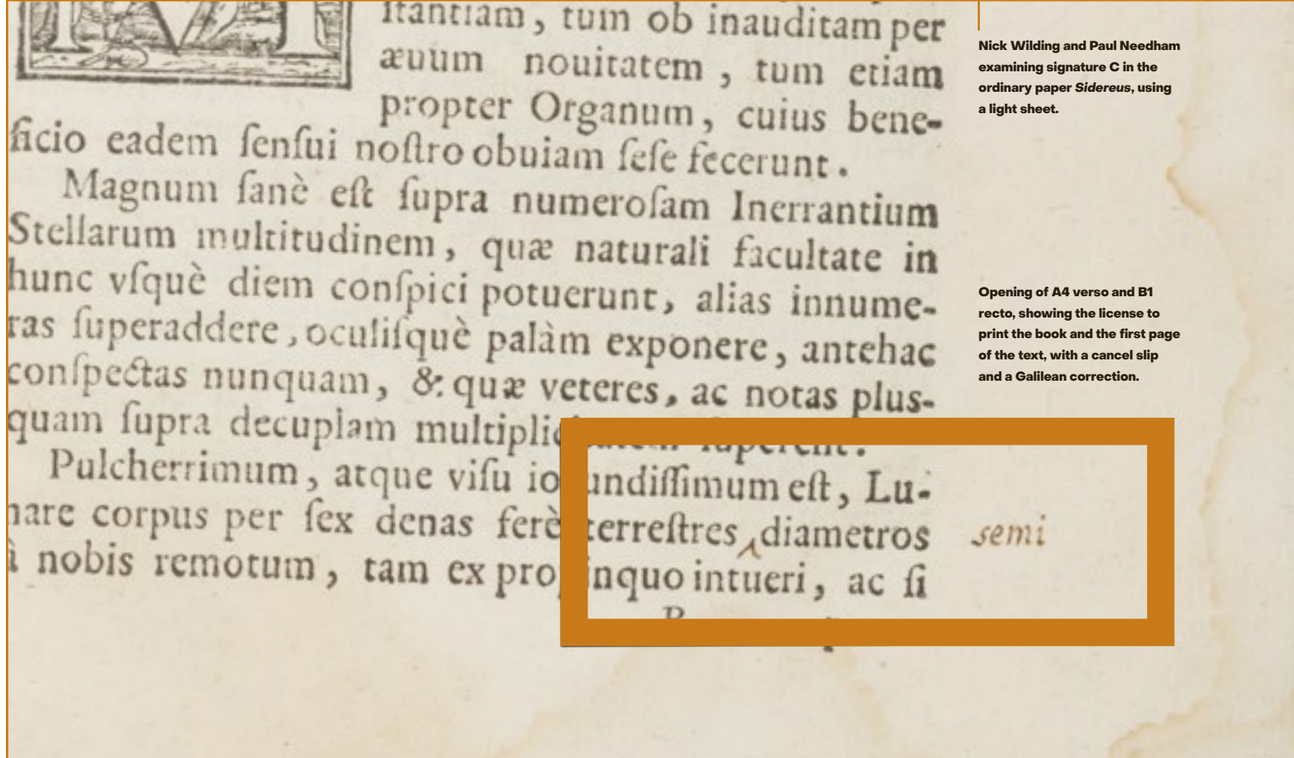
Later work by Needham, Wilding, and Dean revealed that the endpapers have a watermark of a hat, commonly used by papermakers in and around Trento between 1825 and 1850.[6] This likely Trento watermark indicates it might have been re-bound by the man who placed his stamp on the titlepage of *Sidereus*: Lorenzo Puppati (1791–1877). He was a philosopher and poet, and his stamp is known in other books. Wilding also traced later provenance for the book, where it appears in the 1913 *Atti della Pontificia Accademia delle Scienze,* described correctly as the bound with now in the Library's collection.[7] Wilding contacted the successors of this academy, namely the Pontifical Academy of Sciences and the modern Lincean Academy, and both make no claims of ownership on the volume.

The second title in the sammelband is the Frankfurt edition of Johannes Kepler's *Narratio de observatis* of 1611, which at the time of acquisition was the sole significant scientific lifetime publication of Kepler that the Library did not hold. Its presence in the volume first brought the sammelband to the Library's attention, and the addition of the *Narratio* completes our collection of Kepler's scientific works. The *Narratio's* inclusion in the bound with also bears remarking, given its contents. As mentioned above, binding evidence indicates that the titles were all bound with shortly after the appearance of the publications, by a yet to be identified person clearly interested in *Sidereus* and its reception.

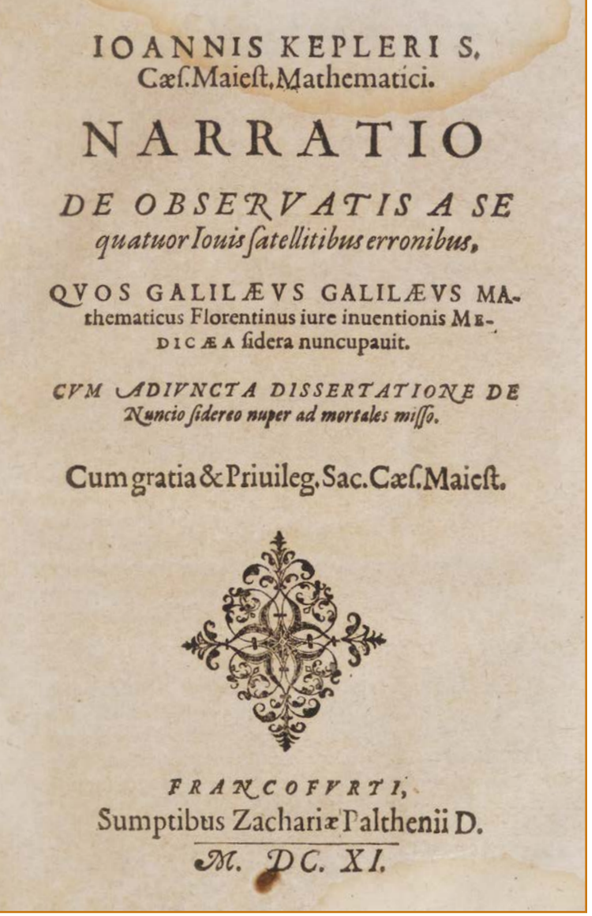
Simply put, Kepler's *Narratio* was the first independent verification of Galileo's observations in *Sidereus*. Indeed, Galileo solicited Kepler's response to *Sidereus* in a letter sent via the Medicean ambassador to the court of Rudolf II, Giuliano de' Medici. This letter included a copy of *Sidereus* that Galileo sent expressly for Kepler to read. His response to *Sidereus* appeared in 1610, titled *Dissertatio cum nuncio sidereo,* which was in essence a laudatory book review, as Kepler lacked a telescope of sufficient quality to replicate Galileo's observations. Kepler's confirmation of Galileo's observations in *Narratio* was key to the wider acceptance of the four moons around Jupiter, as well as the observations of the moon and the stars. Kepler was well-known throughout Europe, and his position as the mathematician to

[6] From LHL catalog record: "copy bound in 19th century in decorated paper over cartonnage boards with spine in unstained sheep parchment. Spine with 4 gold fillets at top, and 7 gold fillets at bottom, one with dog-tooth roll. Leather label on spine "GALILEO KEPLERO CHRISTMA" stamped in gold. Based on examination by Nicholas Pickwoad, the sewing of the textblock was contemporary to the production of the book - all four titles in the bound with were bound early in the 17th century, likely in Italy."
[7] vol 66, p.75.

Nick Wilding and Paul Needham examining signature C in the ordinary paper *Sidereus*, using a light sheet.



Opening of A4 verso and B1 recto, showing the license to print the book and the first page of the text, with a cancel slip and a Galilean correction.


IOANNIS KEPLERI S,
Cæſ. Maieſt. Mathematici.

NARRATIO

DE OBSERVATIS A SE
quatuor Iouis ſatellitibus erronibus,

QVOS GALILÆVS GALILÆVS MA-
thematicus Florentinus iure inuentionis ME-
DICÆA ſidera nuncupauit.

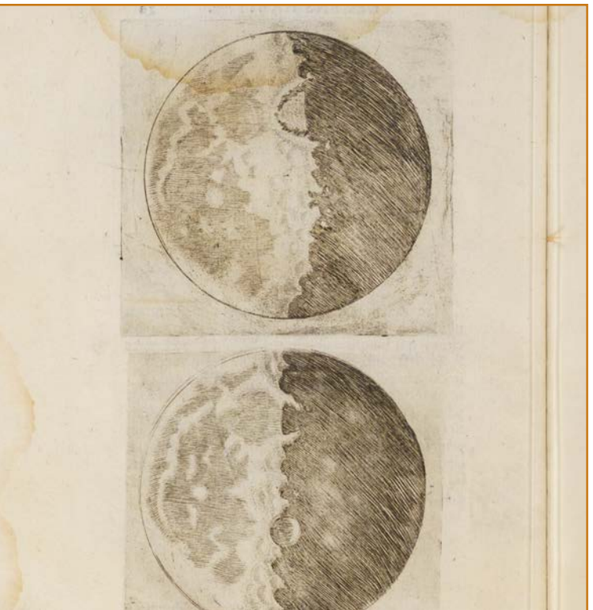
CVM ADIVNCTA DISSERTATIONE DE
Nuncio ſidereo nuper ad mortales miſſo.

Cum gratia & Priuileg. Sac. Cæſ. Maieſt.

FRANCOFVRTI,
Sumptibus Zachariæ Palthenii D.
M. DC. XI.

Titlepage of the *Narratio de observatis.*

Two moon etchings showing the rough surface of the moon, from the verso of C2 of the ordinary paper issue.



Emperor Rudolf II garnered additional respect for the confirmation. The *Narratio's* inclusion in the bound with directly after the text it endorses is important. Finally, the *Narratio* is incredibly scarce in the marketplace, only a single copy having appeared at auction in over 50 years.

The third title in the sammelband is Kepler's *Dioptrice* of 1611, of which the Library already holds a copy. Though significant, it is the least important title in the bound with, but still notable for its inclusion. In this work, Kepler discusses optics, and specifically the optics of the telescope, as well as how a telescope works. Thanks to the telescopic observations in both *Sidereus* and *Narratio*, the *Dioptrice's* inclusion is logical.

The sammelband once had four titles – *Sidereus, Narratio*, *Dioptrice*, and a copy of Jacob Christmann's *Nodus gordius* of 1612. Christmann's text included his observations made with a telescope of poor quality of both Jupiter and Saturn. Unlike the Kepler texts, it was not central to the reception of *Sidereus*, but included contemporary telescopic observations of Jupiter and was a response to Galileo's book. The *Nodus gordius* was removed to allow an export license to be granted for the bound with from Italy. It is quite rare, only 14 copies exist in libraries worldwide, including the Linda Hall Library. Our holding of this item allows users to physically reunite (side by side) the four original texts in the bound with, an opportunity no other library can offer.

To conclude the provenance for the volume, we are left with a set of central questions:

1. Who was important enough to be sent a Galilean corrected copy from the ordinary paper edition via diplomatic mail (which was expensive but far faster than normal mail) but not a fine paper copy? Further, Galileo ensured all engravings were present in the volume, as well as the full asterism leaf.

2. Who owned this *Sidereus,* and also was able to acquire the rare *Narratio* and the rare Christmann text? Likely someone in German-speaking lands, but this is speculation.

3. Who took the three items printed in Germanic lands and had them bound with *Sidereus* in Italy?

There is speculation about this bound with, and to answer these questions, the Library invited Paul Needham and Nick Wilding to come to the Library and examine all three *Siderei nuncii.* Their visit revealed both new information about these copies and asked new questions of these objects.

During their brief visit, Wilding, Needham, and Dean engaged in a close examination of all three versions of *Sidereus nuncius*. The value of having all in the Library's collection was almost immediately evident, as Wilding began tracing sources for the later seventeenth century editions and reprints of *Sidereus,* work which can only be done at the Linda Hall Library. Also noticed were a set of small pinholes in the asterism sheet in the fine paper copy. It was also this close examination that revealed the presence of the already discussed cancel sheet in signature C. Perhaps most important, this initial visit laid the foundation for a revision of Needham's work in *Galileo Makes a Book*. Finally, their work also highlighted the unusual ink around the asterisms in the fine paper copy. Despite their short visit, their work already demonstrates the value and importance of this unique gathering of three *Siderei* in the same collection.

All three versions of *Sidereus nuncius* are cataloged and digitized in both PDF and high-resolution single page images. The Library's holding of all three versions reinforces its place as the world's preeminent library for the studying of early modern science and astronomy, being unique in our Galileo holdings, as well as having great strength in the work of Johannes Kepler. All three versions are freely available to library patrons with a research need to use, examine, and consult these remarkable books. ✲

Belt and sword of Orion, as depicted in the Frankfurt edition.

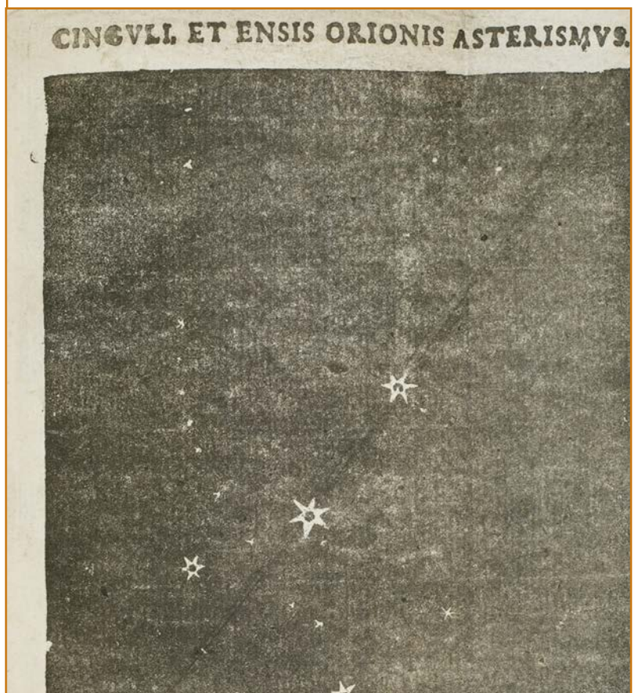
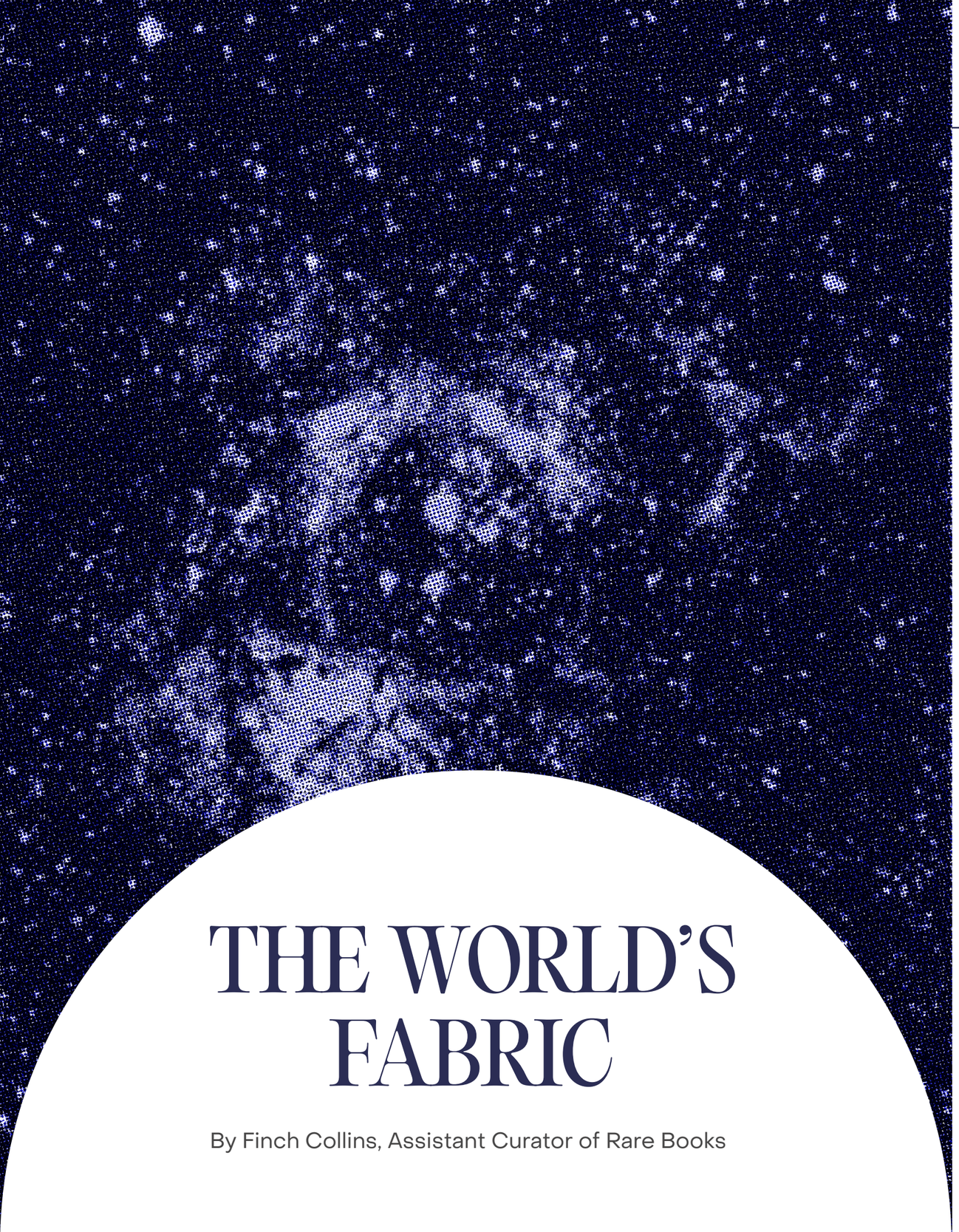


Photo by Finch Collins.



THE WORLD'S FABRIC

By Finch Collins, Assistant Curator of Rare Books

ORBITING EARTH

In the 1600s, debate over the nature of the solar system created significant upheaval in European astronomy. World systems with different arrangements of celestial bodies were a major flashpoint. The system advanced by Tycho Brahe asserted that the Moon and Sun orbit the Earth and all other planets orbit the Sun. The Tychonic system was an extension of the Aristotelian or geocentric system, in which the Earth was the center of the solar system with the Sun, Moon, and planets orbiting it. The Copernican or heliocentric system, meanwhile, positioned the Moon in orbit around the Earth, and the Earth and other planets in orbit around the Sun.

Left: *A Selection of Photographs of Stars, Star-Clusters and Nebulae,* by Isaac Roberts, 1893.

Inkwash diagram of the spheres of motion for the Moon, Mercury, and Venus around the Earth. "Della fabrica del mondo," [1643], leaf 51r.

Galileo Galilei died in 1642. His embrace of heliocentrism had been deemed heretical by the Catholic Church, and consequently, the Church had placed his 1632 book *Dialogo sopra i due massimi sistemi del mondo* (Dialogue Concerning the Two Chief World Systems) on the Roman Index, a list of books banned for lay Roman Catholic readership. Despite this censorship, models placing the Sun at the center of the universe did not disappear from Italian or European astronomy, and students and scholars alike continued their exploration of heliocentrism. A manuscript recently acquired by the Linda Hall provides a window into how an Italian tutor and student learned about astronomy in the immediate post-Galilean period.

"Della fabrica del mondo ouero cosmografia" (Of the fabric of the world, or cosmography), was written as a structured dialogue between a student and a Jesuit tutor, a common teaching tool in early modern Europe. The manuscript features two interlocutors: Pellegrino Cantelli (Pell.), the tutor, and Girolamo Calcagni (Gir.), the student. Throughout this work, Cantelli asks questions and Calcagni answers. The text, divided into three sections, discusses the Earth and the solar system, celestial bodies, and practical astronomy, including astrology. The Library's neatly-written copy includes 29 pages of celestial tables, as well as ink and inkwash diagrams of planetary motion, world systems, and stellar phenomena. The Thomas Fisher Rare Library at the University of Toronto holds the only other know copy of this manuscript.

Dario Tessicini, a University of Genova scholar who studied the Fisher copy of "Della fabrica del mondo," found information about both men in Italian archives. According to his research, Cantelli was a member of the Jesuit order and studied in Bologna or Parma in 1636. When the manuscript was written, he was about 30 years old. Girolamo Calcagni, the student, was a member of the wealthy Calcagni family of Reggio Emilia, near Bologna and Parma. At the time the manuscript was written, Calcagni was about 18 years old.[1] These sparse facts give us a sketch of the manuscript's creation: the older Cantelli was called to instruct the younger Calcagni in astronomy, and this manuscript attests to what they learned. Although the manuscript is an original work, large sections of the text are borrowed from other sources. Such paraphrasing may violate modern

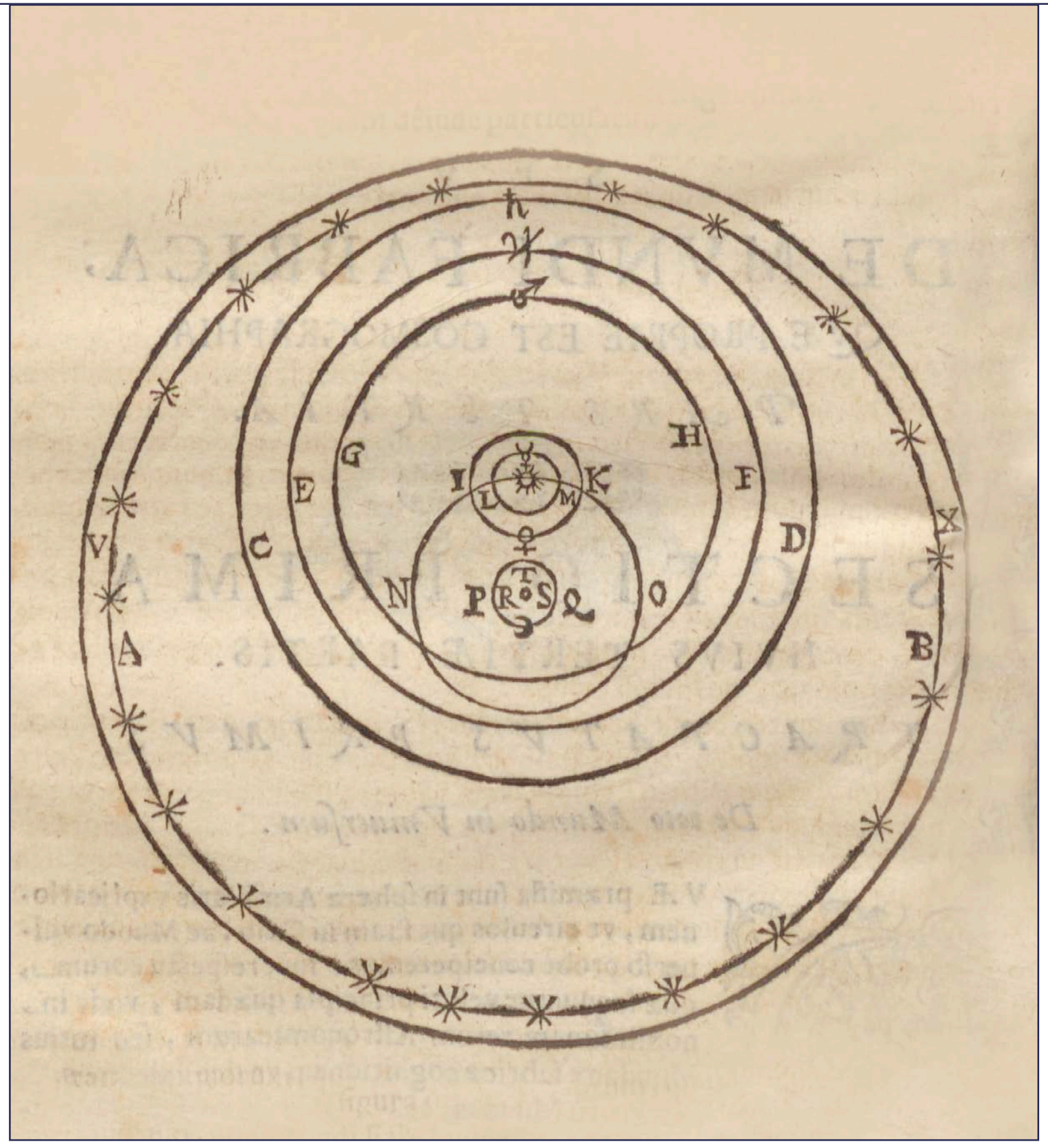


Diagram of the Tychonic system from Giuseppe Biancani, *Sphaera mundi, seu Cosmographia,* 1620, p. 56.

[1] Tessicini, Dario. "Comete celesti, parallasse e cosmografia in un inedito dialogo post-galileiano." Il saggiatore di Galileo a 400 anni dalla sua pubblicazione, 23-25 October 2023, Palazzo Corsini, Rome, Italy.

standards of academic integrity; however, this manuscript was intended for private study.

Tessicini identified Giuseppe Biancani's *Sphaera mundi, seu Cosmographia*, published in 1620, as a major source of the "Della fabrica" manuscript.[2] Biancani was an Italian Jesuit and astronomer who advanced new ideas about the structure of the world system and referenced the work of Tycho, Kepler, Galileo, and others. Many of the diagrams in "Della fabrica" are directly copied from *Sphaera,* complete with aligning lettering.

Tessicini also identified several passages in the manuscript that paraphrase works by Galileo, including *Sidereus nuncius* and *Il saggiatore.* Cantelli references Galileo by name and cites the total number and locations of stars within the Orion and Praesepe clusters (illustrated in *Sidereus*). Further, Cantelli describes such clusters as "an aggregate of very small stars, almost innumerable,"[3] paraphrasing Galileo's *Il saggiatore.* The close resemblance of the language suggests that they had direct access to copies of Galileo's works and consulted them in drafting "Della fabrica del mondo."

The second section of the manuscript concerns celestial bodies, including a notable portion on comets. Debates over comets and comet parallax were the core of several highly public conflicts, including one between Galileo and the Jesuit astronomer Orazio Grassi between 1618 to 1623. Within the manuscript's dialogue, Cantelli and Girolamo highlight the controversy surrounding the origin, formation, and nature of comets, as well as the methods for measuring comet parallax. In a key subsection, a diagram from Biancani's *Sphaera* is replicated to illustrate

[2] Ibid.
[3] "Della fabrica del mondo ouero cosmografia," leaf 108v.

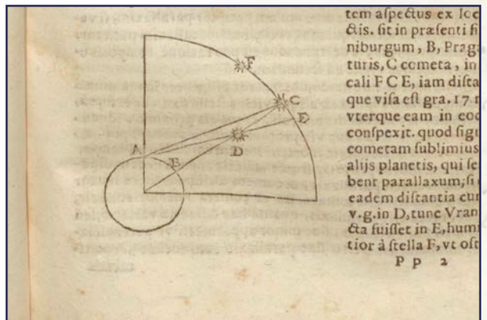
the concept of comet parallax. While the dialogue does not explicitly refer to the dispute between Galileo and Grassi, it does paraphrase extensively from Galileo's *Discorso delle comete*.[4]

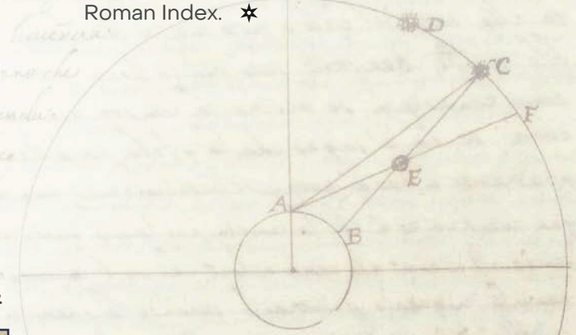
The manuscript dialogue argues that comets are celestial objects that emerge from the "milky circle" of the sky, which "gives creation to the generation of stars and comets,"[5] rather than objects present since the beginning of the universe. While the distinction between changing and unchanging celestial objects may seem nonsensical today—as we understand better the long arc of cosmological time—the question of celestial bodies' malleability was key to the debate over classical cosmology. The Aristotelian or classical model, with the Earth at the center of the universe, posited that all non-Earth celestial bodies were smooth, perfect, and unchanging. Cantelli's arguments against the Aristotelian doctrine are so strong that Calcagni deems the classical model insufficient within the dialogue and asks Cantelli to outright reject that world system.

This structured dialogue provides a fascinating window into the discussion of astronomy and world systems between a scholar and his student. Calcagni and Cantelli present and discuss new ideas cautiously within the manuscript. This dialogue format is an effective tool: it allows questions to be posed, arguments to be declared unclear or insufficient to support, and controversial theories to be indirectly referenced. Also, it is apparent that Cantelli and Calcagni continued their scholarly work after the initial completion of their manuscript. An addendum on one of the blank back pages, dated 20 February 1643, highlighted two noteworthy texts for additional reading: Regiomontanus' observations on the great comet of 1472, and Girolamo Sirtori's *Telescopium* of 1618, the first book published on telescopes.

New ideas in the history of science do not disseminate themselves; books and people spread them. In Galileo's wake, astronomers across Europe continued to question the nature of the solar system and the universe. Their wrestling with inherited models and new observations shaped the fabric of our world. By preserving and studying manuscripts like "Della fabrica," we can learn how ideas spread and minds changed in early modern Europe and today. Researchers can now study this manuscript's content, structure, and history in tandem with the works it draws heavily from in the Library's History of Science Reading Room. Like Cantelli and Calcagni, scholars can continue their study of early modern astronomy with the Library's copy of Sirtori's *Telescopium*, one of three copies of Galileo's *Sidereus nuncius,* and other books on the Roman Index. ✲

Comet parallax determination as illustrated in *Sphaera mundi*, 1620, p. 297.



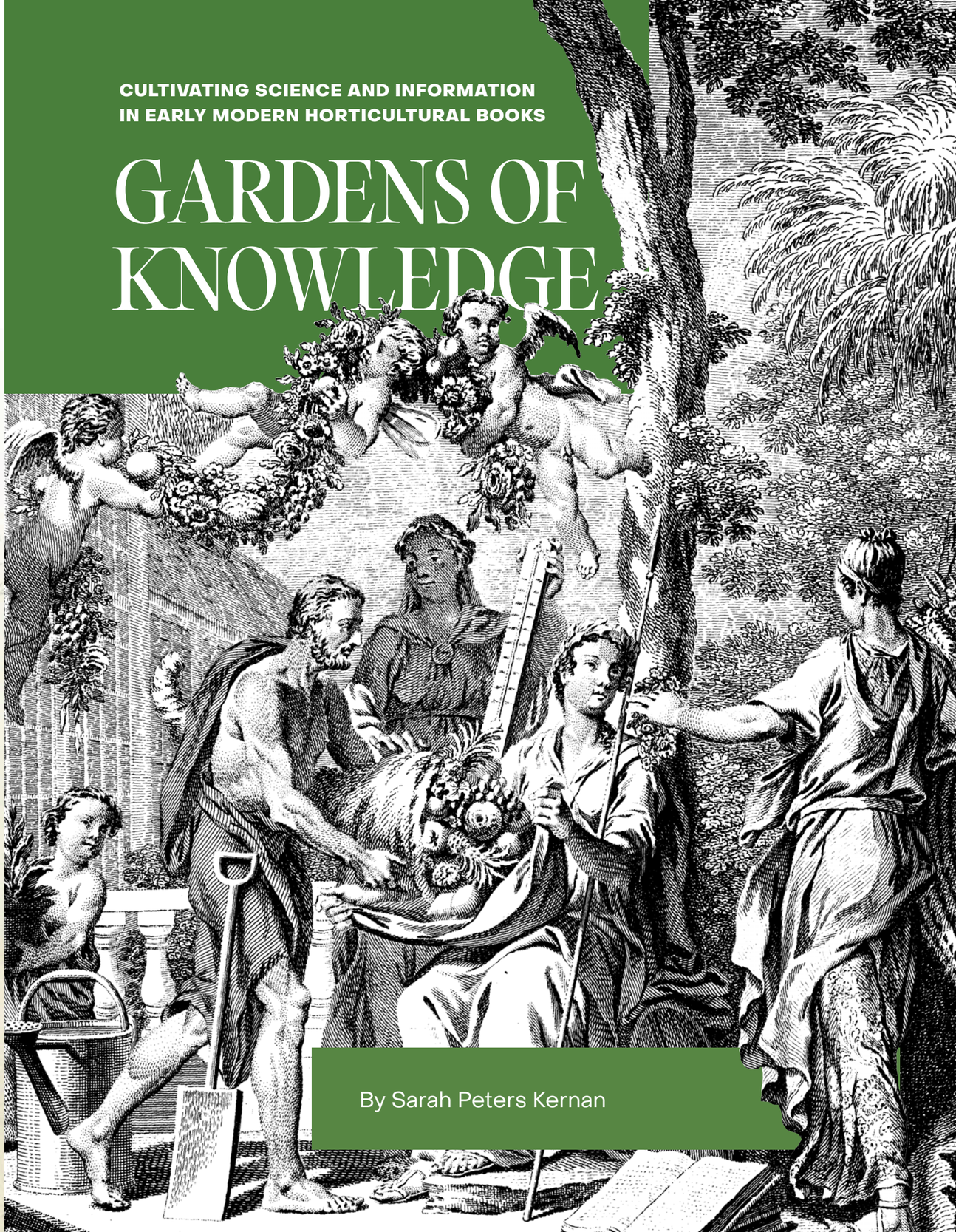


The dialogue on comets in "Della fabrica del mondo" provides instructions for calculating the parallax angle (leaf 101r).

[4] Tessicini, Dario. "Comete celesti, parallasse e cosmografia in un inedito dialogo post-galileiano." Il saggiatore di Galileo a 400 anni dalla sua pubblicazione, 23–25 October 2023, Palazzo Corsini, Rome, Italy.
[5] "Della fabrica del mondo ouero cosmografia," leaf 102r.

CULTIVATING SCIENCE AND INFORMATION IN EARLY MODERN HORTICULTURAL BOOKS

GARDENS OF KNOWLEDGE



By Sarah Peters Kernan

Cropping up throughout the Linda Hall Library's holdings is a substantial collection of early modern European horticultural and agricultural texts. While these books about cultivating plants span several centuries and many geographical regions, the collection is especially strong in eighteenth century English texts. These books reflect a broader interest in not only the production of food and beautification of land, but also exploration, innovation, and experimentation in several arts and sciences. The production of manuals, botanical observations, explicit descriptions of natural "experiments," and expensive dictionaries and encyclopedias contributed to the expansion and encouragement of natural sciences, particularly when aligned with the domestic economy and household information.

Books on horticulture, small-scale plant cultivation, and agriculture, large-scale farming, have been written for thousands of years. Given the fundamental importance of food cultivation throughout various cultures and eras, it is natural that authors have been drawn to this subject. Medieval husbandry guides served as a noteworthy precursor to early modern horticultural texts, offering a wealth of information for managing rural estates, encompassing activities such as gardening, large-scale crop management, beekeeping, masonry, cleaning, culinary recipes, and more. They served both practical and aspirational purposes, providing readers with guidance on creating an upright and self-sufficient home suitable for a morally upright homeowner. In essence, they presented an ideal estate for ideal families.

Previous page image: This opulent frontispiece reflects the grandeur of Philip Miller's *The Gardeners Dictionary,* 1759.

Patterns for use in garden design found in John Parkinson's *Paradisi in sole paradisus terrestris,* 1635.

Medieval and early modern herbals concurrently presented another form of horticultural text. Herbals contained descriptions and uses of plants and usually contained many illustrations, notably of varying degrees of accuracy. The texts presented practical information about identifying, cultivating, and preparing plants for medical and culinary uses, serving as important references for medical professionals and households alike.

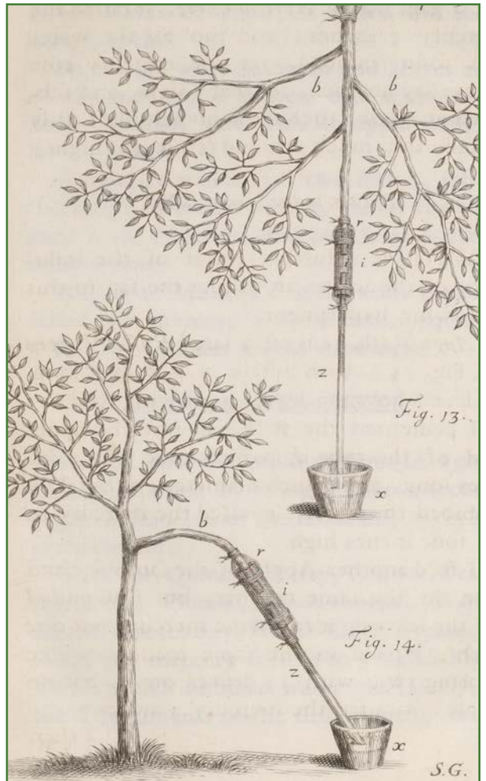
John Parkinson's *Paradisi in sole paradisus terrestris,* first printed in 1629, marks a shift in English horticultural literature. While this text by Parkinson, the Apothecary of London, retains information found in herbals, it also includes separate sections on flower and kitchen gardens and orchards, patterns for garden design, and recipes incorporated into the "uses" of individual plant descriptions. The book is an all-purpose guide for a discerning reader, on the cultivation, use, and pleasure of plants and gardens.

By the mid-1600s, the genre of horticultural and agricultural texts was beginning to reflect a heavy influence of more formalized scientific practices in Europe and the rise of natural philosophy and experimentation. Authors tend to focus on botanical descriptions, observations on growth cycles, and suggestions for improving cultivation, including garden design, fertilization, and grafting. One such example is John Evelyn's *Sylva, or, A discourse of forest-trees, and the propagation of timber in His Majesties dominions* (1664). Many of these books, like Evelyn's *Sylva*, also exhibit a strong connection with major scientific societies, such as the Royal Society of London. In its earliest years, the Royal Society was extremely interested in any kind of botanical, medicinal, or culinary information about plants.

Left: Title page of John Evelyn's *Sylva,* 1664.

Their journal, *Philosophical Transactions of the Royal Society*, regularly published letters detailing experiments and observations about these topics. By the beginning of the eighteenth century, Royal Society members were publishing horticultural books featuring a range of topics such as natural experiments, recipes, and gardening calendars.

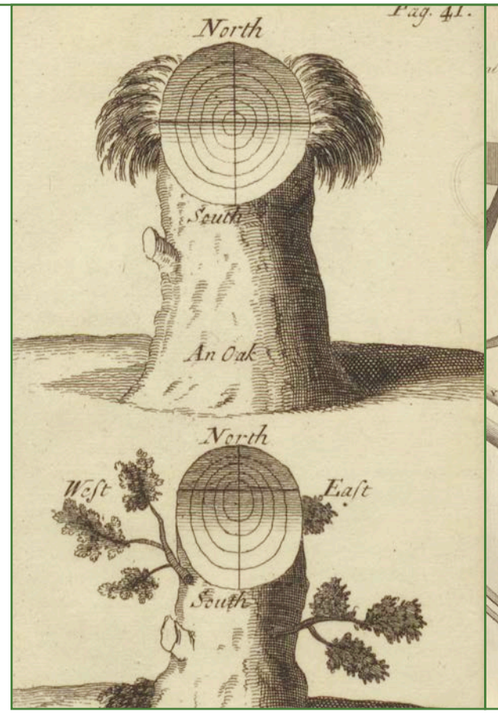
The first half of the eighteenth century witnessed a substantial uptick in publications about gardens, botany, and wide-scale agriculture. Furthermore, these topics were more frequently published independently, rather than incorporated into books containing many related topics, such as husbandry guides. Some of these texts still retained close ties to the Royal Society, like Stephen Hales's *Vegetable Staticks* (1727) which heavily relies on previous experiments and observations published in the *Philosophical Transactions* to execute his experiments on trees. Other texts, like Pierre Le Lorrain's *Curiosities of nature and art in husbandry and gardening* (1707), were similarly filled with experiments and observations, but



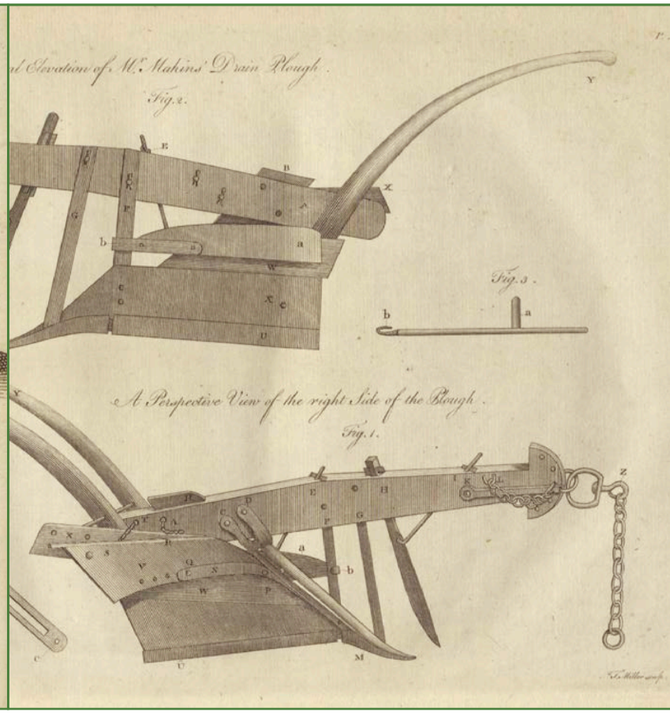
Right: Stephen Hales detailed his experiments with texts and images in *Vegetable Staticks, or, an account of some statical experiments on the sap in vegetables,* 1727. This engraved plate illustrates a preceding experiment on the force with which apricot trees absorbed water.

were not explicitly published by or connected to scientific societies.

While the establishment of formal gardens was a matter of great consequence to European nobility because of the status and wealth reflected in such cultivation, large-scale agriculture remained a more widespread concern throughout Europe in the eighteenth century. Landholders were interested in more efficient methods of growing crops, while others strove to become landholders, gentlemen farmers, and plantation owners in newly-established colonies around the globe. Some books advertised the latest agricultural technologies, like William Bailey's *One hundred and six copper plates of mechanical machines, and implements of husbandry* (1782), while others provided instruction in collecting foreign seed and plant specimens for study and cultivation at home, like John Ellis's *Directions for bringing over seeds and*



Pierre le Lorrain observes the patterns of ring growth in trees in relation to ordinal direction in *Curiosities of nature and art in husbandry and gardening,* 1707.



William Bailey showcases the best agricultural equipment, like this engraving of a drain plow, in *One hundred and six copper plates of mechanical machines, and implements of husbandry,* 1782.

plants, from the East Indies and other distant countries, in a state of vegetation (1770).

These veins of publication led to a variety of distinct categories of horticultural books by the late-eighteenth century: large-scale agricultural guides, botanical descriptions, quotidian gardening manuals, and lavishly-illustrated garden designs. Horticultural books had become coveted and practical items in this period for consumers in many social classes. As such, the books were printed in a range of qualities. Some were thin, pocket-sized volumes consisting exclusively of text, or with rudimentary charts and diagrams that could be easily printed. Other books reflected a gentry or noble audience through their generous yet manageable size, thick and durable paper, and the inclusion of detailed charts and engraved images. And finally, a category of horticultural works focused exclusively on the most elite consumers, featuring oversized books with many fine engravings. This category lent itself particularly well to garden design layouts, renderings of architectural elements within garden settings, and giant encyclopedias and dictionaries of horticultural knowledge.

Such a medley of gardening and agriculture books may seem an odd fit for a History of Science collection today, or for the consideration of cutting-edge scientists centuries ago. The seventeenth and eighteenth centuries, however, regarded the cultivation, use, and discovery of plants as a natural, or scientific, endeavor. Every aspect of a plant, from its growth and uses, was

PLAN GÉNÉRAL DES BÂTIMENS ET JARDINS D'UNE MAISON À BÂTIR DONT LE TERRAIN EST SITUÉ DANS LA BRIE.

Du dessein de J. F. Blondel.

Chemin qui conduit au Chateau Seigneurial.

Maisons

Ruë qui mène à la Paroisse

Ruë

Bassecour pour les Vendanges et Pressoir

Bassecour pour les grain

Bassecour des écuries et remises

Demie Lune

Avenuë

Cour

Bassecour des Cuisines

Bassecour des Volailles et bestiaux

Jardin

Potager

Ruë qui conduit à l'Abreuvoir

Colombier

Terrasse

Terrasse

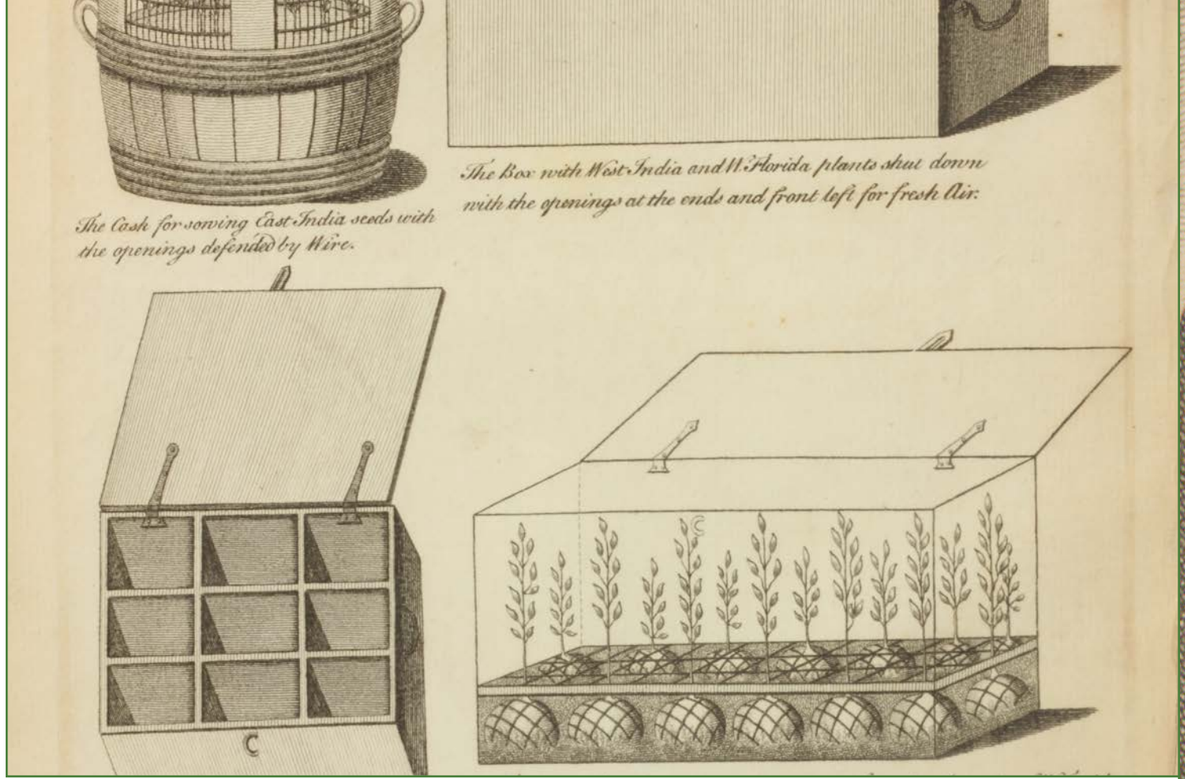
Jardin

potager

A. Corps
– cipal du
– ment.
B. Aile gauche ou
la Chapelle.
C. Aile des cuisines de
avec l'aile vis à vis.
D. Piece d'eau circulaire for
une cascade en face des
temens.
E. Allée en terrasse revêtuë d'u
blette ornée de Vases.
F. Parterre de broderie mesle de
G. Grande Salle de marroniers en
H. Salle verte ornée de niches et C
I. Salle de tilleuls avec niches pour des

K. Cabinets des saisons.
L. Allée qui doit être de la largeur du pignon du corps du bâtiment.
M. Jardin particulier servant à l'aile B.
N. Cascade provenant des eaux d'enhaut et les conduisant au jardin potager, fait en terrasse.
O. Boulingrain planté de tilleuls et orné de figures et bancs.
P. Maison et jardin du Concierge.
Q. Glacière.
S. Melonnerie
T. Figuerie
X. Reservoirs qui reçoivent par des Canaux de Plom de Terre, qui ont leur issu la Cascade N. et qui ensu communiquent à d'autr droits pour la facilité d rosement des légumes.

Jacques-François Blondel's *De la distribution des maisons de plaisance, et de la decoration des edifices en general,* 1737–38, was printed exclusively for elite consumers. It is lavishly illustrated with renderings of pleasure houses and gardens for the French aristocracy.



Above: The frontispiece of John Ellis's *Directions for bringing over seeds and plants, from the East Indies and other distant countries, in a state of vegetation*, 1770.

Right: The frontispiece of John Abercrombie and Thomas Mawe's *Every Man His Own Gardener*, 1784, depicts an Englishman digging in a garden.

considered through the lens of science. Since the relationship between diet and health had been established for thousands of years, a garden which could produce a household's fruit, vegetables, and herbs for a year was a serious matter. Furthermore, the herbs produced in a household garden or foraged nearby were regularly transformed into medicinal lozenges, syrups, poultices, and ointments to heal families and communities. A carefully designed garden could improve health, through the bodily experience of natural beauty and fresh air. And understanding and improving the production of crops for entire populations could improve the natural condition of millions of people.

Even beyond these issues tied to health, the domestic scientific observation and experimentation encouraged within these books served to expand and promote the sciences to wider audiences and strengthen the role of natural philosophy and science in the broader culture. Because of this relationship centuries ago between gardens and scientific knowledge, horticultural books frequently presented information in a scientific manner. Just as in the literature of other natural sciences of the period, horticultural books provided clear descriptions, diagrams with labels, charts and tables, lists of like information within categories, and explanations of observational conditions and experimental processes. This convergence of gardens and knowledge so many centuries ago is just as relevant in Linda Hall Library's collections today. ✲

AN INTERVIEW WITH ROGER HART

NATIONAL ENDOWMENT FOR THE HUMANITIES FELLOW

In April 2022, the Linda Hall Library received a major grant from the National Endowment for the Humanities (NEH) to support the expansion of its fellowship program. These funds enabled the Library to offer a new, nine-month fellowship to a postdoctoral scholar whose research explores the intersection of science and the humanities. Last summer, the Library welcomed its first NEH Fellow: Roger Hart, a professor of Chinese History at Texas Southern University. Roger is the author of two books that examine the circulation of mathematical knowledge among Chinese and European scholars in the years preceding the Scientific Revolution: *The Chinese Roots of Linear Algebra* (2011) and *Imagined Civilizations: China, The West, and Their First Encounter* (2013). During his time in Kansas City, he has turned his attention to the twenty-first century and the global scientific networks associated with the development of quantum computing. The editors of the *Hedgehog* asked Roger to answer some questions about his research and reflect upon his fellowship experience.

Tell us about the research you are conducting at the Linda Hall Library.

My research is on the Second Quantum Revolution, which includes quantum computing, quantum communication, and quantum sensing. The (first) Quantum Revolution of the early twentieth century led to transistors, integrated chips, computers, and the Internet, ushering in the Third Industrial Revolution and the Digital Age. Quantum theory is foundational for all science: all matter and all energy on a sufficiently small scale is described by quantum physics. The Second Quantum Revolution will lead to equally profound changes, through exponentially more powerful computers, provably secure communications, and ultra-precise measurements, all of which will lead to fundamental breakthroughs in almost every field of science, engineering, technology, and medicine.

I am interested in understanding science in its social, political, and historical context. The title of my research project is "Quantum States, Quantum Entanglements: China, the U.S., and the Global Race for Quantum Supremacy." China is now the largest economy in the world, according to analyses by the CIA and IMF; China is also a science superpower, competitive with the U.S. in many areas, ranging from nanotechnology to artificial intelligence. As *Nature Index* noted in 2018, "China's rise is the story of the century in science." One area where China leads the world is the quantum internet. This is the focus of my current research.

The history of quantum computing seems like a very technical project for the Linda Hall Library's first NEH Postdoctoral Fellow. How can the humanities enrich our understanding of this subject?

This is a most important question and really gets to the heart of an extremely important issue, the relation between science and the humanities. Science (understood broadly here to include science, technology, engineering, mathematics, and medicine) is perhaps the most important factor in the development of human civilization. I teach world history, and it is clear that the stages of world history depend on scientific development. Today, in the twenty-first century, the already enormous impact of science is rapidly accelerating—just take for example recent debates over Artificial Intelligence (AI). The Second Quantum Revolution will result in even more profound changes. For example, AI will likely require the power of quantum computers.

While science is important, the humanities are even more so. Indeed, the most important questions we face are addressed not by science but by the humanities—life and death, war and peace, justice, freedom, equality, human rights, everything about the human condition and human happiness—all of these are the domain of the humanities.

So humanistic studies of science are of the utmost importance to understand the implications of science for mankind. With revolutionary emerging sciences such as quantum computing, we have a crucial opportunity to understand, evaluate, and debate the possible implications beforehand. This is the synergy between the Library's mission, "Where Science Lives," and the National Endowment for the Humanities' (NEH) mission to strengthen our nation through the humanities and lessons of history.

You have received several other fellowships during your career, most recently at the Woodrow Wilson Center in Washington, D.C. How has your time at the Linda Hall Library compared to those other research experiences?

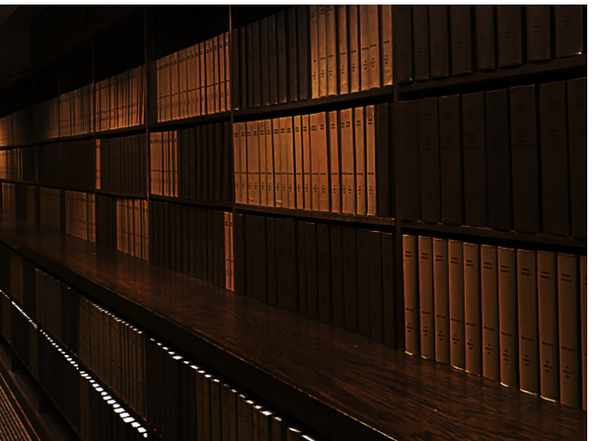
Yes, I have been fortunate to have had some really amazing fellowships in my career, including the Institute for Advanced Study (Princeton) and most recently for this project, fellowships from Fulbright and the Wilson Center. All of them were a tremendous privilege for which I am most grateful. That being said, I think I consider my NEH fellowship here at Linda Hall Library in many ways my most important, for all the reasons I have described above.

How have the Library's collections supported your investigations?

Collecting materials is one of the most time-consuming tasks for researchers. I had already spent considerable time collecting primary sources for this project and published scientific articles on quantum information science, but there were still considerable gaps.

The collection of secondary scholarship at the Library is comprehensive. Because my previous research was on the seventeenth century, the opportunity to read broadly in a number of fields has been absolutely essential. I am particularly fond of the Library's layout, which is very conducive to research. The most recent scholarship is accessible on the second floor, in the beautiful Main Reading Room. For me, this is perfect: it is very easy to browse through contemporary scholarship in various fields without rummaging through the cumulated printed record for the past 100 years. And let me emphasize that picking up a book and reading through it still has many advantages over digital editions.

Linda Hall Library Main Reading Room



I also want to emphasize the role of serendipity. Almost every day I happen across material that is important to my research that I never would have found through digital searches. Examples include displays of recently published books and journals, a bibliography of seventeenth-century mathematical treatises that was being catalogued, and Library exhibitions.

What does a typical day at the Linda Hall Library look like for you? How frequently do you interact with staff members or other research fellows?

Every day at the Library begins with my walk to my office through the Library's gorgeous arboretum and the Main Reading Room, reminding me how privileged I am to have an opportunity to conduct research here. I should first thank the entire staff for their expert assistance, encouragement, and friendliness. Much of my time is admittedly at my computer, so let me mention here several important features that stand out: public events, our monthly seminars, and our weekly check-in meetings.

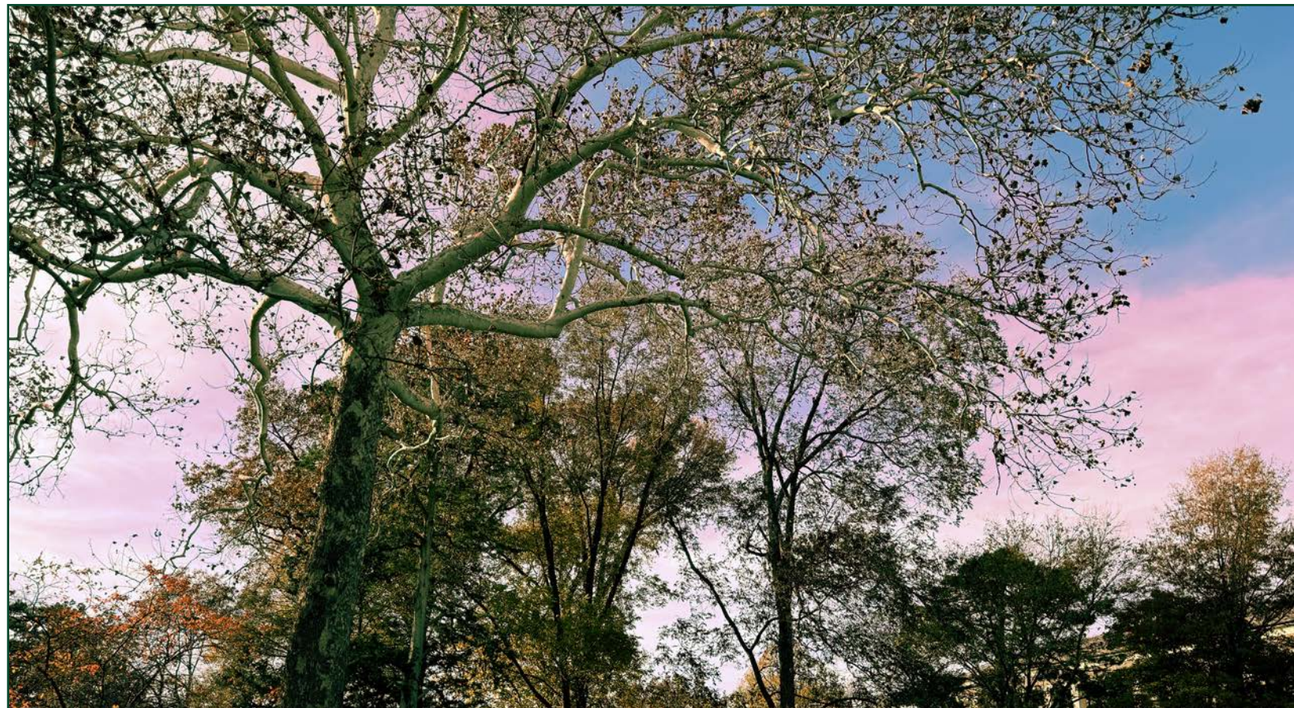
The Library's public lecture series featuring some of the world's foremost scientists has been very enlightening for me, especially the lectures by Library President Dr. Eric Dorfman and by the Library's resident historian, Prof. Emeritus William Ashworth, Jr. The monthly works-in-progress seminars provide a supportive forum for us to help each other in our research.

One of the most important aspects of the fellowship is the chance to meet with Dr. Benjamin Gross, Vice President for Research and Scholarship. Ben's work is an exemplar for me as I move from work on the seventeenth to the twenty-first century. Ben kindly meets with all the fellows regularly. Through my many conversations with Ben, and his introducing me to the oral history interviews collected by the American Institute of Physics (AIP), I changed my entire research direction, from an implicit focus on local knowledges (following recent work in the sociology of scientific knowledge) to instead looking at quantum sciences much more globally.

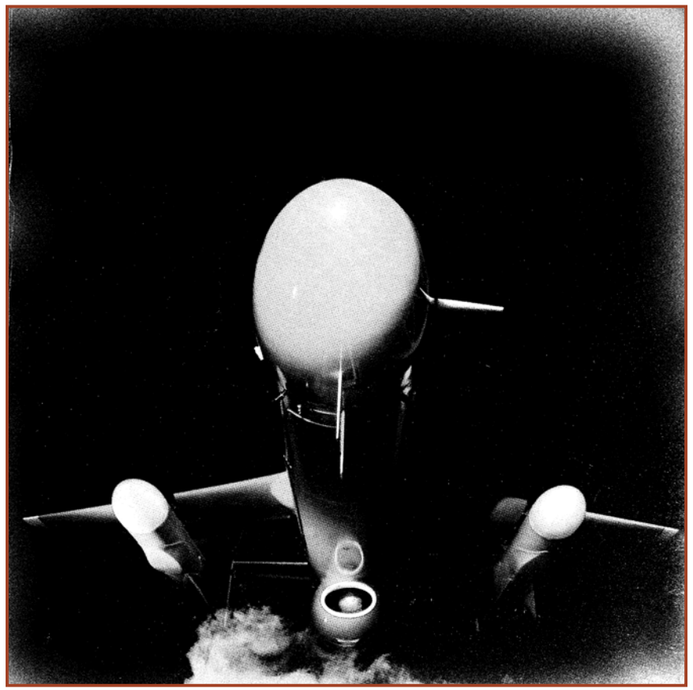
Based on your experiences so far, would you encourage other scholars to apply for a Linda Hall Library fellowship?

Absolutely, I consider this my most successful fellowship. To summarize, science is one of the most important fundamental forces in the development of human civilization; it is the humanities that addresses the most important problems that mankind collectively faces; these issues are of profound importance for the broad public. I cannot think of any other institution that combines as well humanistic study of science for public-facing history. This is the direction that I hope to pursue, and I would most strongly recommend other scholars come to the Linda Hall Library for this reason. ✲

Linda Hall Library Arboretum



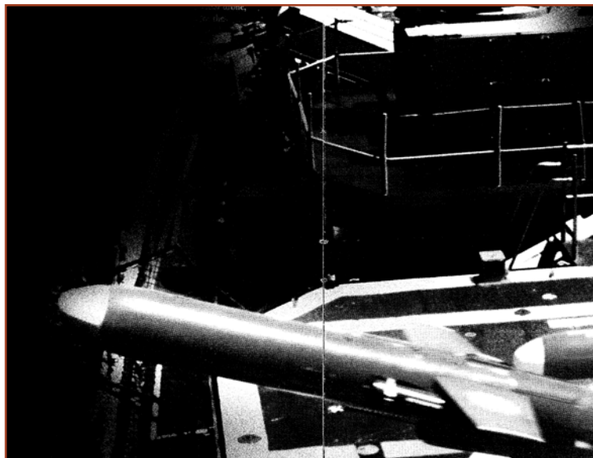
DRONE WARS



Garrett McKinnon
Pearson Fellow in Aerospace History

As Rear Admiral William C. Bowes' delivered the keynote address at the North Atlantic Treaty Organization's (NATO) 1988 symposium on "Unmanned Aerial Vehicles" (UAVs), he recounted the long history of United States military interest in "drones" as a cautionary tale for the technology's future. Bowes, who had just recently been appointed as Director of the newly established Unmanned Aerial Vehicles Joint Project in the United States Department of Defense, noted "UAVs are certainly not a new capability, although their road to acceptance and continued use by the U.S. Services has not been a smooth one."[1] Bowes recalled to his listening audience of NATO nations' military officials that the possibilities of a "pilotless airplane" performing the same actions in war as a piloted airplane had captured U.S. war planners' strategic imagination as early as the First World War. Yet, despite repeated efforts to integrate drones into war during major conflicts like the World Wars and the Cold War, U.S. drone technologies faced recurrent obstacles in functionality and funding. He lamented that though the Vietnam War had ushered in the United States' first mass deployment of surveillance drones, U.S. defeat undercut the need for drone technology, resulting in thousands of UAVs being "mothballed."[2] Bowes characterized the history of U.S. military drone adoption as one defined by starts and stops, warning that despite growing prospects for UAV use in war, another moment of stasis ever-threatened the militant embrace of drones. The challenge he presented to the NATO community in his keynote address was to overcome this spasmodic pattern and cement drone technology's place within arsenals.[3]

Admiral Bowes spoke a truth that belied reality. While U.S. military spending upon, and operational deployment of, drones diminished in the wake of the Vietnam War, interest in UAVs within the intelligence community and military services had remained strong. Furthermore, the 1980s witnessed a dramatic rise in both corporate and scholarly interest in drone technology. Drone-focused institutions outside of but connected to national militaries, like the U.S. based Association for Unmanned Vehicle Systems International (AUVSI), or the United Kingdom's Royal Aeronautical Society, began organizing annual international conferences focused on "Unmanned Aerial Vehicles" and "Remotely Piloted Vehicles" (RPVs) in the late-1970s that have continued up to today. Through conferences and publications, the corporate manufacturers, military officials, and university professors who made up these groups' memberships regularly met and discussed drone technology's potential utilities for warfronts and homefronts. It is with an eye towards analyzing these sorts of informal spaces, where arms makers and admirals rubbed elbows and talked shop, but more importantly engaged in the business of drone war, which brought me back to the



[1] William C. Bowes, Keynote Address, North Atlantic Treaty Organization, Advisory Group for Aerospace Research and Development, AGARD Conference Proceedings No. 436, Guidance and Control of Unmanned Air Vehicles, Letterman Army Institute of Research, Presidio of San Francisco, California, 4-7 October 1988, K-1, Linda Hall Library.
[2] Ibid, K1.
[3] Ibid, K1-K4.

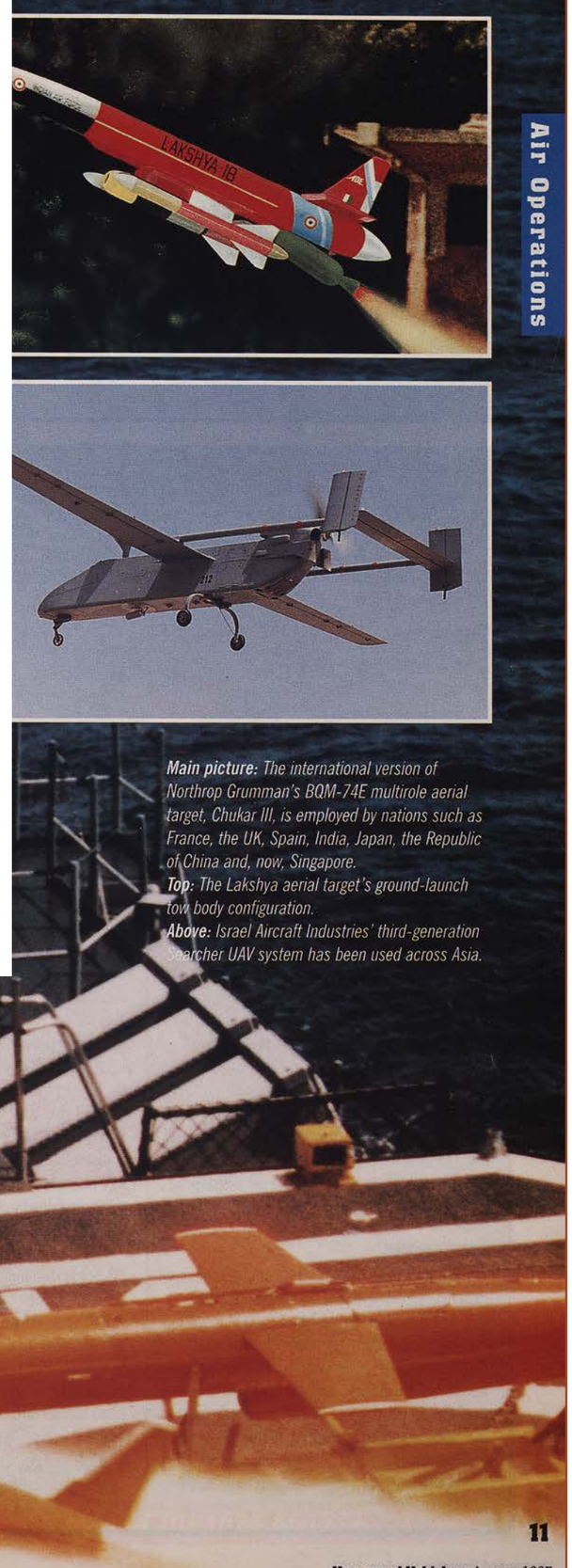
Linda Hall Library in 2023 as its first Pearson Fellow in Aerospace History.

A worldwide arms market for drone technology emerged in the 1980s and 1990s. This explosion of international interest in UAVs, RPVS, or drones coincided with a shift in political economy many term "Neoliberalism." This re-embrace of free market capitalism witnessed national governments reduce regulations over financial markets, sign international trade agreements, hinder labor unions, outsource manufacturing, and engage in austerity measures that privatized or added means testing to social services. Yet, while the neoliberal era proclaimed a reduction in state influence upon the economy, this was hardly the case for the sale of armaments like drones whose manufacture was defined by corporations' government contracts and military contacts.

Doing business in drones was the goal in 1988 as representatives from NATO nations' militaries met in San Francisco. Following Admiral Bowes' keynote addressing the history of U.S. drone war, aircraft manufacturers including Lockheed and British Aerospace gave panel presentations that ranged in focus from ground control stations to automated search algorithms that could aid surveillance drones acquire bombing targets.[4] The conference concluded with a roundtable discussion between British, French, and U.S. officials who answered questions from the audience. The opening question asked panelists their "views as to business prospects for unmanned air vehicles" with all national representatives responding positively. The U.S. official boasted forthcoming competitions for both short range and endurance surveillance drones that promised government contracts for the winning drone manufacturer. The French and British representatives, however, bemoaned "complex" situations and military services that were still "sitting on the fence" in their attitude towards UAVs.[5] Admiral Bowes had highlighted a similar issue of inter-service disfunction in his keynote, explaining that the U.S. Department of Defense created its Unmanned Aerial Vehicle Joint Project to provide central management over what had been disunified drone development projects between the Air Force, Army, and Navy. He suggested a new "corporate approach to the exploitation of unmanned vehicle technology" would help overcome "years of false starts and inter-service rivalry."[6]

Technical capabilities mattered alongside capital exchange. Other questions at the 1988 NATO UAV symposium roundtable included "How quickly will we get autonomous systems?" to which panelists bemoaned "operational types have to be convinced."[7] Someone also inquired about "the feasibility of developing an unmanned fighter aircraft" which panelists insisted the "consensus seemed to be that technologically the concept was perfectly feasible. Courage and the political will to succeed were the most important things needed."[8] Building drones capable of flying themselves to bomb other people seemed easier than convincing the public that such a machine was a necessary war capability. This reticence to make combat drones pervaded the U.S. Department of Defense in the late-1980s. The new Unmanned Aerial Vehicles Joint Project had specifically excluded combat drones from U.S. development projects, instead focusing on drones that could surveil enemies, or disrupt enemy communication systems. Yet, despite official hesitancy, the feasibility of combat drones pervaded the discussions and panel presentations at the NATO symposium.

Many military officials and aircraft manufacturers that attended the 1988 NATO symposium on UAVs participated in other non-state organizations focused on drone technologies. Throughout the 1980s and 1990s, the U.S. based organization Association for Unmanned Aerial Vehicles International (AUVSI) brought audiences from around the world together at destination locations like Disney World.[9] Similarly, the Royal Aeronautical Society held a bi-annual Remotely Piloted Vehicles conference at the University of Bristol. At these sorts of events, military officials mingled with drone manufacturers, attending panels that



Main picture: *The international version of Northrop Grumman's BQM-74E multirole aerial target, Chukar III, is employed by nations such as France, the UK, Spain, India, Japan, the Republic of China and, now, Singapore.*
Top: *The Lakshya aerial target's ground-launch tow body configuration.*
Above: *Israel Aircraft Industries' third-generation Searcher UAV system has been used across Asia.*

The world market for military drone technology reached "beyond Europe" in the late twentieth century to include major UAV producers in Egypt, India, Israel, South Africa, and many other spaces.

[4] Charles T. Elliot, North Atlantic Treaty Organization, Advisory Group for Aerospace Research and Development, AGARD Advisory Report No. 260, Technical Evaluation Report on the Guidance and Control Panel Symposium on Guidance and Control of Unmanned Air Vehicles, 3, Linda Hall Library.
[5] Ibid, 5.
[6] Ibid, 1.
[7] Ibid, 5.
[8] Ibid
[9] Association for Unmanned Vehicle Systems International, AUVSI '96 Proceedings, July 15-19, 1996, Walt Disney World's Contemporary Resort, Orlando Florida, Linda Hall Library.

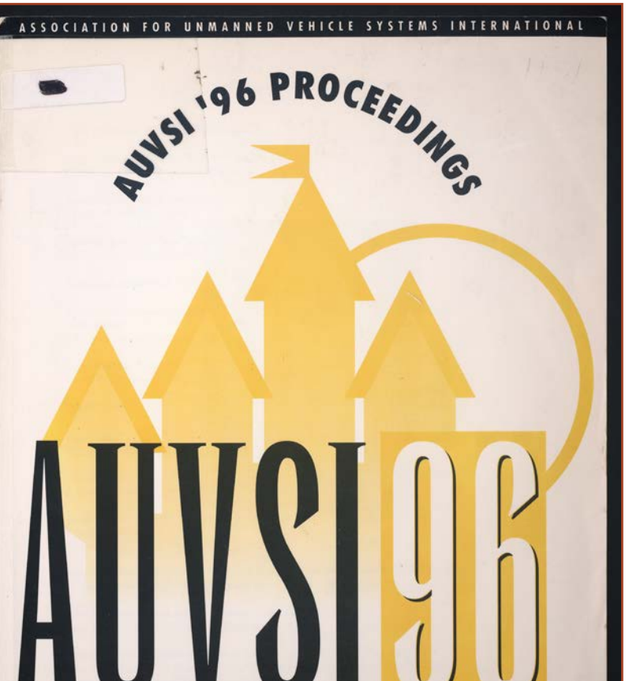
proclaimed a drone's military capabilities, or allowed potential customers the ability to "Try it Before you Fly It."[10] Demonstration airfields were arranged as just one exciting component within a slew of social events and cocktail hours that supplemented conference panels and roundtables.

U.S. and U.K. based drone conferences attracted a diversity of international representatives as the market for UAV technology grew in the final two decades of the twentieth century. The printed conference programs of groups like AUVSI demonstrate the presence of emissaries from around the world who presented papers boasting their own nation's military drone projects or alternatively invited submissions from attendant manufacturers to fulfill open government purchasing contracts. At any one drone conference, for example the Royal Aeronautical Society's Fourth International Conference on Remotely Piloted Vehicles held in 1984, attendants could meet and hear from military or manufacturer representatives attending from countries including Israel, Switzerland, India, China, South Africa, Sweden, Syria, Australia, West Germany, the United States, and the United Kingdom, among others.[11]

Despite the proliferation of drone technology throughout military arsenals around the world in the last decades of the twentieth century, the question of UAVs performing bombing missions remained seriously debated by military officials up through the 1990s. Though there are several examples of drones flying bombing missions in the twentieth century, the September 11th attacks on the World Trade Center and the U.S. declaration of the Global War on Terror largely ended U.S. military officials' reservations about drones performing combat roles. Up until the twenty-first century, most military drones remained limited to serving as targets in firing practices, undertaking surveillance operations, or flying as irritants that jammed enemy communications systems. Premier drone platforms of the late-twentieth century, for example Northrup Grumman's "Predator" drone, were initially built and flown as an endurance surveillance platform which was not retrofitted to carry missiles until after 2001. Weaponization provided additional functionality to drone platforms as appealing products in an ever-expanding world market. Remembering the now long-gone hesitancy to enable drones to kill helps rekindle a serious question in determining just war conduct. Should a person operating a war machine from thousands of miles away be able to push a button and end lives? Are autonomous killing machines a desirable step for humanity? In what ways do drones, far more disposable than an aircraft piloted by a person, make waging war easier, less costly, more likely than ever to erupt? If an adversary might develop and deploy autonomous drones does this necessitate the self-defensive development of similar capabilities? Does a profit motive within war making incentivize making war? Instead of a continued arms race, might a new political will favoring diplomacy, disarmament, truth and reconciliation be imaginable? If not, in what new ways might drones and autonomized weapons platforms threaten the world?

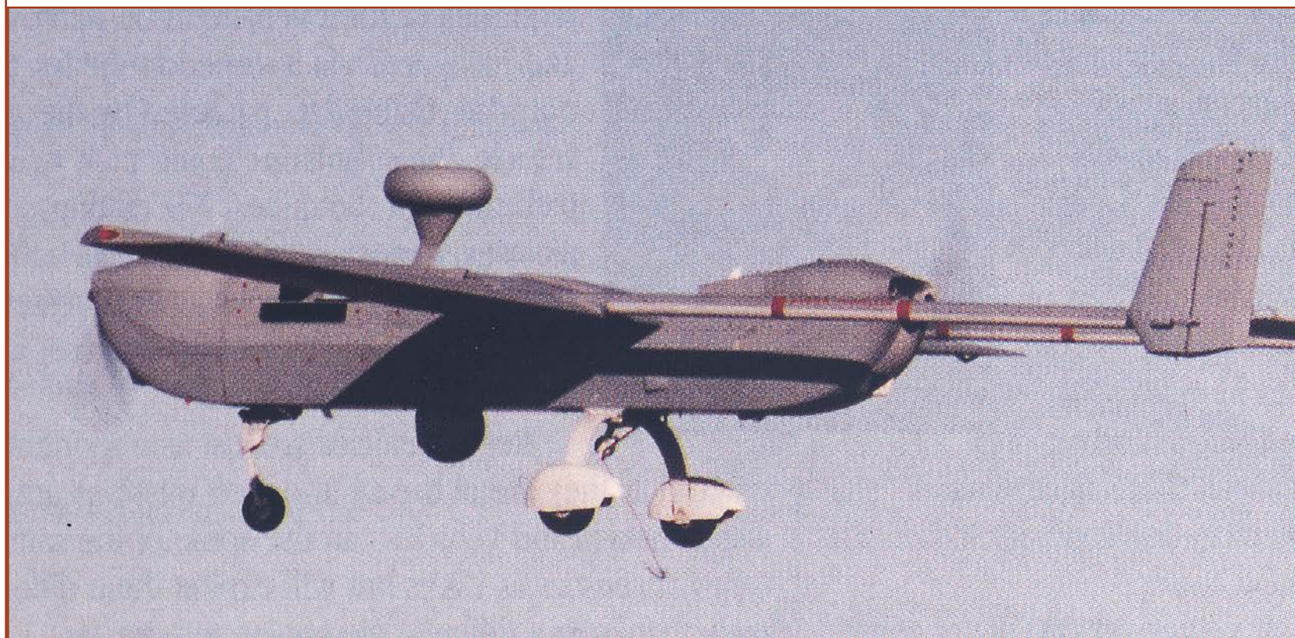
Returning to the Linda Hall Library provided me with the ideal sources and setting to think through these questions. As I enjoyed my time examining historical treasures in the special collections reading room or sipped a cocktail during one of the Library's pre-event President's Circle receptions, the bust of the physicist-philosopher Albert Einstein repeatedly caught my eyes. What might this genius of the twentieth century, a life-long pacifist scarred by a personal experience of World War I who long-advocated for disarmament, think about the current reality of forever wars waged around the world? Perhaps now, more than ever, it is necessary to give serious consideration to his provocation: "You cannot simultaneously prevent and prepare for war." ✲

Annual conferences organized by the Association for Unmanned Aerial Vehicle Systems International (AUVSI) brought drone manufacturers and military officers from around the world to destination locations like Disney World.



[10] R. A. Walster, "System Simulation – 'Try it Before You Fly It,'" Remotely Piloted Vehicles (RPVs) Twelfth International Conference Papers, 9-11 September 1996, Bristol, United Kingdom, Paper 17, Linda Hall Library.
[11] Royal Aeronautical Society and the University of Bristol, Remotely Piloted Vehicles Fourth International Conference, Bristol, UK, 1-11 April 1984, Linda Hall Library, List of Participants, P.1 - P.4, Linda Hall Library.

Shephard Media's magazine *Unmanned Vehicles* helped construct a world market for military drone technology in the 1980s and 1990s. The publication exists today as *Uncrewed Vehicles.*



A SMALL METEORITE LANDS AT THE LIBRARY

By Jason W. Dean
Vice President for Collections and Public Services

One of my favorite aspects of my job is searching for rare books to add to our collection. While browsing the Boston Antiquarian Book Fair in late 2023, I was invited to view a curious copy of a book that ended up being a good fit for our rare book collection. The book, a brief autobiography of American rocketry pioneer Robert H. Goddard, printed in miniature, was not particularly rare or noteworthy; however, this particular copy is bound in meteorite.

Considered the father of modern rocketry, Goddard is the inventor and creator of the first liquid-fueled rocket, which was successfully launched at Auburn, Massachusetts, on March 16, 1926. To commemorate the 40th anniversary of that first launch, Joh. Enschedé en Zonen, Holland, printed a run of 1,926 copies of Goddard's autobiography, bound by Proost en Brant N.V., Holland. From this printing, four copies were bound in meteorite under the direction of Dr. Arno Gschwendtner.

The unique binding uses slices of meteorite as the front and back boards. Gschwendtner spent more than 100 hours researching a suitable meteorite, ultimately deciding to use octahedrite from the Muonionalusta Meteorite, which fell on Northern Scandinavia circa one million years BCE. More than 40 pieces of the meteorite are known to have been recovered, with some weighing in excess of 40 pounds.

Gschwendtner quickly realized that traditional bookbinders were ill prepared to utilize such a strange material, so he recruited Roland Meuter, who was trained in using meteorite in watch dials for Rolex and Jager LeCoultre, from Switzerland for the task. Meuter's slices display a pattern distinctive to the octahedrite Muonionalusta meteorite, composed of iron, nickel, gallium, and germanium. The high iron content in the meteor makes this one of the few books in our collection that we ask patrons to use gloves while handling. ✲

LINDA HALL LIBRARY
SCIENCE • ENGINEERING • TECHNOLOGY

New Acquisitions exhibition presents *Sidereus nuncius* as highlighted in this issue of *Hedgehog*.

July 24, 2024

LINDA HALL LIBRARY
HEDGEHOG
NUMBER 69 • 2024

The Spring 2024 issue shows an illustration of a hedgehog from Volume 8 of Georges-Louis Leclerc, comte de Buffon's *Histoire naturelle* (1760). You can browse all 44 volumes of this natural history encyclopedia by visiting the Linda Hall Library's History of Science Collection.

HEDGEHOG
is published once a year by
The Linda Hall Library
of Science, Engineering & Technology
5109 Cherry Street
Kansas City, Missouri 64110
816.363.4600
fax 816.926.8790
www.lindahall.org

Editor: Paula Y. Wheeler

Editorial Design & Photography:
Joshua Judin