LINDA HALL LIBRARY

HEDGEHOG

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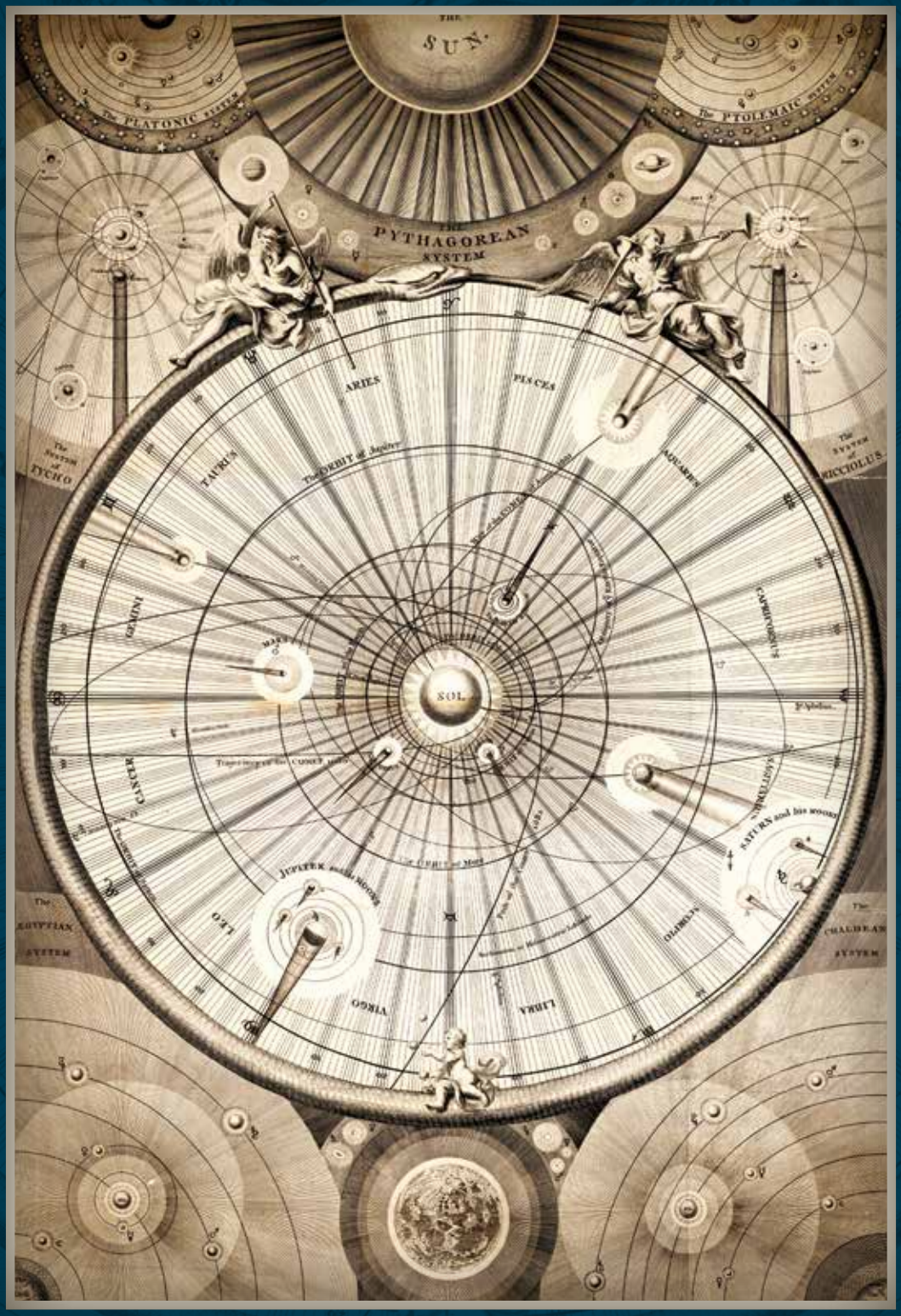


INSIDE

President's Message

In her book, *Illness as Metaphor*, literary critic Susan Sontag considers the usefulness of metaphors when confronting illness, specifically cancer and tuberculosis. In her slim volume, Sontag argues all sides of the question regarding the application of metaphors and their relative usefulness both to patients and to society-at-large. She points to periods in history when tuberculosis was perceived as a disease of creative people, while cancer was viewed as a disease of repression. After laying out her arguments both pro and con, Sontag ultimately concludes that metaphorical thinking should be avoided when confronting illness and that the most useful thing to do when and if afflicted is to focus on the physical components and treatment of the disease.

Whether familiar with Susan Sontag's writings or not, this is the approach many have chosen in the face of the global pandemic. And it is the posture that we have adopted at the Linda Hall Library. Having taken every known precaution to keep our staff and readers safe, over the past year we have endeavored to continue our tradition of providing access to our collections, supporting advanced research and scholarship, and providing a global community with online programming content that informs, instructs, and enlightens. While we cannot cure COVID or any disease, we can shake a defiant fist in its face by maintaining our tradition of excellence in the learning opportunities we offer our constituents.

The essays included in this edition of the *Hedgehog* are evidence that the Linda Hall Library's work has continued to flourish throughout this year of living strangely. Along with our robust schedule of online programs, the acquisitions discussed in these pages, the research reported and commented upon, the digitizing and cataloging projects that help increase the accessibility of our holdings are examples of the dedication to the Library's mission which is to collect, maintain, and make our rich resources available to anyone who needs them.

As another year of learning begins, I look forward to 'seeing' you in whatever form that might take.

Stay well, everybody.

Lisa M. Browar, President

Cover image: Thomas Wright's *A Synopsis of the Universe*

Library News

Linda Hall Library Adopts 'Critical Cataloging'

As years go by, words can lose their original meanings while taking on others. As a result, original meanings, if retained, may later seem insensitive, offensive, outdated, or inaccurate. Thus, language has an inherent potential to perpetuate systemic discrimination and cultural bias unless it is modified.

This language predicament has become evident in the millions of individual entries in library catalogs everywhere that contain information documenting library collections. Many catalog records were created years ago, and it has been common descriptive practice in libraries to re-use language when adding new materials to catalogs. What constitutes appropriate description varies with context over time. Eventually, what was once standard vocabulary may be considered offensive or harmful.

The Linda Hall Library has begun an ongoing review of its catalog entries to identify and revise language created by legacy cataloging and descriptive practices. This practice of review and revision is known as 'critical cataloging.' Critical cataloging's goal is to improve descriptive practices in ways that will promote useful and inclusive access to all materials in a library's collection.

Revisions to the Library's catalog will strive to eliminate cultural bias and discrimination. They will also enhance access to works by and/or related to underrepresented cultures, groups, and individuals by using language that reflects diversity and inclusion.

My Love Affair with the Linda Hall Library...

BY DAVID S. FERRIERO
Archivist of the United States


David S. Ferriero, Archivist of the United States

…began in the 1970s when I was a young library assistant overseeing the MIT Libraries Interlibrary Loan program and filling requests to borrow materials from the collections on campus. One of the regular requestors was the Linda Hall Library (LHL), so I got to know about the research interests of the LHL clientele and develop a sense of the mission and collection of that library. This was important intelligence as I moved on from the lending operation to the borrowing function. As a newly credentialed librarian, I moved from lending books to borrowing books for MIT researchers. This was well before the days of the Internet and electronic library catalogs, so identifying who might have the book or journal you were seeking relied on some guesswork and for me, an understanding of complimentary collections in the country. Linda Hall's terrific science and technology depth was a constant source of support for the work of MIT researchers and faculty. And folks who share resources for a living are good folks! I had many a "friend" in Kansas City in those days!

Fast forward to the wonderful world of social media and my appreciation for Linda Hall continues to grow with every post I read. Libraries and archives collect, protect, and encourage the use of their collections in a mission of creating a literate society. For Linda Hall that means using the collection to create a more science and technology literate society. What has impressed me about the LHL social media presence is the use of the collections to educate and entertain. The posts make connections between current scientific events and past discoveries enabling today's work. I look forward to the daily *Scientist of the Day* post where I am introduced to the important work of someone I may have forgotten and did not know about at all. In addition, the public programming is playing an important role in that literacy training. Creative programming—e.g., the Science of Baking—brings the mysteries of chemistry into the kitchen demystifying the science at work in the kitchen. Podcasts with scientists and LHL staffers make the content accessible and allow for viewer participation.

In sum, my admiration and fondness for the Linda Hall Library is long and deep. Today, in addition to supporting the research of countless scientists and engineers, LHL is playing an important role in increasing the public's level of comfort and understanding of scientific and technological issues. The complexity of today's landscape demands that institutions like LHL contribute to the diffusion of knowledge in the manner that Thomas Jefferson envisioned—studying the past to understand the future. I am so proud of the work that LHL is doing and consider myself the Library's number one fan!

NEXT STEPS IN THE LIBRARY'S TRANSFORMATION:
Connecting to Community Year 2

BY LISA M. BROWAR, President

Last year, I wrote of the progress made by the Linda Hall Library during the first year and a half of its strategic plan's implementation to transform the Library by strengthening its community connections, increasing its impact in the Kansas City area, and subsequently, propelling our metropolitan region to the front rank of scientifically literate places in the United States. We met, and in some areas, surpassed our goals for creating programs, increasing audiences, and raising funds during a pandemic that threatened to narrow our programming possibilities, eliminate its audiences, and dry up its funding.

The strategic plan's implementation launched its second year on January 1, 2021, equipped with the lessons absorbed from the first 18 months' work, and refined strategies to propel us forward as we expand our ability to create partnerships and collaborations, create content, and assume our role as a major participant in Kansas City's STEM ecosystem.

The public health challenges of 2020 continue, and as I write this, Kansas City is experiencing a resumption of indoor mask-wearing. Accordingly, we are poised to reconfigure plans on short notice to assure that the health of our audiences and staff are not compromised as we endeavor to offer the highest quality programming possible that deepens our knowledge and awareness of the ways science, engineering, and technology intersect with and influence modern life.

Throughout 2021, we will:

- Adopt a thematic approach to programs and increase their number and format variety
- Strive to find out what our audience wants and needs in program design and content
- Launch a YouTube channel where our audience can access programming on demand – whenever they wish to view it, wherever they may be
- Continue to pursue our live and virtual collaborations with the Nelson-Atkins Museum, the Kansas City Public Library, the Truman Library Institute, and the National World War I Museum, while creating exciting new partnerships with more of Kansas City's cultural institutions as well as others throughout the United States
- Expand our international audience through programming collaborations by forging new relationships with foreign libraries, museums, and universities
- Draw upon the Library's vast resources to provide intellectually challenging experiences for high-achieving high school students in STEM areas
- Support STEM educators with teacher training and professional learning opportunities created by STEM teachers for STEM teachers
- Create a series of online seminars and mini-courses for adult learners near and far
- Continue to digitize the LHL collection, increasing the accessibility of our holdings

Our goals are ambitious and the challenges numerous, made more so by having to navigate the uncertainties of a global health crisis. But one of the most important lessons we learned in 2020 was that with imagination and energy, there are few challenges that cannot be met and overcome.

Linda Hall Library by the Numbers

1,086,977
Number of items in the collections*

41.8
Number of miles of shelving

489,190
Number of monographs**

312,998
Number of non-serial titles (tech reports, standards, government documents)

43,350
Number of journal titles

82
Number of languages represented in the collections

*Exclusive of the History of Science Collection

**Monograph is a scholarly book or treatise on a single subject or a group of related subjects

Linda Hall Library Fellows Participate in History of Science, Technology and Medicine in Latin America Working Group

Four recipients of Linda Hall Library research fellowships are participating in a working group sponsored by the Consortium for the History of Science, Technology and Medicine* devoted to the History of Science, Technology and Medicine in Latin America. Through their individual and collective scholarship, the members of this working group strive to reveal the lesser-known history of scientific, technological, and medical advances that have taken place throughout Latin America.

The four scholars are:

Justin Castro (associate professor of history, Arkansas State University; 2020-21 LHL fellow) who consulted Latin American books, journals, and engineering society papers for a book to be published by Johns Hopkins University Press entitled, *History of Technology in Latin America*.

Carlos Dimas (assistant professor of history, University of Nevada Las Vegas; 2019-20 LHL fellow) whose research explored how Argentina's government used meteorological observations to consolidate control over the previously contested Patagonian frontier.

Rocio Gomez (assistant professor of Latin American history, Virginia Commonwealth University; 2018-19 LHL fellow) who studied the discovery of vanadium by Mexican chemist Andrés Manuel del Rio and the metal's subsequent impact on the steel industry and military technologies.

Diana Montaño (assistant professor of history at Washington University; 2021-22 LHL fellow) who conducted research on the Necaxa hydroelectric complex in Mexico.

*The Linda Hall Library is one of the founding members of the Consortium for the History of Science, Technology and Medicine, headquartered in Philadelphia, PA

A Celestial Tribute to the Library

BY BENJAMIN GROSS
Vice President for Research and Scholarship

Earlier this year, the Linda Hall Library received news that it had been inducted into an elite club, one whose members include such well-known figures as Marie Curie, Stevie Wonder, Jane Austen, and all six members of Monty Python. In addition to their contributions to science, literature, and the arts, all those luminaries are the namesakes of asteroids, the rocky remnants of the solar system's formation scattered between the orbits of Mars and Jupiter. As of June 2021, the same can be said of the Library, just in time to celebrate the 75th anniversary of its opening to the public.

The asteroid that would eventually be named for the Linda Hall Library was discovered thanks to a collaboration between a pair of Canadian astronomers: Tom Glinos and David Levy. Their partnership began in 2001 at a meeting of the Royal Astronomical Society of Canada in London, Ontario. Glinos, a software engineer who had worked for Canada's first Internet service provider, was about to purchase his dream telescope: a 26-inch Ritchey-Chrétien reflector, similar in design to the Hubble Space Telescope albeit on a much smaller scale. Rather than setting it up in his backyard, he approached Levy, an old friend and one of the world's most successful comet hunters, with a proposal. Levy had previously overseen the construction of the Jarnac Observatory near his house in Vail, Arizona, a setting with far less light pollution than the Toronto suburbs. Glinos suggested that they could expand that facility to include his telescope, which he would operate remotely over the Internet.

The telescope used to discover Asteroid 542600, which was recently renamed in honor of the Linda Hall Library. (Photograph courtesy of David Levy.)

Remotely operated telescopes were not new in 2001, but most of them were housed at universities or professional observatories. Rigging up a telescope to enable nighttime viewing from three time zones away would be a daunting task, but Glinos and Levy were up to the challenge. Levy and his wife Wendee facilitated the construction of a building to house the new telescope, and worked with Glinos to set up the systems that would permit him to precisely maneuver it towards a specific part of the sky. It took several years to calibrate the apparatus, but by 2004, everything was in place for Glinos to start making observations.

Based on conversations with Levy, Glinos chose to concentrate on locating asteroids and comets, a decision that prompted a shift in his observing plan. Previously, he had prioritized visual astronomy, looking at planets, nebulae, or galaxies directly through the eyepiece of a telescope. Unfortunately, most of the asteroids and comets that were large or bright enough to be detected visually had already been spotted. Instead, Glinos decided to embrace astrophotography. He replaced the eyepiece of his telescope with a charge-coupled device (CCD) camera, capable of capturing digital images of very faint objects.

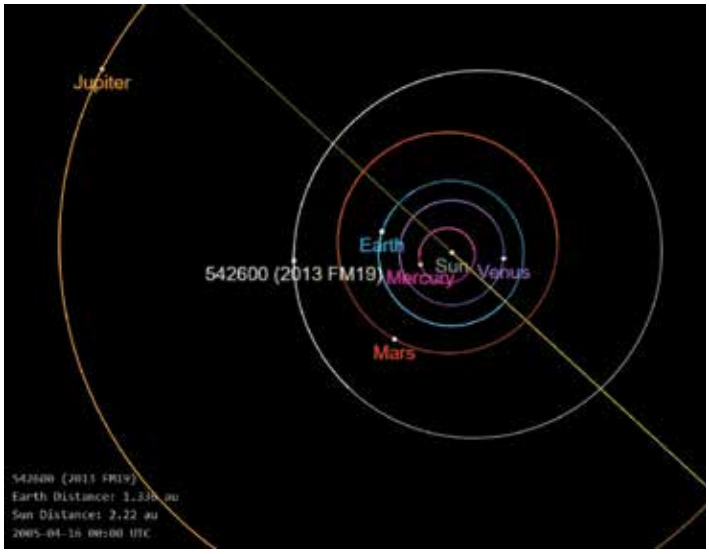
During a typical observation session, Glinos waited until the sun had set in Arizona and activated his

telescope. The roof of his observatory opened, and the telescope rotated toward his chosen section of the sky, occasionally startling visitors to the Levy household. Glinos proceeded to activate the CCD camera and capture an image, methodically shifting the telescope after each exposure and then doubling back to repeat the process. The resulting photographs were then relayed to Toronto, where thanks to the time difference, he could analyze them while listening to *The Tonight Show.* Glinos used special software to rapidly flash three or four images of a sector of sky taken over an extended period of time, effectively creating a very short movie. Background stars in the photographs remained fixed in place, but any asteroids or comets would appear to move. Another program helped him determine whether those objects had previously been identified.

On the evening of April 16, 2005, Glinos spotted a promising new asteroid candidate moving across his screen. He reported his findings to the Minor Planet Center (MPC) at the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, which serves as the central repository for observational data related to asteroids and comets. The MPC eventually confirmed that Glinos had, in fact, located a new asteroid and that he and Levy should share credit for the discovery. The tiny asteroid, no more than a few kilometers in diameter, was given a numerical designation (542600) until the two astronomers could suggest a permanent name.

Glinos and Levy took the responsibility of selecting a name quite seriously. “When you name an asteroid it’s permanent. You know, it becomes immortal,” Glinos explained. The weight of that decision, along with the backlog of almost 300 new asteroids identified as a result of Glinos and Levy’s partnership, explain why they waited to submit a proposal to the MPC. Ultimately, it was Levy who recommended that Asteroid 542600 should be named after the Linda Hall Library, where he had conducted research for his dissertation and, in 2015, donated his observation logs and personal journals.

After briefly discussing the idea with members of the Library staff during a 2019 visit to Kansas City, Levy submitted a proposal asking the MPC to rename the

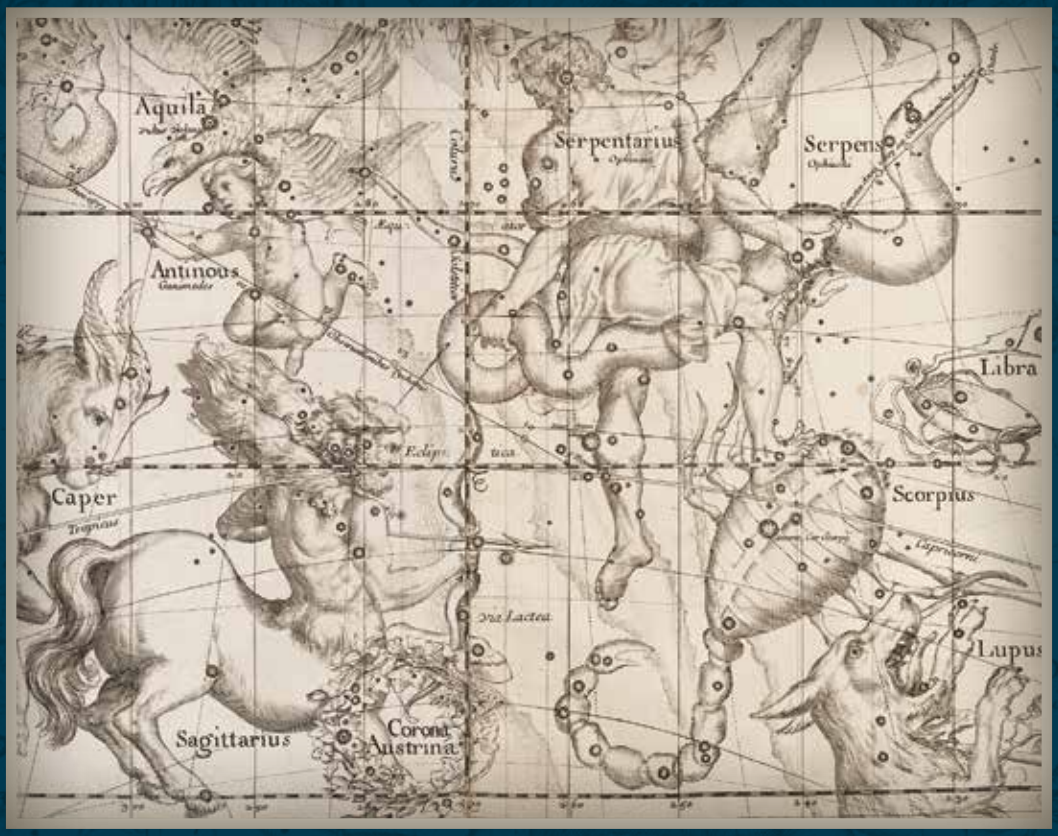


Orbital diagram showing the location of Asteroid 542600 (Lindahall) on April 16, 2005, when it was discovered by Tom Glinos and David Levy. (Image courtesy of the JPL Small-Body Database Browser.)

> “I think a library is the most important thing you can name an asteroid for.” – *David Levy*

asteroid “LindaHallLibrary.” It took almost two years for the International Astronomical Union’s Working Group for Small Body Nomenclature—the final arbiters of all asteroid names—to review their request. Before receiving final approval, the working group asked that the name be modified from “LindaHallLibrary” to “Lindahall.” Levy was confused by the request. (As he later commented, “I think a library is the most important thing you can name an asteroid for.”) Nevertheless, he and Glinos agreed to the change, and the working group officially declared that asteroid 542600 would henceforth be known as “Lindahall” in its June 16, 2021 bulletin.

The Minor Planet Center has cataloged nearly 600,000 asteroids in our solar system, but so far as Levy and Glinos are aware, Lindahall is the only one named after a library. One would be hard-pressed to think of a more fitting honor for an institution whose extensive astronomy collections document humanity’s ongoing efforts to understand our place in the cosmos.



Serpentarius, Aquila, Sagittarius, and Scorpius, detail of plate 3 of Ignace-Gaston Pardies, *Globi coelestis*, 1674.

When Libraries Disperse: The Honeyman Auctions

BY WILLIAM B. ASHWORTH, JR.
Consultant for the History of Science

Personal libraries are enjoyable to build and rewarding to use and display, especially if sufficient funds for acquisition are at hand. There have been many notable history of science book collectors, including Herbert MacLean Evans, Bern Dibner, and Latimer Clark. Often the owners published catalogs of their collections, which have served as valuable reference guides to research libraries, or to others building collections.

What happens to such collections once they are assembled? Sometimes they pass to descendants and can remain intact for hundreds of years, as was the case with the Earl of Macclesfield collection. Often collections are donated or sold intact to research libraries, as was the case with the Chester Thordarson Collection, which was bequeathed to the University of Wisconsin in 1945, or the more recent collection of Samuel and Cecile Barchas, which was sold to Stanford University in 1985.

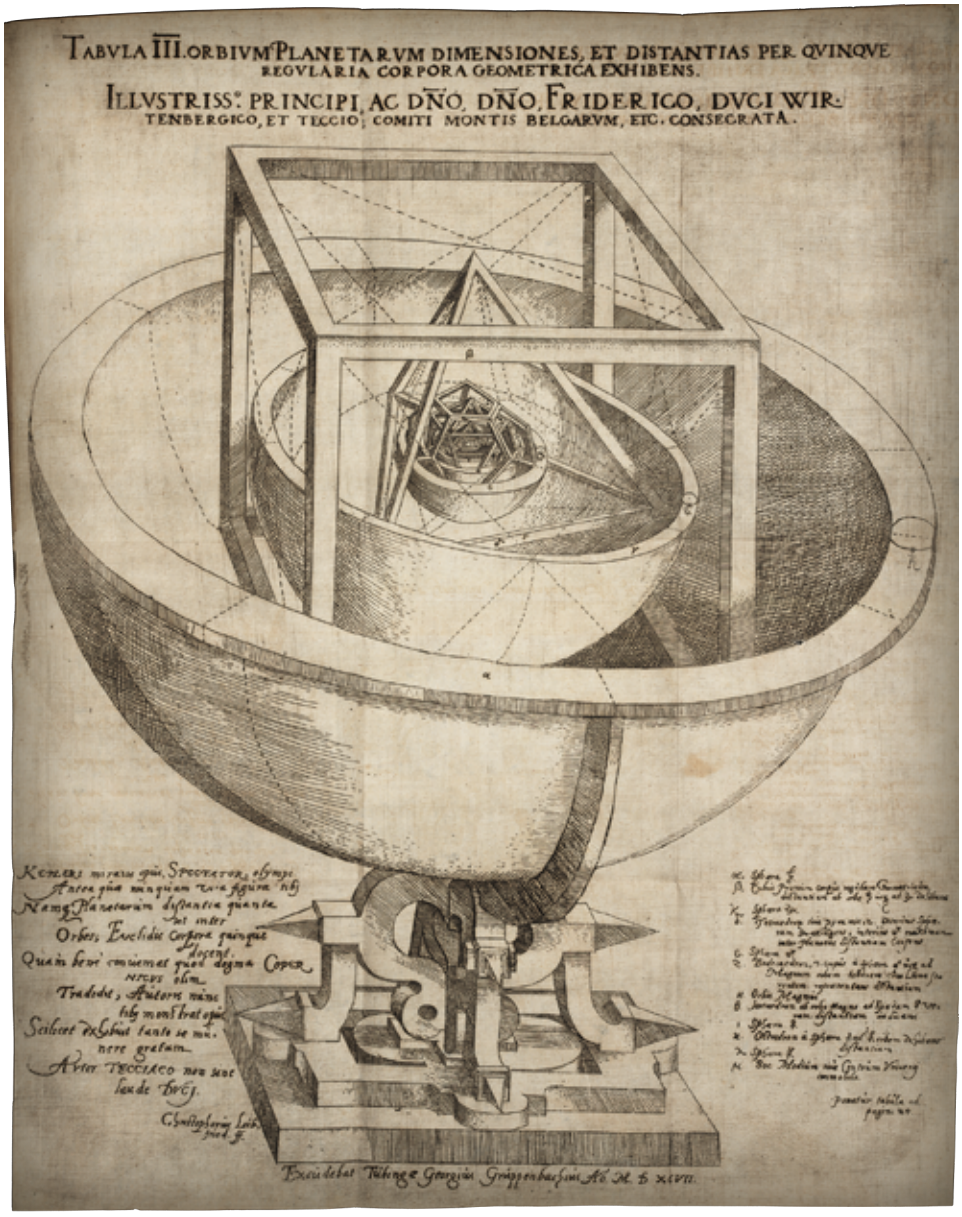
But occasionally private libraries are sold at auction. When the collection is a stellar one, then the auction provides a golden opportunity for libraries (and other collectors) to enrich their own collections in a much more efficient manner than buying books individually from rare book dealers.

We had such an opportunity in 1978, when the first part of the library of Robert Honeyman was offered at auction by Sotheby Parke Bernet. Honeyman was an American engineer who began collecting rare books in both science and literature in the 1920s and continued to do so through the 1950s. The literature collection was gifted to Lehigh University in 1955, but Honeyman continued buying rare science books well into the mid-1970s, when he decided to sell the entire collection at auction. The collection covered all branches of science, amounted to some 3,300 titles, and was rich in incunabula and 16th- and 17th-century books. Nearly all of the works of Isaac Newton, Galileo Galilei, Johannes Kepler, and dozens of other giants were to go on the auction block.

The first day of the auction was Oct. 30, 1978; the auction catalog was thick, with 560 items listed and fully described. I had just started at the Library as the history of science consultant, hired at the same time as Bruce Bradley, the new librarian for the history of science. The Director, Tom Gillies, named a sum we could spend, which was more than a generous amount, and we pored over the first catalog, marking with ticks those items we might consider further, then making lists, and shortlists, and shorter lists, all the while trying to come up with appropriate bids. Entering those bids at the auction in London was Jacob "Jake" Zeitlin, the dean of American rare book dealers in the history of science. Mr. Gillies went to London for the first sale, just because he was curious.

The auction continued through seven sales, each with its own catalog, one every six months, for three and a half years. We acquired 65 items from the Honeyman collection, most of them treasures in their own right, some of them becoming key elements of special collections that would grow in the ensuing decades. For this occasion, we have selected six books to showcase, the tip of our Honeyman iceberg.

We begin with Johannes Kepler's first book, *Mysterium cosmographicum*, published in 1596. In it, Kepler proposed a cosmological scheme in which the sizes of the planetary orbs were determined by a nest of the five perfect or Platonic solids, thus explaining why there are six planets, and why they have the spacing they



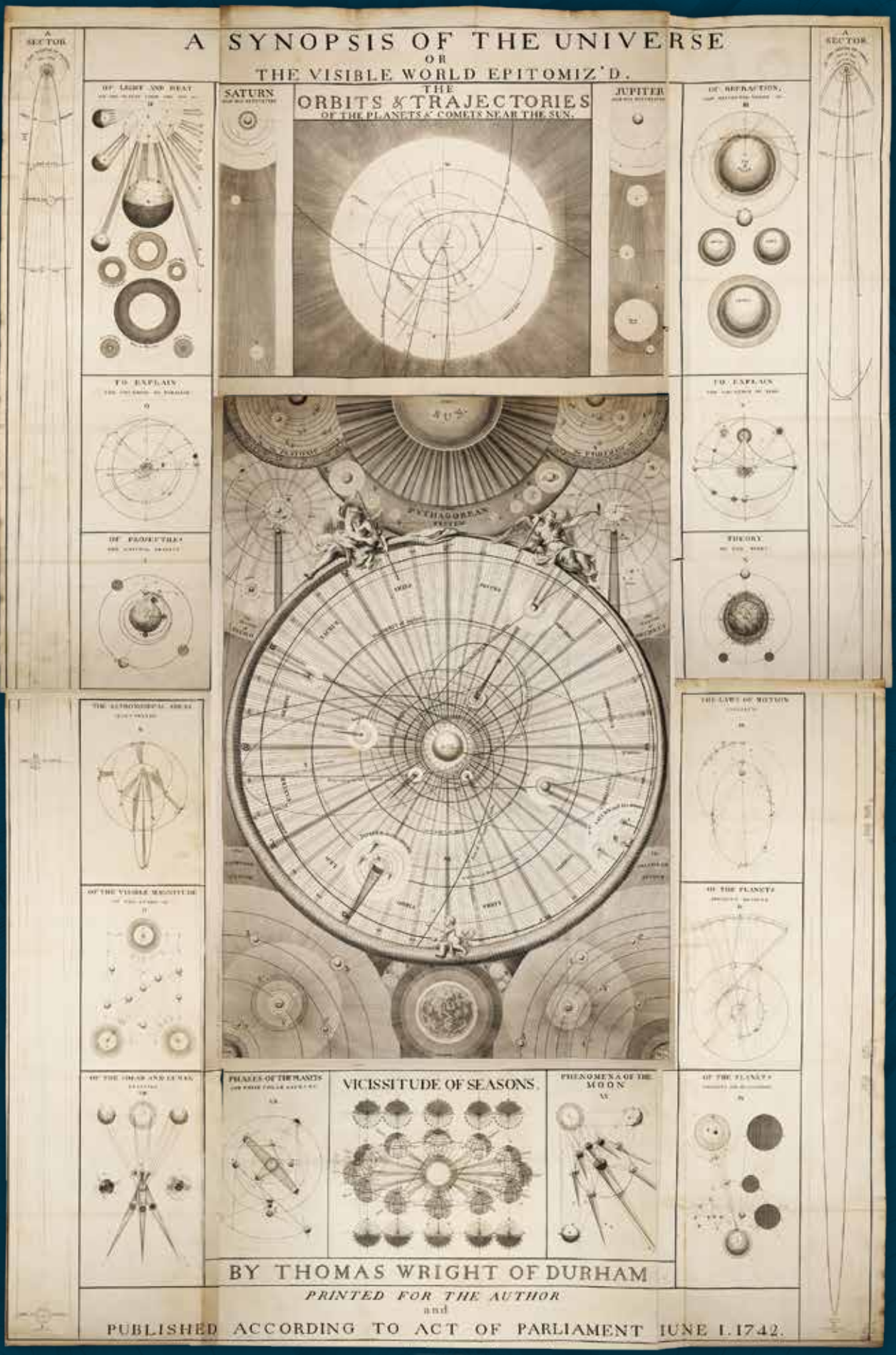
Cosmographic model based on a nest of Platonic solids, folding engraved plate, from Johannes Kepler, *Mysterium cosmographicum*, 1596.

Chameleon, from Claude Perrault's, *Description anatomique d'un caméléon, d'un castor, d'un dromadaire, d'un ours, et d'une gazelle,* 1669.

The Honeyman collection covered all branches of science, amounted to some 3,300 titles, and was rich in incunabula and 16th- and 17th-century books. Nearly all of the works of Isaac Newton, Galileo Galilei, Johannes Kepler, and dozens of other giants were to go on the auction block.

do. The Platonic nest is depicted on a large, fold-out engraving. The book itself has beautiful wrappers made of an old musical manuscript, and it is preserved in a red Morocco slipcase, as were many of the Honeyman books. We bought two first-edition Kepler books at the Honeyman sale, and we have gone on to acquire quite a few more, giving us one of the finest Kepler collections in the United States. It did not start with the two Honeyman books, but they certainly provided a stimulus for further acquisitions.

Another Honeyman book that we acquired was the *Description anatomique* of Claude Perrault, published in 1669. Perrault was an original member of the newly founded Royal Academy of Science in Paris, and he was interested in comparative anatomy—the study of animal anatomy other than human. He and his colleagues collected animals from the King's menagerie that had died and dissected them at Versailles Palace, commissioning an artist to record the process. The *Description* contained the notes and drawings of five dissections and was the first (although unofficial) Academy publication, depicting for the reader the innards of a chameleon, a bear, a lion, a beaver, and a gazelle. The book had a powerful impact on the discipline of natural history. Before Perrault, anatomy was not considered a useful part of natural history; afterwards, it became indispensable. Perrault kept dissecting, and in 1676, he published a much larger work on the same subject, *Mémoires pour servir à l'histoire naturelle des animaux*, which we acquired as the Library's Millionth Volume in 1996. Very few libraries have both the *Description* and the *Memoires*.



The assembled 6 x 4-foot illustration from Thomas Wright's *A Synopsis of the Universe*, which in the Linda Hall copy is cut into 7 folded plates. The image depicts a myriad of astronomical concepts, described in the book's text.

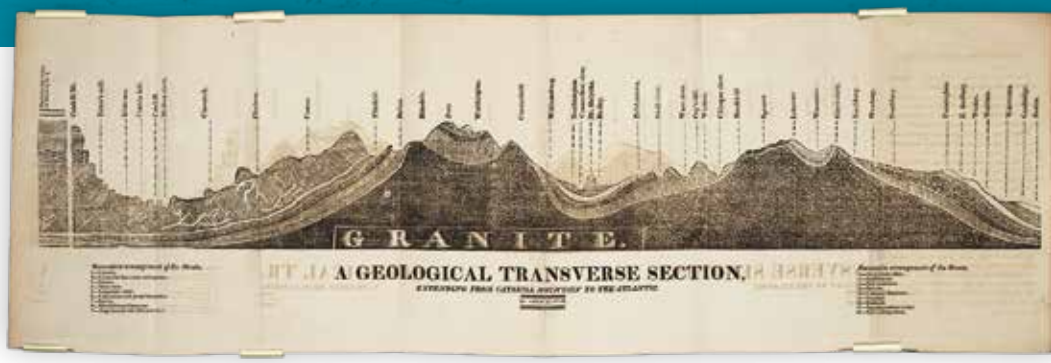
The rarest book we bought at the Honeyman auction was probably Thomas Wright's *Clavis coelestis* (1742). Thomas Wright was a schoolteacher with a strong interest in the heavens and a love for showy cosmological diagrams. His *Original Theory or New Hypothesis of the Universe* (1750), which we have in the Library, is well-known for its claim that the band-like appearance of the Milky Way is a result of the way stars are arranged in the galaxy. But eight years earlier, he published a collection of immense cosmological diagrams, each one folded again and again to fit into the quarto-sized book. A facsimile was published in 1967 of the only complete copy in the world; Honeyman acquired that copy; and we then bought it at the last Honeyman auction in 1981. It is a thoroughly impractical book, with its unwieldy plates, one of which is six feet long when unfolded, but they are cosmologically gorgeous. And it is hard to get any rarer and still exist!

We acquired four celestial atlases from the Honeyman Collection. We had already identified star maps and atlases as a collection strength of the Library, and we thought that the Honeyman auction provided a fine opportunity to enlarge that collection. One of the four we acquired was an atlas by a French Jesuit, Ignace-Gaston Pardies. We did not know it at the time, but it turns out that the Pardies star maps are just about the most attractive star maps ever published, with the constellation figures exceptionally graceful and well-drawn. The atlas we acquired, *Globi coelestis*, was the second edition, which was desirable, because the date of publication, 1690, post-dated the most famous appearance of Halley's comet in 1682, the appearance that Halley himself saw, and Pardies included many historical comets on his star maps, including Halley's comet. We later acquired the first edition of the Pardies atlas (1674, without Halley's comet), so we now have both. The fact that Pardies was a member of the Society of Jesus was also an incentive for us to acquire other works of Jesuit science, which is now a strong specialization in our History of Science Collection.

One of my favorite acquisitions at the Honeyman sales was John Auldjo's

LEFT: Panoramic view of the Vesuvius crater, Sept. 18, 1831, with Auldjo in the center, and others of his party wandering about, folding hand-colored lithograph, from John Auldjo, *Sketches of Vesuvius*, 1832.

BELOW: Amos Eaton's *An Index to the Geology of the Northern States* showing rock formations from Boston to the Hudson River.



Sketches of Vesuvius (1832). This is an unprepossessing book on the shelf, with its pink and gold-star paper boards, but open it up, and a half-dozen folded plates beg to be unfolded, to reveal hand-colored panoramic lithographs of the summit of Mount Vesuvius in mild eruption, with elegant tourists (including Auldjo himself) milling about. Auldjo's book became a key title as we built our volcanism collection, and we displayed Auldjo's book, along with many of its shelf-mates, in our exhibition: *Vulcan's Forge and Fingal's Cave: Volcanoes, Basalt, and the Discovery of Geological Time*, in 2004.

Finally, we are partial to a slim octavo Honeyman book in a black half-leather binding, *An Index to the Geology of the Northern States* (1818), by Amos Eaton, an early American naturalist and geologist. This book was prepared by Eaton for geology classes at William College and other New England schools, and its most striking feature is a long folding woodcut called "A Geological Transverse Section Extending from Catskill Mountain to the Atlantic," one of the first geological sections of any part of North America. This copy was owned and signed by Samuel L. Mitchill, another important early American geologist.

The Honeyman Auctions came at just the right time to provide us with the seeds of many of our special collections. We have purchased significant books at other such auctions, and will continue to do so, but the quality and quantity of the books acquired from Robert Honeyman's Library will always evoke warm thoughts in our institutional memory.

History of Stereo

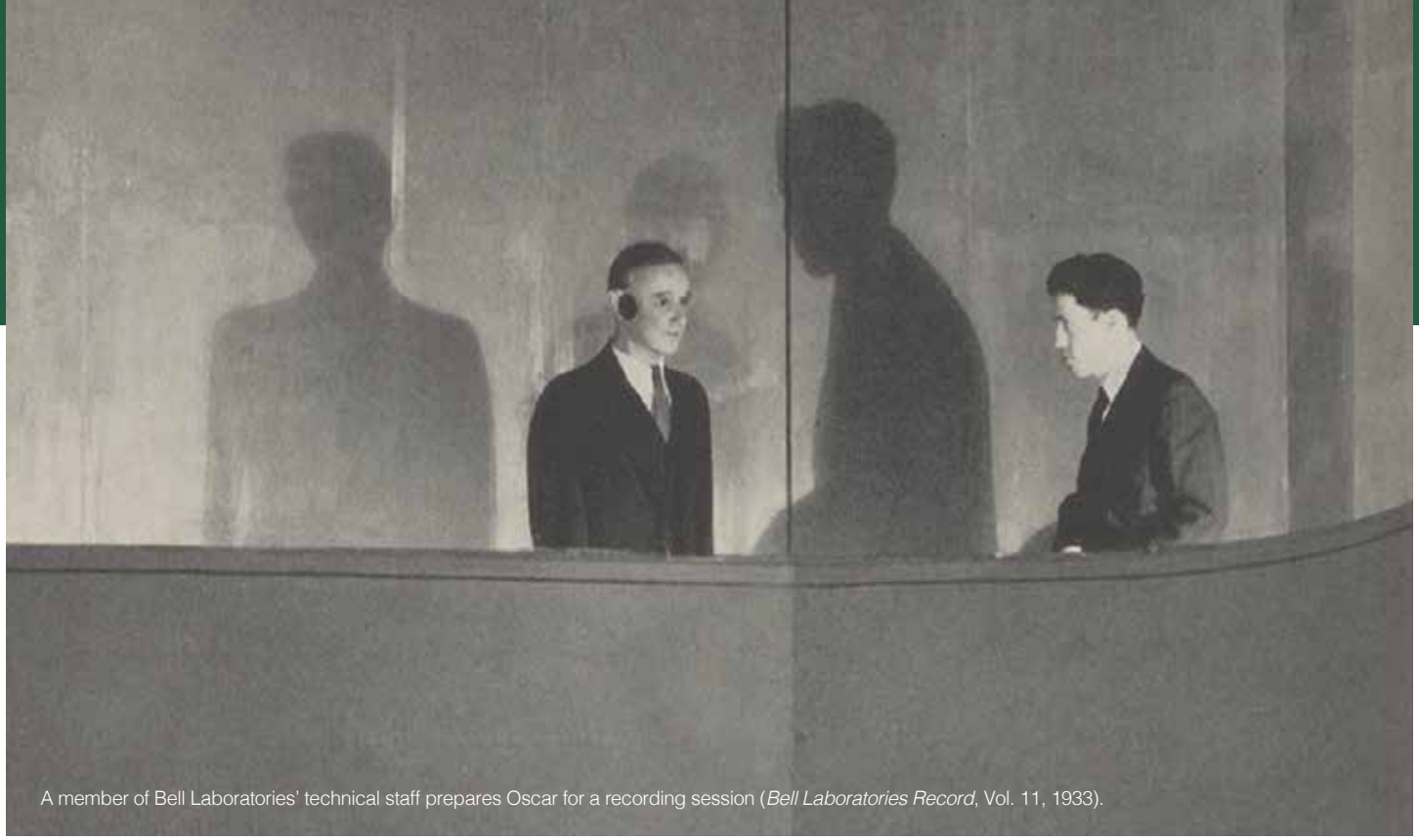
BY HARRY BURSON
Linda Hall Library Fellow

Fig. 4—Into Oscar's head two microphones are set, one on each side

Bell Laboratories Record, Vol. 11, 1933.

In April 1940, Bell Telephone Laboratories (BTL) hosted a pivotal musical event at Carnegie Hall. Hyperbolically reported by the *New York Times* as "the loudest musical sound ever created" that left the listening audience "spellbound" and "a little terrified," the evening's program was not a concert, but a demonstration of newly developed sound technology. For two hours, the select audience—which included film czar Will Hays, IBC chief Thomas. J. Watson, and composer Sergei Rachmaninoff among other luminaries—sat for a program of audio entertainment. Playing from large loudspeakers at the front of the concert hall were pre-recorded selections of orchestral music conducted by Leopold Stokowski, hymns sung by the Mormon Tabernacle Choir, and dramatic recitations by Paul Robeson. This evening at Carnegie Hall was among the first major demonstrations of stereophonic sound—a then-novel format for sound reproduction using multiple speakers, that has become the international standard for recorded sound in the subsequent decades. This spectacular unveiling of stereophony in a venerated setting was the culmination of decades of acoustic research at BTL, which would soon fundamentally change the way listeners experience sonic media.

The Carnegie Hall event marked a shift from the single-speaker limitation of monophonic sound to new ways of hearing in stereo, with the creation of new forms of acoustic space and "auditory perspective" through multi-speaker sound. These stereophonic soundscapes radically altered approaches to audio recording and broadcast across media industries. Nearly all audio that you might encounter on a daily basis—from the immersive audio of virtual reality, to cinematic surround sound, and even the left and right channels of pop music on headphones—has its roots in stereophonic techniques developed by a small team of researchers at Bell Labs during the interwar period in the first half of the twentieth century. Unlike the many histories of three-dimensional images created through the related visual technique of stereoscopy, there are relatively few accounts of the development of stereophonic sound



A member of Bell Laboratories' technical staff prepares Oscar for a recording session (*Bell Laboratories Record*, Vol. 11, 1933).

And despite the seemingly common-sense correspondence between the body's two ears and the standard two channels of audio, the history of the technology reveals a surprisingly complex interplay of scientific, economic, and aesthetic considerations that shaped the sound of stereo.

at BTL. And despite the seemingly common-sense correspondence between the body's two ears and the standard two channels of audio, the history of the technology reveals a surprisingly complex interplay of scientific, economic, and aesthetic considerations that shaped the sound of stereo.

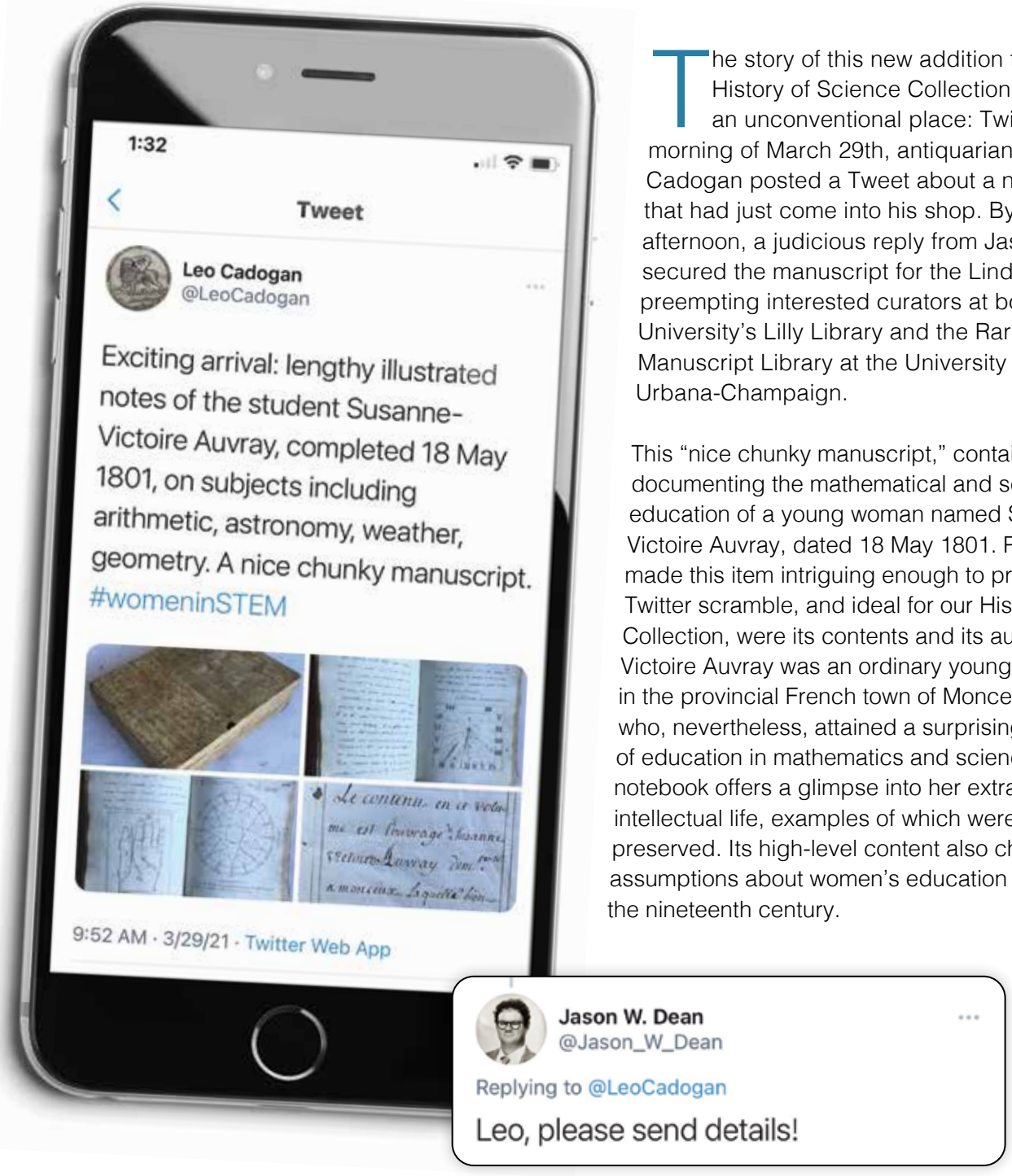
In the first decades of the twentieth century, the fields of both acoustic science and musical aesthetics had limited means to describe the spatial character of hearing. The proliferation of sound technologies such as the phonograph and the telephone helped spur research into spatialized hearing at the same time that multichannel sound was being developed to make use of this understudied aural faculty. Stereophonic sound creates novel representations of auditory space, but what exactly is ideal location on which this space is modeled? What were the ideal listening positions and situations that informed the development of stereo? During my time in Kansas City, I had the opportunity to consult the Linda Hall Library's considerable collection of periodicals and rare books in acoustics and sound technology to trace the history of stereophonic sound.

The central figure in the story of stereo at BTL is Harvey Fletcher, who joined the AT&T corporate family in 1916 as a researcher at Western Electric after completing a PhD in physics under Robert Millikan at the University of Chicago. Early in his career with Western Electric, Fletcher became interested in the nascent field of acoustic science—which was at the time seen as a relatively minor subfield of physics. He came to acoustics through researching underwater submarine sound location during the First World War, when the tactical advantages of such auditory techniques spurred the quick maturation of the field. When the research division of Western Electric became the autonomous entity of Bell Telephone Laboratories in 1925, Fletcher devoted himself to studying hearing, soon becoming the head of acoustic research at BTL.

story continued on page 26

Back to School

BY JAMIE CUMBY
Assistant Curator of Rare Books and Manuscripts



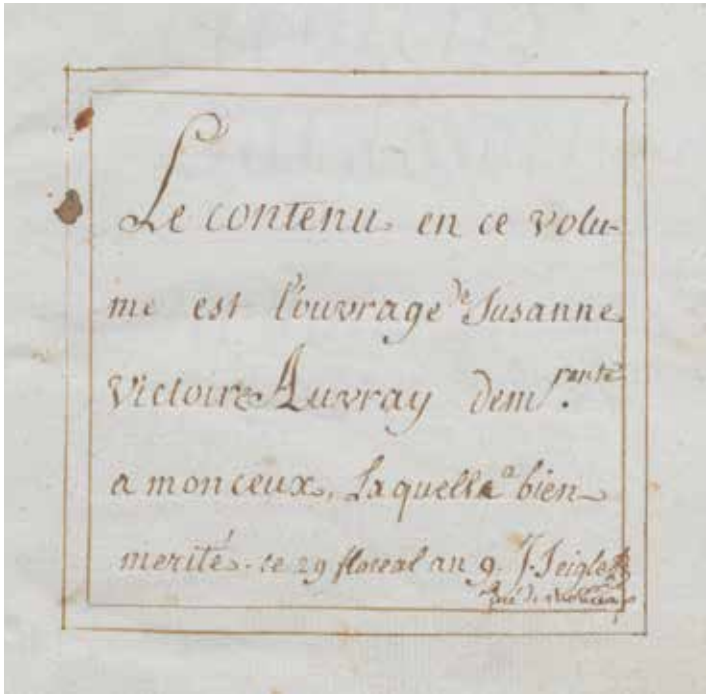
The story of this new addition to the History of Science Collection began in an unconventional place: Twitter. On the morning of March 29th, antiquarian bookseller Leo Cadogan posted a Tweet about a new acquisition that had just come into his shop. By that same afternoon, a judicious reply from Jason Dean had secured the manuscript for the Linda Hall Library, preempting interested curators at both Indiana University's Lilly Library and the Rare Book and Manuscript Library at the University of Illinois, Urbana-Champaign.

This "nice chunky manuscript," contained notes documenting the mathematical and scientific education of a young woman named Susanne-Victoire Auvray, dated 18 May 1801. Part of what made this item intriguing enough to prompt a small Twitter scramble, and ideal for our History of Science Collection, were its contents and its author. Susanne-Victoire Auvray was an ordinary young woman living in the provincial French town of Monceaux-en-Bessin who, nevertheless, attained a surprisingly high level of education in mathematics and science. Susanne's notebook offers a glimpse into her extraordinary intellectual life, examples of which were rarely preserved. Its high-level content also challenges our assumptions about women's education at the turn of the nineteenth century.

> Susanne's notebook offers a glimpse into her extraordinary intellectual life, examples of which were rarely preserved. Its high-level content also challenges our assumptions about women's education at the turn of the nineteenth century.

When the manuscript first came to the Library, we knew little more about Susanne than the information she supplied on the manuscript's introductory page shown here: her name, the date when she completed this course of her studies, her instructor, and the place she lived. These last two facts already revealed something interesting about the nature of Susanne's schooling. The new Republican government of France had great ambitions for wholesale reform of the educational system, with plans to put science at the center of its new curriculum. The rollout of this new educational approach was slowed by political infighting which included the proposed elimination of a provision granting equal access to schooling for boys and girls. Curiously, the small parish school in Monceaux-en-Bessin not only offered the rigorous scientific education that would be more typical of secondary schools in 1801, but it was apparently more progressive in its admissions than the new municipal schools. Because Susanne's instructor was the local parish priest, we can conclude that, as was the case for many provincial schools, the Revolutionary government had not succeeded in altering the basic structure of primary school education in Monceaux-en-Bessin.

After seeing the initial exchange about the manuscript, Estelle Boudillet, a historian working on eighteenth-century Brittany, reached out over Twitter to provide additional records from her own research at the Departmental Archives of Calvados. The biographical details of Susanne's life make her student notebook all



The introductory page, showing Susanne's name, date, and the name of her instructor. Susanne-Victoire Auvray, [*Educational Manuscript*], Monceaux-en-Bessin: 1801.

the more remarkable. She was the daughter of a baker, born in Ellon, only one town over from Monceaux-en-Bessin where she studied, lived, and would eventually marry at age 31. Susanne was born on 14 November 1787, making her 13 years old when she completed her manuscript. Of interest is her age, given what it tells us about where Susanne was in her studies. Primary schooling under the Ancien Régime ended at age 14 for boys, but there was no formal requirement or, indeed, encouragement for girls to complete this course of study. A baker's daughter might reasonably be expected to know basic accounting and arithmetic. Women were often integral parts of family businesses, keeping financial records, assisting with day-to-day operations, and even running the entire operation after the death of a husband or a father. However, there would have been little practical reason for a woman of Susanne's circumstances to study astronomy and physics.

The contents and construction of Susanne's manuscript are almost as interesting as she is. The contents are divided into sections by topic, beginning with basic arithmetic through challenging applied geometry problems, like determining the distance between the moon and the earth *(shown on page 25)*. The

story continued on page 25

Honzō Zufu

BY JASON W. DEAN
Vice President for Special Collections

Few books in the Library's collection are as much a labor of love as *Honzō Zufu*. The author and his family spent 14 years creating the work, and the result is an astonishing publication, two volumes of which the Library acquired in 2021. Fourteen years seems quite a long time, and to be fair, it is. The full set of *Honzō Zufu* comprises 92 volumes, or kan, and the bulk of those volumes were produced by hand by the author and his family.

Kanen Iwasaki (本草圖譜) had a keen, lifelong interest in botany, especially the botany of his native Japan. At 23, Iwasaki studied with the noted Japanese botanist Ono Ranzan, referred to by noted scholar of Chinese literature and archaeology Richard C. Rudolph as the "Linnaeus of Japan." Iwasaki spent three months with Ranzan before the botanist's death. Subsequently, Iwasaki

acquainted himself with a number of Japanese scholars described collectively as *rangakusha* (*ran*, short for Holland, and *gakusha*, short for scholar), who were Japan's foremost scholars of western science. Through these scholars, Iwasaki studied several western books on botany. His exposure to these works led to his publication of the *Honzō Zufu*. (本草圖譜)

In 1820, the Japanese government recognized Iwasaki's work sketching and collecting specimens by granting him a plot of land for his use in the old botanical garden in Koishikawa. During his time sketching and collecting, he also published several books, including one on the cultivation and care of ornamental and medicinal plants in 1818, as well as a book on the mountain plants around Nikkô in 1824. By 1828, Iwasaki created a manuscript version of *Honzō Zufu*, and proposed its publication to the botanical society he founded.

Iwasaki proposed to issue his work, illustrated with woodcuts, in 24 series, each series consisting of four volumes. The first four volumes were priced at one ryô (or approximately $1,200 in 2021). Only four volumes were printed due to a lack of financial support and subscribers. Despite interest in his earlier published works, Iwasaki drastically overestimated public interest in his later work. A later Japanese scholar of Iwasaki states that about only 30 copies of each volume were produced.

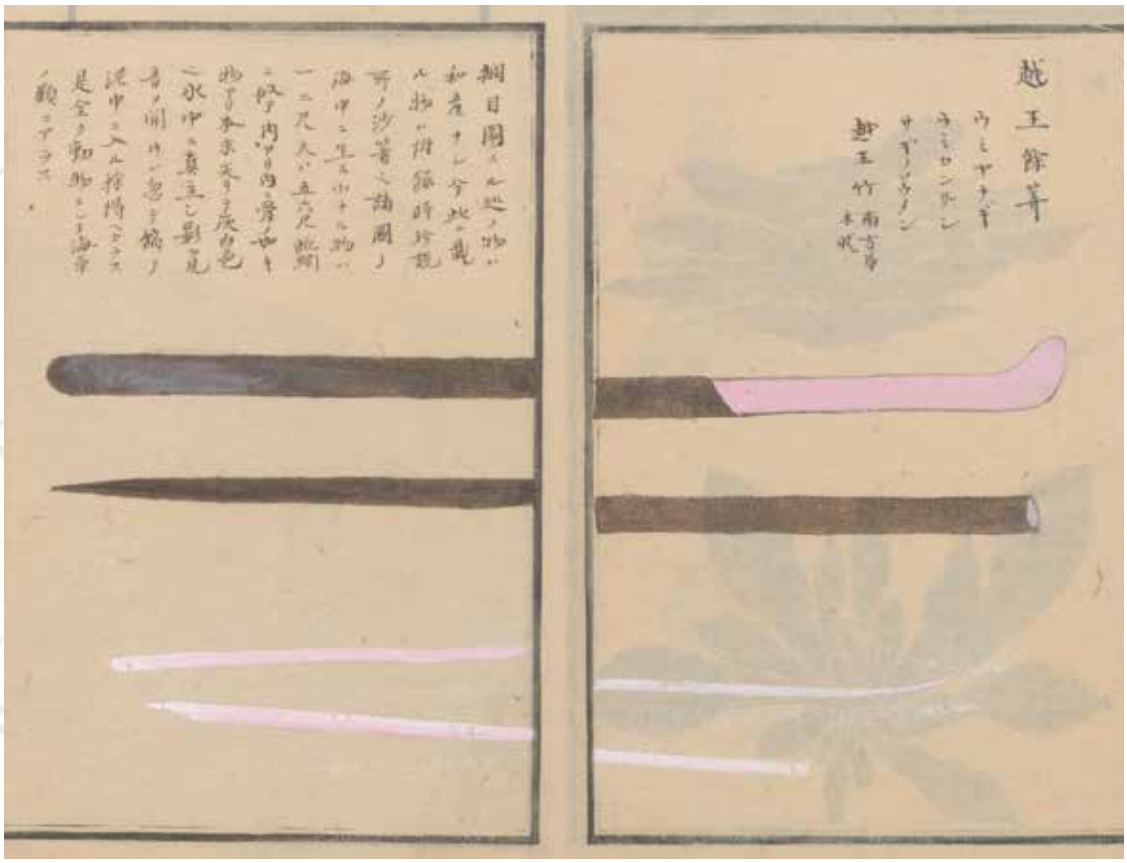
Despite the public's lack of interest, publication of the book continued, albeit utilizing different methods of production. Early volumes (volumes 5-8) were printed in black by woodcuts and hand colored. All volumes after eight are manuscript - the text was written by means of a fine brush and the images are all beautifully hand painted. The Linda Hall Library holds two volumes, *Species of Mountain Plants* (山草類), printed with

woodblocks and hand colored, as well as *Marine Algae* (海藻類), with all manuscript illustrations. Interestingly, the border and publication information for these volumes are all printed, with "Kan'en kaku zō" (灌園閣藏) appearing on the outer fold of each page, indicating that the volumes were issued by the Iwasaki household, and were not later unauthorized copies.

Also striking is how the Japanese book as an object feels both familiar and unfamiliar. Japanese books are read top to bottom, right to left. So, a Japanese book's front seems to be the back to western readers. Japanese books of the age of *Honzō Zufu* are also produced in a different method than the books today. The paper, made of mulberry bark, is markedly thinner and more pliable than western paper. The paper is in long sheets, folded at the outer edge, and sewn together in a style called *fukurotoji* (袋綴). These binding methods are adapted from Chinese book production methods. Due to the string binding, books bound in this style are unable to stand up straight on the shelf, requiring the use of a wraparound case, called a chitsu (帙).

One final question bears answering about the Library's copy of *Honzō Zufu* – why did we acquire an incomplete set from bookseller and friend of the library Jonathan A. Hill? The best estimate is that thirty copies of each volume were made by Iwasaki and his family, making the set rare at the time of production. Also important is that only six complete sets are known worldwide. Therefore, the extreme rarity of the individual volumes, as well as the impossibility of a full set appearing on the market led the Library to acquire the two volumes, which add to our collection of science in non-western languages. Outside of the scarcity of copies, we chose to acquire an incomplete set as there is no other library better equipped to contextualize these volumes in both the Japanese and European traditions. The Linda Hall Library is fortunate in its ability to assure the continued maintenance and availability of Iwasaki's work in perpetuity.

As much as the production of *Honzō Zufu* was a labor of love – so is our effort to acquire, preserve, and provide access to the copy at the Library. Indeed, our two volumes are maximally described in the catalog, and are digitized for individuals to see the world over.


越王餘甘
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昆布
コブ
エビスノ
ヒロノ
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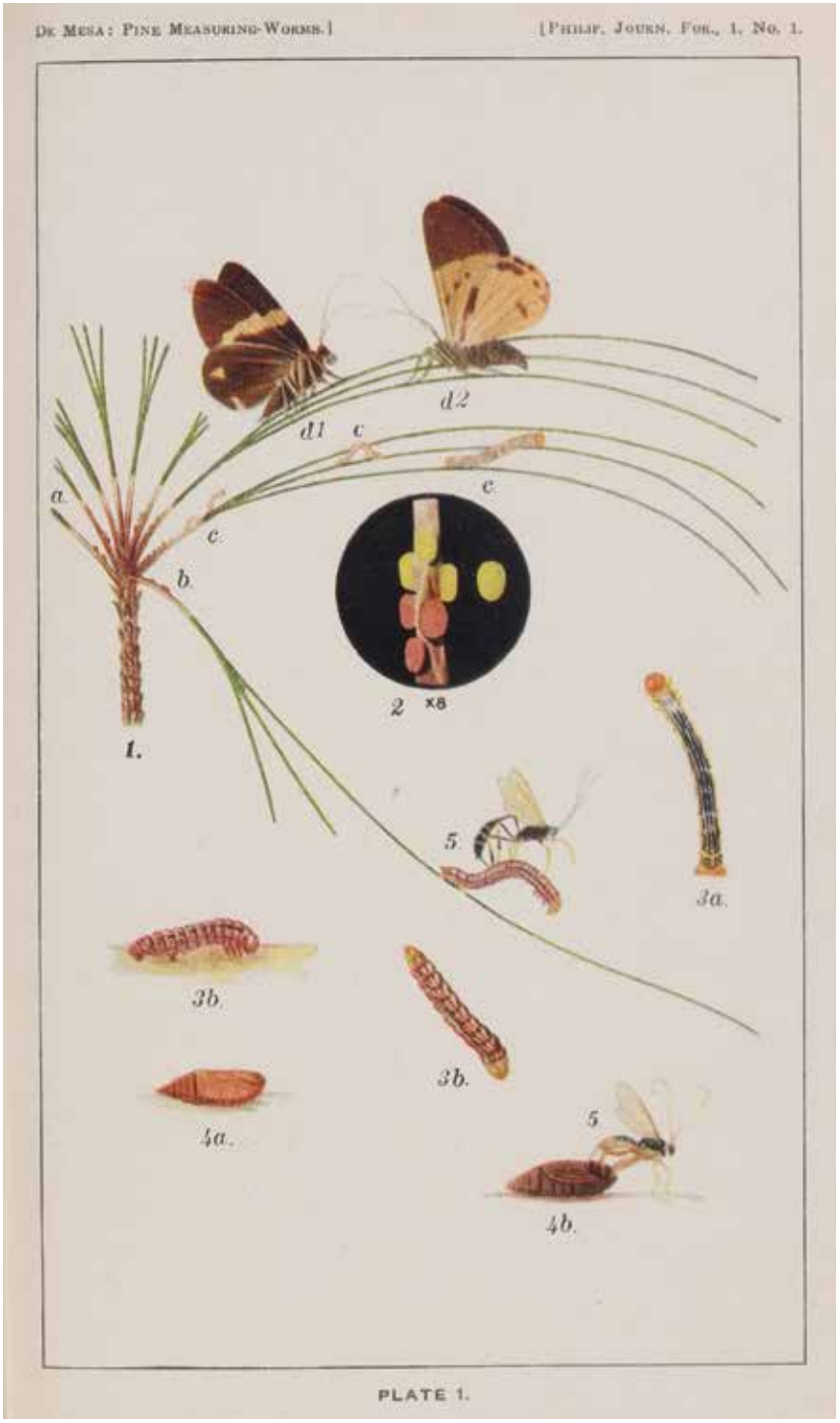
Asian Science is in the Spotlight

BY BEN GIBSON
Digital Initiatives Manager



I t's fascinating how when you are looking forward, you don't know how things are going. But when you look back, you can perfectly connect the dots and see how everything linked together.

When Professor Feng Zhang made this statement, he did so in reference to his involvement in research that was central to the development of optogenetics and CRISPR technologies. Professor Zhang's comment also speaks to one of the primary reasons for the Linda Hall Library's digitization program which is also a driving force behind the CRL/LHL multi-year digitization project to broaden access to historical scientific journals that are not available elsewhere in electronic form. By digitizing these rarely held journals, the Linda Hall Library and the Center for Research Libraries are ensuring their continuing availability on a digital platform.

After digitizing 125,000 pages from 24 Latin American science journals published in 11 different nations and the U.S. territory of Puerto Rico, CRL and LHL are turning their attention to materials from other underrepresented regions by focusing on scientific journals

This plate from the *Philippine Journal of Forestry* illustrates distressed pine needles, adult moths, their destructive pupal stage, and pupae in both healthy and parasitized condition.

Fig. 42. The Kannon Temple at Kamahara, built before the Temmei period. The front stone stair, which consisted originally of 120 steps, had the lower 105 buried by the Volcanic Avalanch of 1783, there remaining since then only 15 steps.

Fig. 43. Bell of the Jorinji Temple. The temple and bell-tower were entirely destroyed by the Volcanic Avalanch of 1783, and this bell which remained buried under the mud for 127 years, was discovered in 1910 from the bed of the Azuma-gawa. (T. Kato, photo.)

Bulletin of the Imperial Earthquake Investigation Committee, Vol. 6, issue 1. Tokyo. March 1912.

published in Asian nations. Digitization of the selected Asian journals began in June 2021 and to date, more than 12,931 pages have been scanned of the entire project's estimated 125,000 pages.

As in past years, most of the journals selected for inclusion were published, in whole or in part, before 1926, and their digital surrogates eventually will be accessible through the Linda Hall Library's online catalog. Care was taken to include materials from underrepresented Asian nations and as a result, the project includes five journals published in the Philippines, three from Malaysia, two from Indonesia, and one from Thailand along with more well-known titles from China, Japan, and India.

One of the most important attributes for materials chosen to be part of the CRL/LHL project is that they are currently unavailable, or only partially available, in digital form. Of additional importance is that a significant number of the selected titles appear in both the Linda Hall Library's and the Center for Research Libraries' collections. The slate of journals to be digitized for the Asian project satisfies both objectives with 15 of the 38 final candidates held by both institutions and only 14 titles partially available online. The 15 shared titles will make up more than 60 percent of the project, and of these 15 titles, only two are partially available online.

Consistent with the Latin American project, the topics of concentration in the Asian project will be meteorology, astronomy, and agriculture. But given the importance to the region of the Pacific Ring of Fire, the string of volcanoes and other sites of seismic activity that circle much of the Pacific Ocean, journals focusing on geology and seismic activity will be well represented. Ten of the journals chosen are dedicated

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to geological science, including two Japanese journals, the *Bulletin of the Imperial Earthquake Investigation Committee*, and the *Seismological Notes of the Imperial Earthquake Investigation Committee*, along with the *Indonesian Seismological Bulletin* which concentrate specifically on seismic activity.

As was true with the Latin American project, the Asian journals were selected not only because they record the dots along the path of scientific progress, but because they offer snapshots of contemporary life in their countries. Japan's *Bulletin of the Imperial Earthquake Investigation Committee* clearly illustrates the impact of volcanic activity on the course of scientific research and on the daily lives of Japan's population and its cultural path. The 1912 volume examines the history of eruptions and earthquakes of the Asama-Yama, a complex volcano located on Japan's main island, Honshu, where activity dates from the Pleistocene era. To improve the ability to predict future seismological events, information about the elevation of the crater bottom, velocities of eruptions, and mapping of their audible range were included. But so too were detailed accounts of the effects and lasting impacts of the eruptions, a great deal of this information focusing on the catastrophic eruption of 1783. Mount Asama most recently erupted in 2009, blanketing the town of Karuizawa in ash, throwing rocks as far away as a kilometer. This event occurred a mere two years after Mount Asama was imaged by the tracking of sub-atomic particles as they traveled through the volcano's interior, a recent example of efforts to improve the ability to predict eruptions.

Less critical, but also offering a glimpse into the intersection of science and civic life, is the story of the successful battle to save the Pine Forest of Baguio from a sudden and never encountered before infestation of millions of Milonia coronifera. Baguio, Philippines, was known as the City of Pines, but in 1934 and dramatically intensifying in 1935, an unprecedented number of pine-needle measuring worms threatened to destroy the forest. A 1938 issue of the *Philppine Journal of Forestry* details the struggle between Agricultural Experient Station personnel, members of the Bureau of Plant Industry, and the millions of unwanted pests destroying the pine forest.

Chemical and biotic control methods were tried, but the caterpillars were eventually conquered not by tachinid flies, lead arsenite, or nicotine sulphate, but instead by the efforts of a dedicated group of citizens who collected the pine-needle measuring worms by hand. And although there are far more sophisticated ways of controlling these pests today, the first recommendation for clearing them from the pine tree in your backyard is still to knock them from the branches or remove them along with the branches they have infested.

The Asian Scientific Journal Digitizing Project will continue through 2021, with journals in the public domain joining the digitized journals from the Latin American collection. These digitized journals will remain available through the Library's online catalog where you can search for some of Professor Zhang's connecting dots and explore the efforts of women and men around the world who created the necessary links to the discoveries of today.

Back to School

(continued from page 17)

composition of the volume itself tells us a bit about how she learned. The volume is made up of several smaller notebooks, generally of about 24 pages each, numbered sequentially (except for section 12, which she repeats 8 times). Each of these notebooks corresponds to different topics and lessons, which Susanne likely carried with her and completed as she progressed through her studies. At the end of her course, she had a tidy, numbered record of the work she had done, which she collected into a single representative volume. The first and last pages, where she shares the date she completed her work and supplies a detailed index, were added last. She had the finished product bound up in a piece of what was, to her, scrap parchment, but is to us a valuable artifact: a legal document from the late sixteenth century. No longer useful as a contract, it found a second life protecting the scholarly achievements of a precocious thirteen-year-old girl.

Despite what we know about it, this manuscript presents more questions than answers: why was Susanne allowed to progress so far in her schooling? Did she aspire to goals other than marriage? Were other young women learning alongside her? Was she truly exceptional, or have other, similar schoolbooks from young women simply not survived? The Linda Hall Library collects similar items to prompt us and future scholars to seek and find answers to those questions. Material evidence like Susanne-Victoire Auvray's notebook allows us to peer into the lives of people working in the margins of science history and create a more comprehensive picture of scientific thought.

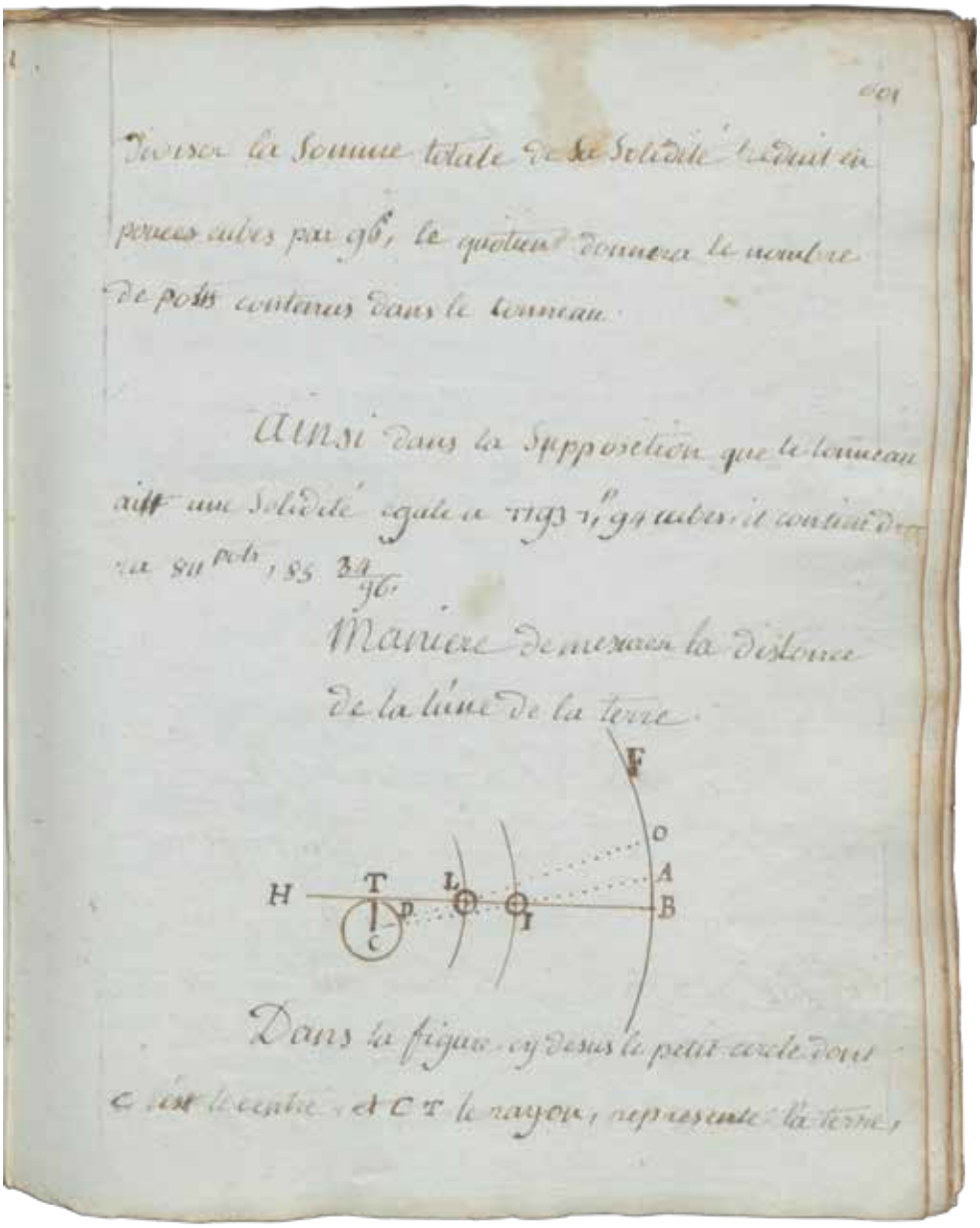

Diagram showing how to determine the distance between the moon and the earth, from Susanne-Victoire Auvray, [*Educational Manuscript*], Monceaux-en-Bessin: 1801.

History of Stereo *(continued from page 15)*

In this position, Fletcher's key insight was that further improvements to the sprawling AT&T telephone system could best be accomplished by research focused on speech and hearing. He reasoned that to improve the audio quality of the telephone, BTL must first understand how customers actually communicated in everyday life. To this end, Fletcher's team endeavored to create a telephone system that would be aurally indistinguishable from a face-to-face conversation with someone standing roughly one meter away. This goal entailed a lengthy period of research in which BTL used the data from innumerable hearing tests to determine the ideal ranges of intensity and frequency (i.e., loudness and pitch) for oral communication. However, even the prototype telephones designed for these high-fidelity specifications failed to produce the sense of auditory presence that had been Fletcher's goal. The BTL engineers had a breakthrough with the realization that the illusion of face-to-face speech was only possible through two microphones paired with two earphones, which simulated the experience of listening with two ears, or "binaural" hearing.

With the seemingly obvious discovery of the importance of binaural hearing, Fletcher's team hit upon a little-understood aspect of human hearing that would become central to Fletcher's research program. Previously, BTL engineers had treated hearing as essentially monoaural, which was quantified in terms of only intensity (measured in decibels) and frequency (measured in cycles per second). The issue of auditory perspective introduced by binaural hearing had been only intermittently studied in the history of acoustic science, leaving Fletcher's team without a numerical basis to measure the success of their telephonic reproduction. With little research to go on and no binaural technologies to employ, BTL designed experimental apparatuses to better understand spatial hearing. A particularly striking example of such a device was the whimsically named "Oscar"—a former tailor's mannequin with microphones installed as ersatz ears. Notwithstanding Oscar's popularity as an interactive demonstration of binaural telephony at the 1933 World's Fair in Chicago, Bell Labs soon abandoned this line of research in terms of communication technologies. Lacking both a clear application for telephony and a firm numerical basis to describe auditory perspective, Fletcher turned to the arts to shape the future of multichannel sound.

Famed Philadelphia Orchestra conductor Leopold Stokowski first became involved with Bell Labs due to his interest in the electronic reproduction of music. Stokowski was interested in making his orchestral music widely available to the general public via disc recordings and radio broadcast, but was displeased by the state of audio fidelity at the time. Fletcher and the other engineers at BTL were eager to bring in the conductor as a consultant to offer advice on aesthetic issues of musical reproduction that fell outside of the technical domain of acoustic science. In addition to improvements in noise reduction and tonal quality, Stokowski was particularly taken with binaural reproduction, which he wrote gave music "a sense of space, of direction, and considerably more definition." Compared to monoaural listening, he believed that in "listening binaurally the music sounds free, spacious, and the choked sensation is gone. It is as if one can breathe entirely freely." In his writing on the subject, he comes back to the themes of presence that binaural sound can provide, which could create the illusion of being aurally transported to the space of the Academy of Music in Philadelphia.

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However, unlike the earlier telephonic experiments to recreate the auditory experience of face-to-face communication, Fletcher and Stokowski's work on binaural reproduction was driven by hazier aesthetic considerations rather than the goal of transparent aural fidelity. Most notably, rather than placing a pair of microphones roughly six inches apart in the seats of the auditorium—an arrangement that would most faithfully reproduce the position of a listener in the auditorium—the conductor determined that the musical transmission sounded best with a pair of microphones placed several feet apart directly next to the orchestra. Accordingly, the arrangement of the microphones created a unique aesthetic experience of the concert hall space that was uncoupled from earlier telephonic attempts to replicate normal binaural audition. As Stokowski's involvement would suggest, the early history of stereo is shaped as much by aesthetic considerations of the creative representations of space as it was by the initial research in binaural hearing.

BTL's last major contribution to the early history of stereo was the decision to reproduce multichannel sound via loudspeakers rather than by headphones. Because of Bell Lab's corporation with Western Electric—a major player in the early days of motion picture sound—applications for multichannel sound in theaters became a clear priority for Fletcher. It was in this shift from headphones to loudspeakers that engineers began making a distinction between strictly "binaural" sound, which primarily used headphones to recreate the auditory perspective of everyday hearing, as compared to stereophonic sound, which generally employed loudspeakers to create an aestheticized representation of acoustic space. With the use of two or three loudspeakers, stereophony fills the space of the auditorium with an approximate representation of another place, whether that is Philadelphia's Academy of Music or the fictional world of the cinema screen.

It was the possible cinematic applications that lead to BTL's stereo demonstration at Carnegie Hall. With an eye towards a possible use in theatrical exhibition, the various musical selections created by Stokowski and others were ultimately recorded and played back on versatile medium of film stock. Without an accompanying image track, Fletcher's team used standard 35mm film to record three channels of sound—to be played out of speakers arranged on the left, center, and right of the stage—plus a fourth "control" track that stored metadata to automatically adjust volume and frequency during playback. Although the Carnegie Hall concert featured little visual accompaniment, this left-center-right stereo setup designed by BTL would become the standard when Hollywood aggressively adopted multichannel sound to accompany the widescreen cinema craze of the 1950s.

Although Fletcher and Stokowski's collaboration culminated in the 1940 stereophonic demonstration at Carnegie Hall, the research pioneered at Bell Labs was already being employed by a variety of other organizations interested in possibilities of multichannel sound. Stokowski notably collaborated with RCA and Disney to create the stereophonic soundtrack of the film *Fantasia*, and also consulted with early forays into stereo at Philips in the Netherlands. In England, Alan Blumlein forged a parallel path in stereophonic research under the employment of EMI. Although World War II put an end to this period of research and development, the work done by Bell Labs in the inter-war period set the stage for hi-fi stereo boom of the 1950s, in which multichannel sound became *de rigueur* for audiophiles and cinephiles alike. In the ensuing decades these early developments in binaural and stereophonic sound at BTL have continued to shape how we experience recorded sound into the twenty-first century.

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October Glory Maple located on the Library's grounds. Photo by Samantha Sanchez

LINDA HALL LIBRARY
HEDGEHOG
NUMBER 67 • Fall 2021

The Fall 2021 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.

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