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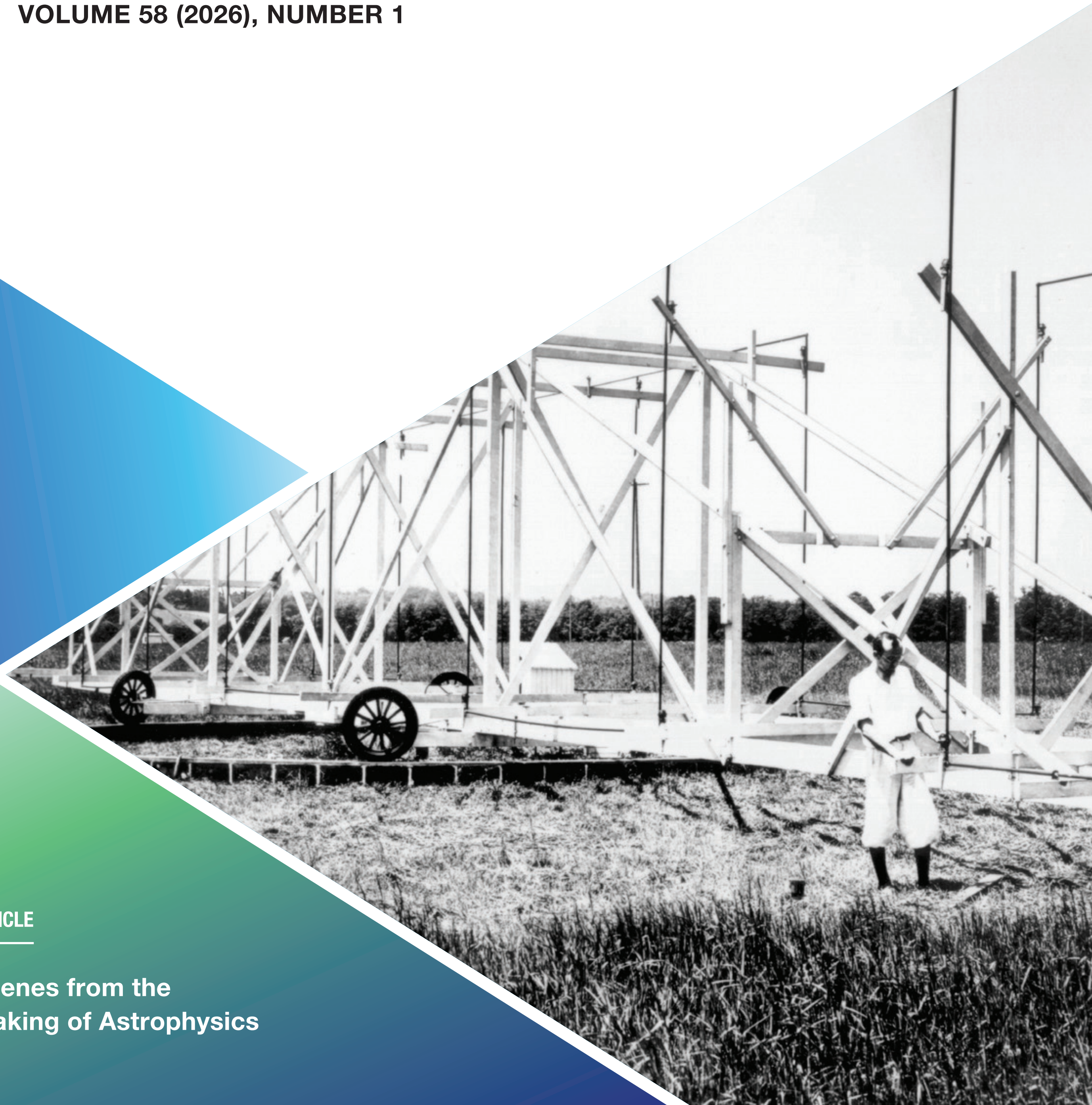

FEATURED ARTICLE

20 Scenes from the Making of Astrophysics

ABOUT THE NEWSLETTER

The *History Newsletter* is a biannual publication of the American Institute of Physics, 1 Physics Ellipse Dr., College Park, MD 20740; email: **history@aip.org** or **nbl@aip.org**. It reports on the activities of the history, library, and archives programs at AIP and on related activities elsewhere.

Any opinions expressed herein do not necessarily represent the views of the American Institute of Physics or its Member Societies. The *Newsletter* is available on request without charge, but we welcome donations (tax deductible) (**foundation.aip.org**). The *Newsletter* is posted online at **https://www.aip.org/research/resources**.

Cover photo: Karl Jansky's rotating antenna nicknamed "Jansky's merry-go-round." Courtesy of NRAO/AUI/NSF.

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DIRECTOR'S INTRODUCTION: PAINTING THE BIGGER PICTURE

By William Thomas, Spencer R. Weart Director of Research in History, Policy, and Culture

Among the great challenges in writing about history is finding ways to cover its broad landscape, rather than allowing our knowledge to cluster around a handful of popular but narrowly delimited topics. Of course, certain subjects continually reward our attention: Albert Einstein will always intrigue historians of physics. Yet, there is so much more history out there, we hope we can be forgiven for being just a little daunted by the task of trying to address the bigger picture in some systematic way.

One way forward is simply to recognize that we need to start somewhere and to find ways of stepping outward from well-trodden environs. As with Einstein, the revolution in quantum physics has attracted perennial interest, and scholars are now approaching the subject in innovative, horizon-expanding ways. For example, Alexei Kojevnikov's *The Copenhagen Network*, published in 2020, takes a much broader view of the community that built quantum physics than is provided in the more usual stories. Similarly, last year's *Women in the History of Quantum Physics* (WiHQP) volume uses women's place in the quantum revolution to deepen our understanding of the kind of research that underpinned the revolution's most familiar achievements.

Starting later this year, AIP will support two international projects through our newly reconfigured Robert H. G. Helleman Memorial Grant Program: "Experimental Cultures Across Borders: Transatlantic Networks and the Making of Quantum Chemistry" and "CTRL-Q—History of Quantum Control: Concepts, Phenomena, and Instrumentation." Focusing on two different periods, these projects will examine the emergence of entire quantum disciplines and, in doing so, help us better understand the sweeping, cascading, long-term consequences that the quantum revolution has had for science and technology. I encourage you to read more about these projects and the people behind them in this newsletter.

Another way of looking at the "broad landscape" problem is to consider how we can take disparate contributions to the historical literature and connect them into a more unified whole. We have been publishing our "Weekly Edition" email newsletter for over a year now, and, while we have been very happy with it, we also want it to add up to something more than a series of fascinating vignettes. Our solution to this is web-based resources that we call "history guides."

Picking up the baton from earlier web exhibits and teaching guides, history guides will provide information about discrete subjects, but they will also build connective tissue between subjects. In this issue, you can read about our first guides, which were developed in partnership with members of the WiHQP collaboration to provide summary and supplemental material for their chapters of the WiHQP book. These guides will naturally connect to future guides on the history of quantum physics, but one guide we have already posted, on Williamina Fleming and the Pickering series of spectral lines, likewise connects to the history of the Harvard College Observatory and its central place in the history of astrophysics.

And by the way, there has recently been an abundance of great work on the long history of astrophysics, some of which we have covered in our "Weekly Edition." This includes Jennifer Bartlett and Thomas Hockey's recent article on the 1869 eclipse's role in launching American astrophysics, Helge Kragh's article on the place of antimatter in cosmology, and a special issue of *Centaurus* on the history and prehistory of multimessenger astronomy. Rebecca Charbonneau's feature article in this issue sketches out a broad picture that we will further develop through our online guides in the months and years ahead.

The Helleman program and the history guides are new tools, and we are still learning how to use them most effectively. We also know it will take time before what we create with them starts to genuinely look like a unified picture. But one other feature of these tools is that they are designed for collaboration, and the task ahead is not as daunting as it might be because we know we'll have a lot of great help.

Invest in the next generation of science historians!

AIP's Niels Bohr Library & Archives (NBL&A) preserves the stories and papers of scientists who shaped our world. Genesis Boykin, a Hampton University graduate, served as an archival intern at NBL&A. She processed the papers of Gloria Lubkin, a longtime editor-in-chief of AIP's *Physics Today*.

By organizing documents and creating a finding aid, Genesis helped make this collection accessible to researchers, preserving Lubkin's legacy.

Will you support AIP's research, history, and archival programs, including NBL&A internships, to preserve the human stories behind scientific discovery?

INTRODUCING AIP'S INAUGURAL HELLEMAN GRANTS

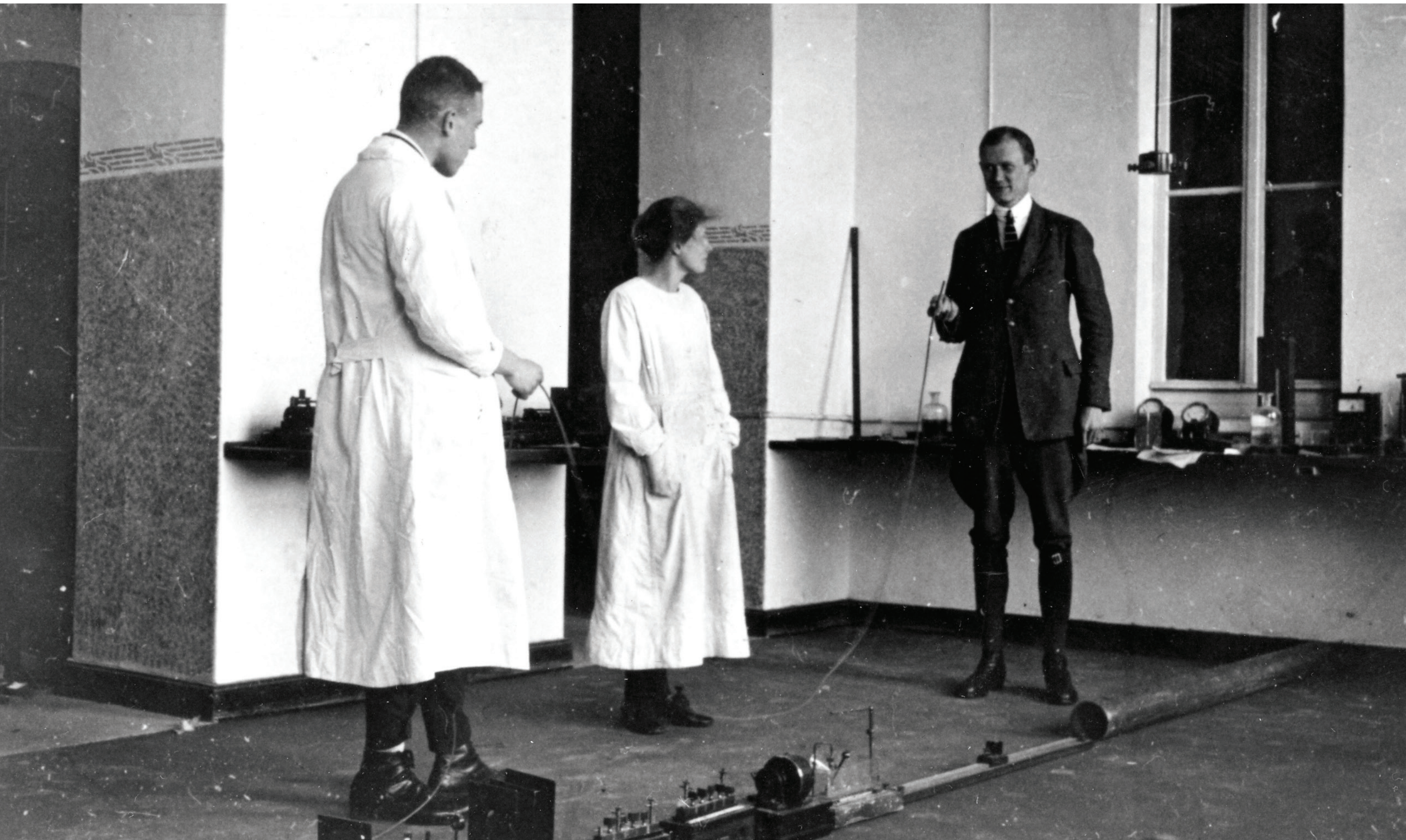
Last year AIP launched a new phase in its Robert H. G. Helleman Memorial Grant and Fellowship program with the aim of fostering international collaboration and career development in the history of the physical sciences. Grants provided through the program will provide $150,000 per year for a period of two years, with the possibility of extension, and project proposals were required to include at least two institutions in different countries.

We received eleven applications, all of which responded creatively to the stipulations in our call for proposals and presented compelling ideas that were quite worthy of support. To help us make the difficult decision of which to fund, we convened a panel of external experts in late April, and we are now happy to announce the inaugural recipients of our Helleman project grants.

While our panel selected these projects based on their individual merits, we are enormously pleased that they form a powerful tandem in their examination of the role of experimental cultures in the creation of new quantum disciplines. Additionally, each has a hub in Munich, Germany, holding out the prospect for direct collaboration between the projects. We are proud to play a role in enabling this sort of initiative, and we are grateful to Robert Helleman for his generous bequest to AIP, making this program possible.

EXPERIMENTAL CULTURES ACROSS BORDERS: TRANSATLANTIC NETWORKS AND THE MAKING OF QUANTUM CHEMISTRY

This project is a collaboration between Andrea Reichenberger (Technical University of Munich), Elise Crull (City College of New York), and Patrick Charbonneau (Duke University) that will entail hiring a Munich-based postdoc to investigate the role of experimental molecular spectroscopy in building the field of quantum chemistry between about 1920 and 1940. The research extends from Crull's work on the spectroscopist Hertha Sponer for the Women in the History of Quantum Physics collaboration, which, by coincidence, she presented at AIP this spring as part of our Lyne Starling Trimble public event series.



By recovering the history of spectroscopy experimentation from archival sources, this project will shed light on an almost "industrial" mode of research geared toward producing incremental refinements and shared technical standards. That exacting work laid essential foundations for the elaboration of theoretical treatments, allowing quantum mechanics to escape its initial applications to simple physical systems so as to illuminate chemical properties and processes.

This history also has important social and political facets that shaped the spread of spectroscopic practices. The rise of European fascism forced the emigration of Sponer and other major players from continental Europe, and a central role was played by an extraordinary network of women that included Sponer, Luise Lange, Hedwig Kohn, Hildegard Stücklen, and Charlotte Houtermans.

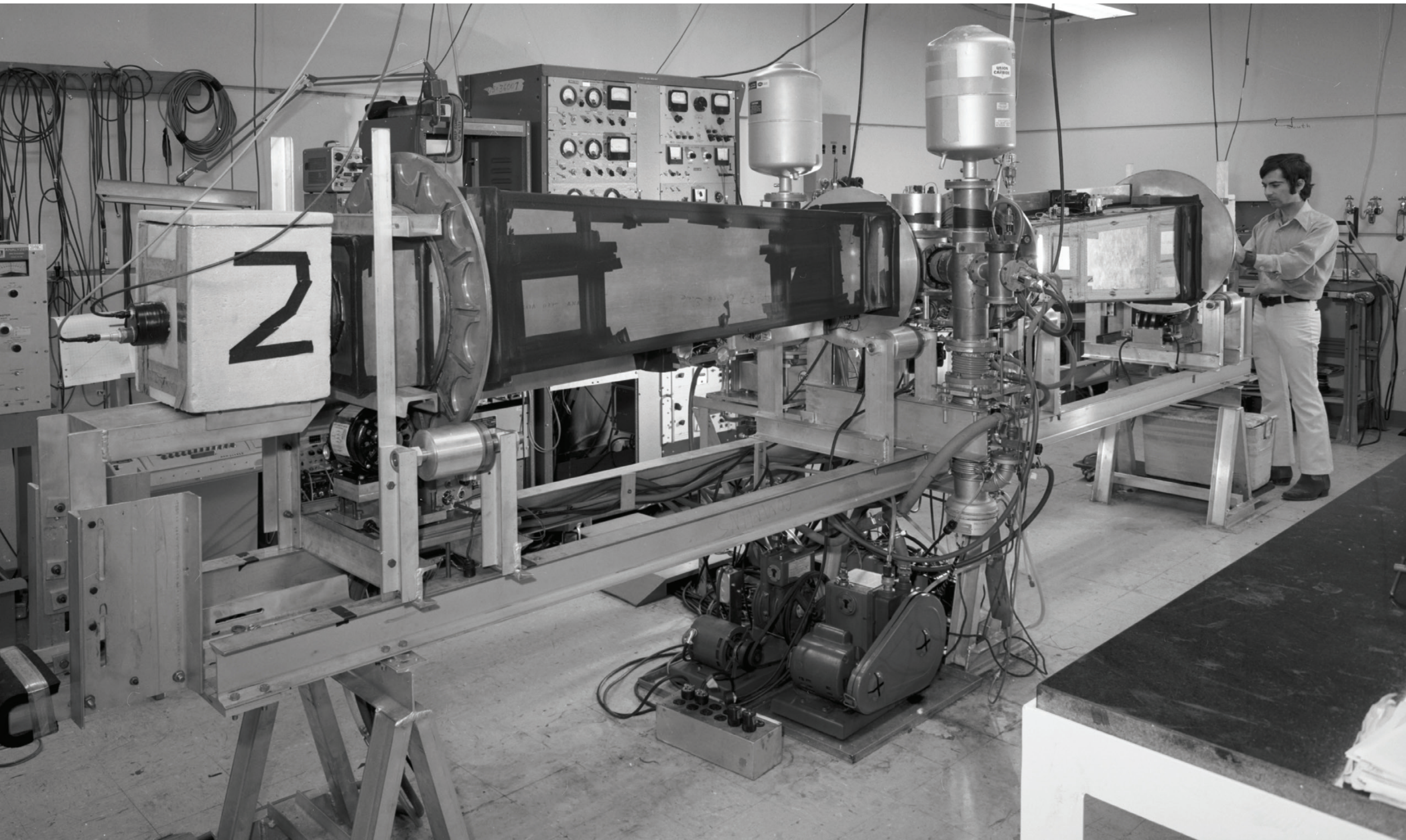
CTRL-Q—HISTORY OF QUANTUM CONTROL: CONCEPTS, PHENOMENA, AND INSTRUMENTATION

This project is a collaboration between Johannes-Geert Hagmann (Deutsches Museum), Jinyan Liu (Institute for the History of Natural Sciences, Chinese Academy of Sciences), and Climério Silva Neto and Olival Freire Jr. (Federal University of Bahia). Rather than supporting one or two students or early-career scholars for the duration of the project, this collaboration aims to build an international research network for training a new generation of historians of quantum physics. It will do so by supporting short-term visiting arrangements, fieldwork campaigns, and workshops and summer schools. In addition, the involvement of the Deutsches Museum offers outstanding capabilities for broader outreach.

The project will expand on the groundwork of scholars such as Freire and the late Joan Bromberg in investigating the role experimentation played in stoking scientific interest in the foundational quantum phenomena that are at the root of present-day fields such as quantum computing. Again by coincidence, this is the same subject we spotlighted in our "Entanglement and Experiment" article in the previous issue of this *Newsletter*. Moving beyond studies of crucial developments, the project will take a global approach to its subject, investigating work not only in North America and Western Europe, but also places such as the Soviet Union, Brazil, Japan, and China.

Bottom left: Hertha Sponer, center, with Wilhelm Hanle, left, and Günther Cario in 1925, from Sponer's Göttingen photo album. AIP Emilio Segrè Visual Archives, Franck Collection.

Bottom right: Stuart Freedman with an experiment that he and John Clauser used to test Bell's theorem in the early 1970s. © The Regents of the University of California, Lawrence Berkeley National Laboratory.



VINCENT FEMIA JOINS AIP AS POSTDOCTORAL FELLOW

Vincent Femia

AIP has a long tradition of employing early-career historians on a rotating basis, starting with ones hired to assist with special projects and expanding in the mid-1980s with a three-year postdoctoral position, which offered its holders an excellent opportunity for independent work and career development. Since 2020, though, that postdoc program has been on hiatus as we shifted resources into building up our permanent staff of historians.

Thanks to a privately funded endowment, we were able to restart the program last year, with the postdoc now referred to as an AIP History Fellow. We ran a search over the winter and interviewed several highly qualified candidates, and we are pleased to announce that in August we will be joined by our latest fellow, Vincent Femia.

Femia is a historian of modern American science and urban history and received his PhD last year from the history department at Princeton University, where he was a student of Michael Gordin and Alison Isenberg. For the last year, he has been working here in Washington, DC, at the Smithsonian Libraries and Archives. His work focuses on the interactions between science, governance, and urbanism in the late 19th and early 20th centuries, with particular emphases on histories of scientific labor, state science, geographies of science, and public and civic cultures of science education and communication.

During his time at AIP, Femia will be working on his first book, *Magnificent Distances: The Rise and Fall of the Capital City of Science, 1862-1920*, which tells the story of what he calls "capital science," a period in Washington's history of symbiosis between scientific boosterism and urban boosterism. While historians have largely explained the growth of state science after the Civil War through institutions (the Smithsonian, the Geological Survey, the National Academy of Sciences) and disciplines (biology, physics, anthropology), this book reveals how the rise of scientific Washington is also a story of urban development.

Magnificent Distances argues that scientists often understood Washington's institutions to be weak, impotent, and, at times, hindrances to the change they wanted. So, they turned to lobbying, politicking, collective organizing, and civic and development projects in a city that aspired to "national" and eventually "model" status after the Union victory in the Civil War. Their efforts took many routes. Architect-engineers controlled municipal improvements; astronomers became lobbyists; naturalists negotiated land development; social scientists pursued uplift through neighborhood reform and institution building; and chemists guarded the city's public health in their efforts to achieve national regulation.

The capital science vision, moreover, was not confined to those in federal employment. Many women who were barred from scientific employment made their own claims to the capital city of science, organizing in alternative spaces and using the city itself as a site for science. And in this period, black intellectuals forged their own institutions for communicating political and scientific ideas, side by side, drawing on capital science boosterism to foment both black leadership and a distinct politics of racial uplift.

Femia began to develop his interests in this area while an undergraduate at Kenyon College, where he worked with history professor Anton Matytsin and physics professor Benjamin Schumacher to chart a self-directed path in the history of science. His honors thesis was on the social politics of the Royal Astronomical Society in the 19th century, focusing especially on amateur astronomer Richard Carrington. In 2016 he studied the history and philosophy of science as a visiting student at the University of Oxford, and he continued his research in the history of science as an MPhil student at the University of Cambridge.

Drawing on research at the Library of Congress, Smithsonian, and other archives, Femia has published articles in the *Journal of Urban History*, *Isis*, and the *Journal of the Gilded Age and Progressive Era*. The last of these examined the political ideas of astronomer Simon Newcomb, arguing his advocacy on subjects ranging from federal support for science to currency reform were closely linked to his life as a Washington resident. During his time at the Smithsonian, Femia also organized a four-part discussion event series, "City of Knowledge: Science, Place, Power," with each discussion held in a different venue, including one here at AIP this past February.

Femia's work has earned several awards, including a Landon Warner Research Grant from Kenyon College to travel to the Royal Greenwich Observatory Archives, held at Cambridge University Library, and the college's Curtis A. Seichter Award for demonstrated excellence in the study of history. At Princeton he received the Philip G. Terrie Award, the Dean's Completion Award, and a Smithsonian Predoctoral Fellowship.

In his spare time, Femia writes music for the guitar and voice (with a love of alternative rock, jazz, and classical music from the 19th and early-20th centuries), plays in a band in DC with a couple of friends, cooks elaborate meals with his fiancé, explores the DC restaurant and bar scene, attempts to balance pleasure reading with his scholarship, and travels to see friends who are dotted around the globe.

PREVIOUS AIP HISTORY POSTDOCS

1985–1989: Finn Aaserud

1989–1993: Ron Doel

1997–2000: Alexei Kojevnikov

2000–2003: Patrick McCray

2004–2007: Babak Ashrafi

2007–2010: Will Thomas

2011–2014: Alex Wellerstein

2014–2016: Teasel Muir–Harmony

2017–2020: Gabriel Henderson

HISTORY GUIDES MAP THE PAST

AIP has a long track record in bringing the history of the physical sciences to new audiences via the internet, initially through the production of web exhibits, each of which has had an individually tailored graphic design and user interface. In the 2010s, we added teaching guides, providing materials specifically crafted for schools. This year we launched our first "history guides," which employ a common template that will make it easier to produce new guides, to update their design, and to link different guides together, creating a kind of map that lets users navigate their way through history.

We will produce many of these guides ourselves, but we also expect to work with historians and scientists outside AIP to produce others. Two years ago in this newsletter, we previewed our partnership with the Women in the History of Quantum Physics (WiHQP) working group. Now, with a new web platform and the history guide template available to us, we are beginning to release the results of this partnership to the public at **aip.org/history**.

The first history guide we posted is on Lucy Mensing, who had a promising but brief career in physics in Germany, right in the middle of the quantum revolution. The guide's designers, Michel Janssen and Gernot Münster, provide not only a summary of biographical material in their chapter on Mensing in the WiHQP book, they also offer an expanded analysis of Mensing's most important scientific contributions, images of Mensing's handwritten reminiscences from 1989 along with a transcription and translation, photos donated by Mensing's daughter to AIP's Emilio Segrè Visual Archives, and embedded video of Janssen's Lyne Starling Trimble lecture on Mensing in 2024.

We have also posted a guide on Williamina Fleming, developed by Maria McEachern and Bretislav Friedrich of the WiHQP collaboration. It recounts Fleming's extraordinary career as a computer at Harvard College Observatory and focuses closely on her discovery of the Pickering series of spectral lines and their significance for quantum physics and astronomy. The Fleming guide is paired with a second guide on the influential developments at Harvard College Observatory under Edward Pickering, its director from 1877 to 1919. It covers contexts crucial for understanding Fleming's career, including Pickering's employment of women computers, his systematic use of photographic methods, his raising and use of philanthropic funds, and his support for the stellar classification systems developed by Fleming and Annie Cannon.

A virtue of the history guide format is that guides can evolve. They can start small and expand later as time allows and new materials become available, and they can also be amended to incorporate new scholarly findings. As of this writing, we expect to soon launch a new guide collecting essays written by scientists who worked at Bell Labs after 1980. It will begin with a small set of essays and expand as others already in hand are edited, and those essays will hopefully inspire the writing of others. And our overall collection of guides will grow as well, with islands of information soon joining together into full historical landscapes.

AIP's policy research team is using the same guide format in its work and earlier this year launched its first guide, on the swirl of developments in US visa and immigration policy that are affecting scientists under the second Trump administration. This area of policy is just one corner of a set of mostly dismaying events that surely represent the most significant shifts in American science policy since the middle of the 20th century. By compiling information about these changes now, it will save the effort of having to recover that knowledge from the historical record later on.

Thus, our highest hope for these guides is that they will blur the distinction between history and current events, creating a more usable historical record for not only historians, but also the scientists, science administrators, and policymakers of the present.

Top right: Lucy Mensing, at center left, on an excursion to the Black Forest in either 1927 or 1928. She would soon marry physicist Wilhelm Schütz, facing her. AIP Emilio Segrè Visual Archives, Mensing Collection, Gift of Dr. Dorothea Roloff.

Bottom right: Reminiscences Lucy Schütz recorded in 1989 about her early career in physics. Michel Janssen and Gernot Münster have transcribed and translated the document, which can be read in its entirety in AIP's new history guide on Mensing. Courtesy of Dr. Dorothea Roloff.

Rückerinnerung Jan. 87

Mein Dr. Diplom

Hamburg 30. März 1925

Die Prüfung wurde vorverlegt, weil ich auf der göttinger Tagung über ~~die~~ meine Dr. Arbeit vortragen sollte.[1]

Ich erhielt ~~eine~~ Prämie von 500 M. Da ich das Leben ~~dort~~ bei der göttinger Tagung kennengelernt hatte (viel mehr ~~Kontakte zwischen Professoren u. Studenten~~ ~~bauts~~ benutzte ich die Prämie ~~das Geld~~ für ein weiteres Studienjahr in Göttingen, Ostern 1925 kam gerade zu der Zeit, als die neue Quantentheorie durch Heisenberg begonnen hatte. Interessante Zeit in der Physik! Ich aß mit Heisenberg u. Hund zu Mittag. Ostern 1926 zurück ~~in~~ nach Hamburg, wollte ich mich aufs Staatsexamen vorbereiten.

Da bekam ich ein Angebot von Landé, zu ihm als Assistentin zu kommen nach Tübingen. Er hatte

[1] Verhältnis von Profes., Assistenten u. Studenten

2)

eine Stelle durch die Notgemeinschaft bekommen.

Ich fuhr daraufhin im August 1926 nach ~~Göttingen~~ Tübingen. Pauli in Hamburg ~~schlug~~ hatte mir ~~vor~~ (geschlagen), den Ramsauer-Effekt (großer Wirkungsquerschnitt der Edel~~gase~~ Atome (?!) nach der neuen Quantenmechanik zu berechnen.

Die Situation in Tübingen war folgende: Gerlach beherrschte das Institut, hatte wohl etwa ~~20~~ 15 Doktoranden. Sein einziger Assistent war Dr. Schütz. ~~Landé hatte ein Zimmer~~ als A.O.-Professor Landé hatte ein Zimmer im Erdgeschoß, in das für mich ein 2. Tisch gestellt wurde. Als gemeinsamen Raum gab[2]

Dann hatte Dr. Back noch einen Arbeitsraum, ein ganz übertrieben bescheidener Mensch (sicher älter als Gerlach), der sich immer bei den Studenten entschuldigte, wenn er (anstatt Gerlach) für ~~Gerl.~~ ~~lesen~~ die Vorlesung halten mußte.

Er hatte ein wichtiges Experiment gemacht, ich glaube, auf dem Gebiet der Optik (Paschen-Back Effekt). Er war wohl so gehemmt,

[2] es nur das Lesezimmer neben der Bibliothek, das so klein war, daß gelegentlich 2 japanische Studenten in Hockstellung Bücher studierten, was ich bestaunte.

UPDATES FROM AIP

LYNE STARLING TRIMBLE PUBLIC EVENTS

This spring AIP hosted three lectures in our Trimble series at our event space in Washington, DC. The series was partially endowed in 2013 through a generous donation that astronomer Virginia Trimble made to AIP in honor of her late father, the chemist Lyne Starling Trimble. You can access recordings of all our recent Trimble events at **aip.org/history/events**.

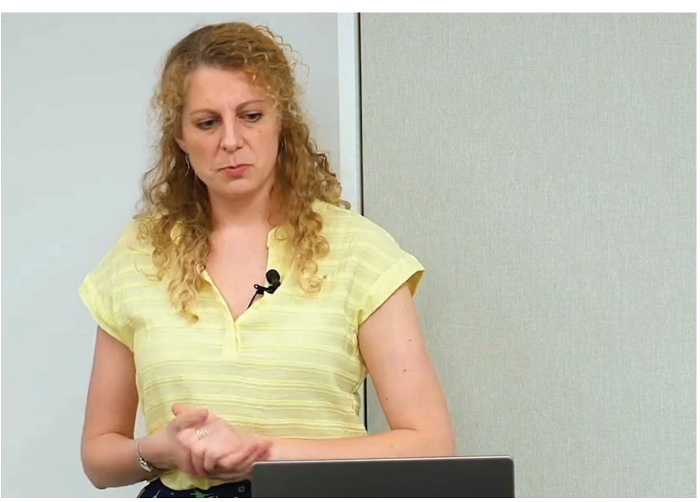
The first lecture of the spring was presented by Elise Crull, a philosopher and historian at the City College of New York. She discussed the significance of the work of German experimenter Hertha Sponer, who operated an innovative and productive laboratory at the University of Göttingen during the height of the quantum revolution. Crull illuminated Sponer's little-acknowledged role in the history of the quantum concept of wave-particle duality and related how the rise of the Nazis drove Sponer to the US, where she found a place at Duke University. Crull's research on Sponer is the basis for a broader international collaboration on the origins of quantum chemistry that AIP is funding through its Helleman grant program, as detailed elsewhere in this issue.

David DeVorkin, retired senior curator for astronomy at the National Air and Space Museum, presented the spring's second lecture, drawing from his recent book on George Carruthers and from his research and exhibit curation around astronomical instruments Carruthers designed that were deployed in space. The most notable example is an ultraviolet telescope carried to the Moon on the Apollo 16 mission. As a black man in the mid-20th-century United States, Carruthers navigated a narrow path to scientific renown that led him from his childhood in Chicago to the University of Illinois and ultimately, a career at the Naval Research Laboratory in Washington, DC. DeVorkin's association with AIP goes back to the late 1970s, when he was a project historian here, and the evening was filled with the warmth and joy of that long friendship.

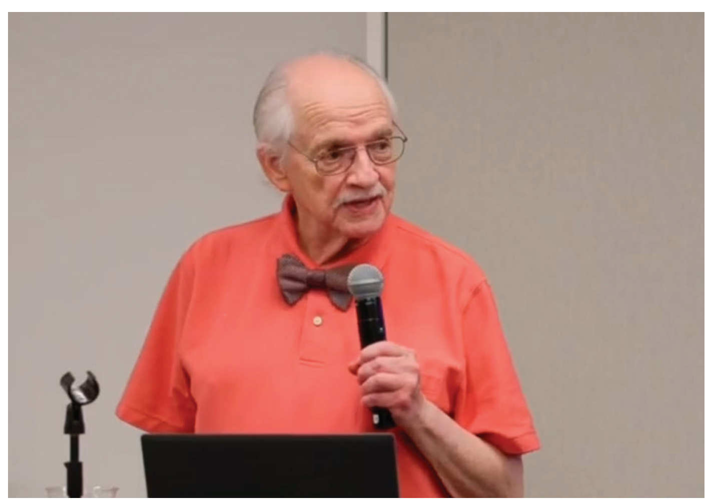
Finally, in the last week of May, we were joined by Dava Sobel, who presented material from her latest book, *The Elements of Marie Curie*. The renowned author of titles such as *Longitude, Galileo's Daughter*, and *The Glass Universe* drew a large crowd with many new faces. They were not disappointed by her account of how Marie Skłodowska Curie's career survived the untimely death of her husband Pierre and a public scandal, and how her fame drew women to Paris who wanted to find a place in the early 20th-century worlds of physics and chemistry. Staff members of AIP's Niels Bohr Library & Archives also presented a display of materials related to Curie as well as some of the copies of Dava Sobel's own books that she donated to us.

On Wednesday, September 23, we will welcome Princeton University's Fara Dabhoiwala, who will present the lecture, "Black Genius: Race, Science, and the Extraordinary Portrait of Francis Williams." Dabhoiwala is currently researching the first-ever biography of Williams, a black 18th-century Jamaican polymath. In an essay in the *London Review of Books* in 2024, Dabhoiwala presented an intriguing analysis of a portrait acquired by the Victoria and Albert Museum in 1928, finding in it striking clues to Williams's expertise in Newtonian physics. We are excited to hear more this fall.

Continued on 14



Elise Crull



David DeVorkin

Dava Sobel

Fara Dabhoiwala

Portrait of Francis Williams. © Victoria and Albert Museum, London.

A VISIT FROM HELLEMAN FELLOW RUWARD MULDER

The first phase of AIP's Robert H. G. Helleman Grant and Fellowship program provided financial assistance for Dutch citizens wishing to work in the United States as graduate students or postdoctoral researchers in physics or related fields such as the history and philosophy of physics. Philosopher and Helleman Fellow Ruward Mulder has been working at the University of California, Irvine, since 2024. This spring he visited the Department of History and Philosophy of Science at the University of Pittsburgh and took a side trip to pay us a visit and deliver a lunchtime talk titled "Conventionalism about the space-time-matter distinction in the early universe?"

Helleman Fellow Ruward Mulder tours the book stacks at the AIP Niels Bohr Library & Archives.

NEWLY POSTED ORAL HISTORIES

Since the last issue of the *Newsletter*, the following interviews have been posted at **repository.aip.org/oral-history-interviews-ohi**:

Emily Brodsky (January 7, 2026)—UC Santa Cruz earthquake scientist

Dale Cruikshank (July 22, 2012)—NASA Ames planetary scientist

Athene Donald (Feb. 4 and 5, 2025)—Cambridge University soft matter physicist

Alice Gast (Feb. 24, 2025)—chemical engineer and Imperial College London president

Helen Jackson (Oct. 10, 2025)—US Air Force physicist

Edwin Krupp (Nov. 13, 2025)—director of the Griffith Observatory

Alex Lips (Nov. 19 and 20, 2024)—former Unilever expert on soft matter

David Malament (Feb. 11 and 12, 2026)—philosopher of physics at UC Irvine

Jami Valentine Miller (Dec. 10, 2025)—patent examiner, founder of African American Women in Physics

J. Robert Oppenheimer (February 1960)—discussing the Manhattan Project

J. Robert Oppenheimer (Nov. 18 and 20, 1963)—discussing quantum mechanics

J. Robert Oppenheimer (Nov. 1, 1966)—discussing Enrico Fermi

Megan Povey (Jan. 23 and Mar. 5, 2025)—University of Leeds food physicist

Rita Sambruna (Apr. 16, 2026)—NASA Goddard astrophysicist

Howard Schnitzer (Aug. 21, 2025)—Brandeis University field theorist

Barbara Sherwood Lollar (July 15 and Oct. 2, 2025)—University of Toronto biogeoscientist

David Simpson (April 2025, multiple sessions)—Former IRIS Consortium president

Jason Wright (Feb. 12, 2026)—Penn State astronomer

For more on the oral histories with J. Robert Oppenheimer, see the related article in this issue.

GRANTS-IN-AID FOR HISTORICAL RESEARCH

AIP provides grants to scholars and writers to support their research in the history of the physical sciences, with application deadlines on April 15 and November 15 each year. In 2026 we raised the maximum award level from $2,500 to $3,000. Thanks to the availability of additional resources through our Robert H. G. Helleman Memorial Fund, we were also able to substantially increase the number of grants awarded during our last two cycles. For more information, see **aip.org/aip/awards/history-grants-in-aid**.

Recipients from the past two cycles:

Bárbara de Almeida Silvério (Federal University of Bahia)—To support research at Harvard University on Annie Cannon's methodology.

Joanna Ashbourn (Oxford University)—To support a conference on error in physics.

Sara Bassanelli (University of Pavia/POLITO)—To support research at archives in the United States on international standards.

Tathagat Bhatia (MIT)—To support research at AIP on information and data practices in the earth sciences.

Luca Campagnoni (University of Padua)—To support archival work in the United States on Bruno Rossi.

Silvia Castillo Vergara (University of Toronto)—To support archival research on quantum information science.

Michelle Frank—To support continuing research on Chien-Shiung Wu.

Penelope Hardy (University of Wisconsin - La Crosse)—To support research in Europe on Jacques Cousteau's vessel *Calypso*.

Friso Hoeneveld—To support research at archives in the United States on Teun Michels.

Jolene Johnson (University of Wisconsin - River Falls)—To support interviews with women in physics at the University of Minnesota.

Edward Landa (University of Maryland)—To support research at Yale University on G. Evelyn Hutchinson and biogeochemistry.

James Lockridge (NSF NOIRLab)—To support archival processing work related to Kitt Peak National Observatory.

Patrick McCray (UC Santa Barbara)—To support interviews related to exoplanet habitability.

Julia Menzel (University of Toronto)—To support archival research at the Aspen Center for Physics.

Sharad Pandian (Princeton University)—To support research at the National Agricultural Library and Wright State University on human calorimetry.

Andra Sonia Petrutiu (Cornell University)—To support transcription of interviews related to supercomputers in India.

Bruce Popp—To support research in Brussels and Paris on the First Solvay Conference.

Nithyanand Rao (University of California, San Diego)—To support research at Virginia Tech and the University of Houston on E. C. George Sudarshan.

Trinidad Rico (Rutgers University)—To support research at Argentinian archives on the Huemul laboratory in Patagonia.

Ohad Reiss-Sorokin (Institute for Advanced Study)—To support research at various archives on Thomas Kuhn and history of science scholarship at Princeton.

Deborah Shapley—To support research at Caltech and the Huntington Library on Harlow Shapley.

Shelly Yiran Shi (University of California San Diego/Caltech)—To support research at archives in California and China on Chien-Shiung Wu.

Amogh Thakkar (New York University)—To support documentary filmmaking on dark matter and dark energy.

Xiaona Wang (University of Warwick)—To support research on Chinese sources used in the "Newton Wars."

Bethan Winter (German Historical Institute Warsaw)—To support interviews and archival research on UK-Soviet fusion collaboration.

This newsletter arrives only twice per year. Now you can learn more about history and the history community's work through our weekly and monthly email newsletters. Sign up at aip.org/newsletters.

REPORTS FROM GRANT-IN-AID RECIPIENTS

AIP grants-in-aid provide support to history researchers, enabling work to proceed in a wide range of areas that we could not support solely in-house. Grants are also an excellent way to bring new people into our worldwide network of collaborators, and they are one of our best tools for giving students and early-career researchers experience in archival work, oral history interviewing, and applying for external research support. We are pleased to share some reports from them on their work.

ARCHIVAL RESEARCH ON COMPLEXITY SCIENCE

Sebastian Fernandez-Mulligan, Yale University

It was 1991 and the largest consumer bank in America was in love with physics. Suits from CitiBank mixed with casual researchers under the arched ceilings of the former Cristo Rey Convent, then home of the Santa Fe Institute (SFI), the nation's first institution wholly dedicated to the pursuit of "complexity science." The gaggle of the clean-cut and the rough-shod met to attend the "CitiBank Session on Science," a symposium marking almost four years of corporate support for scientific research. The day was packed. Specific projects included portfolio forecasting, account performance, and collection strategies for debt. Yet, economics PhDs were left by the wayside. Physicists took center stage, waxing poetic on interest rates and credit cycles. In the first session, statistical physicist Edwin Jaynes stood before the crowd and let the corporate bigwigs have it. "Economic predictions by dynamical models have been disappointing—more useful to nightclub comedians than to managers," he began, "All this time we have had before us one example—the only completely successful case of prediction of mass phenomena: THERMODYNAMICS."

Finance was not the only discipline to fuse with physics at the end of the 20th century. During the 1990s, SFI physicists devised fraud-detection algorithms for banks, simulated the behavior of consumers for McKinsey, modeled the spread of new growth for the US Forest Preserve, simulated the global flow of resources for Brookings, and, during the first year of the Clinton administration, met with the newly minted Vice President Al Gore four times to discuss socioenvironmental policy. In the wake of communism, with liberalism supposedly triumphant, business executives, scientific researchers, and public policymakers turned to physical theories with the confidence that planning could be made precise enough, and general enough, that they could guide the wild behavior of markets without constraining their generative capacity.

These collaborations were the focus of my research, funded by AIP's grant-in-aid. They occurred at a moment when the political economy of science was shifting—federal funding for science began to stall and privately funded programs swooped into the power vacuum. Through archival research in the personal papers of Edwin T. Jaynes, Philip Anderson, David Pines, and the institutional papers of the Santa Fe Institute, I dug into this heady period when theoretical physicists, the scientists par excellence of the Cold War, sought to redefine themselves after its demise. This research forms the tail end of my dissertation, which traces the history of how physicists and their collaborators began to argue that "order," as defined in many-body physics systems, could serve as an analogy for order in nature and society. Today, tools from physics hold an almost mythic status in disciplines from quantitative finance to environmental modeling to neuroscience. Following physicists and their influence across disciplines like cybernetics, economics, and even postmodern literary theory, my research traces the professional trajectories and institutional collaborations that forged this synthesis.

Edwin Jaynes. AIP Emilio Segrè Visual Archives, Physics Today Collection.

ORAL HISTORIES ON THE PHILOSOPHY OF PHYSICS

Mahmoud Jalloh, Caltech

This project originated with the ERC/NWO project "Exiled Empiricists" at Tilburg University, led by Sander Verhaegh. The Exiled Empiricists project aims to investigate the rise of analytic philosophy in the US in the context of migration before and during the Second World War. One component of this project involves oral histories targeting scholars who received their training in philosophy of science during the 1960s and early 1970s in the Anglophone world. The aim of the interviews is to create a catalogue of first-hand recollections of the intellectual climate in which postwar US philosophy of science developed out of the various preexisting philosophical traditions. A further aim of these interviews is to account for changes in the discipline, including demographic and methodological changes, as well as the shifting relationships between the philosophy of science, the history of science, and science itself.

In collaboration with Fons Dewulf, a former postdoc on the Exiled Empiricists project, I have undertaken a philosophy of physics-focused wing of the project. From the beginning of the emergence of philosophy of science as a discipline, the philosophy of physics has been a major subject. The philosophy of physics is particularly interesting because its practitioners often straddle disciplinary boundaries, just as often having advanced training in physics as in philosophy. Indeed, the origin of the discipline can be traced to the philosophical reflections of physicists in the wake of the dual revolutions of relativity and quantum mechanics. Major founding figures, like Henry Margenau or Percy Bridgman, were themselves physicists, or like Hans Reichenbach, had direct training and interactions from major physicists like Einstein and Planck. Therefore, first-hand accounts of these origins not only provide an interesting perspective on the history of philosophy of physics but on the history of physics proper.

With gracious support from AIP, I have been able to do two such interviews so far. The first was with Don Howard, professor of philosophy and former director of the Reilly Center for Science, Technology, and Values at Notre Dame. We discussed, among other things, changing attitudes on the relationship between science and society, Abner Shimony's experimental metaphysics and empirical tests of Bell's theorem, the origins of the Einstein Papers Project, the renaissance of general relativity, and effects of the Cold War. My second interview subject was David Malament, distinguished professor emeritus of logic and philosophy of science at UC Irvine. Our discussion covered the student protest movement, formal methods in the philosophy of physics, philosophy at the Rockefeller Institute, the Chicago Relativity Group, time travel in Gödel universes, the emergence of the philosophy of spacetime, and the nature of philosophical progress.

These, and hopefully more, interviews will be archived with the AIP Niels Bohr Library & Archives. They will reveal that the development of physics and that of philosophy are not as independent as commonly thought.

Mahmoud Jalloh

ARCHIVAL RESEARCH AND INTERVIEWS ON METEOROLOGY IN IRELAND

Katerina Zouboulakis, Trinity College Dublin

Meteorology is faced with the challenge of making the invisible visible. Although the weather can be easily experienced by simply stepping outside, to make sense of the atmosphere and predict its future conditions, multiple variables must be recorded, shared, and calculated. As a scientific practice, meteorology must translate the atmosphere's constantly changing system into visual forms that can be observed, interpreted, and trusted.

Due to the geographic nature of the weather, visual practices have always been embedded into scientific practice from the early use of isobar charts and climate average maps. Visual representations have also been instrumental in communicating current and future weather conditions, as well as garnering public trust in the validity of this scientific practice previously thought to be guesswork. But how are these visual practices developed? What rhetorical strength and epistemic value do they carry? In the simplest terms, what role do the visuals play in the history of meteorology?

My PhD research at Trinity College Dublin explores the visual culture of meteorology in Ireland by examining photographs, film

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footage, diagrams, pamphlets, icons, charts, and satellite imagery. Through this visual material, I hope to understand how the Irish Meteorological Service, Met Éireann, became an independent, trusted scientific authority in the context of Irish nation-building. I aim to reveal the role of the visual in crafting an institutional identity while garnering public trust in an evolving scientific practice undergoing massive changes brought about by the introduction of the supercomputer. More critically, my research will explore the role of the visual in creating, communicating, and disseminating scientific knowledge, both within expert and public communities.

With the support of AIP, I spent two months in the UK exploring several archives, including the British Met Office's, which contained numerous critical Irish documents due to the close collaboration between the two services over the decades. Back home in Ireland, I was able to use the training from the AIP oral history team to refine my interviews, recording several conversations with current and past staff members that have altered the trajectory of my dissertation. Through interviews with past librarians, meteorologists, and computer scientists, as well as current communication officers, climate modelers, and more, I have been able to weave a rich narrative of meteorology in the latter 20th century. It was a wonderful experience to be able to record their stories and develop a full understanding of this scientific discipline during transition. As I write the final few chapters of my dissertation, this work has been the driving force behind my understanding of what happened just a few short decades ago.

Katerina Zouboulakis

ARCHIVAL RESEARCH ON E. C. GEORGE SUDARSHAN

Nithyanand Rao, University of California, San Diego

I have been researching a book-length biography of the late E. C. George Sudarshan. It is a story of, among other things, the politics of credit and recognition and their conditions of possibility. An AIP grant-in-aid enabled me to visit Blacksburg and Houston to access the archival papers of Robert Marshak and Jagdish Mehra, respectively, two men with whom Sudarshan was associated.

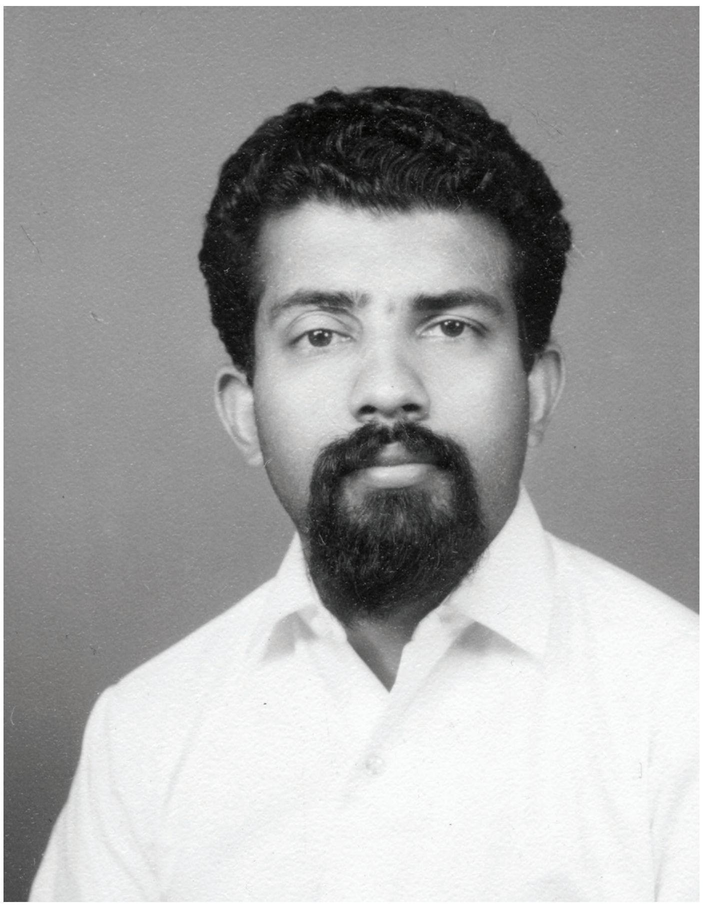
It was with Marshak, his PhD advisor, that Sudarshan proposed the V–A law for weak interactions in 1957 in the face of conflicting experiments. But they felt that their work showing that it had to be V–A was overshadowed by that of Richard Feynman and Murray Gell-Mann, whose joint paper went further but assumed V–A. How this came to be—including a meeting in the summer of 1957 where Marshak and Sudarshan presented their prepublication work to Gell-Mann—is known, but I am interested in the details that would help me write a narrative nonfiction account. I reflect on two aspects of this.

Marshak's collection at Virginia Tech gave me a window on his role in bringing people together. He organized the Rochester conferences in high-energy physics beginning in 1950. It was where physics was done, not merely presented. But space was so limited that graduate students wishing to attend had to request in advance; some were enlisted to serve as bartenders and "projectionists"; and time was so limited that students were not allowed to speak. In this mix, unfortunately, was the young Sudarshan, who had just arrived in Rochester from the Tata Institute of Fundamental Research in 1955. He had answers to puzzles being discussed—especially in light of C. S. Wu's experiments that showed parity was violated—but could not intervene.

Marshak's correspondence showed the long afterlife of these and other events of 1957, especially his valiant efforts to restore some credit to his student and their ultimately dashed hopes of a Nobel Prize. His correspondence also showed the immense care with which he organized the conferences. Staff at the university, even those who functioned as doorkeepers, received letters of gratitude, as did the hotel where attendees were put up. I came away having glimpsed the infrastructural work, Marshak's as well as others', which is never part of the discussions on Nobels.

Jagdish Mehra, a physicist-turned-historian, was closely associated with Sudarshan at the University of Texas at Austin in the late 1960s and early '70s, where they organized talks and conferences inviting physicists and historians. But they had a falling out and, in his later correspondence with others, Mehra identified Sudarshan as one of the "enemies" he had made in his life. However, decades later, Mehra interviewed all the other protagonists in the V–A story and established in great detail how Sudarshan and Marshak were occluded, without anyone intending so, through a perfect storm of circumstances. Also in Mehra's archival collection was Sudarshan's correspondence, which Marshak had shared with Mehra, not to mention taped conversations and newspaper clippings.

Mehra did much of this work at his own expense while battling for jobs. In a strange irony, he, like Sudarshan, came to feel others used his work without giving him due credit, even as professional historians of science critiqued his work as "great man" history as physicists would imagine it. But he kept at it, collecting material that will help me write a different kind of account.



E. C. George Sudarshan. AIP Emilio Segrè Visual Archives, Physics Today Collection.

SCENES FROM THE MAKING OF ASTROPHYSICS

By Rebecca Charbonneau

In 1835 the French philosopher Auguste Comte declared that humanity would never know the chemical composition of the stars. It was, he thought, the perfect example of knowledge that would remain permanently beyond a boundary that science could not cross.[1]

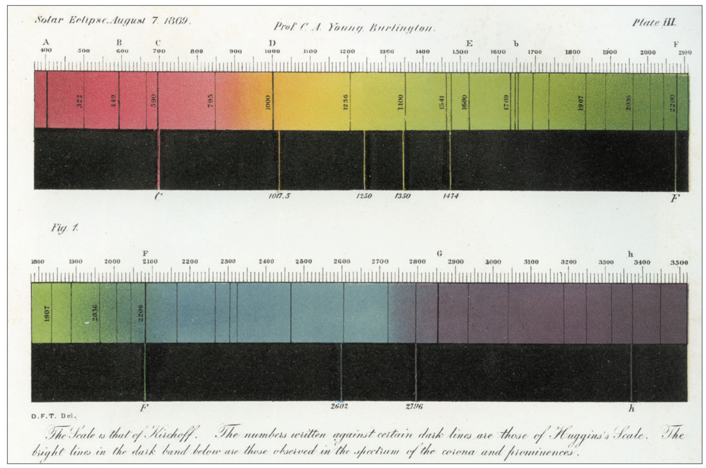
He was, of course, wrong. Within a generation, scientists began to crack the code of starlight and set astronomy on a collision course with physics that would reshape both disciplines from that moment to the present. The story of how that collision unfolded—the story of how astrophysics, distinct from astronomy, came to exist and flourish—is the story of one of the great transformations in the history of science. And, for anyone in Comte's time, it is a story that would have been not only impossible to foresee; it would have been absurd to predict.

SPECTRAL LINES AND A NEW DISCIPLINE

A crucial breakthrough came in the late 1850s, when the German physicist Gustav Kirchhoff and chemist Robert Bunsen showed that the dark lines scattered across the solar spectrum corresponded to the bright emission lines of specific chemical elements produced in the laboratory. Iron, sodium, calcium, magnesium could all be identified in the Sun's atmosphere from millions of miles away. The heavens, it turned out, were composed of the same elements as the Earth.[2]

This was a radical departure from the astronomy that had prevailed for centuries. Traditional positional astronomy concerned itself with tracking the motions of celestial bodies, which was essential work for navigation, timekeeping, and calendar-making that had been starkly separate from speculation about physical processes. But by the 1890s, the new approach had begun to institutionalize: dedicated journals appeared, including the *Astrophysical Journal* in 1895, and leading observatories began to take on the characteristics of experimental laboratories.[3]

In the United States, the door opened to this new kind of inquiry with the total solar eclipse of August 7, 1869. As Jennifer Bartlett and Thomas Hockey have recently shown, when the eclipse swept from Dakota Territory to the Carolinas, it prompted an ambitious expedition organized by the US Nautical Almanac Office, which had no telescopes, no observational mandate, and a staff trained in computation rather than laboratory science. Its superintendent, John Coffin, recruited Dartmouth physicist Charles Young, secured $5,000 in congressional funding (over $100,000 in today's dollars), and dispatched teams to Iowa armed with borrowed spectroscopes and telescopes.



The spectrum Charles Young recorded during his observations of the solar corona. From *Report of the Superintendent of the United States Coast Survey Showing the Progress of the Survey during the Year 1869* (Government Printing Office, 1872).

In Burlington, Iowa, Young made the expedition's most remarkable observation: through a five-prism spectroscope, he detected a faint green emission line from the solar corona that matched no known terrestrial element. Scientists would puzzle over this line for more than seventy years before the Swedish spectroscopist Bengt Edlén identified it in 1942 as the signature of highly ionized iron, an early clue to the astonishingly high temperatures of the Sun's outer atmosphere.[4]

Other participants struggled with unfamiliar instruments and unstable mounts; some tried spectroscopy for the very first time. The results were uneven, but the shift in ambition was unmistakable. American astronomy had begun to imagine itself as an experimental science. One of these participants, Edward Pickering, soon took on the directorship of the Harvard College Observatory, where he implemented a program of photography that allowed stellar spectra to be systematically analyzed.

This daytime analytical work was done by a team of women computers Pickering hired that included figures such as

Williamina Fleming, Antonia Maury, and Annie Cannon, who would transcend their initially intended roles to creatively develop new classifications of stars. These classifications, in turn, informed new theories about not only the composition of stars, but also, as embodied in the Hertzsprung-Russell diagram, how they evolved over their lifespans.[5]

Williamina Fleming, at right, with a device used to illuminate glass plates on which stellar spectra were recorded. Harvard University Archives, HUV 1210 (9-6).

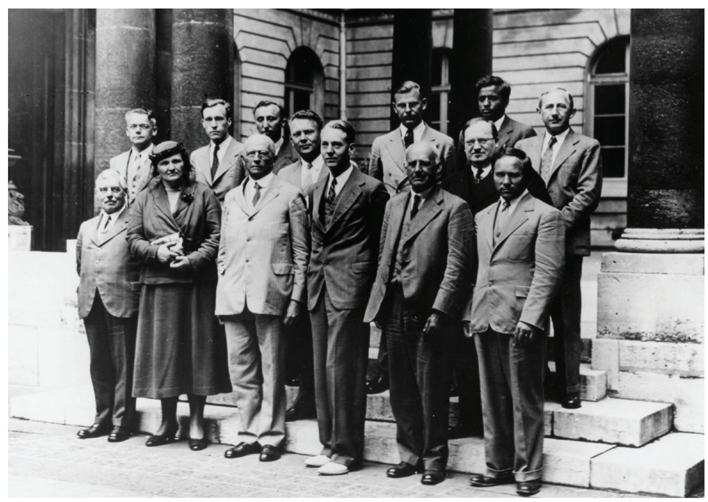
RELATIVITY TRANSFORMS THE COSMOS

If spectroscopy opened a new window to the sky, Albert Einstein's contributions would prove crucial to understanding what could be seen through it. The special theory of relativity introduced the concept of mass-energy equivalence, which would eventually be needed to determine the source of stars' energy, but it was the general theory of relativity that would have the most far-reaching consequences. The idea that space and time could be curved by gravity could explain an enduring mystery of positional astronomy, the precessing perihelion of Mercury, and it predicted that light could be perceivably bent as it passed around stars.

The test came during the total solar eclipse of May 29, 1919. Two British expeditions—one led by Arthur Eddington to the island of Príncipe, off the west coast of Africa, and the other by Andrew Crommelin to Sobral, Brazil—set out to photograph stars near the Sun during totality. If Einstein was right, the Sun's gravity should bend their light by a precise, predictable amount. The conditions were far from ideal: heavy thunderstorms soaked Eddington's site for much of the morning, and only a handful of usable plates survived. But the results, presented at a dramatic joint meeting of the Royal Society and Royal Astronomical Society on November 6, 1919, confirmed the prediction. Einstein became an international celebrity overnight.[6]

The 1919 eclipse is rightly remembered as a triumph for Einstein, but it also signaled the beginning of an era in which fundamental physical theories became an important tool for astrophysics, and astrophysics in turn became a proving ground for profound theories about the universe. In the 1920s, Eddington synthesized ideas about radiation, gravitation, ultradense states of matter, general relativity, and quantum mechanics to explain white dwarfs, unexplained outliers on the Hertzsprung-Russell diagram, as stars that had collapsed at the end of their lives.

This advance set up a legendary confrontation in 1935 with a young Subrahmanyan Chandrasekhar, who invoked the effects of relativity on electrons in ultradense matter to posit that sufficiently massive stars could collapse into still denser masses—a conclusion Eddington vehemently rejected. "Eddington realized that the existence of a limiting mass implies that black holes must occur in nature. But he did not accept that conclusion. He said that must be a reduction *ad absurdum*. … And if he had accepted that he would have been 40 years ahead of anybody else," Chandrasekhar later lamented to AIP's Spencer Weart.[7]



Attendees of the Astrophysical Conference on Novae and White Dwarfs, held in Paris in 1939. Arthur Eddington is second from the right in the front row. Subrahmanyan Chandrasekhar is second from the right in the back row. AIP Emilio Segrè Visual Archives, gift of S. Chandrasekhar.

Meanwhile, Einstein, Willem de Sitter, Georges Lemaître, and other theorists began to consider the implications of general relativity for the shape of the universe itself. The curvature of spacetime by gravity offered a geometry implying the universe has a finite size while lacking an outer edge. The equations of general relativity also suggested this universe would expand with time—a possibility that became the basis for modern cosmology. Einstein rejected the idea initially and introduced a "cosmological constant" to avoid the expansion, which he famously later looked back on as his "greatest blunder."[8]

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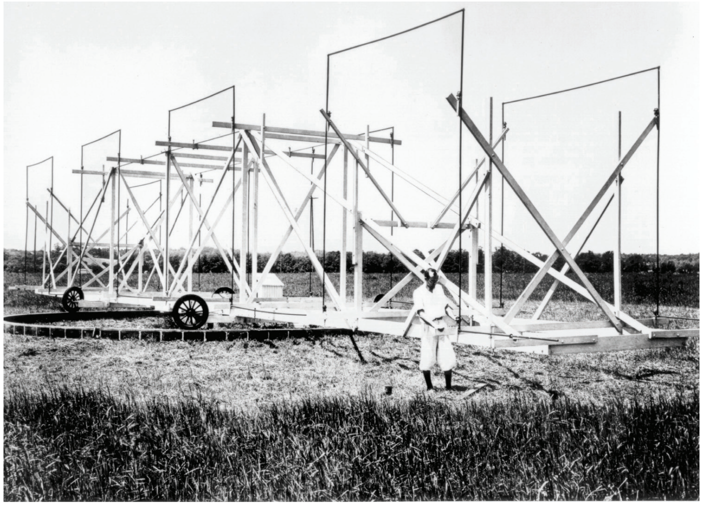


Karl Jansky's rotating antenna nicknamed "Jansky's merry-go-round." Courtesy of NRAO/AUI/NSF.

SECRETS LOCKED IN STATIC

In 1928 Bell Laboratories was trying to find ways to suppress static on telephone calls and assigned a young physicist named Karl Jansky to track down the sources of interference plaguing transatlantic shortwave communications. Working from a field station in Holmdel, New Jersey, Jansky built a large directional antenna. Mounted on a set of Ford Model T wheels so it could rotate full circle, the contraption earned the nickname "Jansky's merry-go-round." He quickly identified static from nearby thunderstorms and more distant storm systems, but there was also a faint, persistent signal of unknown origin.[9]

Jansky noticed that the signal rose and fell not every twenty-four hours but twenty-three hours and fifty-six minutes—the time it takes the Earth to complete one rotation relative to the distant stars rather than the Sun. The signal was keeping time with the galaxy itself. By the spring of 1933, Jansky had traced the strongest emission to the direction of Sagittarius, in the center of the Milky Way. As one former Bell Labs scientist later put it, the discovery fell squarely between the disciplines: radio waves had nothing to do with astronomy, and cosmic signals had nothing to do with telephones.[10]

The discovery made the front page of the *New York Times*, and the next day NBC's Blue Network broadcast an interview with Jansky—including a live sample of the cosmic hiss—to a national audience. Jansky proposed building a thirty-meter dish antenna to continue the work, but Bell Labs reassigned him, seeing no way to eliminate the interference and therefore no business problem left to solve. He never returned to the subject and died in 1950 at the age of forty-four, his work largely unrecognized by astronomers, who had no framework for interpreting radio signals from space.[11]

The person who did follow up was not a professional astronomer but a twenty-six-year-old hobbyist from suburban Chicago. Grote Reber, an electrical engineer and avid ham radio operator, read about Jansky's discovery and applied unsuccessfully for a job at Bell Labs to pursue it further. Taking on the project at his own expense, in 1937 Reber assembled a dish in his yard from scrap lumber, sheet metal, and salvaged Ford parts, leaving his neighbors bewildered. After confirming Jansky's discovery, Reber turned to producing radio-frequency maps of the sky and by 1942 had found bright sources in Cygnus, Cassiopeia, and the galactic center that had no obvious optical counterparts. His results, published in the *Astrophysical Journal*, attracted modest attention at first, and for nearly a decade he was the world's only radio astronomer.[12]

What transformed radio astronomy into a global enterprise was the Second World War. Radar development trained a generation of physicists and engineers in the detection and manipulation of radio-frequency signals, and many of them turned their expertise to the sky when they resumed peacetime work. Martin Ryle and his colleagues at Cambridge pioneered radio interferometry—the technique of linking networks of small antennas to achieve the resolving power of a much larger instrument—and used it to catalogue hundreds of discrete radio sources across the sky. At Jodrell Bank in the Cheshire countryside, Bernard Lovell constructed a massive steerable dish, 250 feet in diameter and the largest in the world when it was completed in 1957, just in time to track the carrier rocket of Sputnik. In Australia radio astronomers at CSIRO's facilities made foundational contributions to understanding the structure of the Milky Way at radio wavelengths.[13]

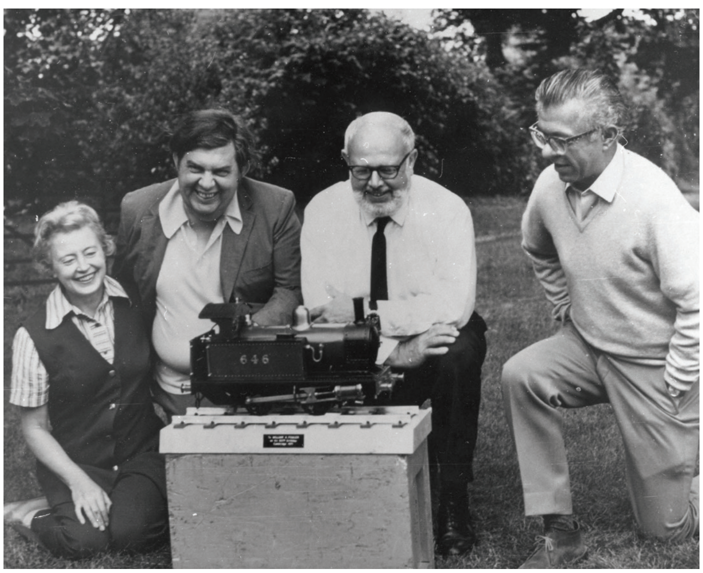
The field grew with extraordinary speed: by the early 1960s, radio observatories on three continents were producing data that optical telescopes simply could not. Back at Holmdel, Bell Labs now saw fit to employ radio astronomers. Robert W. Wilson and Arno Penzias took over an antenna built to accompany an early communications satellite, but, like Jansky decades earlier, they encountered mysterious noise that they could not attribute to any source of interference.

From left, Arno Penzias and Robert W. Wilson being interviewed after winning a share of the 1978 Nobel Prize in Physics for their serendipitous discovery of the cosmic microwave background. AIP Emilio Segrè Visual Archives, Physics Today Collection.

Unlike Jansky's signal, this one appeared to come from every point in the sky. Eventually, they learned of Princeton University theorist Robert Dicke's theory that a universe that had expanded from a single point would have left behind a low-level radiation background. Wilson and Penzias had serendipitously discovered what soon came to be seen as crucial evidence in favor of the "Big Bang" theory of the expanding universe.[14]

A VIOLENT UNIVERSE COMES INTO FOCUS

In the late 1930s, physicist Hans Bethe uncovered the source of stellar energy by positing that reactions between elements in the stars are governed by the fusion of nuclei rather than chemistry. Working out the proton-proton chain and the carbon-nitrogen-oxygen cycle, he discovered how hydrogen can become helium and how mass destroyed in the process is converted into energy in accord with Einstein's equation $E=mc^2$.[15] Almost twenty years later, Margaret Burbidge, Geoffrey Burbidge, William Fowler, and Fred Hoyle harmonized astrophysical measurements, laboratory data, and Hoyle's theoretical ideas about stellar evolution into a landmark 1957 paper describing how, during their lives and deaths, stars forge nearly every element heavier than helium.[16]



From left, Margaret Burbidge, Geoffrey Burbidge, William Fowler, and Fred Hoyle posing with a model steam train presented to Fowler in honor of his 60th birthday. AIP Emilio Segrè Visual Archives, Clayton Collection.

Historians Luisa Bonolis and Stefano Furlan have recently highlighted the collaboration between the Burbidges, Fowler, and Hoyle as indicative of the intense disciplinary bridge-building that began to characterize astrophysics. They further point to a symposium held in Dallas in 1963 as an "epochal" gathering of radio and optical astronomers, relativists, and theoretical astrophysicists to explore an idea put forward by Fowler and Hoyle that connected the almost unexplainable energy output of ultrabright radio sources, soon known as quasars, with the extreme gravitational collapse phenomenon originally posited by Chandrasekhar.

Soon, astrophysics would be routinely challenged by all sorts of extreme phenomena that were characteristic of what Bonolis and Furlan call "the violent universe," borrowing from the title of a 1969 documentary in which Carl Sagan made his debut as an on-screen presenter. In the 1960s, Livermore Laboratory physicist Stirling Colgate moved fluidly between simulating thermonuclear explosions and supernovas, and his programs were soon adapted to modeling the formation of black holes, which had not yet been proven to exist. In 1967 Jocelyn Bell Burnell serendipitously discovered a pulsar using a radio array she had helped build, and these were soon identified as neutron stars, another previously hypothetical product of stellar collapse. Efforts to study cosmic rays fed into the emergence of x-ray and gamma-ray astronomy, aided by the access rockets now provided to space, further revealing the startlingly high energies produced in less quiescent corners of the cosmos.[17]

The aftermath of Supernova 1987A captured by the James Webb Space Telescope's NIRCam instrument in 2022. NASA, ESA, CSA, Mikako Matsuura (Cardiff University), Richard Arendt (NASA-GSFC, UMBC), Claes Fransson (Stockholm University), Josefin Larsson (KTH); Image Processing: Alyssa Pagan (STScI).

By the final decades of the 20th century, astronomers had opened observational windows across the entire electromagnetic spectrum—infrared, ultraviolet, x-ray, gamma-ray—and had even begun detecting neutrinos from the Sun and from Supernova 1987A. The culmination came in 2015, when the Laser Interferometer Gravitational-Wave Observatory (LIGO) detected gravitational waves, a phenomenon first predicted by Einstein's general theory of relativity a century earlier. The first detection, and many after, recorded black holes merging. Then, in 2017, another detection, in concert with telescopes around the world, captured a neutron star collision, confirming the event as an important mechanism for the synthesis of heavy elements. A new era of "multimessenger" astronomy had arrived.[18]

HISTORY IN PROGRESS

It was not unreasonable of Auguste Comte to suppose in 1835 that physical knowledge of the stars was unattainable. In fact, it is

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shocking to consider just how much knowledge has proven to be within reach. Many of the episodes related here are well known to astronomers and historians. But what we are only beginning to grasp is how astrophysicists learned to measure and reason about objects that are not just millions of miles, but sometimes billions of light years away. Astrophysicists proved extraordinarily adept in learning how to know.

There are still astrophysical mysteries that challenge observational skill and the laws of physics themselves: dark matter, dark energy, the dominance of matter over antimatter. It is possible that there will be some mysteries of the universe that will never be solved. But if astrophysicists remain optimistic that they can be, the history of astrophysics offers reason to suppose they may be right.

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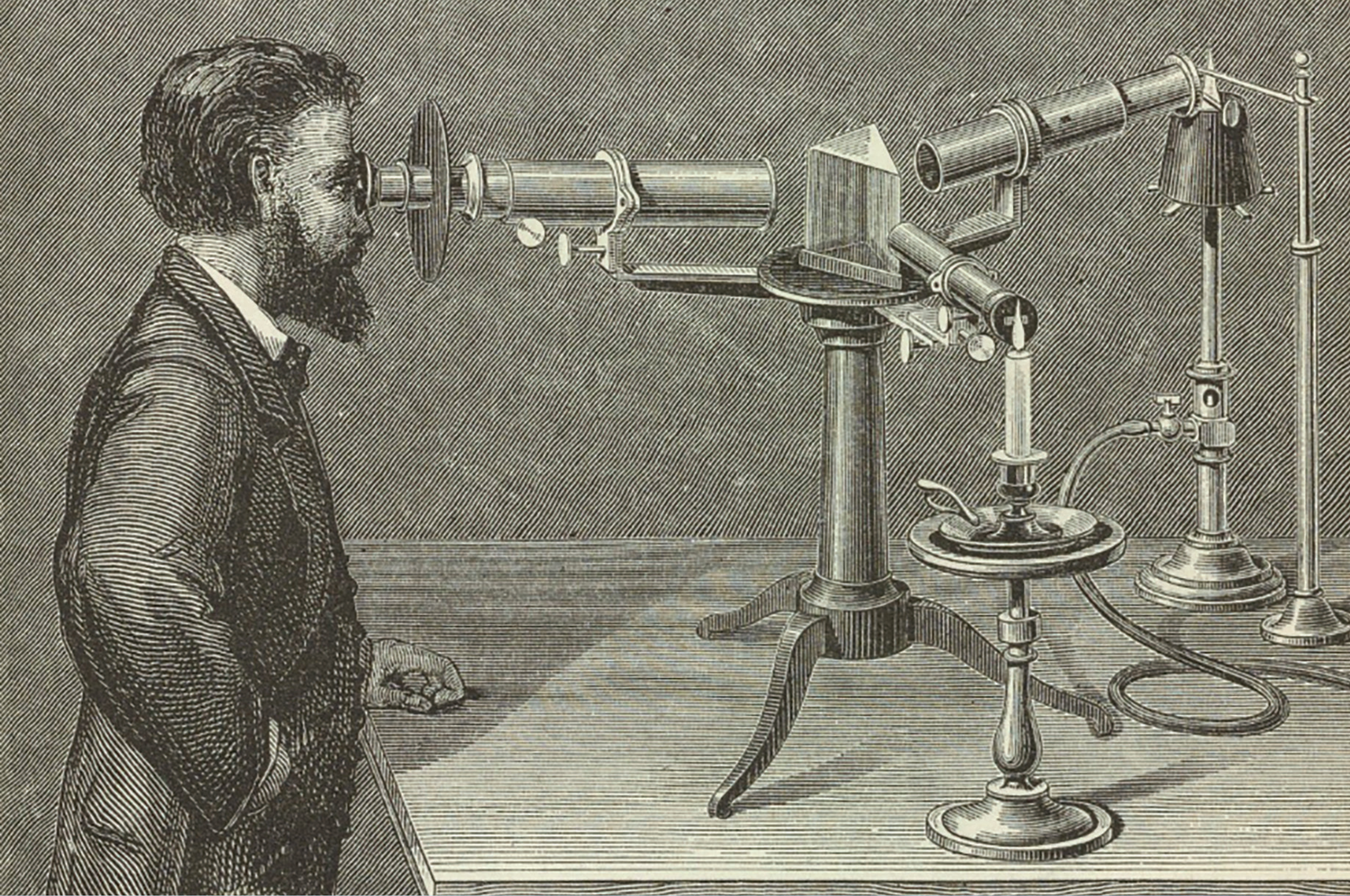
15. H. A. Bethe, "Energy Production in Stars," *Physical Review* 55, no. 5 (1939): 434–456, doi.org/10.1103/PhysRev.55.434.
16. E. Margaret Burbidge, G. R. Burbidge, William A. Fowler, and F. Hoyle, "Synthesis of the Elements in Stars," *Reviews of Modern Physics* 29, no. 4 (1957): 547–650, doi.org/10.1103/RevModPhys.29.547.
17. Luisa Bonolis and Stefano Furlan, "Unveiling the Violent Universe, Part 1. New Cosmic Messengers, New Astronomies: Building a Transdisciplinary Research Culture," *European Physical Journal* H 50, article no. 14 (2025), doi.org/10.1140/epjh/s13129-025-00102-0; see also chapter 7 in Kellerman and Bouton, *Star Noise*.
18. Historians have only begun to outline the history of multi-messenger astronomy; see the special issue *Centaurus* 67, no. 1 (2025), doi.org/10.1484/J.CNT.5.143069, edited by Luisa Bonolis, Roberto Lalli, and Adele La Rana.

Top right: An illustration of a compound spectroscope allowing an observer to measure the position of individual spectral lines within the spectrum of optical light. From the 1872 book *Spectrum Analysis in Its Application to Terrestrial Substances and the Physical Constitution of the Heavenly Bodies* by Heinrich Schellen. Courtesy of Science History Institute.

Bottom right: The LIGO site in Livingston, Louisiana. A second site is located in Hanford, Washington, and the correlation of signals between the two sites allows LIGO to distinguish true gravitational wave signals from local noise. Caltech/MIT/LIGO Lab.



AIP OPENS OPPENHEIMER INTERVIEWS TO THE PUBLIC

In April the AIP Niels Bohr Library & Archives added three interviews with Robert Oppenheimer to its online oral history collection. For decades, anyone interested in consulting the interviews had to seek permission from Oppenheimer's family and then do so again if they wanted to quote from them in a publication. But, with so many historical resources now freely available online, including the vast majority of our oral histories, the difficulty of consulting these important sources was becoming increasingly unusual. To facilitate discoverability and access, AIP and the Oppenheimer family negotiated a revised use agreement for the interviews, and now the transcripts, along with all associated media, are freely available to consult and use for non-commercial purposes.

In a statement, the Oppenheimer family remarked, "The archive's mission of increasing access to and promoting research of the history of science aligns with the family's interest in making Oppenheimer's historical role in science more broadly accessible by presenting Oppenheimer's thoughts and recollections from his own perspective."

Each of the interviews has a markedly different focus. One was conducted by the philosopher Thomas Kuhn as part of the sprawling Sources for History of Quantum Physics project of the early 1960s. It deals mainly with Oppenheimer's early education in quantum mechanics in Europe, and it has long been a crucial source for biographers.[1] The second was conducted on film by AIP historian Charles Weiner in 1966, months before Oppenheimer's death, and provided footage for a documentary on Enrico Fermi.[2] The third interview was conducted by journalist Robert Cahn in 1960 for an article he wrote for the *Saturday Evening Post* on the first atomic bomb test. A copy of the transcript was donated to AIP in the late 1990s by physicist Al Bartlett.[3]

To celebrate the public release of these interviews, AIP Foundation hosted a special fireside chat event at our offices in downtown Washington, DC, on April 8. The panelists were Kai Bird, coauthor of the Oppenheimer biography *American Prometheus*, which was the basis for Christopher Nolan's Oscar-winning *Oppenheimer* film, and Oppenheimer grandchildren Charles Oppenheimer and Dorothy Oppenheimer Vanderford. MIT historian and physicist David Kaiser served as moderator. The panelists reflected on the significance of having access to Oppenheimer's experiences, as told in his own words, as well as on the responsibilities of stewarding Oppenheimer's legacy.[4]

This important milestone represented an extraordinary cross-AIP effort, showcasing the organization's ongoing commitment to the history of physics. Allison Buser on the Niels Bohr Library & Archives team led the negotiation of the new use agreement, researched the interviews' provenance, and organized a display of Oppenheimer-related archival materials for the April 8 event. The interviews were also the cover story in the June 2026 issue of *Physics Today*, featuring articles written by Buser and *PT* editor and historian of science Ryan Dahn. AIP's communications and marketing teams and AIP Foundation put in tremendous work in getting the word out to broad audiences.

References:

1. Transcript at doi.org/10.1063/nbla.kmew.hvwx, audio at repository.aip.org/node/151143.
2. Transcript at doi.org/10.1063/nbla.fcrs.embu, video at repository.aip.org/node/151135.
3. Transcript at doi.org/10.1063/nbla.mlyg.hdxa.
4. Video at youtu.be/SJ3EJuvKfTM.

Top right: From the left, David Kaiser, Charles Oppenheimer, Kai Bird, and Dorothy Oppenheimer Vanderford discuss Robert Oppenheimer's legacy.

Bottom right: AIP archivist Allison Buser, at left, shows guests archival materials on display at the AIP Foundation event marking the public release of AIP's oral histories with Robert Oppenheimer.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STANDING DOWN THE INTERNATIONAL CATALOG OF SOURCES

By Chip Calhoun

The AIP Niels Bohr Library & Archives (NBL&A) is transitioning away from its International Catalog of Sources—an online catalog that strived to describe all primary sources on the history of physics at institutions across the world—toward a catalog focused solely on our own library and archival holdings. This is in response to the growth of internet search technology, the rise of alternative library cataloging consortia, and the rapidly expanding universe of primary source material.

The International Catalog of Sources (ICOS) began as a series of print publications that described holdings at other institutions as well as our own. When we moved onto the internet in the late 1990s, we adapted that same thinking to our online catalog. At the time, many institutions lacked usable online catalogs, and the means for even finding websites were similarly inadequate.

As an outgrowth of ICOS, we also created the Physics History Finding Aids Web Site (PHFAWS; we can't resist an unwieldy acronym). With PHFAWS, we offered to host finding aids for other institutions on our website to increase discoverability. This quickly grew into a project to not only catalog online finding aids hosted at institutions all over the world, but also to make them all discoverable through a single bespoke search engine. The proliferation of finding aids, and the different technologies behind them, eventually made the search feature effectively impossible to maintain, and the results have always been inconsistent.

Users now have many other ways to find archival records. The first and most obvious choice for many users is modern web search engines. A more exacting tool is the search hub of the Consortium for History of Science, Technology and Medicine, a group which includes AIP as a member institution. OCLC offers WorldCat, "the world's largest library catalog," which lets users search a catalog compiled from libraries worldwide and directs users to books and archives at nearby libraries. WorldCat has a sister project at OCLC, ArchiveGrid, which focuses on searching archival holdings all over the world. AIP contributes to each of these tools.

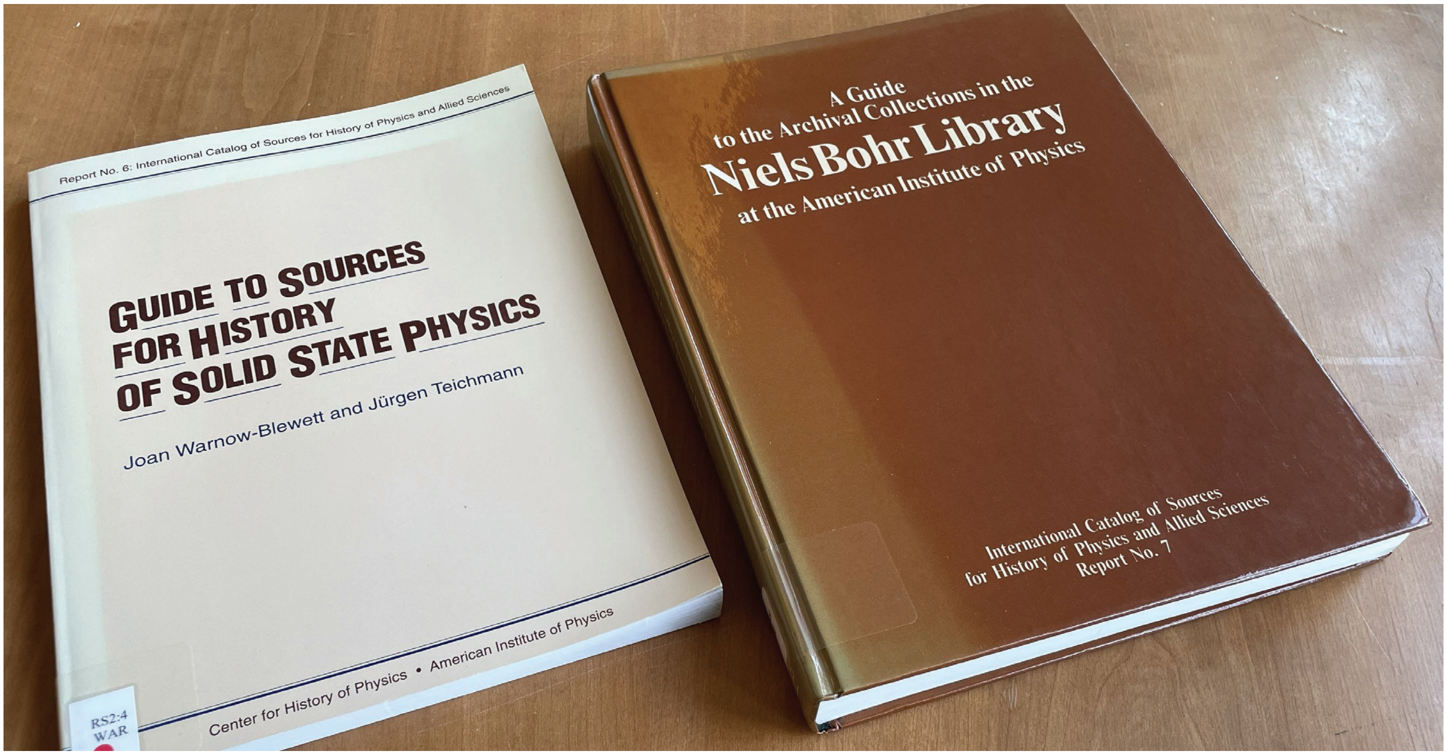
As new technologies have emerged and grown, the limitations of ICOS have become evident. Maintaining the catalog required biannual surveys of outside institutions; in the early days these could be done in a few hours, but with the growth of the internet these surveys expanded into projects that each consumed a month or more of staff time. Additionally, as a US institution seeking to embrace the whole world's output, we were never able to fully document collections outside the Anglosphere.

ICOS was a natural extension of our other strategies for supporting outside institutions in the description of physics history material, which will continue. We track records of physicists and organizations which merit being preserved, guide these records toward deposit at other institutions, and follow up to ensure that these records are processed. Our Grants to Archives help institutions prioritize work on these collections. We remain committed to preserving and making known the history of physics, regardless of who holds custody of the material.

You will see the change in our catalog in the coming months. Users will still be able to search all of our holdings and will have the option of focusing only on books and published materials, or on archives, or faceting searches along many other criteria. Removing the records from other institutions will make it much easier for researchers to find NBL&A materials. The data collected for ICOS will be preserved and may be used in future projects. We will also continue to host archival finding aids for institutions that do not have web hosting for their own. Ultimately, our hope is a more coherent search experience for our users while we continue to support the work of other institutions in other ways.

Top right: Print editions of two AIP publications that predated the web-based ICOS.

Bottom right: A sample search in our catalog. Searches can be narrowed down by collection area, format, and other factors.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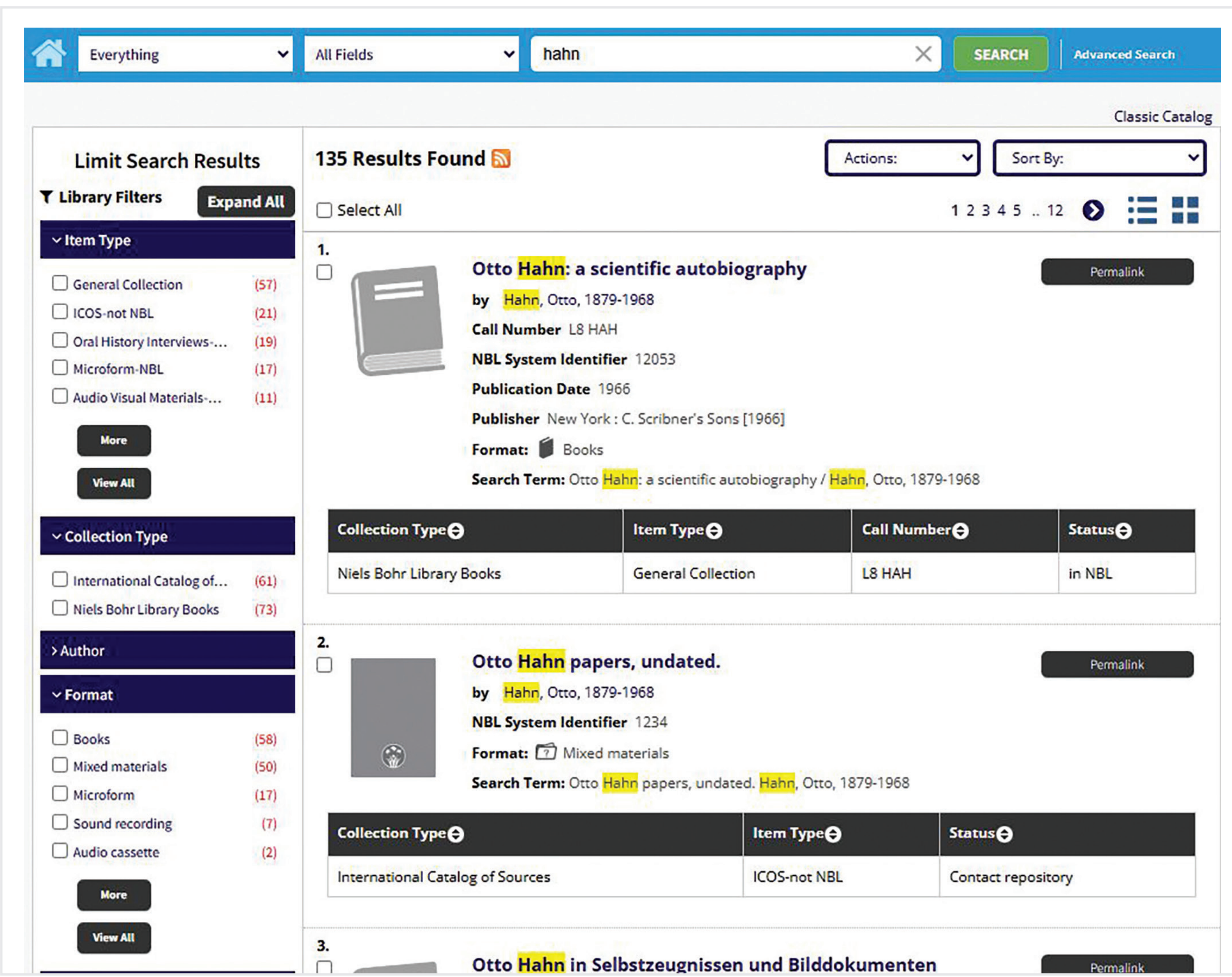
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If there are any errors in the giving list, please accept our apologies in advance and let us know of any corrections so that we may ensure accuracy in future listings. For any corrections, questions, or concerns, please contact Lanetta Gilder in the AIP Foundation office at **lgilder@aip.org**.

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Have you already included us in your estate plan? Please let us know.
If you are ready to begin or have questions, we're here to help. Contact Rebecca Stefanon at **rstefanon@aip.org** for more information or sample language to share with your advisor.

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