John Lewis Heilbron (1934-2023)

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Born March 17, 1934, in San Francisco, John Lewis Heilbron was the elder of the two sons of Louis Henry Heilbron and Delphine Heilbron née Rosenblatt. His father, the child of gifted musicians, was a prominent labor lawyer and an architect of California's new State College and University system; his mother, a civic leader dedicated to San Francisco's many minority populations, became president of the regional YWCA. "And so we grew to maturity and confusion," Heilbron recalled, "with a Jewish mother who ran the Young Women's Christian Association".[1] Like his maternal grandfather, father, and younger brother David, he went to Lowell High School in San Francisco. Lowell was then as now among the most competitive public high schools in the state; in those years, its graduates felt that they "had had about as good a time as you could have".[2] Heilbron was class president in his senior year, distinguishing himself in debate, and graduating in 1951.[3] He earned his Bachelor of Arts in Physics at the University of California, Berkeley in 1955, where he was a member of Phi Beta Kappa, his Master's degree in the same setting and subject in 1958, and his doctorate, likewise at Berkeley, but with the crucial switch somewhere en route to History, in 1964.

Accounts of this conversion differ, though not incommensurably so, if we set aside a newspaper report from April 1959 on the occasion of his marriage to Patricia Lucero that the groom was working toward a doctorate in Philosophy.[4] Decades later, Heilbron recalled that when he realized in the midst of calculations for graduate work in physics, that

1 Heilbron, "Memorial Service for Delphine R. Heilbron".
2 Heilbron, David, "A Friend's View of Judge Stephen Breyer".
3 Lowell High School Student Organization, *Red and White,* 133, 202.
4 "John Heilbron Weds Patricia Lucero".

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he "didn't care how they came out", he began to see the appeal of the history rather than the practice of science. His encounter with Thomas Kuhn, then a professor of History of Science at Berkeley, was life-changing, as was the evidently novel privilege of working with a man "who cared more about arriving at the truth than winning arguments".[5] In 1992 Heilbron's father described Kuhn as one who upon hearing his son give a paper on Galileo in a graduate seminar, immediately sought him out as a disciple, urging him to switch his doctoral degree from Physics to History, a change which Kuhn himself had not made.[6] And in an interview of 2007, Heilbron portrayed himself with amusing implausibility as a "slow learner" – a gesture to the decision to abandon three or four years of work in Physics – and as "lucky" in that his term papers in eighteenth-century electricity happened to interest Kuhn more than they did him.[7] Kuhn's landmark study, *The Structure of Scientific Revolutions,* first published in 1962, acknowledges Heilbron as a member of a quartet – the others being the philosophers of science Paul Feyerabend (1924-1994) and Ernest Nagel (1901-1985) and the theoretical physicist H. Pierre Noyes (1923-2016) – whose contributions were fundamental to the work.[8]

Heilbron's dissertation, "A History of the Problem of Atomic Structure from the Discovery of the Electron to the Beginning of Quantum Mechanics", was the backdrop for the dozens of interviews he conducted from 1962 to 1964, at times with Kuhn but more frequently alone, in Northern and Southern California, England, Belgium, the Netherlands, Switzerland, and Denmark, of physicists whose contributions to the field dated to 1900-1930.[9] These dialogues typically involved the subject's family and socio-economic background, his introduction to the sciences in general and to physics in particular, the difficulty or ease with which his studies had progressed, the relevance of war, nationalism, and antisemitism, the role of religious, educational, and state institutions, his access to pertinent courses, textbooks, journals, instruments, experimental results, theoretical concepts, and well-disposed mentors, and the degree of excitement, skepticism, or incomprehension with which developments in the discipline had been met. Where his respondents struggled to recall dates, names, or places, Heilbron provided those desiderata, and when one speaker, the English mathematician Ebenezer Cunningham (1881-1977), worried over his contributions, he assured him that rambling had neither occurred nor been re-

5 Schoch, "An Upright Man"; Heilbron, "Thomas Samuel Kuhn", 515; the phrase is repurposed, as Heilbron notes, from Kuhn's address to the philosopher of science Carl Hempel in 1990.

6 Heilbron, Louis, *Most of a Century,* 369; Heilbron, "Thomas Samuel Kuhn", 506-507.

7 Heilbron, "Science and History"; Kuhn, *The Structure of Scientific Revolutions,* 14 n. 3.

8 Kuhn, *The Structure of Scientific Revolutions*, XLVI.

9 The transcripts of these interviews are on the website of the American Institute of Physics in the Neils Bohr Library & Archives, under "Oral History Interviews"; Heilbron's interview with the Czech physicist Guido Beck (1903-1988), included there, took place later, in Philadelphia in April 1967.

corded: "Oh, no. We can straighten it out very easily".[10]

While Heilbron would later insist on the need to supplement these distant accounts with publications and correspondence from the era under scrutiny, and would regard the border between the scientist's personal recollections and less accurate popularizations of scientific progress as shifting and porous – the speaker occasionally becoming a protagonist in his own increasingly burnished narrative – the transcripts themselves convey a warm, obliging, and very perceptive presence.[11] Take, for instance, this exchange in the home of the Dutch physicist Adriaan Fokker (1887-1972) concerning the null or light-like interval of spacetime, where there is no apparent separation between event and observation:

> Fokker: Now, we say the interval is zero, and I say, "No, it's just a kind of direct contact". It's mystical. In my student time I was very much impressed by Professor [Jacob Samuel Speyer]; that was the man of Sanskrit. I followed his general course on these mythological figures there and the mystical things, and I read the book of [Max Müller] and that too was a department where I would have liked to explore. Now I'm very much impressed by this idea of the interval zero, and I call it the presence of the past and the not present. You catch me? And the light cone is just my presence. I have a friend who told me that this idea was also in the *Confessions* of St. Augustine.
> Heilbron: I noticed that here.
> Fokker: Yes, I borrowed the book from him, and that is a real fundamental thing. You can say that it is one of God's secrets that we are interpreting. And if we live and we are thinking here, just wondering, we are living interval zero. If we recollect what has happened yesterday, or a year ago, and at the present here and now, things and events which have taken place there and then — in our common way of speaking. And that is a much more important concept than the relativity of simultaneity.[12]

Not hocus pocus but *hoc opus est, hic labor:*[13] the business of trying to understand scientists on their own often arcane terms, to account for and evaluate their beliefs, practices, and broader place within society, and to make those findings not just legible but

[10] Interview of Ebenezer Cunningham.

[11] Heilbron, "Inaugural Lecture at the Max Planck Institute for the History of Science".

[12] Interview of Adriaan Fokker. Fokker refers to the Dutch philologist and translator Jacob Samuel Speyer (1849-1913) and to the German-born Oxford philologist and Orientalist Friedrich Max Müller (1823-1900); he has perhaps the latter's *Comparative Mythology,* first published in 1856, in mind. The reference to Augustine likely concerns *Confessions* XI, xv-xviii. For Kuhn's unease with the agrammatical tenor of "simultaneity of relativity", see *The Last Writings,* 85.

[13] "That is the task, that is the labor". Virgil, *Aeneid* 6: 129, describing the great challenge of returning to the upper air after the easy descent into the Underworld.

also engaging to a broader and perhaps indifferent public would occupy Heilbron for his entire career as teacher, writer, editor, and administrator. From 1964-1967, he worked as an assistant professor to establish the Program in the History and Philosophy of Science, now the Department of History and Sociology of Science, at the University of Pennsylvania. Returning to Berkeley in the fall of 1967, he advanced from the rank of assistant to associate professor of History in 1971, and to full professor in 1973, when he founded and directed Berkeley's Office for History of Science and Technology. In 1974 he published *H. G. J. Moseley, The Life and Letters of an English Physicist, 1887-1915*, and in 1979, *Electricity in the 17th and 18th Centuries: A Study of Early Modern Physics.* He began twenty-five years as editor of *Historical Studies in the Physical Sciences* – subsequently *Historical Studies in the Physical and Biological Sciences* and now *Historical Studies in the Natural Sciences* – in 1980. Distinguishing himself in teaching, he became the Class of 1936 Professor of History and History of Science in 1985. *Lawrence and His Laboratory: Nuclear Science in Berkeley, 1931-1961,* co-authored with Robert Seidel and Bruce Wheaton, appeared in 1981, and in 1986, *The Dilemmas of an Upright Man: Max Planck as Spokesman for German Science.*

Those and other publications, including his *Weighing Imponderables* (1993) and *Geometry Civilized* (1998), emerged with and in the wake of his robust administrative contributions: Heilbron served as chairman of Berkeley's Academic Senate from 1988-1990, and as the University's Vice Chancellor from 1990-1994. These cannot have been easy years either in personal or in professional terms: in 1993 Heilbron lost both his mother and his first wife, and the University of California system faced dramatic budget cuts in this period. Berkeley also had a high-profile case involving gender discrimination, and another where what many would see as racist, homophobic, sexist, and unscientific teaching material, presented alongside more orthodox arguments, conflicted with the ideals of free speech, departmental and disciplinary autonomy, and academic freedom.[14] Though scholars have been known to resist administrative labor unless sufficiently rewarded with lucre, leave time or the like, or to carry them out with studied incompetence, Heilbron insisted both on the ethical imperative of service to one's institution and on the intellectual perspective acquired in the trenches.[15]

His was the most active of retirements, and we are its beneficiaries. After assuming emeritus status in 1995, Heilbron would be a senior research fellow at Worcester College, Oxford, as well as a visiting professor at Yale University and at the California Institute of Technology. He and his second wife, Alison Browning, divided their time between Shilton in Oxfordshire, where they especially enjoyed gardening and seeing "the regulars" at the Rose & Crown, and Pasadena, California, much enlivened by the warm presence of Moti Feingold, Jed Buchwald, and the late Noel Swerdlow. The visits to California also

[14] Heilbron, "Science and History"; Selvin, "Harrison Case"; Id., "The Raging Bull of Berkeley".
[15] Schoch, "An Upright Man"; Heilbron, "Science and History".

allowed Heilbron to maintain close ties to his many friends in Berkeley, to his father, who died in 2007 at the age of 99, and to his brother, whom he lost in 2020.

Even with the care and feeding of faculty behind him, Heilbron continued to emphasize the importance of administrative labor in his work. His magisterial *The Sun in the Church. Cathedrals as Solar Observatories* (1999) addresses from its first page the workings of the Roman Catholic Church as it confronted a very public "problem in administration", its inability to establish a calendar where Easter could be determined accurately, in theoretical rather than observational fashion, and thus in advance.[16] In addition, then, to the fundamental task of showing how meridian lines and ancillary devices were designed, built, used, adapted, and too often destroyed, and what they revealed about the sun, the earth, their relationship, the atmosphere, and the limits of the eye and of the instruments themselves, Heilbron also examined the administrative maneuvers that allowed Catholic astronomers to pursue and to publish their research after the colossal blunder of Galileo's condemnation in 1633.

The relevance of those mechanisms to the practices of modern-day universities emerges through anachronisms such as "early retirement" for a lazy theologian, one astronomer's "gift for getting gifts", and another's taste for "big science", and the durable "practice of ignor[ing] administrative contributions" during the French Revolution.[17] More crucially, on occasion there is no anachronism, no stretch to suture archaic institutions to their contemporary counterparts, just an uncanny anticipation of questions we in academia are still asking today, and to which we often have only provisional and faltering responses. Such was the case of the Jesuit Yves-Marie André in 1712, who eventually learned to offer Copernicanism as hypothetical, and as one alternative among several world systems, but whose early career was hampered by remarks of an inconvenient candor: can those who have no juridical authority legitimately cast aspersions on thinkers who are otherwise well regarded by the community at large? and do schools exist for no purpose but for the public denunciation of every opinion they happen not to like?[18]

For readers of this journal, Heilbron's *Galileo* (2010), *The Ghost of Galileo in a Forgotten Painting from the English Civil War* (2021), and *The Incomparable Monsignor: Francesco Bianchini's World of Science, History, and Court Intrigue* (2022) are likely to be the most familiar territory. Galileo was, more or less, the point about which the Church's administrative efforts to maintain expertise in research, teaching, and publications revolved in *The Sun in the Church.* And yet he figured only briefly in the observations associated with meridian lines, and less because of his own findings than because of what he disclosed in the spring of 1631 about his plan to study the sun as it set on the peaks of Pietrapana for

[16] Heilbron, *The Sun in the Church,* 3.
[17] *Ibid*., 50, 87, 117, 153, 210, 223.
[18] *Ibid*., 214-215; Cousin, "Sur un manuscrit", 15.

four to six successive summer solstices, and because of his eventual endorsement of the discoveries of a fellow Copernican on the antepenultimate page of the *Dialogue concerning the Two Chief World Systems*. In the interest of enrolling a gradual change in the obliquity of the ecliptic as evidence of a moving earth, in November 1631 Galileo had agreed to *intarsiare* or "ornament" the final section of his treatise with praise for Cesare Marsili's work, alluding to his status as a member of Bologna's aristocracy and to his "learned manuscript" describing a slight but constant shift in a meridian line, by implication the one installed some fifty-five years earlier in San Petronio.[19] As it happened, there is no record that Galileo carried out his solstitial observations in 1631 or 1632, and on that day in 1633, he would renounce the tenets of a centrally located sun and mobile earth and by implication abandon all such research. Marsili, for his part, having died three months earlier, was buried in his family's chapel in San Petronio; his account of the drift of the meridian line has vanished.

This version of Galileo – persuasive, evasive, ceremonious, sometimes short on factual details, and attuned above all else to a Copernican agenda – emerges in full force in Heilbron's rewarding biography of 2010. The conceit underpinning *Galileo* is the resemblance of the astronomer to his fictional contemporary, Don Quixote, Cervantes' novel having been published in 1605 and its sequel in 1615. While Galileo's library included the Italian translations of 1622 and 1625, the comparison is initially a surprising one.[20] The most famous of the Spanish protagonist's misadventures in the original novel were his convictions that the sails of a windmill were the arms of a giant enemy and the hammering of a wool mill the blows of jousting knights; in the sequel, just after boasting of his knowledge of the terrestrial and celestial spheres, he concluded that the mills about to crush him and his boat were the ramparts of a fortress full of captives.[21] For Galileo, by contrast, such mechanisms, however useful, were depicted as child's play: he was said to have constructed them as a boy, and in the *Dialogue* and the *Discourses on Two New Sciences* treadmills and millstones were associated with the weaker arguments of the Peripatetic Simplicio.[22]

But Heilbron's argument is elsewhere: both Galileo the "patrician humanist" and Don Quixote maintain bookish and often inapplicable idealizations of the worlds they inhabit, and theirs is a commitment so unyielding, so public, and to some so bewildering that they themselves become caricatural. Beyond the enormous advantage that Galileo enjoys from

[19] Heilbron, *The Sun in the Church,* 176-179; OG, XIV, 225-227, 239-241, 280-283, 300-301, 311-312; OG, VII, 487.

[20] For the most complete account of Galileo's library see https://www.museogalileo.it/it/biblioteca-e-istituto-di-ricerca/progetti/banche-dati-e-bibliografie/863-biblioteca-di-galileo.html

[21] Cervantes, *Don Quixote,* 68-69, 155-158, 658-661; as fortresses generally did contain mills for preparing gunpowder and grinding flour, the last illusion is not entirely absurd.

[22] Gattei, *On the Life of Galileo,* 4-5; Valleriani, *Galileo Engineer*, 12, 67-69, 181; OG, VII, 158, 294; OG, VIII, 109.

our Copernican perspective, there is another crucial difference between these two living legends. The astronomer, trafficking in tidy, frequently repurposed geometrical models, ingenious thought experiments masquerading as actual events, acute visual and aural observations, sophisticated instruments, and superb powers of persuasion, generally outran his actual and imagined interlocutors in rhetorical terms, while Don Quixote establishes himself early as the durable icon of vain erudition, and the unrivaled victim of his own and others' illusions. But the trajectories of what we might call their careers – their ability to continue promoting their idiosyncratic world visions – differ little, for both progress from increasingly frenetic activity to inevitable conflicts with the more powerful, a sudden enforced retirement to a rustic life, and a dramatic renunciation of all that they have pursued.

Heilbron's ambivalent treatment of Galileo in this disruptive guise – his view that scientific progress both depended upon and was slowed by that figure's inability to compromise – reemerges in 2021 in *The Ghost of Galileo.* This lively study concerns a portrait of a student, John Bankes junior, with his tutor, the physician Maurice Williams, painted about 1643 by Francis Cleyn and consigned to discreet oblivion in an estate in Dorset, Kingston Lacy, until Heilbron and Alison Browning rediscovered it in 2010. The painting, likely commissioned by the Royalist lawyer and parliamentarian Sir John Bankes Senior, includes a globe, a telescope, and two books, one of which is clearly Galileo's *Dialogue concerning the Two Chief World Systems,* and the other whose obscured title, Paolo Sarpi's *History of the Council of Trent,* Heilbron establishes over the course of the monograph. Among the converging lines of inquiry here are the reasons for the invidious interest of English parliamentarians in the legal structure of the Venetian Republic and in Sarpi and Galileo in particular, how Sir John Bankes, especially when he served as Attorney General and as Chief Justice, managed to act with integrity in addressing the conflicts between his role as defender of Charles I's capricious royal prerogatives and the fidelity he owed to the English constitution, how the physician Maurice Williams evaluated Galileo's work on falling bodies and a mobile earth, the several possible readings of the portrait's scholarly props, and the relationship of artistic and scientific representation.

While his experience in academic administration had been the backdrop of *The Sun in the Church,* Heilbron's emphasis here, as one might expect in a work completed in 2021 and concerned with a painting produced in the first phase of the English civil war, falls more on the governance of a fractious state. For most contemporary readers it is impossible to overlook his repeated references to rulers who believe themselves above the law, their deployment of lawyers and judges as instruments to circumvent legislative bodies, their abuse of emergency powers, the volatile nature of obscure legal precedents, the rapacious self-enrichment of government officials, the "transformation of black into white, now commonplace among politicians", the relevance of scientific and medical expertise to the state, the constant threat of sedition, and the danger and downfall of polities where

neither laws nor magistrates are honored.[23]

In *The Incomparable Monsignor,* published in 2022, Heilbron focused on one who "if judged by his depth and breadth of mind, [was] the greatest Italian ever".[24] These are fighting words, and but for Foscolo's *forse*, "perhaps", likely intolerable to readers of this journal. The man under scrutiny was the polymath Francesco Bianchini, encountered in *The Sun in the Church* as a shrewd propagator of Galileian science and the prime mover behind the meridian line at Santa Maria degli Angeli in Rome.[25] As the subtitle suggests, his world, ranging well beyond that basilica, involved science, history, and courtly intrigue. The biography opens *in media res,* with three travel-worn characters better suited to a sentimental novel – a pious princess, a pregnant woman, and a bold soldier of fortune – making their shabby way in the spring of 1719 from a fortress in Innsbruck to Rome; the obvious question concerns their connection to the erudite astronomer, antiquarian, and chronologist Monsignor Bianchini.

The entertaining answer takes the better part of the book. Bianchini's Jesuit education, his way of being Galileian after the condemnation of Copernicanism, his membership in and occasional role as an informant about learned academies, his interest in the evidentiary value of material artifacts for establishing a universal chronology, and his careful preparation of the meridian line in Rome for the Jubilee of 1700 all seem plausible activities for this energetic, ambitious, slightly duplicitous prelate. It is in Santa Maria degli Angeli, the familiar territory of the solar observatory, that an unusual personage emerges; she is female, for one thing, and while she had only a cameo appearance in *The Sun in the Church,* here she is introduced as Maria Casimira Sobieska, dowager Queen of Poland, veteran political meddler, and grandmother of Maria Clementina Sobieska, the pious teenager encountered in the opening pages.[26]

Bianchini's portfolio would thus include his work as a diplomat and as an informant for those who supported the claims of James III, the stateless Stuart and Catholic Pretender to the English throne, and who saw the pious princess as an appropriate bride. Such efforts involved trips to France and England in 1712-1713; while not engaged in ceremonies, sight-seeing, and composing cyphered reports, Bianchini visited monuments, libraries, the *Académie des Sciences*, the Sorbonne, the Paris observatory, and Oxford, witnessed experiments at the Royal Society, and conferred with Isaac Newton on their mutual interest in a universal chronology. The Stuart-Sobieski marriage took place in the fall of 1719, an heir and a spare were soon produced, but James' shambolic plans to take the throne did not materialize, which left Bianchini free to devote his last decade to archeology, survey-

[23] Heilbron, *The Ghost of Galileo,* 100, 102, 110, 115, 199, 237-238, 290.

[24] Heilbron, *The Sun in the Church,* 148; Id., *The Incomparable Monsignor,* 2, 72; Foscolo, "Antiquari e Critici", 276.

[25] Heilbron, *The Sun in the Church,* 147-168, 197.

[26] Heilbron, *The Sun in the Church,* 160, 165; Id., *The Incomparable Monsignor,* 75-77, 171-186.

ing, and observations of the moon and Venus.

In an interview some fifteen years before the book's publication, Heilbron described Bianchini as a figure who "could not have been more different" from his previous biographical subjects – the physicists Henry Moseley, Max Planck, and Ernest Lawrence – or for that matter, from Heilbron himself, but this study does present occasional moments of authorial identification, particularly in the realm of historiography.[27] In working as an antiquarian and chronologist, Bianchini relied on three types of evidence to establish the dates on which his system depended. The first and most important was material, generally a monument or a coin created to commemorate a contemporary event of recognized public significance, and thus written in words or symbols legible to that original audience. The second sort involved critical evaluation of the testimonies of historians over time about the event, or what we might call primary and secondary sources. Finally, the dates assigned both to historical and celestial events needed to be scrutinized and at times adjusted, particularly in keeping with an informed understanding of the astronomical knowledge, methods, and instruments of the latter source.[28] While Bianchini developed these rules in order to answer questions about matters such as the number of centuries since the voyage of the Argonauts, they are broadly characteristic of Heilbron's own method in *The Sun in the Church, Galileo, The Ghost of Galileo,* and *The Incomparable Monsignor.*

This is not to say, however, that Heilbron wholly accepted the notion of public monuments as the first and best repositories of indisputable and crucial historical material; his analysis of meridian lines, for example, acknowledged that alongside measurements of the obliquity of the ecliptic, the length of the tropical year, the role of atmospheric refraction, and attention to the limits of the instruments themselves, gratuitous flattery of powerful patrons and numerological adjustment to accommodate their designs on history had their place in the inscriptions.[29] This passing recognition complements scholarly views that our voluble public memorials depend upon the strategic silences of a sustained cultural amnesia, and often have an anachronic character, and it is broadly consonant with the current and perennial distrust of public artworks.[30]

Heilbron also accorded a certain skepticism to the primary documents associated with his subjects. This posture is familiar within the ambit of Galileo Studies, where suggestions of technological or scientific appropriation or religious dissimulation or rhetorical exaggeration often find some support in his private correspondence, manuscript materials, and the texts of his contemporaries. But such doubts also accompany Heilbron's me-

[27] Heilbron, "Science and History".

[28] Heilbron, *The Incomparable Monsignor*, 52-52, 206; Id., "Science and History"; Id., "History of Science, History of Learning".

[29] Heilbron, *The Incomparable Monsignor*, 52, 88, 94-95, 98-99; Id., *The Ghost of Galileo,* 309-310.

[30] See for instance Anderson, *Imagined Communities*, 187-206; Nagel and Wood, *Anachronic Renaissance*; Dickerman *et al.*, "A Questionnaire on Monuments".

ticulous scrutiny of the much more circumspect work of Sir John Bankes and Monsignor Francesco Bianchini, precisely *because* they were so circumspect, particularly in situations where any explicit record of their religious, ethical, or scientific beliefs would have been compromising.[31] That self-censorship, that ability to refrain from commentary on the incompatible doctrines of royal prerogatives and constitutional law, in Bankes' case, or on heliocentrism and Scripture, in Bianchini's, those refuges in ambiguity and regular retreats to an *arrière boutique,* had at least two significant consequences for Heilbron's historiography.

It required him, first of all, to articulate a vision of scientific progress that operates as an efficient and less clamorous alternative to Kuhn's model of "normal" and "revolutionary" science. Whereas Kuhn, particularly in his later works, was at pains to describe how thinkers holding incommensurable visions of science – either the modern historian and his subject, or a pair of contemporaries such as Copernicus and almost any other astronomer of the sixteenth century – could communicate at all, Heilbron's focus was on the ways in which Catholic astronomers and their audiences after 1633 recognized and exploited equivocation. While Kuhn's final concern was the conditions giving rise to rigorous, universal, and prelinguistic cognitive structures, Heilbron's interest lay in the more local linguistic and social conventions that allowed astronomers, authors, and their readers to adopt a thinly disguised heliocentric viewpoint whenever useful.[32] And where Kuhn wrote persuasively of all societies' dependence both upon unambiguous and plausible cognitive structures and upon trustworthy specialists whose task it was to maintain such taxonomies, to adjust them as needed, and to transmit them to future generations, and of the unraveling of an entire intellectual and sociocultural world when the discovery of natural phenomena or the invention of physical or mental instruments strained and destroyed those archives, Heilbron accepted that societies might tolerate epistemological conflict at least in the short run, and that scientists, especially those working under adverse circumstances, might cultivate ambiguity, combine self-censorship with the rigorous practice of their profession, and assume that their results were intelligible to an informed elite.[33] Only in his rare references to the difference between radical system-wrecking innovations provided by Galileo, Kepler, and Descartes and the non-committal stance shared by those skeptical of all human knowledge, by those who assigned physical causes to the occasional and inscrutable intervention of God, and by "sophisticates like Bianchini" and "wafflers like Cassini", did he draw distinctions reminiscent of Kuhn's revolutionary and normal figures.[34]

[31] Heilbron, *The Ghost of Galileo,* 137, 226, 232; Id., *The Incomparable Monsignor,* 124, 136-137.
[32] Kuhn, *The Last Writings,* 167-265.
[33] *Ibid.,* 248-252.
[34] Heilbron, *The Sun in the Church*, 218; Id., *The Ghost of Galileo,* 361-362; Id., "History of Science, History of Learning", 216-217.

His interest in what it was that scientists thought when the documentary trail proved thin or ambiguous had a second historiographical consequence, at once stylistic and substantive. Recognizing that scientific writers often used dialogues to present viewpoints they were then obliged to condemn – Galileo's being both the most spectacular and the most spectacular failure – Heilbron increasingly relied on the genre and its variants in his later works.[35] This was a brisk, effective way of conveying conjectures – the subject's as well as the biographer's – and to some extent eliding the difference between the two. Among the most enjoyable pages of *Galileo,* for instance, are those devoted to an imagined dialogue in the summer of 1609 between "Gal" and "Al", or Galileo and Alexander, the latter being both Galileo's alter ego and more inclined to algebraic than geometric formulation. This vignette allowed Heilbron to show Galileo's, or rather Gal's, early familiarity with the times-square rule, to present the contributions and objections of Guidobaldo del Monte and Paolo Sarpi, and to expose the relative intractability of the physical experiments with inked balls on inclined planes and paired pendulums, and the idle appeal of misleading drawings. Gal emerges as a bit of a bluffer – "I can fix that up", he replies when Al notes a startling inconsistency in his demonstration – an aesthete assuming the coincidence of the beautiful and the true, a speaker swinging between hyperbole and self-doubt.[36] Though the dialogue is replete with actual and historically plausible details – wine-drinking, Santorio Santorio's *pulsilogium,* the trajectories of cannon-balls, and antiquated Aristotelian terms – there's just enough of our idiom – "your dodgy derivative", "a piece of cake", and "the jury is out" – to remind us of the factitious nature of this exercise.[37]

An elaborated version of this technique characterizes the superb exchange imagined between the two sitters in the portrait from Kingston Lacy, John Bankes Junior and his tutor Dr. Maurice Williams, and the artist Francis Cleyn, in the final pages of *The Ghost of Galileo.* Set in Gray's Inn eight or so years after the completion of the painting, it is explicitly modeled on Galileo's *Dialogue,* but with a crucial corrective: Bankes plays the affable Sagredo, Williams the knowing Salviati, but the artist, a late comer to the conversation, is neither Simplicio nor a simpleton. Among their topics are the several ways in which the portrait might be read, why the unnamed book alongside Galileo's *Dialogue* must be Sarpi's *History of the Council of Trent,* the utility of suspended belief, the scientist's need to avoid skepticism and voluntarism in explaining the natural world, Galileo's dependence upon convenient mathematical fictions, and the necessary reliance of both the astronomer and the artist on abstraction, or a kind of caricature, of a much more complex reality.[38] This dialogue likewise includes anachronisms such as "impressionism", "three-body prob-

35 Heilbron, *The Incomparable Monsignor,* 12-13, 20-21.
36 Heilbron, *Galileo,* 128-142.
37 *Ibid.,* 136, 139.
38 Heilbron, *The Ghost of Galileo,* 341-378.

lem", "post-modern", and "complementary values", this last being repurposed to describe the mutual exclusivity of exactitude and the depiction of essence.[39]

Its most extraordinary moment, however, is when Cleyn claims to have overheard the late king Charles mutter as he examined the painting, "Galileo could stand for me", and goes on to speculate about the shared status of the ruler and astronomer as "embattled witness[es] to the truth" and as martyrs of a sort.[40] The false ring is wholly warranted: it appears an echo of Salviati's "recollection" of Galileo's sudden and lengthy epiphany about the correlation of a tilted solar axis with the seasonal variation in the apparent path of sunspots, an insight almost certainly lifted from Christoph Scheiner's *Rosa Ursina* and retrofitted to a Copernican world system.[41] What is crucial here is the ability of both imagined dialogues to convey what register as persuasive "truths" and, by contrast, what we might call "real fakes".

Heilbron's ventriloquism and use of anachronism offer a tacit recognition that even the most fully documented events are mute, or at best muted, and that only with the forceful intervention of the historian do they disclose anything significant. He insisted, especially in his later years, on the interpretive and creative aspect of the biographer's task, comparing it both to necromancy and more decorously to novel-writing.[42] This is by no means to suggest that there were labor-saving alternatives to his meticulous evaluation of primary and secondary sources – there are none – but rather that their presentation as a plausible and compelling narrative necessarily involved conjecture and artistry. Heilbron's increasing emphasis on the relevance of literary techniques to historiography is complemented by greater attention to literary works themselves within his later monographs, both as an effective means to reach a broader public, and as part of his conviction that a scientist's aesthetic choices correlated – sometimes – with other and less obvious intellectual dispositions.[43]

The most obvious such instance, of course, is his association of Galileo's preference for a coherent and plausible presentation of the marvelous in Lodovico Ariosto's *Orlando Furioso* – a grand and glitzy *verosimile* – with his persuasive, often misleading, scaling up of counter-intuitive scenarios in the natural world, or his rejection of psychological complexity in Torquato Tasso's *Gerusalemme Liberata* with his tendency to substitute an idealized geometrical account of phenomena for a messier causal reckoning.[44] But Heilbron discussed genres other than Renaissance dialogues and romances in his later works; provided they conveyed something about the historical moment or biographical subject, he

[39] *Ibid.,* 350, 370, 372, 373.
[40] *Ibid.,* 363-365.
[41] Galileo, *Dialogo,* 374-375; Heilbron, *Galileo,* 280-281.
[42] Heilbron, "Science and History".
[43] *Ibid.*
[44] Heilbron, *Galileo,* 16-23; Id., "Have I Explained Anything?"

gestured to shorter forms of poetry such as sonnets, epigrams, and couplets, to masques, and to novels.[45] Eulogies were useful, obituaries inaccurate.[46] He had neither the time nor the space for ancient epic, but in a discussion of the difficulties of classical physics around 1900, he produced, or rather parodied, their hallmark feature, the Homeric simile: "As when Galileo sliced through the accumulated conundrums of motion by replacing physics with mathematics, so now H. A. Lorentz (Leyden) transformed Maxwell's equations for moving bodies so as to kill terms that predicted detectable effects arising from the motion".[47] And taking a serio-comic approach to Henri Poincaré's contemporaneous suggestion that the field of physics was an ever-expanding library, that the experimentalists managed an inadequate budget to buy new books, and that the mathematical physicists arranged the entire collection and indicated its lacunae, Heilbron also made superb use of the modest genre of the card catalogue entry to describe the growth of the discipline and the manner in which it was organized.[48]

"There is more". This sentence, and its variants "And there is more", "There is much more", "There is more delight to come" appear regularly in Heilbron's work, an agreeable alternative to a paragraph break, or a means of encouraging restive readers through a technical discussion, or elsewhere a festive signal of foolishness or worse, as in his reference to the Nazi appropriation of Galileo and Kepler as heroes in the struggle against the "mystical Jewish physics of Einstein's relativity".[49] In Heilbron's case, and in the interest of accuracy, one might add that there is much more to relate about his work in twentieth-century physics and his numerous awards. His *Rutherford and the Explosion of Atoms* was published in 2003, as was the *Oxford Companion to the History of Modern Science,* where he served as general editor. *Love, Literature, and the Quantum Atom,* co-written with Finn Asserud, emerged in 2013, followed by *Physics. A Short History from Quintessence to Quarks* (2015), *The History of Physics. A Very Short Introduction* (2018), and *Niels Bohr. A Very Short Introduction* (2019). Between the poles of modern and early modern physics, he and René Sigrist edited a volume devoted to the work of an eighteenth-century natural philosopher, instrument-maker, fossil-collector, religious fanatic, secret agent, and reactionary, *Jean André Deluc. Historian of Earth and Man* (2011).

Heilbron was a member of the Royal Swedish Academy of Sciences, the American Academy of Arts and Sciences, the American Philosophical Society, and the *Académie Internationale d'Histoire des Sciences,* over which he presided from 2001 through 2005. He

45 Heilbron, *The Sun in the Church,* 23, 38; Id., *Galileo,* 11-16, 61-62, 174, 222-229; Id., *Ghost of Galileo,* 145-152, 162-168; Id., *The Incomparable Monsignor,* 168-170, 175, 243-244, 253.

46 Heilbron, *The Sun in the Church,* 82, 91, 143, 148-149, 197, 199; Id., *The Incomparable Monsignor,* 73, 241.

47 Heilbron, *Physics: A Short History*, 141-142.

48 *Ibid.,* 136-138; Poincaré, *Sur les rapports,* 4.

49 Heilbron, *The Ghost of Galileo*, 386.

was awarded honorary doctorates from Yale University, and the Universities of Pavia, Bologna, and Uppsala. He received the George Sarton Medal from the History of Science Society, the Alexandre Koyré Medal from the *Académie Internationale d'Histoire des Sciences,* the Marc-Auguste Pictet Medal from the *Société de Physique et d'Histoire Naturelle de Genève*, the Abraham Pais Prize for the History of Physics from the American Physical Society, and the *Premio Internazionale Galileo Galilei* from the University of Pisa.

These are among the "representative books" and "representative awards" listed in Heilbron's laconic *curriculum vitae,* some fraction of the legacy this most accomplished and generous of scholars has left us. Heilbron spent his last months in Padua, where he was accompanied by Alison, and where he delivered a final lecture on Galileo's *Assayer.* He succumbed to a brief illness on November 5, 2023. There is, fortunately, more. *Quantum Drama: From the Bohr-Einstein Debate to the Riddle of Entanglement,* co-written with Jim Baggott, is forthcoming from Oxford University Press. A memorial volume edited by Stefano Gattei, and including a bibliography of Heilbron's works, will be published by Springer in the *Archimedes* series in late 2024. And *Vincenzo Galilei. The Renaissance Dialogue between Music and Science,* edited by Ferdinando Abbri and Natacha Fabbri, will emerge from Olschki in late 2024 with Heilbron's essay, "Music and Motion".

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