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PUBLIC SCIENCE IN THE ENLIGHTENMENT

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Mi Gyung Kim, *Affinity, That Elusive Dream: A Genealogy of the Chemical Revolution* (Cambridge, MA: MIT Press, 2003)

Guiliano Pancaldi, *Volta: Science and Culture in the Age of Enlightenment* (Princeton, NJ: Princeton University Press, 2003)

To challenge the presumed isolation of the scientific method from social concerns and forces, to question the inevitability of progress, to explore the ideological and polemical aspects of science—all these are by now goals commonly stated in historical studies of science. In the quest for these desiderata over the past twenty years or so, historians of science have in many cases distanced themselves from intellectual history in its idealist, disembodied form. However, in spite of salutary moves to analyze instruments, laboratory practices, visual representations, institutions and politics, a great deal of the raw material for the history of science remains textual, very often in the form of print. And, as the existence of this journal attests, intellectual history has retooled to take seriously the contexts for ideas and intellectual movements. At the present moment, when intellectual historians and historians of science are allied in the game of contextualizing our subjects, it is worth considering how current scholarship is working to define multi-layered contexts for scientific ideas and the texts in which they appear.

A monolithic and essentialist view of the Enlightenment, anchored by a core of canonical texts, is no longer taken for granted by historians of science. This state of affairs has not resulted, however, in the demise of the Enlightenment, broadly construed, as a touchstone for studies of science in this period.[1] Ideally, locating the sciences in culture should contribute to a deeper understanding of the values, forms of sociability, ideologies and literary practices that went into the social and cultural mix we still call the Enlightenment. Like other fields of history,

1 William Clark, Jan Golinski and Simon Schaffer, eds., *The Sciences in Enlightened Europe* (University of Chicago Press, 1999).

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though perhaps somewhat more reluctantly, history of science has moved away from recounting the accomplishments of and influences on heroic geniuses and their discoveries. The romantic story of the genius whose inspiration and insight lead him to profound truth is a hard plot to resist, though much of current historiography of science tries to do just this in various ways. This shift has led to more nuanced views of how science interacts with culture, which in turn means looking at how individuals shape and are shaped by a whole panoply of practices, theories and ideas. Great men have not disappeared from the history of science; nor have great ideas. They have rather been incorporated into accounts of how discoveries are constructed and established as credible, and how individuals function in networks of power and production. The seminal concepts and texts that used to comprise the canon for the history of science have been embedded in a dense web of people, institutions, cultural and political practices, literary and experimental techniques, theological and metaphysical commitments, books, letters and visual images. This essay examines two explorations of eighteenth-century science to show how some of their themes resonate productively with studies of other aspects of Enlightenment culture. Both of these books are quite specialized, based on meticulous archival and textual research, but they also address larger questions that warrant attention from intellectual and cultural historians who might otherwise assume too easily that chemistry and electricity are esoteric and overly technical subjects with little crossover appeal.

Mi Gyung Kim's *Affinity, That Elusive Dream* analyzes French chemistry as practiced, written and taught from the early days of the Paris Academy of Sciences in the late seventeenth century to the beginnings of modern chemistry at the turn of the nineteenth century. This ambitious revisionist account of the genesis and development of the Chemical Revolution (so named by Antoine Lavoisier and his collaborators in the 1780s) traces the dynamic process by which chemistry became a fashionable and public science by the end of the eighteenth century, notwithstanding its deep roots in the specialized and sometimes secret worlds of medicine, industry and alchemy. Several analytic threads run through the book. The core narrative line, as the title indicates, follows the chemists' pursuit of affinity as the key to understanding chemical reactions and the relations among chemical substances. In a way, then, this is the history of a concept, but it is not an idealist history. Kim shows how distinct, sometimes rival, traditions within chemistry interacted productively as the discipline entered the public sphere and as its practitioners continually shaped their identities as participants in this sphere. Traditions, in this approach, provide resources and conditions of possibility for future developments; they do not function as absolute constraints. The two main traditions she explores, located primarily in two complementary institutional settings at the Jardin du roi and the Académie des sciences in Paris, are the didactic tradition (linked to medicine and pharmacy) and the research

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tradition (linked to natural philosophy). She also ties these institutionally based traditions to intellectual sources outside France, especially through the works of Hermann Boerhaave and Georg-Ernst Stahl.

The cast of characters is too extensive to summarize succinctly here. Two pivotal "theoretical moments" punctuated chemistry's development from a trade or art practiced by apothecaries, alchemists and metallurgists into an elite part of the public culture of the high Enlightenment. The first crystallized around Wilhelm Homberg, a Paris academician in the early years of the eighteenth century, and the second around Antoine Lavoisier in the 1780s, when the problems of classification and composition appeared especially acute to practitioners. Kim's exegesis of the layers of chemical discourse and practice shows that the distinct but often overlapping "theory domains" of composition (the elements or material principles of compounds) and affinity (the strength and nature of forces binding components together) informed the work of chemists throughout this period. The development of the science was not merely a linear accumulation of knowledge culminating in the realization that the old chemistry had to be overthrown. The dynamic was convoluted, as chemists with different agendas, training, techniques and aptitudes took on the task of ordering knowledge about their particular corners of the chemical world. When Lavoisier rewrote this history for his own purposes, he portrayed progress, in high Enlightenment fashion, as the overthrow of reigning theories or systems rather than as a continuous process of using new problems as the route to more fully articulated theories of affinity.

So what did affinity mean to these generations of chemists? A powerful but problematic theoretical tool, the notion underwent shifts in meanings and theoretical functions over the course of the eighteenth century, but it anchored a surprising range of chemical practice. Mysterious in themselves but observable by their effects, affinities were the selective forces of attraction between the "principles" (simple substances) that combined to form compounds manipulated in the laboratory. Afficionados of late eighteenth-century German literature will recall the "elective affinities," modeled explicitly on the chemical concept, that drove the dissociations and recombinations of Goethe's characters in his eponymous novel *Wahlverwandschaften*. As enunciated by Etienne-François Geoffroy much earlier in the century, "Every time when two substances with some disposition to join each other are found combined, if there follows a third which has more *rapport* (affinity) with one of the two, one is united with it by letting go of the other" (p. 135, translation modified slightly). The affinity of substance A for substance B drives the reaction that results in their combination; it is also a distinguishing attribute of each substance. In this way, affinity was useful for classification, as well as for a dynamic theory of how chemicals combine and how strongly they were bound to each other. The defining characteristic of a substance would be its differing propensities for combination with an array of

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other substances. So the force of affinity is not an absolute, but a measure of the relative strength of a whole set of forces that govern relations among sets of compounds and principles. If they could only be unraveled, these hierarchies of interlocking affinities might bring order to the realm of chemistry. This was the function of affinity tables, which proliferated through the century, as they were refined and expanded to incorporate new results. In these tables, substances were ranged in columns and rows according to the strength of their affinity to combine with each other. Affinity was a powerful tool, conceptually and practically, but its ultimate payoff, as Kim's title suggests, remained elusive. The dream was to quantify these forces as the basis for systematizing the convoluted relations among substances throughout nature. The problem remained how to sort out the affinity relations among not just the simplest principles, but higher-level compounds as well.

Chemistry was a science surprisingly rich in cultural meanings. Contemporaries associated the immaterial forces of affinity with the activity and productivity of nature. Kim does not explore the resonances of affinity with sensibility, and such connections undoubtedly would be hard to draw out explicitly. Such resonances might help to make sense of the imaginative pull of affinity on all manner of writers (and readers) in the Enlightenment—Goethe being only the most obvious. Sensibility as an ideal mode of behavior and affective response to art, literature and individual relationships had its counterpart in materialist representations of nature and the active forces underpinning all change and development in the physical world. This version of materialism went beyond the inert mechanism familiar from Cartesian physics by locating the forces of natural change in matter, no longer inert but capable of action. I am not suggesting that affinity, in the chemical context, was equivalent to sensibility as expressed in the other arts and sciences, but there was some common ground in the way activity was conceived in relation to matter. This is an aspect of the interface between Enlightenment science, philosophy, literature, art and sociability that warrants further research.

Kim writes quite consciously for the small community of historians of chemistry, but she also raises issues with ramifications well beyond her narrow specialty. She is attuned to the workings of theory and philosophy in the laboratory and the didactic practices of chemists. Her strategy is to lay out the lineage of practices and theories, while simultaneously mapping the "standpoints" of individual chemists, with their particular training, institutional positions and motivations. The sweep of her narrative, with all its detours into various chemical theories and practices, illuminates the multivocality of science and the interplay between individual chemists and their community and evolving discipline. Because much of her material is relatively unknown even within the history of chemistry, and conceptually difficult to boot, this is an ambitious task,

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and the book is not easy reading. However, the work of following the close textual analysis is amply repaid for those with enough interest in the historiographical issues to make the effort.

Through her history of chemistry, Kim also contributes to the history of the public sphere. She draws on Habermas in this regard, as we would expect, though she confines her explicit comments about his work to the footnotes. Her case is a forceful argument for including science in the developing public sphere, as the chemists of mid-century (Rouelle's lectures and Macquer's books) fed the "Enlightenment public's taste for universal knowledge" (p. 164). And she makes much of the literary status of chemical writing—something we might not expect. Here Pierre-Joseph Macquer is a key figure: the success of his literary innovations opened the field for Lavoisier's reform of nomenclature and theory. Condorcet's academic eulogy made Macquer into an exemplary enlightened chemist, whose work displayed the virtues of clarity, utility, sound method and solid facts, all in the service of "the general system of our knowledge." His writings had "expanded the taste for chemistry by showing how easy it was to learn."[2] Macquer, much like Condorcet after him, recognized the shifting public role of chemistry and directed his exposition to audiences avid to develop their "taste" for the science. In part, he accomplished this by using the Newtonian language of attraction, evocative for the literate public of the rationality endorsed by the scientific and philosophical elite.

The public face of chemistry was very closely tied to language, literary techniques and publication strategies. Habermas privileged the role of fiction in the emergence of the literary public sphere, which he characterized as a phenomenon particular to the class of bourgeois property owners; attention to the place of science in public discourse enriches this picture with the addition of the literary aspect of scientific knowledge, and the public's receptivity to it. However, the category of "bourgeois," defined as a group with shared economic interests, does not map very accurately onto the multifaceted audiences for science. Certainly some of the auditors at chemical lectures, or the spectators at electrical demonstrations, or the readers of the many periodicals and books that touched on these matters, could be described as bourgeois property holders. But there were also landed aristocrats, fashionable ladies, medical students, hack writers, visitors from the provinces or from abroad, apothecaries, and even government ministers. They were not all getting the same thing from publicly available science, to be sure, but it was precisely the eclectic nature of the audience that characterized this kind of science in the Enlightenment.

2 Condorcet, "Eloge de M. Macquer," *Histoire de l'Académie royale des sciences* (1784), cited in Kim, *Affinity*, 164.

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On the one hand, chemists tapped into a broad fascination with experiment, spectacle and public utility (via industrial and pharmacological applications of chemical knowledge). On the other, they cultivated highly specialized knowledge that required extensive experience and skill, and this could only be appreciated by other specialists. At different times, prominent chemists integrated their science with Paracelsian, Cartesian or Newtonian philosophies, which also contributed to the burgeoning public interest in their work over the course of the eighteenth century. The connection of chemistry to philosophy, and the appetite of a varied public for chemical lectures and demonstrations, may be difficult to understand from our vantage point, when chemistry is commonly regarded, even by the educated elite, as something to be suffered through on the way to something else, or even to be avoided at all costs. Historians of the Enlightenment may find the ins and outs of affinity chemistry arcane, but they will appreciate the rather subtle story of chemists using theory and language to forge their discipline in relation to a wider public.

At the end of the eighteenth century, Lavoisier portrayed his reconfiguration of chemical theory, and the corresponding wholesale revision of chemical nomenclature, as a triumph of clarity and rationality over obscurity and inconsistency. For present purposes, I leave aside the substance of the theories in question. Suffice it to say that Lavoisier's definitive account of his "revolution in chemistry" strategically omitted affinity as a theoretical tool and caricatured the chemistry of his predecessors as crudely empirical, with no rigorous methodological or theoretical underpinnings. He presented his reformation of chemical theory as eminently rational and analytic—in short, as enlightened. This rhetorical move, ensconced in his canonical introductory textbook of the new chemistry, and written in clear and accessible language, was so successful that subsequent histories tended to take Lavoisier's word for the conceptual bankruptcy of the affinity chemistry that had brought chemistry into the Enlightenment. Without at all denying Lavoisier's accomplishments, Kim exhumes the theories and techniques of affinity that the self-styled revolutionary meticulously erased from his heritage and shows how embedded these traditions of teaching, practice and theory were in the reformed chemistry he championed. This rehabilitation of a variant lineage of ideas and practices allows a reframing of the strategies and resources chemists used to make sense of nature. It explicates not only Lavoisier's reformulation of chemistry, but the practices of some of those predecessors he wished to supersede. The point is not to denigrate Lavoisier, but to examine his rhetorical strategies and the layers of language and practice that underpinned his nomenclature reform and his vision for a transparent, and public, chemistry.

Kim is interested in understanding how language worked to accomplish the goals of chemists working in the affinity tradition. One salient theme is the way

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chemists, in their teaching and writing, mediated and negotiated between their esoteric knowledge and more general philosophical principles or approaches to nature. She distinguishes public language from esoteric language, and takes pains to show how separating these two kinds of language can expose overlapping aspects of how chemistry functions in the larger social and intellectual world. Attention to public language and philosophical chemistry is only part of the project, since chemical practice was rooted in other languages corresponding to techniques, especially those of pharmacy and metallurgy. This rather technical story incorporates the role of literary and philosophical aspirations and practices, the provinces and the periphery, the public role of chemists, the didactic impulse, disciplinary formation, rhetorical strategies, patronage—in short, the staples of situated knowledge. Tracing and understanding just where continuities and discontinuities lie in the unfolding of the Chemical Revolution, Kim has discerned a web of what she calls "cognitive, methodological, epistemological and institutional transitions" in the evolution of chemistry in eighteenth-century France (p. 453). Her history of chemical theory refuses to isolate theory from the laboratory, the lecture hall, or the public and its philosophical interests.

Guiliano Pancaldi's book, though it focuses on Alessandro Volta and his canonical discovery—the electric battery—also sets out to complicate the great-man picture of the history of science. This is less a revision of a particular heroic narrative than an inquiry into the motivations, strategies and resources used by one man working at the geographical periphery of science, in Austrian (and later Napoleonic) Lombardy. Geographically distant from the main centers of science, Volta worked hard at making a name for himself in a pan-European community of knowledge. His attempts were not always successful, but they highlight the salient features of the scientific landscape of the time.

The Voltaic pile or battery, an iconic instrument of physical science, has hitherto been rather better known than its inventor, though Volta has certainly occupied a prominent place in the Italian pantheon of scientific and cultural heroes. Pancaldi has exploited a rich cache of Volta's personal and scientific papers to widen the field of view from the battery itself to its inventor and his long career in electrical research and in the Lombard state educational system. Through this career, with its ups and downs and shifts in direction, he gets at the cultural significance of electrical science, as well as the conceptual insights that led to the construction of the battery. The battery was the last in a string of instruments Volta made and promoted to demonstrate novel electrical phenomena, in the context of vigorous contemporary debates about the nature and laws of electricity. Fully aware of the cultural, political and practical ramifications of Volta's various discoveries, Pancaldi deconstructs the notion of the heroic inventor. In effect, he uses the biographical framework to explore the dynamics of discovery and promulgation of science at a time when the

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status and aims of physicists and natural philosophers were evolving rapidly. In many ways, although electricity was a much newer science than chemistry, these developments parallel the evolution of the chemical community, which by the 1780s was also incorporating new phenomena (especially the behavior of gases) into both theory and practice. Where chemists remade the esoteric knowledge and laboratory practices of their predecessors into a science suitable for the appreciation of a self-styled enlightened public, electricians (as they were called) made and performed their science in public from the beginning.

In addition to his lively portrait of this fashionable science, Pancaldi offers a new account of the genesis of the battery, showing Volta making use of the work of an English electrician, William Nicholson, who had worked on the mechanism by which the torpedo fish produced electrical shocks. Recovering the sources Volta drew on for inspiration, Pancaldi constructs a detailed narrative of the discovery based on laboratory notebooks and other manuscripts. At this level, the story recounts Volta's thought processes and the stages he went through in putting together the apparatus. Pancaldi then adroitly takes this internal story to another level to display the dynamics (intellectual and conceptual as well as institutional and political) of the European electrical community, and especially the links connecting individual practitioners to governments and institutions in different locales. Volta is a prime candidate for this kind of analysis because he traveled widely, working hard to negotiate a space for himself in the elite institutions of London and Paris, as well as participating, closer to home, in a bitter controversy with Luigi Galvani. His base in Lombardy also meant that he was subject to shifting political and bureaucratic powers, which affected his self-presentation, and the reception accorded his instruments by electricians abroad.

For heuristic purposes, Pancaldi describes three different kinds of maps used by Volta to navigate across Europe, corresponding to overlapping but distinct audiences for his theoretical, instrumental and administrative work. The most obvious perhaps is the map of expert electrical researchers, scattered through the institutions and capitals of Europe, and especially London, Paris, Leiden, Zurich, Göttingen and Berlin. Volta also negotiated the map of Enlightenment culture and politics more generally, which corresponded closely in geographical terms to the locations of the experts, with the important addition of Austria. In these places, the electricians often belonged to the circles that included philosophers, political reformers and literary types. Finally, Volta had to refer to a map of political power—what Pancaldi calls the "civil servant's map" (p. 175). This was shifting terrain at the end of the century, when Lombardy was taken away from Austria by the French under Napoleon. Volta was able to gain Bonaparte's patronage, and thereby to enhance his standing in the Paris community of physicists, where he had earlier been treated with some skepticism. Volta's travels across these landscapes, and the dissemination of his instruments and his books, show

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how his outsider status, as an Italian with no institutional imprimatur and no formal training, illuminates the workings of the scientific community to which he ultimately gained entrance. The geographical metaphor functions dynamically, as more than a grid on which actors move, because points of favorable reception and patronage change over time, in response not just to political changes, but also to material objects—and especially to the different versions of the battery.

Although Volta aspired to devise a theory of electricity, to explain the phenomena he demonstrated with his novel instruments, he found that his instruments traveled much better than his books or his theories, and served to establish his reputation in a way that his writings could not. Unlike some other canonical scientific instruments (early air pumps, Lavoisier's ice calorimeter, Newton's prisms), the Voltaic pile was easily built in large or small sizes from commonly available materials. The theory of the battery was as elusive as the chemists' affinity theory, but for the most part there was no dispute about the effects of these devices, and they were quickly put to a variety of investigative uses in different places. Kim's layers of analysis mirror the layers of chemical language and practice that she carefully prises apart in order to expose their interactions. The discourse of theory mediated between chemical philosophy and practice. Volta hoped to do something similar, by proposing quantifiable theoretical concepts like tension and intensity that he could measure with devices of his own invention. These measures were to mediate between the phenomena and theories of fluids and forces. However, this did not work particularly well, as his various publics did not find these concepts convincing or useful, though they did use the instruments and the measuring techniques. Pancaldi does not speculate about the reasons for this failure, but shows how Volta reframed his scientific persona to adjust for this reception.

Even more so than chemistry, electricity was an eminently fashionable science in enlightened European circles. It was spectacular, popular with a variety of audiences, and a locus for radical revisions in claims about the operations of natural forces and processes. In the last decades of the eighteenth century, it also produced striking new phenomena (the decomposition of water, electrical stimulation of animal muscles, electrical induction) that strongly implied the interconnection of chemistry, electricity and life. Both Kim and Pancaldi stress the new kind of public science being promoted and patronized in this period, and amass empirical evidence for the ways in which chemistry and electrical physics operated as exemplars of public science. Although neither of them pushes hard in this direction, they also show how science was gaining cultural authority, an authority that eventually fostered a symbiotic relationship with the state. To explore the ramifications of the public representation of science is not to imply that the scientific community was opening its doors to all and sundry. In fact, at the end of the eighteenth century, as these experimental sciences were cultivating

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the public and developing a broadly philosophical and accessible language, the laboratory and theoretical practices of science were becoming more, not less, specialized. The Paris Academy of Sciences, a central institution for both these stories, was more exclusive in its membership and more concerned with policing the boundaries of acceptable science than ever before. Ironically, the push for a transparent rational language and public display of scientific results accompanied the solidification of the line separating insiders from outsiders, along with the increasing technical specialization of nascent disciplines. As science appealed to a growing public, its practitioners worked harder to define themselves as a meritocratic elite.

The dynamic of the public sphere, with its flowering of new institutions of sociability, informs both of these accounts. Social utility, public instruction, critical conversation and public display—all these were features of Enlightenment science. A few years ago, Thomas Broman gave a scathing assessment of the disregard of historians of science for the interpretive value of Habermasian notions of criticism and the public sphere, but it seems to me that many of the insights developed in cultural and social history have indeed percolated into studies that are focused not on science in general but on the practices of individuals like Volta and the traditions of the affinity chemists.[3] Volta, like his chemist contemporaries, openly cultivated the public taste for science in order to enhance his own status, and especially to facilitate the crossing of geographical and political boundaries. Though Pancaldi does not pursue this line of argument explicitly, the increasingly experienced public for science was at least implicitly asked to exert the kind of capacity for criticism that Broman, applying Habermas, used to define Enlightenment scientific culture.

Both Kim and Pancaldi address the issue of how individuals draw on and give back to the institutions, social groups, disciplines and ideas around them. In that sense, both their books are part of a larger trend to integrate local stories with global ones, where global is defined according to circumstances of sources and of historical situations. Kim takes what she calls a genealogical approach to scientific change, writing about theories and ideas without assuming that ideas (dissociated from techniques, instruments, training and rhetoric) drive the development of science. Genealogy also gives her the notion of a more or less stable tradition, perpetuated in print and in lectures, that connected chemists to their predecessors and their contemporaries. Here she elaborates on Foucault's use of genealogy, which stresses the techniques brought to bear on knowledge to maintain or alter its structure over time, and turns it to her own

3 For a perceptive and useful analysis of the links of science to criticism and the public sphere, see Thomas Broman, "The Habermasian Public Sphere and 'Science *in* the Enlightenment,'" *History of Science* 36 (1998), 123–49.

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purposes. Techniques include literary and graphic techniques for representing nature (affinity tables, textbooks), as well as laboratory techniques and training regimens. Genealogy (as for Foucault) involves more than tracing the filiation of ideas, as the lines connecting texts and traditions diverge, cross and intertwine. That is to say, ideas and concepts do not simply beget their offspring in a linear chain of descent, which is the way intellectual history has sometimes been written. The varied contexts for the production, promulgation and representation of ideas mean that these ideas or concepts do not simply give rise to the next generation of ideas enabled by eye-opening discoveries. Nor can individuals easily be labeled the "founding fathers" of this or that discipline, once they are placed into these contexts.

If Kim's book about affinity chemistry were simply an account of continuities and discontinuities, it would be a laudable but restricted work. Enriched by following many strands of analysis in and around the main narrative, it becomes a dynamic portrait of a community of practice in which individuals bring various elements of training, predilection, motivation and interest into play. Philosophy, theory and laboratory technique are all part of the picture. Similarly, the core structure of Pancaldi's study of Volta is biographical, but it expands outward to look at networks of specialists, patrons and readers. The role of the public, or various publics, is relevant for the development of the persona of the man of science in the Enlightenment, a figure that did not exist in previous eras. Whether chemists or natural philosophers or electricians or mathematicians or naturalists, these individuals were all concerned with articulating their identities with respect to their peers at home and abroad, as well as to their patrons and lay readers and auditors. This is not to say that there was a single type of the "man of science." We can recognize themes and trends, and these resonate with familiar themes of Enlightenment cultural history, but there was no single path to scientific success in this period. Whatever notion of public sphere we might project retrospectively onto this period for heuristic purposes, the actors in question self-consciously addressed what they called "the public," and their gestures and attitudes toward the public became crucial features of the man of science. We can break down the public into different constituencies with different interests and motivations, but the framing of scientific work as fodder for public consumption, whether in periodicals or lectures or spectacular demonstrations, came to define the place of science in Enlightenment culture.[4] Defining the arrows of causality in this picture is a daunting, and perhaps impossible, task. The books under review have undertaken to explore this terrain without recourse to deterministic or reductionist explanatory frameworks.

4 Jan Golinski, *Science as Public Culture: Chemistry and Enlightenment in Britain, 1760–1820* (Cambridge University Press, 1992).

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Both authors show how the nuts and bolts of science emerge from the dynamic interplay of local factors and long-distance networks, of material culture and theoretical frameworks, of tradition and innovation. The ways in which different sciences became part of public culture while consolidating their status as expert discourse can then be related to the history of triumphalist narratives of discovery and truth, a genre that flourished in the Enlightenment. We should also note that fascination with chemistry and electricity often involved serious attention by readers and auditors to sophisticated concepts and empirical details. Though it often proved to be spectacular, the universe was not simply a spectacle to be admired passively. Science as fashionable pastime has become a familiar theme in eighteenth-century studies. Unlike notions of popularization or popular science, however, an emphasis on the public aspects of scientific knowledge leads us to think about how science is produced, represented and put to use, and not only how it is disseminated for the amusement or edification of non-practitioners. Public teaching of chemistry brought the science to a wider audience, to be sure, but it also changed the way chemists conceptualized and ordered the principles of their science, which in turn affected their choice of problems and theoretical approaches. In order to configure their knowledge claims for the public, chemists like Macquer and Lavoisier had to clarify and systematize their principles and theories for themselves and their peers as well. Kim argues that the philosophical language used to frame chemistry as a public science affected the practice and development of the discipline itself. Among the audience for chemical lectures at the Jardin des plantes in Paris were aspiring chemists as well as fashionable women and philosophers like Diderot and Rousseau. In Volta's case, audiences across Europe, specialist and dilettante alike, welcomed and assimilated the phenomena demonstrated with his instruments, and the batteries were replicated in a wide range of sizes and prices. Even as they welcomed his technical innovations, they disregarded (to Volta's considerable dismay) the concepts he formulated to explain what was going on. The productive interplay of theory and demonstration, teaching and experimental practice, writing treatises and demonstrating spectacular effects, reveals as well an interplay between science accessible to a broad public and the specialized knowledge jealously guarded by elite institutions.

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