

Palgrave Handbooks of Literature and Science

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This series of handbooks is devoted to the study of the rich and complex history of the relationship between literature and science, from medieval times to the present moment. While this is a topic not unknown to literary criticism (especially in the middle years of the 20th century), the work assembled in these five volumes represents a fundamentally new approach to the vital story of the interconnectedness of literature and science, an approach that is grounded firmly upon an understanding of the status of both literature and science as discourses dedicated to the production of knowledge.

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Howard Marchitello • Evelyn Tribble
Editors

The Palgrave
Handbook of Early
Modern Literature and
Science

palgrave
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To the memory of Paolo Barucchieri
—H.M.

To Carmean Johnson
—E.T.

SERIES PREFACE

This series of handbooks is devoted to the study of the rich and complex history of the relationship between literature and science, from medieval times to the present moment. While this is a topic not unknown to literary criticism (especially in the middle years of the twentieth century), the work assembled in these five volumes represents a fundamentally new approach to the vital story of the interconnectedness of literature and science, an approach that is grounded firmly upon an understanding of the status of both literature and science as discourses dedicated to the production of knowledge.

All of the essays in the volumes were commissioned especially and exclusively for this series; as such, these volumes present the best of current thinking and writing about literature and science—and do so from a wide range of critical and disciplinary perspectives. The critics and authors assembled in this series are literary critics, historians, historians of science, art historians, librarians, and scholars of visual and material culture. The result of bringing together critics from across the disciplines is a robust and multi-dimensional engagement with the most important issues and controversies animating the study of literature and science. The individual writers across these five volumes are leading critics in their fields of study, those scholars who have literally shaped this field of study. These scholars are joined by newer critical voices in the field—evidence of the depth of interest across the academic ranks in this crucial area of study.

The series consists of five volumes, organized broadly by historical period: medieval, early modern, eighteenth century, nineteenth century, and twentieth and twenty-first centuries. The editorial teams for each of the five volumes have been encouraged to think in innovative ways about the particular shape for their specific volumes, in part because the natures of both literature and science are always evolving such that (for example) what might be apt for thinking about Renaissance literature and science may be quite different from how the nineteenth or twentieth century constructed this relationship. Or what we might consider the “forms” of literature have changed, often radically, so that where the medieval or early modern notions of “literature” include devotional

texts (or emblems or epic poems), twentieth-century “literature” can arguably include film or photography or works that are “born digital.” The spirit of inquiry is meant to be matched by a corresponding spirit of expansiveness and inclusion.

Howard Marchitello
General Editor

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CONTENTS

Acknowledgments	ix
Contributors	xv
List of Figures	xxi
List of Tables	xxiii
Introduction	xxv
<i>Howard Marchitello and Evelyn Tribble</i>	
Part I Theorizing Early Modern Science and Literature	1
The Grounds of Literature and Science: Margaret Cavendish's Creature Manifesto	3
<i>Liza Blake</i>	
'Deductions from Metaphors': Figurative Truth, Poetical Language, and Early Modern Science	27
<i>Wendy Beth Hyman</i>	
Imaginary Voyages: The New Science and Its Search for a Vantage Point (Or: How the Imagination Was Used to Domesticate the Exotic)	49
<i>Ofer Gal</i>	

Francis Bacon's Literary-Scientific Utopia <i>Angus Fletcher</i>	73
Part II Reading Matter	93
John Donne and the New Science <i>Mary Thomas Crane</i>	95
God's Game of Hide-and-Seek: Bacon and Allegory <i>Kristen Poole</i>	115
Crafting Early Modern Readers: Galileo and His Interlocutors <i>Crystal Hall</i>	139
Milton, the Poetics of Matter, and the Sciences of Reading <i>Elizabeth Spiller</i>	159
Reading Literally: Boyle, the Bible, and the Book of Nature <i>James J. Bono</i>	179
Communicating Medical Recipes: Robert Boyle's Genre and Rhetorical Strategies for Print <i>Michelle DiMeo</i>	209
Part III Pre-disciplinary Knowledges	229
The Orphic Physics of Early Modern Eloquence <i>Jenny C. Mann</i>	231
Hurricanes, Tempests, and the Meteorological Globe <i>Steve Mentz</i>	257
Milton, Leibniz, and the Measure of Motion <i>Shankar Raman</i>	277

No Joyful Voices: The Silence of the Urns in Browne's <i>Hydriotaphia</i> and Contemporary Archaeology <i>Philip Schwyzer</i>	295
Robert Boyle's 'Accidents of an Ague' and Its Precursors <i>Claire Preston</i>	311
Poetico-Mathematical Women and <i>The Ladies' Diary</i> <i>Jacqueline D. Wernimont</i>	337
Curiosity and the Occult: The Ambiguities of Science in Eighteenth-Century British Literature <i>Barbara M. Benedict</i>	351
Part IV Modalities	375
Medical Discourses of Virginitv and the Bed-Trick in Shakespearean Drama <i>Kaara L. Peterson</i>	377
'Angry Mab with Blisters Plague': The Pre-Modern Science of Contagion in <i>Romeo and Juliet</i> <i>Mary Floyd-Wilson</i>	401
Poetic Science: Wonder and the Seas of Cognition in Bacon and <i>Pericles</i> <i>Jean E. Feerick</i>	423
A Mythography of Water: Hydraulic Engineering and the Imagination <i>Louise Noble</i>	445
Hybrid Philosophers: Cavendish's Reading of Hooke's <i>Micrographia</i> <i>Ian Lawson</i>	467

Making Worlds: Invention and Fiction in Bacon and Cavendish <i>Frédérique Aït-Touati</i>	489
Afterword <i>Peter Dear</i>	505
Selected Topical Bibliography and Suggested Further Readings <i>Christopher L. Morrow</i>	515
Index	537

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LIST OF FIGURES

Fig. 1	Newton's Nov. 28, 1679 diagram: the stone A falls to the east, towards D, with the rotation of the earth	59
Fig. 2	Hooke's Dec. 9, 1679 diagram. The stone falling through earth will orbit the center along AFGHA	61
Fig. 3	Newton's <i>System of the world</i>	62
Fig. 4	Robert Fludd's 'Vision of the triple soul in the body' from <i>Utriusque Cosmi</i> (1617)	66
Fig. 1	Frontispiece of Daniel Defoe's <i>A System of Magic; or, a History of the Black Art</i> (London: J. Roberts, 1727); 719. H. 14	357
Fig. 2	Joseph Glanvill, <i>Saducimus Triumphatus</i> , Part II (London, 1681). 719.H.4, frontispiece	364
Fig. 3	Valentine Greatraks, <i>A Brief Account</i> (London, 1666). 551.B.11 (1)	365
Fig. 1	Drainage mills, from Walter Blith, <i>The English Improver Improved or the Survey of Husbandry Surveyed</i> (London: 1652)	456
Fig. 2	Forcing water upwards, from John Bate, <i>The Mysteries of Nature and Art</i> (London 1654)	458
Fig. 3	Details of the working parts of a windmill, from John Bate, <i>The English Improver Improved or the Survey of Husbandry Surveyed</i> (London: 1652)	459
Fig. 1	<i>Artifice</i> from Ripa's <i>Iconologia</i>	473
Fig. 2	The louse from <i>Micrographia</i>	476

LIST OF TABLES

Table 1	Total appearances of new books on each day of Galileo's dialogues	141
Table 2	Books by classical and medieval authors implied to have been read by interlocutors in Galileo's <i>Dialogue Concerning the Two Chief World Systems</i> and <i>Discourses and Mathematical Demonstrations Concerning Two New Sciences</i>	142
Table 3	Books by sixteenth- and seventeenth-century authors implied to have been read by interlocutors in Galileo's <i>Dialogue Concerning the Two Chief World Systems</i> and <i>Discourses and Mathematical Demonstrations Concerning Two New Sciences</i>	143
Table 4	Total books read by Salviati, Sagredo and Simplicio in each dialogue with additional consideration for the books mentioned in both dialogues	145

INTRODUCTION

Howard Marchitello and Evelyn Tribble

Now I, who am no Orlando, possess nothing impenetrable but the shield of truth; for the rest, naked and unarmed, I take refuge in the protection of your Highness, at whose mere glance must fall any madman who imperiously attempts to mount irrational assaults.—Galileo Galilei¹

1

The year 1623 saw two publishing events that appeared to be both miles and worlds apart: the publication in London of *Mr. William Shakespeare's Comedies, Histories & Tragedies* (the First Folio) and the publication in Rome of Galileo's *Il Saggiatore* (*The Assayer*), his landmark contribution to the so-called Controversy of the Comets of 1618. By conventional accounts (which this Introduction will not contest), the former constitutes one of the greatest literary events in the Western tradition and provided posterity with a corpus of dramatic and poetic texts upon which the very notion of canonicity has been founded, while the latter stands as a foundational manifestation of the emergent scientific revolution and those techniques and principles that would become enshrined in the so-called scientific method. And by equally conventional accounts—which this Introduction will contest—these two landmark books can be said to mark two distinct trajectories that articulate divergent paths: the literary, on the one hand, and the scientific, on the other. Or: the creative and the empirical; the profoundly imaginative and the resolutely factual. These two trajectories—which by convention we will come to call *disciplines* (in the broadest sense of the term)—and the separation between them have typically been understood to describe a fundamental division of the kingdom of human culture and experience: on the one side, the unfettered work of the human imagination and on the other the relentless (and accumulative) production of a rigorously rational and explicable catalog of solid truths.²

The history of cultural criticism, writ large, has been quite content since the time of Shakespeare's First Folio and Galileo's *Assayer* to police this division—a division that prompted, among countless others, one especially resilient articulation: C.P. Snow's 'two cultures.'³ This is not to say that literary critics have

paid no heed to the relationship that obtains, in various moments, between literature and science. Indeed, one significant version of literary criticism, beginning in the first half of the twentieth century and continuing well into the 1960s and 1970s, was principally concerned with exploring the nature of this relationship. This is especially true for studies of sixteenth- and seventeenth-century English literature, works that were of central importance to critics such as Charles M. Coffin, William Empson, and Marjorie Hope Nicolson.⁴ All of these critics (and there are more besides) were working rather against the grain of the dominant literary critical practice of the time, the New Criticism. Within the ascendancy of New Criticism, these were scholars who were deeply invested in understanding early modern science as they found it reflected in the literature of the period. Their efforts were largely dedicated to reading literary writers (especially the poets, with John Donne as perhaps their most significant exemplar) against the backdrop of the new science. This work—as innovative and important and compelling as it was—was nevertheless confined to what can be considered influence study: how did English poets respond to the frequently radical and potentially destabilizing effects of scientific writing?⁵

But the current critical conversation that addresses the relationship between literature and science has undergone something of its own revolution. Critics who study early modern culture with a particular concern to understand both literature and science are no longer focused on charting the ways in which scientific discourse (observation, experimentation, discovery, theorization, and so on) are reflected in literature or other arts, but rather the ways in which both science and literature are mutually informing and mutually sustaining. The presiding question is no longer how do literary writers react to scientific writers, but rather how are the literary and scientific practices imbricated? Can we understand the literary as no less a discourse for the production of knowledge than science is understood to be? Can we understand science as a profoundly imaginative and creative discourse? And, perhaps most ambitiously, can we look back to the early modern period now and see the literary and the scientific as the not-yet-differentiated disciplines—or world views—that the conventional argument and understanding have determined? In other words, this new generation of critics does not study the literary and the scientific as distinct, but rather as productively *in-distinct* cultural undertakings and operations.

It is upon this ground (to give this new species of work a local habitation) that we can turn now to a play such as *King Lear*—as Mary Thomas Crane does in her recent book *Losing Touch with Nature: Literature and the New Science in Sixteenth-Century England*—and see in it the profound poetic negotiation of a problem provided (we might say) by physics and the attending anxiety occasioned by the world reimagined as atomic in nature. On this powerful reading, *Lear* emerges as a play that is ‘at least partly a response to a frightening new world in which the fabric of the universe is riddled with nothingness.’ For Crane, writing from a critical vantage point enabled by the new understanding of the relationship between early modern literature and science (as well as insights garnered from recent work in cognitive science), Shakespeare and his

works can be rediscovered, as it were, as manifesting an underlying and informing interest in ‘changing ideas about the nature of matter, especially concepts such as divisibility and void space that arose as particulate theories challenged the Aristotelian elements.’⁶ Crane (who is one of the contributors to the present volume) can stand as an apt example of the new literature-and-science critic whose work is helping to redefine this particularly urgent field of critical inquiry, one for which the early modern period is especially fertile.

The reasons for this sea change in how critics conceive of the literary-scientific are many, no doubt, but among them there are two that are perhaps most important. The first follows as a consequence of the celebrated ‘turn to history’ (or, more precisely, the ‘re-turn to history’) prompted by New Historicism and Cultural Materialism. In the face of this return to history, what principally fell away quickly from the prerequisites of the New Criticism was the exclusivity of focus on conceiving the literary text strictly as an aesthetic object existing in more or less total isolation from the culture that produced it and the culture of its reception. Indeed, the history of late twentieth-century literary criticism is a series of shifts away from this notion—whether by way of a whole range of new practices that gather under the rubric of ‘theory’ in the 1970s and 1980s, or through the efforts of many of those critical practices ruled out of order by the leading theorists and practitioners of the New Criticism—the personal, affective, and moral among them. It was perhaps these innovations that served to dismantle the strict New Critical focus on the aesthetic object and established the possibility of thinking about literature in relation to the fullness of its cultural embeddedness, a rethinking that brought into sharper focus matters of race and class, for instance, together with the transformative impact of gender and gender studies, postcolonial studies, and many others.

Among the many consequences of these seismic changes in the nature of criticism, we would point to one key achievement as decisive: the dissolution of ideas of historical background and literary object occupying the critical foreground. What this change enables is a productive blending of the historical and the literary. And what follows once our focus is on culture rather than exclusively on its aesthetic objects is the liberation of the critic and criticism from the limiting strictures represented by the demands of literary *judgment* as the *raison d’être* of criticism—the shift, we might say, from (aesthetic) appreciation to intellectual investigation and interrogation. No longer tied to matters of judgment and valuation, the critic is free to think about literature in new ways: as a discursive engagement with political matters, for instance, or as one of the virtually endless forces that produce culture—a realignment of the directionality of the flow of production. The literary can now more readily be seen as sharing in the production of culture, rather than culture expressing itself in a literature that is reduced to an instrumental role as a reflective device. This new configuration of the relation between literature and science allows for greater insight into the functioning of both literature and science in a reciprocal way. This new critical paradigm allows us better to see and to appreciate the ways in which both literature and science are systems dedicated to the production of knowledge.

The second major change that has contributed to the new ways in which critics are thinking about early modern science and literature follows from transformations within the fields of the history and the philosophy of science in recent decades, a change that has allowed for a new understanding of science to emerge, an understanding of science as indeed wholly enmeshed within culture and society, and as fully engaged in language—and in discourse—as are any other manifestations of human thought, including literature. Science is no longer a naturally privileged undertaking but rather a fully human—social, political, biased, and deeply interested—set of discursive practices. The loss of its prior transcendence has been compensated for by a new and fresh richness as science *as an object of study* has come of age. The history of this transformation has been written by practitioners in science studies—a complex constellation of discourses dedicated to the study of the practices and the ideologies of science in its various disciplinary forms.⁷ These practitioners are historians and philosophers; but they are also sociologists, cognitive scientists, and literary critics. And their studies range widely and include discussions as various as mechanics, physics, mathematics, medicine, astronomy, cosmology, geography, horticulture, cognitive theory studies, and animal studies.⁸

2

With these basic but essential reimaginations in place we can look back to literary and scientific texts from the period that have all along signaled the defining *absence* of the two cultures divide. Within this new critical dispensation, and in our critical and historical analyses of texts from the period, it is crucial that the literary and the scientific are not understood as fundamentally separate—indeed, that they should be reconceived as essentially *inseparable* is a key feature of this criticism and of the essays assembled in this collection. As one significant example of the mutually implicated and mutually sustaining nature of the literary and the scientific in the early modern period, consider Galileo's *The Assayer*. This was a text—a polemic, in truth—written in response to a number of texts published in the wake of the tremendous curiosity and anxiety and writing occasioned by the appearance of three comets within the span of several months in the autumn and winter of 1618. Comets had always been considered extraordinary objects (or events), portents of calamity and catastrophe. For natural philosophers, comets had been a key topic of speculation at least since the time of Tycho's work on the comet of 1577, especially because their apparent motion through the heavens (if indeed they were celestial objects and not atmospheric disturbances) seemed to disprove the existence of Ptolemy's crystalline spheres—and with them, perhaps, the geocentric model of the universe altogether.

The Assayer responds to both Horatio Grassi's *On the Three Comets of the Year 1618* (1619) and his later pamphlet *The Astronomical Balance*, published under the pseudonym Lothario Sarsi (1619).⁹ The story of these texts and the dynamics between their two authors is beyond the scope of this Introduction, but Galileo's contribution to the debate provides a perfectly apposite insight

into his scientific-literary imagination. *The Assayer* is, as many critics have argued, one of Galileo's finest *literary* efforts. Indeed, there are even some contemporary suggestions that Galileo's entire purpose in writing *The Assayer* as a treatise on comets—Galileo's understanding of comets as merely atmospheric phenomena seemed wholly inconsistent with his major astronomical discoveries and texts about them—was strictly literary in nature: one correspondent in fact suggested that Galileo did not intend his remarks to be taken seriously and identified *The Assayer* as simply a literary performance.¹⁰ At the same time, modern critics have seen *The Assayer*—as a statement of purpose in general—as perhaps the most significant of Galileo's works, largely due to its careful articulation of *method*. Stillman Drake considers *The Assayer* to be Galileo's 'scientific manifesto ... [and] one of the most celebrated polemic works in the history of physical science.' He continues: 'Apart from literary considerations or the matter of scientific content as such, *The Assayer* and its attendant polemics deserve study for their bearing upon the origin of modern scientific method.'¹¹

There are any number of important issues in *The Assayer*—including Galileo's rejection of philosophical or occult qualities alleged to be inherent in matter, his theorization of the nature of proper scientific evidence, and so forth. But the most frequently noted moment in *The Assayer* (and perhaps the most well-known passage in all of Galileo's works) is one in which he identifies the heart of scientific investigation as fundamentally a literary process—a matter, that is, of inscription and reading:

It seems to me that I discern in Sarsi a firm belief that in philosophizing it is essential to support oneself upon the opinion of some celebrated author, as if when our minds are not wedded to the reasoning of some other person they ought to remain completely barren and sterile. Possibly he thinks that philosophy is a book of fiction created by some man, like the *Iliad* or *Orlando Furioso*—books in which the least important thing is whether what is written in them is true. Well, Sig. Sarsi, that is not the way matters stand. Philosophy is written in this grand book—I mean the universe—which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend the language and interpret the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles, and other geometrical figures, without which it is humanly impossible to understand a single word of it; without these, one is wandering about in a dark labyrinth. (*Assayer*, 183–84)

Later in the same book Galileo will underline something integral to science and method that he holds to be axiomatic: 'nature takes no delight in poetry.' He elaborates:

This proposition is quite true, even though Sarsi shows that he does not believe it, and pretends not to recognize either nature or poetry and not to know that fables and fictions are in a sense essential to poetry, which could not exist without them, while any sort of falsehood is so abhorrent to nature that it is no more possible to find one in her than to find darkness in light. (*Assayer*, 186)

But this strident assertion should not be taken to mean that Galileo, as a reader of literature and as a writer of scientific texts, did not himself delight in poetry. Rather, Galileo here asserts a simple premise that underwrites his science: there can be no falsehoods in nature—and, by extension, it follows that though there can be error, there are no falsehoods in the true scientific knowledge of nature.¹² Another way to phrase this is to say that Galileo's assertion that nature does not delight in poetry is to say that Galilean science (and science in general) cannot abide poetry as its *content* (no fables allowed), but as Galileo's works demonstrate time and again, poetry—or fable—most certainly has a place as *method*.

As an illustration of this notion that the imaginative, creative, poetic, artistic, and, indeed, the false function essentially within Galileo's science, we can consider briefly a key moment in the evolution of Galileo's work on hydrostatics. In the summer of 1611, what might have been an important event in the history of fluid mechanics (and hydrostatics more particularly) did not take place: a public contest between Galileo and Lodovico delle Colombe on the behavior of bodies in water. Galileo was to argue that bodies either float or sink based upon '*gravità in specie*,' while for Colombe, the floating or sinking of objects was wholly a function of their form. The event was to include demonstrations and experiments meant to prove the case, one way or the other, but was canceled at the command of Cosimo II, who was perhaps anxious for both the outcome and the demands of courtly decorum.

In place of this public contest Galileo composed two important documents. The first was a brief unpublished essay—cast in the form of a letter to Cosimo—written in 1611 and preserved in Favaro's *Edizione nazionale*; the second was a thoroughly revised and expanded treatise on the matter—*Discorso Intorno alle Cose che Stanno in su' l'Acqua o che in Quella si Muovono* (*Discourse on Bodies in Water*) published in 1612.¹³ In addition to—or, indeed, as a part of—Galileo's specifically scientific work achieved in his studies on floating bodies, his essay and his *Discorso* manifest an important relationship, an indebtedness even, to what one might call the poetic imaginary. In particular, these texts (and there are others in Galileo's archive besides—including *The Assayer* [1623], and his *Dialogue Concerning the Two Chief World Systems* [1632])—display both the important influence of Ludovico Ariosto's romance epic *Orlando Furioso* (1516, 1532) on Galileo's imagination and Galileo's appropriation of poetry precisely for its power as a discourse for the production of knowledge.

A number of critics have written on Galileo's relationship to poetry—perhaps none as powerfully or comprehensively as Crystal Hall, whose recent *Galileo's Reading* has illuminated with particular clarity and precision both the depth and the complexity of this relationship. In her discussion of the courtly setting within which Galileo was situated and its significance for him as a thinker and writer, Hall notes that the 'literary and philosophical epistemologies' Galileo deploys are intertwined, 'working inseparably and equally' in the service of his writing—a writing that exceeds the strict parameters imposed by the 'scientific' and the 'poetic.' For Galileo, Hall writes, poetry becomes

‘a model for thinking through philosophical problems’ and, with Ariosto’s *Orlando* in mind, Hall concludes:

The use of epic poetry to exemplify that virtue achieved a dual purpose: by its very nature as valorous, it was an authority on virtue, and it was part of the princely court culture that supported Galileo’s investigations.¹⁴

This duality is another way of thinking about the relationship for Galileo between poetry and science more broadly. The figure that emerges in Galileo’s work on floating bodies is the *composite*, a term that is crucial for both Galileo’s hydrostatics, on the one hand, and, on the other, for a more general understanding of the scientific-literary as the *method* of Galilean discourse.

At the heart of general argument concerning the sinking or floating of objects in water is the debate concerning the nature of form/s—a debate, in other words, about the nature of bodies. And the two bodies in question are both that particular set of objects to be placed in water and the water itself, what Galileo will call the ‘bodily character of water.’¹⁵ For delle Colombe and the Peripatetics, the entire subject of sinking or floating was wholly—and simply—a matter of form: objects that are flat—a sheet of ice, for example—float on water due to the inability of such flat objects to overcome a resistance to division that was assumed to be inherent in water.¹⁶ And as for sinking, that, too, is for delle Colombe strictly a formal matter: bodies of a compact form—a small sphere, for instance, or a cube—naturally descend in water precisely because their form does have the ability to overcome water’s natural resistance to division.

For his part, Galileo offers both a devastating critique of the Aristotelian arguments and a compelling scientific *theory* that displaces form as the essential characteristic that determines the behavior of bodies in water and replaces it with a functional notion of specific gravity.¹⁷ Galileo offers a number of initial responses: If flat objects cannot overcome water’s resistance to division, what accounts for the fact that a piece of flat ice that had been held at the bottom of a container of water rises to the top and floats? How has the ice overcome water’s resistance to division in rising to and floating on the surface of the water, even against the weight, as it were, of gravity? As even a simple thought experiment such as this makes clear, Galileo’s first target in his assault on the Peripatetic position is the very notion of water somehow possessing an inherent and natural resistance to division.¹⁸ Delle Colombe and the others came to hold this view in large part because their understanding of Aristotle’s fundamental theory of motion (of any kind) required an enabling resistance in any medium through which an object might move. The Peripatetics supplied another example that they argued affirmed the notion of water’s resistance to division: the difference between a sword striking water on its flat side and striking it on its edge: for the latter we can easily imagine the sword slicing through the water with ease, while for the former we can equally well expect to see far greater resistance. Undaunted, Galileo’s response was to point out

that the sword in both cases moved easily through water and that the apparent resistance to the flat side of the blade was in fact more precisely understood as a matter only of *speed* of motion through water.¹⁹

When pressed further, as they will be by Galileo's scientific analysis of hydrostatics, delle Colombe and his fellow Aristotelians will hit upon what appears to be manifest proof that form and shape are strict determinants after all: they offer two objects made from the same material—in this case, ebony—one of which sinks when shaped into a ball and one of which floats when shaped as a thin 'slice' of the heavier-than-water wood. This 'ebony chip' and arguments meant to explain its habit of floating on water will stand as the central 'proof' that sinking and floating are functions of the forms bodies take.

Galileo's argument meant to explain why the ebony chip floats offers an interesting example of an ingenious explanation that happens to be both scientific (on the level of method) and at the same time completely wrong, as we know today (and on that account rather like Galileo's theory of the tides as a phenomenon that is a function of the earth's two motions).²⁰ At the same time, Galileo's ebony chip argument offers another instance of the argument by way of form as an attempt to explain a natural event. Galileo's response to the ebony chip depends upon two features of this event that escaped the notice of delle Colombe and his allies. The first is that the chip was placed *upon* the water rather than *in* the water—that is, the chip was not uniformly wet. The second—and, for our purposes here, the more interesting—feature of this event, as Galileo understood and described it, was that when placed upon the water the chip maintained a dry surface and that dry surface formed a particular relationship to the air above the surface of the water, a relationship that effectively transformed the nature of the chip as an object and body by virtue of forming a 'composite body' with the lighter-than-water air. It was this hybrid form, Galileo argued, that floated: the chip was part ebony and part air in such a ratio that its absolute and relative weight was less than the weight of water such a body would displace. The composite body—part ebony chip, part air—floats in the small depression it makes in the surface of the water.

Galileo's composite body is an apt figuration not only of ebony chips resting on the surface (or, more strictly, *in* the surface) of water, but also of Galileo's own scientific-literary practices. Where in the foregoing illustration it is the composite body of the chip combined with air that is centrally on display, we can see an analogous or corresponding composite at work in Galileo's writing—writing that emerges from his imagination, which cannot be restricted to the scientific or to the poetic, but rather to both simultaneously. This is in part a function of the intimate relationship between early modern science and early modern literature as coordinate systems for the production of knowledge—or, indeed, it can be understood as a function of what current critical work on science and literature of the sixteenth and seventeenth centuries such as is collected in this volume has demonstrated is the virtual *identity* between these two great discourses, prior to their strict disciplinary division, begun in earnest by the time of Newton and more or less fully mature by the beginning of the nineteenth century.

The particular feature of Galileo's thinking about floating bodies that is important to the present discussion is the interconnectedness figured (*embodied*) in his notion of the composite bodies—not only as a scientific concept, but also as a way of describing and understanding the form of epistemological inquiry on offer in the *Discorso*. Perhaps the best illustration of this connectedness—this *hyphenization* of the scientific-literary—is Galileo's invocation of an important moment in Ariosto's *Orlando Furioso*, a work whose titular hero has already appeared as an epigraph to this Introduction in Galileo's playful dis-identification: 'I, who am no Orlando.' But how does Galileo, in this particular instance, come to the Orlando reference at all?

Having reaffirmed his commitment to the theoretical and experimental results of his investigations into hydrostatics, Galileo assures Cosimo of the steadfastness of his (Galileo's) character and the correctness of his work, even as he cannot be sure how the Peripatetics will respond, an uncertainty founded upon what Galileo stresses is an unhelpful and probably blind adherence to the works and the legacy of Aristotle:

I know not whether the adversaries will give me credit for the work thus accomplished, or whether they, finding themselves under a strict oath obliged to sustain religiously every decree of Aristotle (perhaps fearing that if disdained he might invoke to their destruction a great company of his most invincible heroes), have resolved to choke me off and exterminate me as a profaner of his sacred laws.²¹

While this passage clearly gives voice, if sardonically, to Galileo's long-standing and, by 1612, increasingly strident critique of Aristotelian natural philosophy, the register within which these particular sentiments are voiced is the poetic—and, more specifically, the poetics of Ariosto and his concern with that great figure of form inherited from the ancients, Proteus. Galileo's essay continues:

In this [assault on Galileo] they would imitate the inhabitants of the Isle of Pianto when, angered against Orlando, in recompense for his having liberated so many innocent virgins from the horrible holocaust of the monster, they moved against him, lamenting their strange religion and vainly fearing the wrath of Proteus, terrified of submission in the vast ocean.²²

But the islanders' fears of Proteus are perhaps unfounded. Orlando's defeat of the sea-orc (Canto 11)—achieved at sea through a combination of strategy and strength—not only secures the safety and freedom of the sacrificial victim (Olympia), but draws the attention of Proteus and other sea-gods:

The ancient Proteus from his grotto came. He'd seen Orlando enter and then leave. That gaping mouth; then, witnessing its shame, He'd seen him to the shore the monster heave. And at this uproar, heedless he became. Of all his flock, and fled; and I believe. That Neptune's dolphins harnessed were that day. To speed to Ethiopia straight away. (Fuor della grotta il vecchio Proteo, quando. Ode tanto

rumor, sopra il mare esce; E visto entrare e uscir dell'orca Orlando, E al lito trar
 sì smisurato pesce, Fugge per l'alto Oceano, obbliando Lo sparso gregge: e sì il
 tumulto cresce, Che fatto al carro i suoi delfini porre, Quel di Nettuno in Etiopia
 corre.)²³

Not only does the greatness of Orlando frighten and drive Proteus and the other gods off in fear, the fury that the islanders feared from the wrath of Proteus is replaced by the combined powers of Orlando—‘Thirty he kills, with but ten strokes, or few / More, if truth precisely I must tell’ (11.51.3–4)—and the King of Ireland’s army: ‘Thus they submit to fire and violence / And every battlement in ruin lies; / At every home and farmstead troops arrive / And not a single soul is left alive’ (11.53.5–8).

It would be something of a standard argument to suggest that Galileo found Ariosto’s telling of Orlando and the Ebuda island episode as a correlative to his thinking about hydrostatics; this would indeed be what one might expect from an influence model of literature and science criticism. And it might be an apt argument and would not likely generate much resistance. It would be another thing altogether to suggest that Galileo finds in hydrostatics an apt correlative to his understanding of Ariosto’s poetic vision of the towering heroic figure and his efforts to banish the master manipulator of form, the sea-god Proteus. But the most appropriate assertion here may well be that there is likely *no* priority that can be assigned to either Galileo’s relationship to Ariosto or to hydrostatics. And this is what it means to talk about an *identity* operative in the early modern period between poetry and science—between these two mutually sustaining and mutually informing systems for the production of knowledge.

3

We have divided this book into four sections, but as might be expected from the material and the approaches, the boundaries between them are fluid rather than rigid. A number of writers weave in and out across sections, amongst them that notorious boundary-crosser Margaret Cavendish, but also Francis Bacon, Robert Boyle, Thomas Browne, William Shakespeare, and John Donne. And the range of genres, tools, and texts is equally vast and eclectic, encompassing recipes (DiMeo), hurricanes (Mentz), almanacs (Wernimont), burial urns (Schwyzer), virtuosi, frauds and tricksters (Benedict), bed-tricks (Peterson), drains and dykes (Noble), microscopes, telescopes, and matter. Taken together these essays show that today’s disciplinary divides are back-formations, impositions of binary order upon a much richer and heterogeneous historical reality.

We begin with four essays that in different ways theorize the relationship between early modern science and literature. Liza Blake opens the volume with ‘[The Grounds of Literature and Science: Margaret Cavendish’s Creature Manifesto](#).’ Blake asks whether literature and science ‘is one discipline, or two disciplines, or several’ (4). Noting the long shadow of C.P. Snow’s ‘two cultures’

paradigm, she questions whether our conceptual frameworks are adequate for imagining the relationship between humanities and science. Blake finds a model of a ‘non-hierarchical, non-reductive way’ (6) to think this relationship in the works of Margaret Cavendish. Cavendish rebelled against the Royal Society’s setting of firm boundaries between natural philosophy and poetry, insisting instead on the rational *grounds* that underpin both reason and fancy. This line of attack, begun in her *Observations Upon Experimental Philosophy*, is extended and deepened later in her career in *The Grounds of Natural Philosophy* (1668). Here Cavendish develops the concept of the ‘creature’: ‘ALL *Creatures* are Composed-Figures, by the consent of Associating Parts’ (13). Blake argues that the ‘creature’ is a remarkably productive means to think through the intersection of different knowledges and conceive of relationships among disciplines as assemblages rather than divides. Cavendish’s theory of these relationships, then, may provide a model for contemporary conversation across disciplines: ‘individual disciplines may retain their partial forms of knowledge, but must also forge associations with other disciplines, patterns of action that may create a composite knowledge-creature’ (16). This essay is a fitting opening to a volume in many ways committed to assembling such composite creatures in a new form of interdisciplinarity.

Wendy Beth Hyman’s “‘Deductions from Metaphors’: Figurative Truth, Poetical Language, and Early Modern Science,’ similarly troubles neat distinctions between disciplines. Hyman argues that metaphor functioned as a forensic device for scientists and natural philosophers and as an epistemological strategy for poets, ‘one that allowed literature to “think”’ (28). Contemporary views of the role of metaphor in scientific thinking privileged the views of Robert Boyle’s hostility to rhetorical devices and the concomitant tenet that scientific language should be transparent and free from figurative flourishes. While this view might look like a settled matter now, Hyman reminds us that it was far from so in the seventeenth century, when Boyle’s rhetoric sat alongside other more ‘cacophonous’ prose styles such as those of Thomas Browne. Hyman traces a different path through Browne, who saw metaphor as a ‘productive conceptual and even epistemological strategy’ (34). For Browne the ‘plain style’ advocated by Thomas Sprat and others was inherently reductive; in his view ‘truth *itself* is resistant, multiple and not approachable by any frontal assault’ (35). Both divinity and natural philosophy for Browne are wildly heterogeneous and thus accommodated not by Boyle’s anorexic rhetoric but by a much messier one that grapples with heterogeneity of the world. Such a practice points the way to recovering the history of poesis as a rigorous knowledge-generating mode of thought.

Ofer Gal, in ‘Imaginary Voyages: The New Science and Its Search for a Vantage Point,’ provides yet another way of telling the story of the distance between early modern and contemporary ways of thinking about the relationship between literature and science. From our perspective science might be seen as the triumph of the detachment of the observer from the observed. This division might seem to consign imagination to the realm of poetics, but this is a

post-Romantic assumption. In the early modern new science, imagination was not needed for ‘bold speculations’ but in order to ‘domesticate and familiarize concepts’ that seemed foreign to common sense. Imagination was needed to bridge the gap between what instruments such as the telescope tell us must be true—we are speeding through space and spinning on an axis—and the experiential everyday that tells us we are on solid ground. How could the earth move without ‘a trace left in our experience?’ (51). To understand such paradoxes, we need “imagination not in the romantic sense of creative rupture,” but in its ‘traditional capacity: the structuring, disciplining faculty, which could rearrange inconsistent images into a coherent, sensible narrative’ (52). In this historical moment, it was reason that was extravagant, generating unthinkable verities; and it was imagination that was called upon to domesticate these difficult truths.

Part I concludes with Angus Fletcher’s examination of ‘Francis Bacon’s Literary-Scientific Utopia.’ Like Gal, Fletcher recovers a fundamentally pragmatic role of literature in the realm of the new sciences. In *The New Atlantis*, Francis Bacon confronts the problem of forging community in the wake of the scientific method. Bacon finds the answer in literature. Borrowing from the very writer whose execution he had ensured—Sir Walter Raleigh—Bacon appropriates the travel narrative as a perfect vehicle for engendering community bonds. Bacon’s recognition that ‘group behaviors were habituated by literature’ was in many ways a return to traditional humanist conceptions of the civic benefits of literature, as in Edmund Spenser’s stated aim to ‘fashion a gentleman or noble person in vertuous and gentle discipline.’ *The New Atlantis*’s preoccupation with the dynamic of surveillance models the exchange of ‘the ideal of personal autonomy for the physical good of a self-regulating society’ (83). Although this may be a somewhat disconcerting view of literature’s ability to promote pro-sociality, Fletcher shows that Bacon took seriously the capacity of literature and science to work symbiotically. But such rapprochements seem rare today, with literature viewed not as a practical equipment for living, but as an arcane pursuit removed from the everyday. And this disciplinary divide is equally a problem for sciences. Provocatively, Fletcher suggests that were this unfortunate segregation to end, we might be able to ‘engineer an empirical togetherness out of poetry and fable’ (84).

Part II takes up ‘Reading Matter,’ conceived of as the material supports of reading, methods and strategies of reading, the kinds of readers constructed and imagined by early modern texts, intertextuality, and genre, as well as the variety of ways literary and scientific texts were published and disseminated. Recent decades of scholarship on the material text has gone far to dispel the idea that print is a mere transparent vehicle for ideas. Scholars of early modern culture have become increasingly aware of the range of strategies and significations attached to early modern print, as well as the rich interrelationships between print, scribal, and oral cultures. Moreover, reading strategies and genres were in flux in this period, and some assumptions about genre and

reading modes are actually the result of reading back contemporary distinctions into the early modern period.

In ‘John Donne and the New Science,’ Mary Thomas Crane questions the widely held conception that John Donne was in the vanguard of interest in the new science, far in advance of his sixteenth-century predecessors such as Edmund Spenser and Gabriel Harvey. This view both underplays Donne’s ambivalence about the new science and neglects the relatively widespread interest in and knowledge of the scientific revolution in late sixteenth-century England. Like Gal, Crane notes that the Copernican model of the world challenged Aristotelian notions of common sense: the ‘precept that ordinary sensory experience necessarily provides access to truth about the universe’ (97). Like Fletcher, Crane argues that the travel narrative provides a ready-made generic form for managing this disjuncture between sensory experience and the revelations garnered from new instruments and new ways of seeing the world. Crane argues that the disquiet of Spenser about decline and decay, as embodied in *The Mutability Cantos*, is inherited by Donne as he manages his own ambivalence about new science. As Crane demonstrates, Donne’s famous complaint that the ‘new philosophy has thrown all in doubt,’ like other observations about the new sciences commonly seen to originate with Donne, in fact ‘closely reflects the ideas and concerns seen in earlier writers like Recorde, Digges, Harvey, and Spenser’ (101). Donne’s deep-seated ambivalence about science as articulated in the ‘First Anniversary’ and *Ignatius his Conclave*, is thus also a reworking of early literary engagements with the new philosophy.

In ‘God’s Game of Hide-and-Seek: Bacon and Allegory,’ Kristen Poole revisits the assumption that allegory is a mode fundamentally antagonistic to the new science. In a similar vein to Hyman’s rehabilitation of metaphor as a vehicle for natural philosophy, Poole explodes the myth that allegory and science are inimical. The assumption that these are incompatible modes of thought is anachronistic, and the separation of science and allegory is yet another example of the temporally backward construction of their relationship. Poole demonstrates this contention by revisiting the relationship between allegory and literalism in Protestant thought, arguing that a distinctly Protestant inflection of allegory underpins Bacon’s work. Allegory’s bad press—its association with medieval nit-picking—neglects recent work on the complexity of the Protestant concept of the literal, which in this period ‘was conceptualized as a complex and multi-dimensional, not as a simple, discrete meaning’ (121). Thus the mode of reading Bacon actually advocates is much more complex than is usually assumed. Like Fletcher, Poole rereads *The New Atlantis* as a travel narrative, but one that invites a playful form of allegorical reading, a game of hide and seek that both presents the world in a literal unadorned form of language, but which also demands searching for what is hidden: that is, allegory.

In ‘Crafting Early Modern Readers: Galileo and His Interlocutors,’ Crystal Hall takes up another under-examined form: the dialogue, often dismissed as a hoary and mechanical form for conveying didactic information. But unlike

many other natural philosophers who employ the dialogue form in relatively inert ways, Galileo instead engages in the drama of the dialogue itself, conveying the texture of the debate and demonstrating the ‘necessary reading skills for the successful new philosopher’ (141). An ardent writer in the margin himself, Galileo was highly alert to material ways of guiding readers, including typography, lists, and annotations. In the *Chief World Systems* and the *Two New Sciences*, Galileo’s interlocutors allude to a vast range of texts, ranging from Ariosto to Aristotle to Brahe. The material form of Galileo’s texts models ways of synthesizing and ‘navigating the sea of information’ (141) that must be mastered by the new philosopher. As readers progress through the dialogues, they are guided through the welter of sources into the independent analytic reading practices that enable understanding of Galileo’s mathematical principles.

Elizabeth Spiller also engages material practices of reading in her chapter on ‘Milton, the Poetics of Matter, and the Sciences of Reading.’ Spiller recovers the materialism of Milton’s reading quite literally, situating it within intense debates about the nature of physical matter. As Spiller shows, conflicting theories of matter, such as those that underpinned competing views of Galenic and Paracelsian medicine, were absolutely central to the new sciences. Building upon recent scholarship in the material text and historical phenomenology which has alerted us to the embodied nature of reading, Spiller argues that Milton’s evolving view of the nature of physical matter underpinned changes in his theories of reading. Tracing Milton’s reading practices from his commonplace book to *Areopagitica* through *On Christian Doctrine*, Spiller shows how Milton’s views of matter changed from a Galenic, humoral model to a monist model influenced by a number of Paracelsian texts published in England after the 1640s: ‘This philosophical tradition is relevant to understanding Milton’s attitude toward reading because the cornerstone of this “Christian philosophy” was the belief that knowledge is embodied’ (168).

James J. Bono turns to the reading practices and theory of Robert Boyle, perhaps surprisingly finding Boyle’s model for reading the Book of Nature pre-saged in his early treatise on the Bible, *Some Considerations Touching the Style of the Holy Scripture* (1661). Like Poole, Bono challenges simplistic understandings of concepts of literal reading. True literality ‘is a compression’ (183), always selective rather than partial. Thinking of the literal in this way generates new strategies of reading, and Boyle’s treatise on interpreting Scripture can be seen to establish a set of ‘artful practices’ for reading the Book of Nature literally. The ‘fundamental importance of attention to particulars’ in reading the scriptures provides a cognitive model for reading the Book of Nature. As fallen readers, we have no direct access either to the scriptures or to nature; instead Boyle needs the practices and instruments of human art. For Boyle, cultivated attention results in what Bono describes as an emergent ethics of reading. The ‘sedulous artist’ eschews enthusiasm, attends to particulars, and, importantly does so ‘with a studied lack of self-deception.’ These practices, Bono argues, constitute a ‘cultural poetics of science’ (188). Bono’s essay itself shows how attentiveness to the particulars of reading practices generates understandings

of the relationship between literature and science that cut across traditional disciplinary boundaries.

The final chapter in Part II also takes up Boyle, but in a rather different context. Michelle DiMeo's 'Communicating Medical Recipes: Robert Boyle's Genre and Rhetorical Strategies for Print' explores a moment later on in Boyle's career. If the young Boyle used scripture to establish a model of artful reading practices as Bono suggests, late in his life Boyle engaged in a seemingly more mundane endeavor: publishing his *Medical Experiments* for a lay audience. DiMeo situates Boyle's work within the recipe genre, about which an increasingly robust body of scholarship has been published in recent decades. These by definition are eclectic forms, cutting across print, scribal, and oral cultures. DiMeo notes that scribal publication of such recipes was not rare among the educated class; it was much less common to publish them for a wider audience. Boyle dips a toe into print when he prints but does not publish a small collection of recipes in 1688, using the press for a small limited run that was then circulated privately. But he envisaged a wider audience for his *Medicinal Experiments*, a collection intended for the lay public that was printed in 1692, a year after his death. DiMeo notes that writing within this genre was apparently difficult for Boyle, as shown by numerous revisions as he struggled with questions of audience and form. In the move to publication, Boyle grappled with the possibility of miscommunication and the limitations and constraints of the recipe genre, which necessarily flattened complexity. Hamstrung by the impossibility of providing full context as he could in his experimental essays, Boyle hit upon the expedient of classifying his recipes according to their proven efficacy. DiMeo's essay shows that reading Boyle within the context of contemporary publishing genres provides a window into the larger publication politics surrounding vernacular medical texts.

Part III comprises seven essays that engage what we describe as 'pre-disciplinary knowledges.' These chapters continue the project of seeing the early modern period before disciplines were defined and demarcated, when the direction and emphases of the new science was still up for grabs, when literature and science could be seen as densely entangled rather than mutually suspicious.

The first chapter takes up 'The Orphic Physics of Early Modern Eloquence.' Taking up the concept of 'energeia,' Jenny C. Mann argues that in the early modern period words were not seen as inert; instead, the capacity of skilled language to move readers and audiences places it within the realm of physics: 'the natural science of matter and motion' (233). Following Mary Thomas Crane's division of sixteenth-century natural philosophy into the Aristotelian tradition and the occult science or 'secrets' tradition, Mann argues that early modern rhetorical theory can be seen as 'a physics of occult rhetorical impressions' (233). This view of the place of rhetoric is best exemplified by the myth of Orpheus, who becomes a figure for the efficacy of skilled language, its capacity to physically impress the listener through *energeia*. Mann locates a cultural shift in this view with John Milton's poem 'On Shakespeare, 1630.' Suspicious

of the material force of artful language, Milton worries that such ‘deep impressions’ may work to ‘dispossess the human mind of its potential agency’ (246). Milton’s skepticism prefigures a shift in the history of knowledge, the separation of linguistic eloquence from natural philosophy.

Steve Mentz begins his chapter on ‘Hurricanes, Tempests, and the Meteorological Globe’ with a deceptively simple question: why didn’t Shakespeare call the play *The Hurricane*, a term that had recently entered the English language in the wake of accounts of the extraordinary ferocity of western Atlantic storms? Mentz traces a history of ways of thinking weather, as traditional Aristotelian accounts came into conflict with experiential knowledge of sailors and settlers. Among those who participated in the interplay between these new modes of artisan knowledge and elite thought were writers of fictions. The word itself—normally written as ‘Furricanes’—attracted Nashe, Heywood, and Shakespeare: ‘the poetic force of this exotic word limns the way novel land- and sea-scapes entered English imaginations’ (261). Mentz finds mismatches between received systems of thought and new evidence and experiences that challenged them; attempts to capture hurricanes in language evidence ‘the strain catastrophe puts on existing literary and cultural forms’ (268). Mentz’s perception that ‘storms fracture understanding’ (267) reveals the ways in which fictions work as ways to think catastrophe.

Shankar Raman’s chapter on ‘Milton, Leibniz, and the Measure of Motion’ begins with a fall: not the Fall of Man, but the fall of Mulciber as related in Book 2 of *Paradise Lost*. Milton’s description of Mulciber highlights a fundamental paradox of motion: it is both flowing and punctual: ‘double-sided, simultaneously indivisible and divisible’ (280). Aristotle manages this doubleness through the principle of symphysis, a sort of grafting of the two components of motion, but this solution fails to account for the complexity of ‘the labyrinth of the continuum’ (279) that engaged both Milton and Leibniz. Leibniz turns to differential calculus as a way of grappling ‘with the shifting, mobile multiplicity of a world that seems to evade our conscious attempts to fix it in our understanding’ (285). Raman finds parallels in Milton’s attempts to convey the incommensurability of divine and human knowledge through epic poetry. Both Leibniz and Milton confront the ‘paradoxes of infinite enumeration’ (290), but engage these through different systems: differential calculus and epic fiction. Raman finds surprising and unpredictable links between these systems, both of which are ways to prod the human imagination to grasp worlds that remain just out of reach.

The next chapter in Part III, Philip Schwyzer’s ‘No Joyful Voices: The Silence of the Urns in Browne’s *Hydriotaphia* and Contemporary Archaeology,’ links literature and archaeology through a re-examination of Thomas Browne’s *Hydriotaphie: Urne-Burial*. Schwyzer begins by noting that Browne’s lengthy discussion of the excavation of Anglo-Saxon funerary urns has usually been dismissed as simply a prompt or heuristic for more interestingly philosophical matters. But Browne took his urns seriously, describing them so meticulously that archaeologists today can identify them with confidence. His patience in

describing them and his interest in their indecipherability links his work to the work of contemporary archaeologists, or the study of ‘the relationship between living scholars, long-dead people, and the artefacts that mutely mediate between them’ (296). Schwyzer provocatively sets Browne in dialogue with contemporary post-processual archaeology; Browne’s recognition that funerary customs are ‘communicative practices (298), signaling attitudes to death and commemoration’ aligns him with recent trends in archaeological research.

Claire Preston’s essay, ‘Robert Boyle’s “Accidents of an Age” and Its Precursors,’ juxtaposes the illness narratives of John Donne and Robert Boyle. Boyle’s account of his illness appears in *Occasional Reflections* (1655) and is influenced by John Donne’s 1624 *Devotions Upon Emergent Occasions*, a text also discussed by Wendy Beth Hyman in this volume. Both Donne and Boyle repurpose the ancient genre of the ‘consilium’ or case history: ‘like early-modern doctors, Donne and Boyle each adapt what has been described as “the cognitive practice of attention” for their own idiosyncratic case’ (312). Donne and Boyle adapt the consilium genre in distinctive ways. While both engage in minute attention to the progress of the disease and analysis of its course, Donne’s narrative is ‘fevered’ (316), intensely self-absorbed, full of immediate spiritual turmoil, while Boyle’s narrative is more detached. Preston argues that by mapping the different uses to which each writer puts the consilium, we can chart a journey from the ‘confessional to the “laboratorial”’ (326).

Jacqueline Wernimont’s chapter on ‘Poetico-Mathematical Women and *The Ladies’ Diary*’ places the 1703 almanac *The Ladies Diary* within the context of what Timothy Reiss has described as ‘aesthetic rationalism.’ This hybrid, ‘fantastic,’ text, Wernimont argues, ‘makes evident the strong intertwining of mathematics and poetry in early modern thought’ (339). Like Raman, she notes that both poetry and mathematics are symbolic systems engaging the imagination. *The Ladies Diary* is embedded in existing traditions of periodical literature, but extends their reach by direct address to a female audience and by soliciting reader submissions of poetic and mathematical ‘enigmas.’ Wernimont shows that poetry and mathematics are linked through pleasure, wit, and play. Her chapter also has important links to other essays in this volume on reading and materiality: providing a ‘textual space’ (346) for the demonstration of skill, publications such as *The Ladies Diary* did not simply reflect new forms of knowledge, but actively invented them.

Part III concludes with Barbara M. Benedict’s ‘Curiosity and the Occult: The Ambiguities of Science in Eighteenth-Century British Literature,’ which traces the contested boundaries among curiosity, science, magic, and fraud in early modern literature. In a period in which the distinctions between chemistry and alchemy, science and magic, were blurred, curiosity held an indeterminate place: was it evidence of human superiority and progress, or ‘an impious prying into the secrets of the universe that God had wisely hidden?’ (352). Benedict is particularly interested in the figure of the ‘virtuoso,’ especially as he was satirized on stage or page. The line between science and magic, fraud and natural philosophy, were blurred throughout the period, and the genres with

which these were engaged were equally multifarious. This essay is a particularly fitting conclusion to this section on ‘pre-disciplinary knowledges,’ since it shows so precisely the welter and jumble of areas of inquiry that made up the ecology of early modern literature and science.

Our final section, Part IV, ‘Modalities,’ presents the multiple modes of disciplinary engagements with the emergent practices of early modern science, including theater, medicine, hydraulics, microscopes, and poetics. Part IV begins with two essays that examine the intertwining of theatrical and medical discourses in the early modern period. Both show how a re-examination of medical and scientific discourses teases out elements in early modern play that have been occluded by modern assumptions about disciplinary divides. Kaara L. Peterson’s chapter on ‘Medical Discourses of Virginité and the Bed-Trick in Shakespearean Drama’ takes up the bed-trick, the theatrical plot device in which one woman is sexually substituted for another. Often dismissed as a cheap theatric, the bed-trick is shown by Peterson to instead be deeply implicated in medical discourses about the diseases of virginité. Seen in the context of early modern medical discourses about virginité, the bed-trick becomes an instance of the cultural preoccupation with the diseases of virginité—and ways of addressing ‘(in)salubrious virginité’ (378).

Mary Floyd-Wilson examines a different set of medical discourses in her essay on “‘Angry Mab with Blisters Plague’: The Pre-Modern Science of Contagion in *Romeo and Juliet*.” Plague ‘habits of thought’ (400) profoundly demonstrate the border-crossings that characterize early modern discourses of literature and science. Plague treatises in particular evoke multiple discourses of causation, indiscriminately mixing supernatural, preternatural, and natural modes of explanation. Plague culture hangs like a miasma over *Romeo and Juliet*, and competing modes of causation that inform its dramatic structure are not derived from literary sources alone, but also result from the impingement of scientific and medical modes of thought upon the play.

Yet another admixture of theatre and science is explored in Jean E. Feerick chapter: ‘Poetic Science: Wonder and the Seas of Cognition in Bacon and *Pericles*.’ Feerick argues that the modern ‘two-culture’ thinking that polarizes arts and sciences has blinded us to the intimate connections between the ways of thought promulgated by poetry and philosophy. Juxtaposing Bacon’s account of how art ‘manages the mind’s activity’ and the play *Pericles*’s models of cognition, she suggests that such pairing may help ‘recall the poetic side of science and the “knowing” side of art’ (425). Both Bacon and Shakespeare figure the mind as ‘tossing on the ocean.’ While Bacon and Shakespeare have often been seen to have radically opposed views, Feerick argues that Shakespeare’s presentation in *Pericles* of ‘artfully rendered wonders’ (430) serve to arrest attention, in precisely the way that Bacon advocates for natural philosophy. *Pericles*, and theatre at large, thus function as a sort of ‘cognitive laboratory’ (429).

Louis Noble’s ‘A Mythography of Water: Hydraulic Engineering and the Imagination’ similarly links science and the imagination; in particular, Noble examines how water was imagined. Early modern England saw a fascination

with projects of controlling water, and engaged in an ‘imaginative alliance between water and hydraulic invention’ (443). Large-scale engineering projects such as draining the fens were practical but also fundamentally creative, and such schemes should be considered alongside other ways of imagining water in the period, such as Edmund Spenser’s inventory of England’s rivers and Hotspur’s dreams of controlling the landscape in *Henry IV, Part I*. Reading treatises on water control in the light of an emerging hydraulic imagination demonstrates the profound entanglement of the imaginative and the practical arts in this period.

The final two chapters in the volume take up Margaret Cavendish’s challenges to the project of natural philosophy. Ian Lawson’s ‘Hybrid Philosophers: Cavendish’s Reading of Hooke’s *Micrographia*,’ stages a conflict between two modes of reading. In *The Blazing World*, Margaret Cavendish responds skeptically to Hooke’s microscope: Lawson argues that the hybrid animal-philosopher creatures in her fiction parody the ‘animacules’ that Hooke so enthusiastically describes in his *Micrographia*. This satire extends not just to the specifics of Hooke’s project, but also to the underlying assumptions behind it. Cavendish thought that ‘deluding glasses’ (465) of the microscopes ‘intoxicated so many Mens brains,’ and caused them to ‘lay aside’ more productive arts (466). Her parodies of natural philosophers as bear-men mount a critique of the mechanist assumptions behind Hooke’s inventions and implicitly make a case for a new approach to natural philosophy.

Frédérique Ait-Touati’s chapter on ‘Making Worlds: Invention and Fiction in Bacon and Cavendish’ similarly explores Cavendish’s critique of natural philosophy through an extended consideration of the role of ‘invention’ in literary and scientific discourses of the early modern period. While the rhetorical definition of ‘inventio’ stressed finding what was already there in an act of *imitatio*, Francis Bacon proposed that the term must be ‘redefined, and properly redesigned as a tool for producing knowledge’ (489) if it was to be useful for science. Thus began the transformation of the concept from imitation to novelty; for Bacon ‘*inventio* was no longer considered to entail taking and rearranging elements from an existing repertoire, but rather discovering the treasures held by nature’ (489). Ait-Touati shows that ‘invention’ was also taking on a similar set of implications in the domain of literature, arguing that Cavendish was herself invested in an emerging sense of ‘invention as the original creation of the author; originality as a criterion by which a value of a work is to be judged’ (491). Yet these parallel shifts in meaning of the term do not presage a rapprochement between literature and science; rather, they mark the beginning of their division into separate domains of inquiry.

* * *

As we hope this Introduction and brief overview suggest, the essays gathered here range across vast territories and produce seemingly unlikely unions: between physics and rhetoric, math and Milton, Boyle, and the Bible, plague and plays, among many others. They do not determine in advance the bound-

aries between literature and science. So-called scientific writing turns out to traffic in metaphor, wit, imagination, and the playfulness normally associated with the literary arts, and literature provides material forms and rhetorical strategies for thinking physics, mathematics, archaeology, and medicine. By gathering together the following generous selection of essays by leading critics it is our intention both to represent and to commemorate the new generation of critical work dedicated to the study of the rich and complex relationship between literature and science in the early modern period. At the same time, this collection is meant to prompt new and continuing work in this crucial area of literary and historical study.

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NOTES

1. Untitled manuscript essay, quoted in Stillman Drake, *Galileo at Work: His Scientific Biography* (Chicago: University of Chicago Press, 1978), 174. This essay appears in Favaro's *Le opere di Galileo Galilei: Edizione nazionale ...* (Florence: G. Barbèra, 1890–1909), vol. 4.
2. For a powerful critique of these trajectories, see Claire Preston, *The Poetics of Scientific Investigation in Seventeenth-Century England* (Oxford: Oxford University Press, 2015), especially the Introduction. See also Howard Marchitello, *The Machine in the Text: Science and Literature in the Age of Shakespeare and Galileo* (Oxford: Oxford University Press, 2011); Elizabeth Spiller, *Science, Reading, and Renaissance Literature: The Art of Making Knowledge, 1580–1670* (Cambridge: Cambridge University Press, 2004), as well as Christopher Morrow, 'Selected Topical Bibliography and Suggested Further Readings' in the present volume.
3. C.P. Snow, *The Two Cultures*, ed. Stefan Collini (Cambridge: Cambridge University Press, 1988).
4. See Charles M. Coffin, *John Donne and the New Philosophy* (New York: Columbia University Press, 1937), William Empson, *Essays on Renaissance Literature, vol. 1: Donne and the New Philosophy*, ed. John Haffenden (Cambridge: Cambridge University Press, 1993), and Marjorie Hope Nicolson, *The Breaking of the Circle: Studies in the Effect of the 'New Science' upon Seventeenth-Century Poetry* (Evanston: Northwestern University Press, 1950), *Newton Demands the Muse: Newton's Opticks and the Eighteenth-Century Poets* (Princeton: Princeton University Press, 1946), and *Science and Imagination* (Ithaca: Cornell University Press, 1956).
5. See Howard Marchitello, 'Science Studies and English Renaissance Literature,' *Literature Compass* 3, no. 3 (2006): 341–65.

6. Mary Thomas Crane, *Losing Touch with Nature: Literature and the New Science in Sixteenth Century England* (Baltimore: Johns Hopkins University Press, 2014), 124.
7. The following anthologies of essays are essential reading: *The Science Studies Reader*, ed. Mario Biagioli (New York: Routledge, 1999) and *A History of Scientific Thought: Elements of a History of Science*, ed. Michel Serres (Oxford: Blackwell, 1995).
8. For examples, see: Judy A. Hayden, ed. *Travel Narratives, the New Science, and Literary Discourse, 1569–1750* (Farnham: Ashgate, 2012); Kathleen Long, ed. *Gender and Scientific Discourse in Early Modern England* (Farnham: Ashgate, 2010); Juliet Cummins and David Burchell, eds. *Science, Literature and Rhetoric in Early Modern England* (Farnham: Ashgate, 2007); Angus Fletcher, *Time, Space, and Motion in the Age of Shakespeare* (Cambridge: Harvard University Press, 2007); Katharine Park and Lorraine Daston, eds. *Early Modern Science, The Cambridge History of Science*, vol. 3 (Cambridge: Cambridge University Press, 2006); Claire Preston, *Thomas Browne and the Writing of Early Modern Science* (Cambridge: Cambridge University Press, 2005).
9. These primary texts, and others, were published together as *The Controversy on the Comets of 1618*, trans. Stillman Drake and C.D. O'Malley (Philadelphia: University of Pennsylvania Press, 1960). Grassi's second work on comets was itself a response to a Mario Guiducci's *Discourse on the Comets* [1619], a work now generally held to have been largely—or perhaps entirely—written by Galileo himself; see Drake and O'Malley (especially the Introduction, vii–xxv) and David Wootton, *Galileo: Watcher of the Skies* (New Haven and London: Yale University Press, 2010), chapter 23.
10. More particularly, this writer identifies Galileo's text as a theatrical performance: '*questo teatro letterario*,' quoted in Wootton, 160.
11. Drake and O'Malley, vii. This notion is seconded by David Wootton, who considers *The Assayer* to be Galileo's 'most extended discussion of scientific methodology' (Wootton, 161).
12. It is this premise, moreover, that assures Galileo of the reality of the moons of Jupiter, for example, or the fact of spots on the surface of the sun—scientific truths that were fiercely contested in the aftermath of their initial Galilean discovery.
13. Quotations from the *Discorso* are from Stillman Drake, *Cause, Experiment and Science* (Chicago: University of Chicago Press, 1981).
14. Crystal Hall, *Galileo's Reading* (Cambridge: Cambridge University Press, 2014), 69. See also Mario Biagioli, *Galileo Courtier: The Practice of Science in the Culture of Absolutism* (Chicago: University of Chicago Press, 1993), especially chapter 2.
15. Quoted in Drake, *Cause*, 80.

16. The origin of the debate concerning bodies in water arose from the (natural) philosophical debate concerning what happens to water in the cold. Following Aristotle, the Peripatetics took it as axiomatic that ice is simply condensed water whereas for Galileo, noting that ice takes up more space than does the water from which it was formed, ice can only be 'rarefied' (that is, expanded) water. See Stillman Drake, 'Galileo Gleanings VIII: The Origin of Galileo's Book on Floating Bodies and the Question of the Unknown Academician,' *Isis* 5, no. 1 (1960): 56–63.
17. Unfortunately for delle Colombe and the other Peripatetics, Galileo had long been interested in hydrostatics; as Drake demonstrates, Galileo had been at work on the topic as early as 1607—and quite possibly earlier, in the mid- to late-1580s (*Galileo at Work*, 123–4).
18. One of Galileo's most important assertions in the *Discorso* is that his study of hydrostatics may well open on to a more rigorous and theoretical understanding of water itself, an argument that leads Galileo to conclude that there is no resistance in water, only movement: 'I shall say further that when we advance to a more internal contemplation of the nature of water and other fluids, we shall perhaps discover that the constitution of their parts is such that they not only do not oppose division, but that there is nothing in them that must be divided' (*Cause*, 116–17).
19. In fact, Galileo will claim that there is *no* body in existence that cannot pass easily through water (*Cause*, 86).
20. As we know today, it is surface tension—a kind of *resistance at the surface* of water, in fact—that accounts for the chip floating.
21. Quoted in *Galileo at Work*, 173.
22. Quoted in *Galileo at Work*, 173–4.
23. Lodovico Ariosto, *Orlando Furioso*, trans. Barbara Reynolds (Harmondsworth: Penguin, 1975), II.44 (356).