Introduction
Science Under the Literary Microscope

Susan M. Gaines,
Sina Farzin, and
Roslynn D. Haynes

Over the course of the twentieth century, scientific literacy and public engagement with science became increasingly critical to socioeconomic development and democratic governance. Nearly every sphere of society in the industrialized world came to depend on scientific knowledge and technology. In democratic societies, this meant that scientific practice and knowledge production were accompanied by new forms of public awareness and debate. Media coverage of science intensified, school science curricula expanded, and scientific institutions dedicated more and more attention to science communication. In the cultural realm, nonfiction popular-science books, magazines, and TV programs flourished, as did the imaginative extrapolations of technological innovation that gave rise to the publishing category known as science fiction, or SF. In the last decade of the century, we also began to see a proliferation of novels with explicit, in-depth depictions and explorations of actual scientific research practices—both contemporary and historical—and of the lives and work-worlds of scientist characters. Ian McEwan, Richard Powers, Barbara Kingsolver, Ann Patchett, A. S. Byatt, Simon Mawer, Allegra Goodman, Joyce Carol Oates, Anthony Doerr, and Jonathan Franzen are just a few of the more well-known authors of literary fiction who have focused on scientific subjects in their novels since the 1990s.

The rising turn-of-the-millennium tide of novels *about* science opened a creative space in which the novel-reading public—including cultural com-

mentators and their audiences, working scientists, and general readers—can experience and think critically about the ways that scientific knowledge is generated and used. In *Under the Literary Microscope*, we examine the public discourse taking place in and around this creative space, focusing on novels that explore the complex social institutions and practices of modern science as well as the labyrinth of economic, political, educational, and moral factors that impact those practices and the knowledge produced. Before we delve into this distinctly contemporary discourse—which should interest not only literary and cultural-studies scholars and sociologists of science but also educators and practitioners of science communication—we take a quick gallop through time to review its antecedents in the novel's long history of engagement with public discourse about science.[1]

The Novel and the Rise of Modern Science

Over its long history, the novel has explored nearly every domain of human experience and relationships, from love, sex, family, and friendship to hate, violence, and death. It has participated in the major social discourses of its time, with stories that engaged with history, politics, economics, religion, philosophy, psychology, sociology, and the sciences. In recent decades, as humanities scholars have turned their attention to the study of literature and science, the coevolution of modern science and modern literary forms has become ever more apparent (see, for example, Secord 2014; Sleigh 2010; Rogers 2014). Even before the rise of the European novel, Johannes Kepler and Francis Bacon used a form of fictional narrative to develop and promote their thought experiments—Kepler on astronomy in *Somnium* (1634) and Bacon on scientific method and institutional structures in *New Atlantis* ([1627] 1909) (Chen-Morris 2005; Kelly 2016)—while Francis Godwin's speculative utopian fiction, *The Man in the Moone* (1638), was inspired by the new Copernican astronomy (Martin 2016). In Britain, debates in the newly founded Royal Society about experimental methods and about the relative merits of pure and applied knowledge—what Bacon called the "light" and "fruit" of science, respectively—circulated among the educated classes and made their way into fictional forms. Margaret Cavendish paired her publication of *Observations upon Experimental Philosophy* with publication of *The Descrip-*

tion of a New World, Called the Blazing World (1668), a satirical fantasy that mocked the Society for its obsession with new scientific instruments, which she thought interfered with natural vision and commonsense observation. Thomas Shadwell's popular play, *The Virtuoso* (1676), ridiculed the amateur scientific dabblers, or "virtuosi," as gullible fools who were out of touch with the real world, and Jonathan Swift's trenchant social satire, *Gulliver's Travels* (1726), exposed the squandering of resources in the pursuit of useless and potentially destructive scientific experiments.[2] But Robert Paltock's later *Life and Adventures of Peter Wilkins* (1751)—the story of a castaway whose survival depends on logical experimentation with his natural environment—celebrated the practical potential of the new forms of empiricism.

By the nineteenth century, the social and economic promises of scientific knowledge—and the power it engendered—had begun to spark the imaginations of creative writers and spawn new kinds of fictional speculation and experimentation. Mary Shelley's *Frankenstein* (1818) explored the presumed implications of early experiments with "animal electricity" in a cautionary tale about an overly optimistic attempt to transcend human limitations. In some of his early novels, H. G. Wells, who had a university science degree, engaged with the ongoing debates about vivisection and evolution, writing about the abuse of knowledge by arrogant, ethically deficient scientists. In *The Mudfog Papers* (1837–38), Charles Dickens satirized science enthusiasts' mental prowess, "obsession with detail," and generally "exaggerated sense of importance," which he saw reflected in the early attempts to institutionalize the practice of science (Zerbe 2016, 218, 219). Jules Verne, however, reacted to the new knowledge with unconditional wonder, producing a popular series of adventure stories that attempted "to sum up all the geographical, geological, physical, and astronomical knowledge amassed by modern science" ([1866] 2005, 320). The writer Émile Zola responded directly to the new epistemology as such, rather than to its products. Claiming that "if the experimental method leads to the knowledge of physical life, it should also lead to knowledge of the passionate and intellectual life," he set out to design a "literature governed on science," adapting the experimental method to the writing of his novels ([1880] 1893, 1–2).

With the rise of literary realism, novelists in the late nineteenth century began employing more rounded, fully realized characters while continuing to engage in debates about the changing social status of science and

emerging scientific concepts: evolution and biological classification in Elisabeth Gaskell's *Wives and Daughters* (1866), the use of scientific methods in medicine and agriculture in George Eliot's *Middlemarch* (1871), new discoveries in astronomy in Thomas Hardy's *Two on a Tower* (1882), and debates over vivisection in Wilkie Collins's *Heart and Science* (1883). These novels and others of the time—including George Gissing's *Born in Exile* (1892) and H. G. Wells's *Love and Mr Lewisham* (1900), *Ann Veronica* (1909a), and *Tono-Bungay* (1909b)—recounted the struggles of young people who were trying to enter the new professions in a society that was not yet ready to adopt scientific values.[3]

While nineteenth-century novelists were responding imaginatively to new scientific methods and discoveries, scientists were utilizing the familiar narrative techniques of literature in their scientific reports and public presentations. The chemist Humphry Davy employed dialogue and made "visionary use of fact" to address the philosophical implications of new ideas about the geological history of the earth and the nature of time; Charles Lyell's *Principles of Geology* (1830–33) was embellished with rhetorical deftness and peppered with references to respected literary figures; and Charles Darwin's *On the Origin of Species* (1859) reads like a nineteenth-century novel, building a grand plot and larger meaning from the sequential first-person accounting of small observations and experiments (see Secord 2014, 157–62; Nieto-Galan 2016, 41–51). Scientific literature—both scientists' narrative accounts of their research and popularizations of science—was immensely popular, produced in mass and circulated not only in educated upper-class circles but also among the middle class and newly literate sectors of the working class (Nieto-Galan 2016, 38–41). The practice of science itself was gradually becoming professionalized, but there was still a continuum between the production of scientific knowledge and its integration in the wider society, where science was regarded as a practical and entertaining extension of common sense (Bensaude-Vincent 2001). Public interest in science coincided with and was fueled by new ideas about educating the masses and—with the invention of the steam-powered printing press—by mass-market publishing, as exemplified by the Society for the Diffusion of Useful Knowledge, with its *Penny Magazine* and "Library of Useful Knowledge" (Secord 2014, 16–17, 108–9). Along with professionals who practiced and taught science in universities, a new class of amateur and professional science writers emerged to interpret the new knowledge for lay audiences (see Nieto-Galan 2016, 38–41).[4]

By the end of the nineteenth century, the professionalization and formalization of science along with the explosion of knowledge, proliferation of disciplines, and separation of classical and scientific education systems had begun to generate a distinct knowledge gap between scientists and other members of the educated populace. The activities and institutional settings of scientific research disappeared from direct public view, and the knowledge produced was assessed by an exclusive scientific elite. Increasingly, reports of new scientific findings were published in dedicated scientific journals and written in a style and a technical language that were inaccessible not only to general readers but even to scientists from different disciplines. A distinct divide thus emerged between the specialized journals that scientists used in developing and verifying knowledge, and the popular scientific publications read by the general public. The professional scientific journals became the gatekeepers of knowledge, and the popular-science publications, which had engaged a wide cross section of amateur and professional scientists, ceased to play a role in the process of knowledge production and legitimation. Instead, scientists began to view popular-science publications and reports on scientific developments in the general media as tools for simplifying concepts and informing the public.[5]

Early twentieth-century discoveries in theoretical physics that seemed contrary to common sense and intuition contributed to a pervasive sense that scientists lived in a different world from ordinary citizens, and the media typically depicted them as high priests and "wizards" with special powers (LaFollette 1990). A wave of science popularization efforts after World War I had the counterproductive effect of portraying scientific knowledge as something that could be comprehended by the general public only if it was oversimplified and spoon-fed to them, either by scientists or by carefully selected science writers (Bensaude-Vincent 2001, 106–8). Understanding science became, in effect, a passive activity, and the lively public discussion that had accompanied the early development of modern science was replaced by a one-way flow of information. The technological "fruits" of science were contributing to what was seen as social and economic progress—the industrialization of production, new medicines and vaccines, transport and communication networks—and, more ambiguously, to national defense. But the basic scientific knowledge that made such technologies and applications possible—

Bacon's "light"—was now hidden from public view in what seemed to be a closed, unapproachable, and generally incomprehensible scientific culture. Scientists, as well as the public at large, regarded scientific practice and the knowledge it generated as being beyond the average citizen's purview—not just incomprehensible but also exempt from public scrutiny or responsibility.

The direct engagement with emerging scientific methods, ideas, and institutions—whether satirical, celebratory, emulative, or purely descriptive—that was so central to nineteenth-century literature and culture receded to the sidelines in the twentieth century. Although scholars of literature and science have documented interactions between the sciences and the arts throughout history,[6] they have also noted that reciprocity between these two cultural realms was much more apparent in the eighteenth and nineteenth centuries, before contemporary structures of institutional and professional science were fully consolidated, than it was during most of the twentieth century (Shuttleworth 2017, 46; Dillon 2018, 315). The restructuring of education systems at the turn of the century generated debates about the societal roles of science and the humanities that reverberated through academic communities for many decades and left their mark on literary production (e.g., Huxley 1901, 187–205; Arnold 1885; Collini 1998). In the Anglophone world, influential literary figures who had no scientific education or direct contact with science—D. H. Lawrence, Joseph Conrad, Henry James, and James Joyce, for example—tended to be hostile to its instrumentalization and skeptical of whether it was an appropriate or even accessible subject for serious literature. At the same time, they were exposed to science through popular-science writing in journals and books, and while lampooning scientific methods to expose the limitations of science and challenge narratives of scientific progress, they also appropriated scientific terminology and concepts for metaphors and for their experiments with form and character.[7] Virginia Woolf, who was less skeptical of scientific progress than many of her peers, went further, making a concerted effort to educate herself in the natural sciences and attempting to assimilate and explore the philosophical implications of scientific understandings of physics, geologic time, evolution, and biology in her fiction (Henry 2012; Livingstone 2018).

In the 1920s and 1930s a handful of British novelists who had trained as scientists wrote about the practices and everyday "business" of doing science,[8] but these works had relatively little enduring impact in the literary world (Russell 2010, 289–90). Most fiction writers with a more than passing

interest in scientific discoveries followed the lead of Jules Verne's futuristic scientific adventure stories and H. G. Wells's immensely popular scientific romances. They used their novels to speculate about future technological innovations, focusing their attention on world-building rather than on the intersubjective social relations of bourgeois society, inward reflection, psychology, and aesthetic experimentation that dominated twentieth-century literary fashions and set the standard for mainstream publishing. The result was that the realm of literary production itself began to bifurcate, mirroring ever-more-pronounced disciplinary divisions in the wider culture—divisions that the physical chemist turned novelist C. P. Snow would later remonstrate against with his controversial but infectious catchphrase "two cultures" of sciences and arts, whose adherents, he claimed, were divided by a "gulf of mutual incomprehension" ([1959] 1998, 4).

When the American pulp-magazine industry appropriated and developed science fiction (SF) as a commercial publishing genre in the 1920s and 1930s, it emphasized mass production and required authors to follow certain formulas, earning the genre a reputation as low-grade escapist entertainment whose space wars, aliens, and distant future worlds were not taken seriously either as literature or as reflections on contemporary scientific practice and its repercussions. Many works transcended these specifications—successful midcentury SF writers such as Isaac Asimov, Arthur C. Clarke, Ursula Le Guin, J. G. Ballard, and Octavia Butler were certainly responding knowledgeably to developments in space exploration, artificial intelligence, telecommunications, nuclear physics, astronomy, and ecology, offering profound speculations about their social implications (Rees and Morus 2019).[9] Nevertheless, most early and midcentury SF was concerned with the effects and repercussions—whether social or material—of new technologies rather than with the processes and instrumentalization of scientific knowledge production that had generated them. In a 1968 essay, Arthur C. Clarke emphasized the imaginative limitations of science, noting that "any sufficiently advanced technology is indistinguishable from magic" when viewed from the past (255), and indeed, this is how the futuristic technologies of SF were usually portrayed, with little explication of the scientific, social, economic, and political processes that produced them. The actual practice of science in the twentieth century was increasingly collaborative, institution-based, and socially and politically contingent. But in literature and film, if the practice of scientific research was portrayed at all, it tended to be constrained by seventeenth-

and eighteenth-century stereotypes in which scientific knowledge and its consequences were determined by the bad or good intentions of obsessed villains or socially naive geniuses working in isolation (see Haynes 2017; Weingart, Muhl, and Pansegrau 2003).

Changing Societal Constellations and the New Scientific Literacy

In the 1960s, scientific, cultural, and socioeconomic developments again began to alter the relationship between science and the public, paving the way for the reengagement of literature and science that we see today. Developments in the life sciences and information sciences were giving rise to commercial research laboratories in fast-growing new industries that depended more on the acquisition and processing of science-based knowledge than on material resources. Such industries required new instruments of social, political, and economic monitoring, which in turn gave rise to service industries based on expertise in new math- and science-based disciplines such as computer programming, cybernetics, behavioral economics, and development planning. Sociologists began predicting the emergence of a "post-industrial society" in which highly educated workforces would replace production labor as the main motor for an economy that would be driven by knowledge and new ideas (Touraine 1969; Bell 1973). At the same time, the emphasis on individual equality and empowerment during the 1960s and the expansion of higher education over the following decades massively increased the proportion of the public that was privy to basic scientific knowledge and had a predisposition to critical thinking (Schofer and Meyer 2005).

As scientific principles and methodologies moved to the center of economic growth and became integrated into the fabric of society, the idea that rational, scientific planning was the key to solving the problems of the modern world became entrenched at all levels of society. But there was also a growing post–World War II disquiet among scientists about the uses and abuses of scientific knowledge. Physicists began to publicize their concerns about developing nuclear technologies, and in so doing they laid open to public scrutiny the disputes and uncertainties that had been playing out within the scientific community since before the war. Debates between experts became a public affair and had a feedback effect of creating a demand for yet more expertise and counterexpertise, which in turn drew more public attention (Agar 2008).

The publication of Rachel Carson's critically acclaimed and bestselling *The Sea Around Us* (1951) and *Silent Spring* (1962), with their careful research and eloquent prose, not only reopened the conversation between science and the public but also made a case for staging it in literature. Carson's lyrical writing brought decades of oceanographic research alive for an increasingly well-educated and interested public. And her detailed explanation of the ecological fallout of DDT made it clear that the fruits of science were not only contributing to social and economic progress but also generating unintended, delocalized, and unpredictable consequences. "If we are going to live," Carson wrote, "so intimately with these chemicals—eating and drinking them, taking them into the very marrow of our bones—we had better know something about their nature and their power" ([1962] 2002, 17). At a time when questioning established knowledge was becoming the norm, the highly visible scientific and political debates generated by *Silent Spring* revealed the inner workings of the hitherto closed and opaque scientific sphere.[10]

The new penchant for questioning the social outcomes of scientific research led to a heightened interest in both scrutinizing and promoting the activities of the scientific sphere. The 1970s and 1980s saw enhanced media coverage of scientific developments, renewed public outreach by scientific research institutions, the introduction of more science content into school curricula, and the emergence of science and technology studies as a discipline in Western universities. In the United States and Britain, popular-science publications in the form of scientific memoirs and books about new discoveries rose in popularity throughout the 1970s and 1980s, contributing to what Bruce Lewenstein, adopting the French term for the integration of science into a wider cultural matrix, considers the beginning of a new "*culture scientifique*" (2009, 347) and what Jay Clayton, considering the growing scientific literacy apparent in works of fiction at the end of the millennium, calls an "undisciplined culture"—a culture in which the exponentially bifurcating disciplines and forms of knowledge of the past century were beginning to mix and converge (2002).[11] The books that made the newspaper culture pages and hit bestseller lists were written by scientists as well as journalists, and they ranged from complex accounts of the latest research on the origin of the universe, chaos theory, and the extraordinary fossils in the Burgess Shale to exposés on socially and politically sensitive scientific issues such as evolution and climate change. Television documentary science series like *The Ascent of Man* (1973) and *Cosmos* (1980) became immensely popular, and scientists who

interacted with the public or engaged with literature—Carl Sagan, David Attenborough, Richard Feynman, Oliver Sacks, and Stephen Jay Gould, among others—took on the character of public intellectuals or even celebrities.

New scientific understandings of the natural world and increased public interest in scientific discovery were accompanied by a growing awareness—among both scientists and the wider public—of the ambiguities of interpreting scientific observations and of the global-scale risks associated with technological progress. Observing the social contingencies of scientific research and the complex cultural and natural factors that determined technological development and its outcomes, social science scholars began to question modernity's mantra that a rational, formalized scientific culture could control nature and minimize risk and uncertainty (see Latour and Woolgar 1979; Douglas and Wildavsky 1982).

By the 1990s, the anticipation of risk had permeated the structure of Western societies to such an extent that sociologists coined the term "risk society" to describe the process of societal modernization (Giddens 1999; Beck 1992).[12] Scientists and their institutions were required to defend their knowledge in the public arena and to foresee the uses it might be put to and the risks it might incur as it rippled out into different social, economic, and political contexts. Deliberation on the fallouts of scientific discovery and technological progress—nuclear catastrophe, chemical pollution, loss of biodiversity, climate change, and the unforeseen consequences of geoengineering and genetic engineering—now takes place on the public stage, where scientists are called on to voice opinions and to enter into debate with economists and social scientists, representatives of citizens' social movements, ethicists, policy-makers, politicians, and one another. The debates and uncertainties inherent in the processes of establishing scientific facts are also played out and exploited in the political arena, where they may be invoked as grounds for action or inaction in political decision- and policy-making. The dynamic nature of the scientific process may even be cited as de facto grounds for ignoring scientific evidence, as we have seen in the treatment of climate change science and pandemic evidence in the United States.

Perhaps, then, it is no wonder that, with the Anthropocene epoch becoming apparent in the geologic record, the novel's place in this societal cacophony should begin to expand and transmute. The relationship between technological innovation and social risk has long been a topic of SF. In the

mid-twentieth century, pivotal works of what is often described as postmodern fiction parodied Western society's mass consumption of new technologies and drew metaphors and analogies from the physical and biological sciences (Cordle 1999; McHale [1987] 2004).[13] And in the past few decades, scientifically literate novelists have begun writing about science *directly*, taking scientific issues and knowledge as their subjects and creating works that go even further toward blurring the boundaries of literary fiction and SF with their themes, approaches, and readerships. The SF worlds are moving closer to home—or home is moving closer to them—and we are seeing more stories about credible, near-future worlds and the scientific, economic, and social circumstances that produce them (see chapter 8). More remarkable after the long hiatus of attention is the rising tide of mainstream realist novels *about* science that began in the 1990s. Novels such as Barbara Kingsolver's *Flight Behavior* (2012), Ann Patchett's *State of Wonder* (2011), Allegra Goodman's *Intuition* (2006), Eileen Pollack's *Perfect Life* (2016), Simon Mawer's *Mendel's Dwarf* (1999), and Karen Joy Fowler's *We Are All Completely Beside Ourselves* (2013) have been taking science seriously in new ways (see chapter 1). They incorporate scientific understandings of the natural world, probe the institutions and practices of science, and rely on processes of scientific discovery for their plots. Often based on extensive background research in the scientific literature, these new works delve into the minds of scientist characters, carefully negotiating the interplay between fact, plausibility, realism, and imagination to render scientific knowledge, processes, applications, and technologies in great detail (Haynes 2016; Kirchhofer and Roxburgh 2016).[14]

Writers, critics, and pundits have alternately disregarded and celebrated this recent turn in the way that fiction is dealing with science and technology, providing labels such as "science in fiction," "geek novels," "lab lit," "mundane science fiction," and, simply, "science novels" (e.g., Gaines 2001; Clayton 2002; Rohn 2010; Bouton 2012; Schaffeld 2016). Whatever we call them, these science novels capture the attention of literary *and* scientific readerships, not least because of the ways they dramatize and humanize both the work of science and its potential repercussions (Kirchhofer and Auguscik 2017). In a culture dominated by the instant and often thoughtless exchange of out-of-context three-line messages and by floods of undigested information—of facts and not-facts, news and false news, anecdotes and gossip without context—we find an expanding fictional space for slow, contemplative, nuanced thinking

about the socially and economically contingent power of science to both illuminate and transform nature and to both mitigate and generate social change and risk.

From a sociological perspective, the novel is exceptionally well suited to such a discourse, as it offers a narrative frame and a focusing mechanism for ambivalent and pluralistic perspectives on complex issues as well as a platform in the public sphere. In his influential discussion of Flaubert's realistic novels, sociologist Pierre Bourdieu emphasized this ability "to concentrate and condense in the concrete singularity of a sensitive figure . . . all the complexity of a structure and a history which scientific analysis must laboriously unfold and deploy" (1992, 24). This focusing mechanism and dependence on the singularity of character and perspective *in interaction with* others, combined with aesthetic devices that generate empathy with such characters and perspectives, allows us "a view of particular societies from the inside: we come to know something of what it feels like to be inside a particular habitus, to experience a world as self-evident" (Felski 2008, 92). Novels, of course, are neither mere representations or translations of social dynamics nor, for our purposes, purely works of art to be considered for their aesthetic qualities alone or without reference to the individual and social contexts and developments of their creation and reception. The interdisciplinary mix of literary and sociological expertise we have assembled for this volume, rather, allows us to consider these works of fiction from both within and beyond their texts.

The chapters in part 1 provide a literary and a sociological entrée to those that follow: In chapter 1, two literary scholars give an overview of the turn-of-the-millennium wave of literary fiction about science, with examples of the innovations in form, style, and character development that have been brought to bear on several of the most prominent scientific issues. In chapter 2, two sociologists review the institutional prehistory and history of science that still informs many cultural representations; and in chapter 3, they reexamine the sociological functions of stereotypes and investigate how old, entrenched stereotypes of scientists are used, adapted, or incorporated into the complex, differentiated representations of science found in recent fiction geared to different audiences.

Each of the chapters in parts 2 and 3 focuses on a different aspect of the practice and social context of science, as mediated by varied—though by no

means exhaustive—and strategically overlapping selections of science novels.[15] Part 2 concentrates on how external societal factors impact scientific work and knowledge. In chapter 4, a literary scholar and an astronomer team up to explore how character-driven novels provide insight and elicit reader understanding of the risks inherent to work in scientific professions that are not typically viewed as dangerous to their practitioners but are often regarded as the source of new dangers and risks for society at large. Chapter 5 merges sociological approaches with those from cultural and literary studies to examine how a work of speculative fiction by the prominent novelist Margaret Atwood contributes to debates on the roles of science in society. Chapter 6 turns a feminist lens on the portrayal of science in novels featuring women scientists as main characters. Chapter 7, the pivotal final chapter of part 2, illustrates and dissects the sociological components and ramifications of the economization of science, as revealed by a cross section of contemporary novels about science.

The essays in part 3 focus on discussions of the societal outcomes of science. In chapter 8, a scholar of SF reviews the genre's historical development and takes a close look at its most recent preoccupations and its convergence with the new mainstream fiction about science. Chapter 9 looks at how top-selling SF novels are challenging the notion that science can contain and control its creations, and in chapter 10 another team of cultural studies scholars and sociologists makes a bold attempt to investigate the social resonance of Barbara Kingsolver's 2012 climate change novel, *Flight Behavior.* Taken together, the essays in *Under the Literary Microscope* reveal some of the ways that the contemporary novel may help us understand and come to grips with our science-based societies in the Anthropocene.

Notes

1. Since the 1970s, humanities scholars have generated a wide range of interdisciplinary research on the relationships, influences, and analogies between literary and scientific or technological developments. This research has deepened our understanding of the cultural embeddedness of scientific knowledge production and diffusion, and it has challenged overly simplistic and often Eurocentric narratives of rationalization and progress. There are many fine surveys of that literature, and it is not our goal to duplicate them here. Instead, this brief introduction offers a summary of the historical context of the contemporary science novel for our interdisciplinary readership.

For more comprehensive surveys of literature and science scholarship, see, for example, Markley 2018; Willis 2014; Clarke and Rossini 2011; and Gossin 2002.

2. On eighteenth-century satires of emerging scientific methodologies, see Lund 1998.

3. There are innumerable studies of the influence of science on nineteenth-century novels, such as Shuttleworth's now classic study of how scientific developments influenced George Eliot's work (1984). Otis (2002) provides a good introduction to this literature and an annotated collection of readings that exemplify nineteenth-century literature's engagement with science, and Willis (2006) discusses the science in nineteenth-century science fiction novels and what it reveals about the contemporaneous culture of science.

4. For detailed accounts of the nineteenth-century growth of popular-science periodicals and books and of their relationship to the creation of scientific knowledge, see also Lightman 2016; Shuttleworth and Cantor 2004; and Broks 2006, chaps. 1 and 2.

5. For accounts of the historic development of science writing and publishing and of their relationship to scientific knowledge production, the public, and the professionalization of science, see Broks 2006; and Henson et al. 2004.

6. Examples include Beer ([1983] 2009) on Darwin, Squier (1996) on early twentieth-century embryology, and Bruce Clarke (2001) on late nineteenth-century physics.

7. Whitworth (2010) reviews modernist novelists' ambivalent treatments of science in the early to mid-twentieth century; Morrisson (2017) synthesizes decades of what he calls "new modernism" and literature and science studies to trace the relationships between developments in early twentieth-century science, print media, and literary arts.

8. Examples include A. J. Cronin, E. C. Large, Nigel Balchin, C. P. Snow, and William Cooper (pseudonym of Harry Summerfield Hoff).

9. The marginalization of the science fiction genre became apparent not just in the publishing industry but also in the academic study of literature, where science fiction studies emerged as a separate subfield from literature and science studies (Dihal 2017).

10. For an account of how environmental literature has dealt with scientific ambiguities since Carson, see Heise 2015.

11. Clayton notes some similarities (and differences) between the turn-of-the-millennium intellectual traffic in science, engineering, and the arts, and cultural and intellectual transactions in the "pre-disciplinary" nineteenth century; Shuttleworth (2017) likewise sees such an analogy in the development of "citizen science" movements, and we might also note it in Milburn's examination of the ways that technology research enterprises have started consciously "using" or drawing on science fiction imaginaries to jumpstart innovation (2010).

12. For discussions of the concept of the risk society as manifest and generated by narrative representation, particularly in late twentieth-century and early twenty-first-century novels, see Mayer and von Mossner 2014; and Heise 2008.

13. In his discussion of postmodern writers' engagement with developments in the sciences of cybernetics, Porush (1992) credits Thomas Pynchon's "dialogue with various sciences" in *V.* (1963), *The Crying of Lot 49* (1967), and *Gravity's Rainbow* (1973) and his use of metaphor as a "weapon in his literary arsenal against cybernetic determinism" with "leading American literary critics into an engagement with contemporary scientific ideas" (214). McHale describes how writers such as William Burroughs, Kurt Vonnegut, Italo Calvino, and Pynchon were following parallel tracks with science fiction writers and "absorb[ing] motifs and topoi from science fiction writing, mining science fiction for its raw materials" (2004, 65). Vanderbeke (2011) discusses allusions and mentions of quantum physics in novels from the mid- and late twentieth century, and Cordle (2008) describes how writers from the pe-

riod were responding to the uncertainties of nuclear technologies.

14. In a broader literary context, the realism we see in these science novels may exemplify what Peter Boxall, in his bid to distinguish the characteristics of an emerging twenty-first-century novel, identified as "the attempt, in the contemporary novel, to grasp the texture of the contemporary real . . . a strikingly new attention to the nature of our reality—its materiality, its relation to touch, to narrative and to visuality" (2013, 10).

15. The wave of contemporary novels about science has been most prominent in British and American literature, which comprises the majority of this volume's corpus. To date, we find little mention of similar trends in other national literatures, though we can identify a handful of novels from Canada and Australia: Margaret Atwood's speculative *Oryx and Crake* (2003), Colin McAdam's *A Beautiful Truth* (2013), Andrew Westoll's *The Jungle South of the Mountain* (2016), and Esi Edugyan's historical novel *Washington Black* (2018) in Canada; and Graeme Simsion's *The Rosie Project* (2013), Janette Turner Hospital's *Charades* (1987), and Amanda Niehaus's *The Breeding Season* (2019) in Australia. In the German-language literature we find a dozen or so science novels—several by biologist turned novelist Bernhard Kegel as well as Thea Dorn's *Die Unglückseligen*, Franz Schätzing's *Der Schwarm*, and a number of historical science novels such as Jo Lendle's *Alles Land*, Martin Kluger's *Die Gehilfin*, and Daniel Kehlmann's *Die Vermessung der Welt*.

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