Making Science, Making Scientists, Making Science Fiction: On the Co-Creation of Science and Science Fiction in the Social Imaginary

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Making Science, Making Scientists, Making Science Fiction

On the Co-Creation of Science and Science Fiction in the Social Imaginary

Brad TABAS

There is a quite typical explanation of the relationship between science and science fiction that goes something like this: "Science and science fiction are twins, with no one sure which is the elder. As with many twins, they have similar but not identical interests, a common language which they invented and speak with ease but which puzzles outsiders, and the ability to inspire and encourage each other, sometimes with no more than a look or a word. They finish each other's sentences and think the same thoughts at almost the same time even when they're far apart." (Pilkington 2017)

The basic idea behind this explanation is that science inspires science fiction, and science fiction inspires science, with fiction providing speculations that inspire scientific research, and breakthroughs in scientific research inspiring fictions. As Hugo Gernsback (2017), one of the founders of this view put it: science fictions (or *scientifictions*, as he called them) "have the knack of imparting knowledge," (i.e. following and integrating science) but they also provide "inspiration" even a capacity for "prophesy" (i.e. they predict and inspire science). Yet if science and science fiction are "twins," most critics nevertheless uphold their fundamental difference. As Lawrence Krauss explains, citing a famous phrase of Richard Feynman's: "science is imagination in a straightjacket," and the difference between science and science fiction is that science "explores what is possible in our universe" while science fiction explores "what might be possible in any universe." (Krauss, 2014) Which does not mean that some, particularly those whose science of reference is theoretical physics, find that the limits between science and science fiction less neat than statements like the above might make appear. The eminent physicist Roger Penrose (2017), for example, has recently described as the role played by "faith," "fantasy," and "fashion" in theoretical physics, ultimately suggesting that in the case of theories such as string theory and quantum gravity, cases at the very limits of scientific knowledge, the difference between the scientific truth and scientific fiction are vague enough that much of the currently recognized scientific paradigm may (in both good and bad ways) amount to no more than faith in fashionable fantasy (i.e. a belief in a science fiction).

But as well-founded—or not—as this vision of the relationship between science and science fiction may be, this text will offer a rather different take on how to think about science and science fiction. In the above account of the relationship between science and science fiction the point of view taken on the nature of science is what might be called a content-based view. Science is understood as a collection of methodically demonstrated theories about the natural world, and science fiction is understood as speculatively fabulating theories via the imagination. Yet this understanding of science as theory-production, or perhaps more specifically as a method for producing empirically-grounded and testable theories, is itself an idea about science. Ideas about science are not scientific ideas, in the sense that they are not the content of scientific theories but can be philosophical

or even just folk-wisdom about science. Granted, most scientist's ideas about science are the product of reflections on the historical practice of scientific theory production, thus they are in a sense "scientific," but not necessarily in the same way that natural scientific knowledge often is. Yet, where these theories differ might also be said to relate to their ideas of science, and the boundaries that they place between science and non-science. With respect to what is included in science, Popper, for example, understands science as only including theory and empirically testable facts, while Kuhn quite clearly includes scientists and social aspects of scientific practice within the ambit of his theory of science. Yet let us not dwell too much on the philosophers, for it is not only philosophers who have ideas about science, but most everyone within societies that possess science has ideas about science, some highly elaborated like those of the philosophers, others highly detailed like those of practicing scientists, and finally some ideas are quite vague, like those possessed by children and ordinary citizens having little interest in science. Science fiction writers—too—have ideas about science, and they express these ideas in their works. More to the point, in expressing these ideas, they contribute to the transformation of cultural ideas about science, affecting both the way that readers understand the nature and meaning of particular scientific discoveries, as well as the nature of science itself. Yet of course science fiction does not only affect the meaning of science: changes in scientific paradigms also affect the forms taken by science fictions.

In the following, we will be interested in the social practices that lead to changes in the idea of science in the broad and somewhat vague sense that science appears in the collective social imaginary, tracing out the entangled relationship between science fiction and changing ideas of science. Ideas of science as they are used here are paradigmatic ideas regarding science held by the majority of the members of a society, what might be described semiotically as the meaning of the signifier "science," let us just call it the *meaning* of "science." Note well that the meaning of science contains many elements that have nothing at all to do with scientific knowledge or scientific theories, including the relevance of science to politics, attitudes considering the applicability of scientific ideas to everyday life, and, of course, visions about the relationship of fiction to science and science to fiction. Now all of this may superficially seem like

something distant from what scientists themselves understand science to be. Yet the facts contradict this suggestion, at least to the degree that scientists are clearly aware that social ideas about science exist—and indeed matter. Consider, for example, Darwin's well-known hesitations to publish his research on evolution. It is unlikely that he doubted the epistemic veracity of his findings; his hesitations stemmed rather from his awareness that his discoveries meant a wholly new understanding of the relationship between natural science and religion, which is to say a wholly new (and perhaps ethically and politically undesirable) meaning of science. One likewise finds in Einstein's desire to rescue certain aspects of causal necessity from Bohr a line of argumentation rooted in his concern about the idea of science as such, about the impact that his theories might have on the overall self-understanding of science and scientists, a fear that history validates in light of the complex network of interactions linking the discovery of relativity with the late-twentieth century emergence of cultural relativism (and its attendant attacks upon science). Suffice to say, these cases illustrate the degree to which paradigmatic scientific discoveries can be not only ruptures in theory and evidence but transformations in the meaning of science as an idea within general culture. Returning to the question of science fiction, it is worth drawing reader's attention to the fact that Einstein's famed suggestion that "god does not play dice" is itself an attempt to use science fiction (sure this story is only five words long and lacking interesting plot and character development it does indeed possess both) to stabilize and articulate his vision of the meaning of science, and to express how he thought that scientists and others ought to approach science and future engagements in scientific research.

Ideas about science as we are interested in them are popular generalizations, and they tend to involve certain key discoveries and charismatic scientists that stand for the whole of science in a way that one is tempted (with Barthes [1968]) to call mythological, such that Einstein's marvelous locks and the way that they project a certain idea of scientist as genius are as much part of the idea of science as are the actual mathematical equations in his theory. Note that these kinds of popular or collective ideas about science (science in the broadest sense) clearly do influence the happening of science in the narrow, laboratory experimental sense. What politicians and non-scientist administrators think about science plays

a role in which projects are funded, which types of scientific experiments are deemed worthy of pursuit, and which are not—for ethical or other reasons—to be accepted into science. What youths think about science dictates whether they become scientists and likewise influences what scientific disciplines they are likely to pursue, even what postures that may take as they engage in this pursuit. What working scientists think about the big-picture value and meaning of science dictates perhaps only indirectly inflects the contents of their scientific discoveries, but it directly influences all aspects of how they go about practically organizing the social network of their laboratories. For instance, (to cite recent debates in the history of the philosophy of science) a laboratory will differ depending upon whether the scientists understand science to be the product of rigorous method or anything-goes Feyerabendian anarchism, whether they see it as a product and reflection of white-male dominated power relations, or as a wholly impersonal process. It goes without saying that ideas about the meaning of science within any society and at every point in history are multiple and contested, though they, like other broadly held collective visions of collective practices, or what Graham Harman (2018) slightly idiosyncratically refers to as phenomenological objects, which is to say unities that are perceived as such by collectives, nevertheless tend to display sufficient consistency and unity despite disputed frontiers to make them both meaningful objects of contestation and meaningful objects of study.

Obviously, the effects of scientific representations upon scientific practice are mediated, and the feed-back loop is a long one, hardly so short and simple to articulate as the case in which a scientist finds a new theory in a work of science fiction and so sets out to test it. One way of clarifying this long feedback loop is to consider the social functioning of anticipated futures, recognizing that any claim or model representing the meaning of science is also the expression of an anticipated future of science. By anticipation, I mean ideas and beliefs about the future such as they appear in, and structure, any given present. As Riel Miller, the Head of Future Literacy program at UNESCO writes: "The future does not exist in the present but anticipation does. The form the future takes in the present is anticipation." (2018: 2) Models and exemplars are projections into the future, actors use them as solid ground around which to orient their actions with respect

to an uncertain because unknown future. Exemplary scientists, models of science, representations of the scientific way of the world, all of these paradigmatic illustrations of the meaning of science form key parts of what Jassanoff (2015) has called the "sociotechnical imaginary," a set of collective ideas about science and technology which crystalize the past of science in such a way as to structure the social horizon of expectations towards the future of science. Anticipations about the meaning of science contribute to motivating individuals to become scientists, they inspire institutions to set in place the material and economic conditions propitious for meaningful scientific labor, they contribute to differentiating between lines of scientific research that are perceived of as interesting and exciting and others that seem yawn-inducing. Anticipations also play a key role in the ratification of scientific theories. As Kuhn points out in his "Objectivity, Value Judgements, and Theory Choice," (1977) one of the key criteria used by groups of scientists to decide between competing scientific paradigms is "fruitfulness"—a perceived likelihood that one theory will open up broader future horizons than the other. Simply put, the specialists anticipate that the one theory will end up being better than the other. It goes without saying that such decisions regarding fruitfulness are in a certain sense self-fulfilling prophesies: the more research is oriented around a particular thesis; the more evidence will come to light supporting the thesis. While it is evidently true that our anticipations do not always correspond with what actually comes to pass (indeed, much of history and all revolutionary historical and social change in science is a product of anticipations not corresponding with reality), it is also true, as John Urry (2016) has remarked, that anticipated futures always do have a performative dimension, which is to say that when we act as if a specific future is likely, that belief changes the future that occurs, whether or not what we anticipate actually comes to pass. Of course, thwarted expectations do happen—and this plays a key role in science fiction literature. One can find many books about scientists who feel let down with the gap between their ideals about science and its practical reality. In Cixin Liu's recent *Ball Lightning* (2018), the main character always dreams of becoming a scientist—until he actually becomes one. Or in the work of Gregory Benford, we continually find represented scenes depicting scientists at work—or more precisely scenes representing scientists being pulled away

from their real scientific work by administrators, journalists, and other meddling non-scientists.

Judging from just the two lightly sketched examples above, we can see that the relationship between ideas of science and science fiction is rather different from the vision of their relationship that has been inherited from Gernsback and often perpetuated by the tradition. If science fiction and science remain twins, focusing on the meaning of science offers a radical shift in attention: our center of interest is less the direct production of scientific knowledge and more the production of the collective understanding of science which conditions it as a social practice, and which indirectly influences the kinds of scientific knowledge that subsequently emerge. Within this framework, we rediscover the apparent dialogue between science fiction and science where the one seems to do work that is then taken up by the other, and we also discover points at which the neat distinction between the two seems to blur. In the normal case we might say that scientists engaged in scientific activities nourish the collective meaning of science by enacting their ideas about what it means to be a scientist and to do science, while science fiction writers, by representing scientists and science, alter the meaning of science (and so scientific practice), by provoking reflection upon the nature of scientific being and acting in their readers (scientists and otherwise). So formulated, we might wish to say that the enactment of the meaning of science in scientific practice expresses the present of science, while the representation of science in science fiction—science in what Suivin (2016) has called a "cognitively estranged" form, namely a form that resembles science but differs from it in some logical but meaningful way—represents an anticipated (or dreaded) future scientific practice, with the telos of the anticipation here correlating with whether the science fiction presents science positively or negatively (i.e., as a collectively utopian or dystopian practice, though the gaps between science fiction's science and science as a social practice need not be imagined quite so binarily). But, of course, we can also formulate exceptional cases that alter this nice separation of roles. It is not clear, for example, whether the "fashionable" physicists described by Penrose are doing science or rather unconsciously performing a kind of collective and improvisatory science fiction theatre reflecting their ideal perception of the meaning of science as it might be translated into practice. Or, to give

a very different example that we will later discuss more extensively, the portrayal of science in Ursula K. Le Guin's *The Dispossessed* is so ambiguous, so resistant to providing an idealized (or a demonized) image of science that the ultimate argument of the text seems to be that scientist-readers can only enact the meaning of what it is to be a scientist and practice science without a model, and so must understand their doing of science as a self-conscious production of a possible representation of science, in other terms, as a science fiction.

Exempla, Paradigms, Models

Though it may not be immediately apparent to readers, the account of science fiction above draws upon (and extends) a rather classic vision of the didactic role of fiction within society, namely the idea that works of literature provide *exempla*. I use the Latin here to evoke the fact that we are dealing with a notion from classical rhetoric, one in which the very idea of presenting an example is understood to serve as a kind of moral argument. Though little discussed today, the idea of producing didactic examples to guide practical comportment was very much part of the compositional logic of Classical and Early Modern literature, it formed part of the basic idea behind non-fictional biographies like Plutarch's *Lives* or didactic tales like Aesopic fables, and Defoe's *Robinson Crusoe* is quite clearly also meant to offer readers a moral example. If the notion of moral exemplarity seems to have fallen into desuetude in sophisticated literary works and in mainstream literary criticism since the 18th century, it is true that the practice, if not necessarily in the discourses around literary practice, that moral exemplification has survived quite well in science fiction. Indeed, as a genre that in recent history has often been classified as "YA" (young adult fiction), the norms and indeed social uses of SF are often unapologetically didactic. My MIT edition of Mary Shelley's *Frankenstein* (2017), for example, is subtitled: "Annotated for Scientists, Engineers, and Creators of All Kinds" and contains editorial material precisely aimed at influencing the moral formation of its science-student readers, teaching them to avoid following the bad example of the scientist Dr. Frankenstein. Indeed, the entire "mad scientist" subgenre including *The Island of Dr. Moreau* and *Blade Runner* can be read in this way. The drive to produce positive examples is

also key part of the compositional logic of the genre, reflected, for example, in the predilection for *Bildungsroman* type-narrations among SF authors from Heinlein onwards. That said, my suggestion or interpretation of the didactic dimension within science fiction, and that is to say the influence that science fiction plays on teaching readers to understand the meaning of being a scientist and engaging in scientific practice (or the way of the scientific world), is broader and more ambitious than is typical. On the one hand, the lessons that I would allege are taught by science fictions are both broader and less moral than merely avoiding becoming Dr. Frankenstein, including a multitude of aspects linked to what Greenblatt (1980) has called the "self-fashioning" of scientists, going from the rather banal (how to dress like a scientist) to more serious concerns like the social consciousness of the scientist, the overall sense of self-value that scientists attribute to their work, and even their generalized sense of what that work is. While a quite banal interpretation of these impacts suggests that the exemplification of the meaning of science upon the self-formation of the scientist only affects science in an upstream way (it is, for example, well documented that many scientists became scientists because of their love of science fiction (Berger 1977, Clegg 2015, Pilkington 2017, and Krauss 2014), it is also true many scientists keep on reading SF into their old age, and so presumably continue being impacted by the representations of science conveyed by science fiction.

If SF provides models, it is interesting to remember that philosophy of science has, at least since Kuhn, understood science to function according to a logic of exemplarity. In fact, the Kuhnian word paradigm is nothing other than the Greek version of the Latin word *exemplum*. According to James Ladyman's reading, Kuhn's theory is essentially an explanation which shows that learning how to do science involves learning a set of paradigms that are held up collectively as examples of scientificity:

> *Exemplars are those successful parts of science that all beginning scientists learn, and that provide them with a model for the future development of their subject. Anyone familiar with a modern scientific discipline will recognise that teaching by example plays an important role in the training of scientists. Textbooks are full of standard problems and their solutions, and students are set exercises that require them to adapt the techniques used in the examples to new situations.*

> *The idea is that, by repeating this process, eventually, if they have the aptitude for it, students will learn how to apply these techniques to new kinds of problems that nobody has yet managed to solve.* (Ladyman 2001: 99)

It is also the case that a paradigm in science is just a heuristic exemplum used to illustrate the problems of science, and that is to say a way for organizing or making sense of the multiplicity of science even for scientists. Likewise, the idea that being a scientist could be understood by its practitioners as self-consciously performing an exemplary idea of how to act in the name of science is well documented. As work on the history of the scientific autobiographies and biographies has brought to light, scientists have long been quite conscious of forming themselves into exemplary scientific actors based upon the lives of other exemplary scientific actors (Lawrence and Shapin 1998; Daston and Sibun 2003). Of course, these studies have mostly focused on the development of science in the narrow sense and have rarely looked outside of non-fiction examples in their study of the formation of scientist-subjects. But it would be surprising if the desire to NOT BE Dr. Frankenstein had not influenced more than one scientist's pursuit of their work.

Looking at the logics of co-formation of science and science fiction from the perspective that I am recommending offers many possibilities, from re-reading classic texts of the genre to re-writing the history of science from the point of view of changing social ideas about science as expressed in fiction, few of which we could hope to meaningfully explore here. In what remains of this text our modest aim is to offer a ground-level dramatization of the cultural battlefield on which ideas of science were being formed at one particular juncture in the history of science and science fiction. The period that we will attend to is now known as the "science wars," and it might be classified in Kuhnian terms as a revolutionary period in the history of ideas about science. What was at stake, in this Post-Relativistic struggle, was the meaning of science after relativity, with supposedly "anti-science" voices of relativism being nothing more than proponents of one possible account of how the new and paradigmatic idea of science ought to be constituted in the wake of Einstein's revolutionary ideas.

Post-Relativity Crises

Einstein described the aftermath of his discoveries in quantum physics as a crisis: "It was as if the ground had been pulled out from under one, with no firm foundation to be seen anywhere, upon which one could have built." As philosopher and historian of science Ian Hacking (2012) puts it, Einstein's special (1905) and then general (1916) theory of relativity "were more shattering events than we can well conceive." At the core of this revolutionary event was the idea that physics, once resting on the firm foundations of absolute space and time and on the idea that the smallest particles were actually identifiable as some definite thing, had passed into a moment where all space and time were relative to observer position, and where (in the words of Bohr) "everything we call real is made of things that cannot be regarded as real." To bowdlerize (and collective visions of science always have an element of this): science had shown that absolute scientific truth no longer existed, and scientifically speaking everything in science was relative.

It is paradoxical but true that the viewpoint that the defenders of science attributed to the "fashionable" humanistic "anti-science" worldview that they call relativism is nothing but that an interpretation of Einstein's discoveries relative to the meaning of science. Numerous researchers have laid bare the influence of Einstein's discoveries upon the popular consciousness of the 20th century, including Whitworth in his *Einstein's Wake* (2002) and Hayles in her *The Cosmic Web* (1984). It is also true (or at least so suggests Hacking (2012)) that Einstein's ontology is also—ultimately, and in a far subtler form—the metaphor or model of truth at work in scientific discourse as it is theorized by Thomas Kuhn. To cite a typical passage in which this relativistic structure appears, Kuhn claims that science is something involving "techniques of persuasion... argument and counterargument in a situation in which there can be no proof," in other words, that all paradigms are only relatively, and not absolutely true, they are true from the perspective of those that adopt them, and untrue to those that refuse to see things from that perspective. Needless to say, statements like these led Imre Lakatos to suggest that Kuhn had made theory choice into "a matter for mob psychology" (1970) and that the Kuhn's deductions about the meaning of the new image of science furnished by Einstein and what it implied for the meaning and nature

of scientific practice were hardly agreed upon by everyone. In retrospect, Kuhn himself was rather moderate figure in these struggles, figures like Feyerabend (1975), Harding (1986), Fox Keller (1986), and Harraway (1988) were far happier to take up extreme positions and to stir up debate. They drew radical conclusions relative to the observer-dependence of science by showing the ways that collective theory choice was entangled with larger socio-political issues such as gender, economics and race. In the most extreme cases, figures like Aronowitz (1988) and Ross (1991) went so far as to render the observer-dependence of science into a theoretical framework which revealed it to be an ideology of the (white) capitalist classes, a powerful force using knowledge to uphold an exploitative and inegalitarian system. Unsurprisingly and quite defensively, some scientists took umbrage at this usage of science against science (though they tended not to see "fashionable skepticism" as actually being a product of an informed interpretation of science). Conservative defenders of the absolute authority of science like Gross and Levitt (1994) accused post-Kuhnian science studies of facile relativism (which was admittedly at times the case) and insisted (parodically in their turn) upon the absolute epistemic solidity and unquestionable objectivity of the findings and methods of natural science. Tensions were further elevated when the physicist Sokal (1996) published a parody pretending to offer a post-modern deconstruction of the capitalist politics of physics in the leading cultural studies journal *Social Text*, which he then revealed to be a hoax (on the front page of the *New York Times* no less, and to the great shame of the editors of *Social Text*). Sokal took himself to have demonstrated the manifest lack of understanding of the real nature of scientific thought on the part of its post-modern critics, while his targets pointed out that Sokal himself had been disingenuous about his work and intentions, exploiting his social power as a scientist to slip his false article into the journal, and so he had failed to properly act as a scientist.

In retrospect, these debates are not particularly interesting in themselves, since they generally were animated on both sides by overstatements and falsifying over-simplifications of the alternative positions. *Yet what they do demonstrate is both the transitional and disputed state of ideas about science in the late twentieth century as well as their perceived importance—both among scientists and non-scientists alike—for both the practice of science and the well-being of society.*

I want to turn now to two science fiction writers from the period, Gregory Benford and Ursula K. Le Guin. Both of these authors deal in minor ways with questions linked to relativity and particle physics, but they are more exemplary in that they devote a great deal of time to representing issues linked with the meaning of science and the nature of being a scientist, and in some cases actively engaging with the lines of debate brought to the fore during the science wars. From our point of view, it is this exploration of the meaning of science—and not the stock science fiction tropes made possible by the Einsteinian revolution (time travel, worm holes, new conceptions of time and space)—that is really where the most interesting work done by science fiction relative to science is done. For unlike the empty debates that characterized the science wars, Benford and Le Guin have left us with something—images of science, the scientist, what they should be and should not be, that have not yet ceased to have a positive (or at least transformative) effect of both science and society.

Benford, or Minority Science in Action

Readers of Benford should be little surprised to find him evoked here, for if many other hard science fiction authors (Robinson, Vinge, Liu, Scalzi) portray scientists and science, few have so explicitly expressed a commitment to using science fiction to show us "what the hell science is doing in society" (Benford 1985). Perhaps Benford's desire to "depict scientists as they actually are, especially at work" (Benford 1988: 588) comes from the fact that he himself is a professor of Astrophysics, though this is doubtless more the efficient cause of his interest in depicting science and scientists in science fiction, with the final cause being the profound cultural conflicts around the meaning of science that went on around him.

Traces of the struggles for the meaning of science are to be found throughout Benford's works, but it is perhaps in his 1985 novel *Cosm* that his treatment of the politics of scientific practice is most extensive and compelling. *Cosm* is a tale about a scientific discovery—the finding and interpretation of a kind of "macroparticle" that appears out of a botched experiment in a particle accelerator and which turns out to be a miniature cosmos. Yet it is less a tale about the discovery itself and more a story about the scientist-hero—Alicia Butterworth, a black, female particle

physicist—and her struggle to both understand the cosm in the cosmos and to get the scientific community to take the revolutionary discovery seriously. By choosing a female minority hero Benford very clearly engages with debates raging around the gender and racial politics of science. The argument of his narrative exemplum is that contemporary science, despite its malfunctions, is not just politics and discourse, and more than that, its commitment to objective truth can be a motor for social justice.

The early chapters of the novel clearly show the traces of Benford's engagement with the debates about the meaning of science raging throughout the academy. Benford approves of the work of philosophers of science like Pickering (1985) and Latour and Woolgar (1986) whose careful descriptions of science in action as a mangle of practice apparently coincide with Benford's sense of the reality of science: "Most people envisioned labs as tidy and clean, with white-coated scientists working alone, making careful, meticulous movements. Experiments in nuclear and particle physics were big, often noisy, and where neatness didn't matter, fairly sloppy. Big steel racks packed with instrumentation crowded together, some out of alignment. The odor of oil and shaved steel hung everywhere. Makeshift wooden housings covered thick bunches of wrist-thick electrical cabling. Some cable bunches were so fat that little ladders had been passed over them for foot traffic. Necessary chaos."(330) A few pages later Benford addresses the role of language and metaphors in science, implicitly acknowledging (and perhaps rebutting) the work of feminist critics of science such as Carolyn Merchant (1980), who in a celebrated work on Bacon pointed out violence of gendered metaphors structuring the imaginary relationship between the male scientist and a female nature. As Benford writes: "Particle physics was rich in imagery of change—annihilation, disintegration, fluctuations, decay—and counterposed with phrases of stability. Experiments began from simple initial conditions; particles assumed their ground state from which experimenters perturbed them; all in pursuit of the new, of signal over noise. But such thinking assumed careful preparation. The mystery suspended under the trap was raw reality, unprepared" (335). Benford both acknowledges the role of metaphor in science, and via his emphasis on metaphors of mutability, suggests the intrinsic openness of science itself to social change. Nevertheless, in the end, his emphasis upon "raw reality" suggests that there must be more than metaphor

at work in science. This idea that there is a bit more gets additional substance as Benford launches into a more or less open position-taking on what he clearly takes to be a betrayal of science by recent discourses around science. Echoing Gross and Levitt, he laments the rise of "fashionable skepticism," but he expresses even more concern with the emergence of what he calls "sardonic science," "a blend of speculation, ironically oblique points of view, reinterpretations of the same data." (336) Benford's beef here is with scientists and theorists that think that they can replace experiment with discursive reframing, with its attendant suggestion that there is nothing out there worth actually studying (Einstein's paradigm shift was, of course, a discursive reframing, and his debate with Bohr involved the limits of experimental measurability). Yet if Benford is critical of paradiastolic approaches to scientific knowledge production, he also acknowledges the essential rightness of Kuhn's description of how science works, nearly paraphrasing the *Structure of Scientific Revolutions* account of "normal science" and its complicated social relationship to revolutionary scientific discoveries: "Most scientific research flows along well-charted channels. Within a recognized framework it seeks to discover minor eddies and byways, expanding knowledge without breaking boundaries. It strums with the tension between the known and the half-seen. Alicia had always scorned such conventional, safe approaches. Relativistic Heavy Ion Collider (RHIC), after all, was a bold stab into new terrain; its failure to yield any eyebrow-raising discoveries so far did not deny its initial ambition. But she had worked within a community, using time-honored approaches. She saw now the comforts of those boundaries. At this juncture she had to voyage into territory wholly unknown." (371)

Coupled with these engagements with various theoretical conceptions of science, Benford also offers lovely thick-descriptions of scientific life and scientific practice, particularly as it bears on the specific ways in which the social norms among scientists might hinder someone like Alicia from succeeding. Consistent with the findings of sociologists dealing with the challenges of institutional diversity (for example, Mor Barak 2015), Alicia suffers under the weight of "an identity imposed by other's expectations" (331) and feels hurt, rather than thankful, when her research proposals are openly accepted because of "minority scientist's points" (337) and not merely because of their intrinsic scientific virtues. Ever sensitive

to the ways in which scientists need to fight for research time amidst a sea of other professional distractions, Benford tries to point out realistic ways in which Alicia's time would be more imposed upon than that of her white male peers. She is constantly hounded by a bureaucrat of a department chair, for example, who wants her to spend her research time attending board meetings of the "Gender Education" committee in her capacity as a "minority woman." (361) Yet despite Benford's admirable attempts to bring to light sources of epistemic injustice barring individuals like Alicia from successfully achieving recognition as scientists, there is also much that he overlooks. First of all, Alicia never experiences outright racism or discrimination within the scientific community (nor is implicit racism really suggested). While this is arguably justified by reality, it nevertheless shows Benford backing down from taking a strong position against the existing norms. Likewise, Alica is portrayed as someone who has no fear of speaking out, even if self-censorship has often been found to be one of the major sources of epistemic injustice suffered by minority knowers (Fricker 2007). Benford should also be reproached for utterly ignoring, or perhaps falsifying, the socio-political forces that do so much to dissuade minority participation in the natural sciences. Alicia has wealthy and highly-educated parents, and so unlike the statistical majority of those belonging to underprivileged minorities, she grew up with access to excellent educational opportunities. Finally, and perhaps most damningly, is Benford's choice to represent Alicia as only capable of achieving recognition for her discovery via the help of the straight, white, and utterly stereotypical theoretical physicist Max Jalon, with their relationship itself, a union between an experimentalist and a theoretician, almost parodically reinforcing gender stereotypes which would see men as more rational and women as more embodied.

Navigating through the challenges to the spread of scientific knowledge posed by scientific practice, Alicia succeeds, and in so doing she becomes a paradigm figure or scientist-hero, a model scientist to be imitated. It is thus interesting to consider her paradigmatic qualities and virtues, particularly with respect to the ways in which these echo and differ from the gentleman scientist virtues that were characteristic of what Daston and Sibun (2003) call "scientist personae" since the 17th century, norms which included, according to research done by Lawrence and Shapin (1998), mol-

ding their habits of eating, sleeping, and exercising in order to exemplify their total embodiment of the scientific virtues. Like nearly any scientist from any period, Alicia is quite obviously gifted with what Catherine Elgin (2013) has described as "epistemic virtues," intelligence, an open-minded sensitivity to evidence and argument, capable of showing care and consistency. But if this alone should be necessary for pursuing science within an ideal world, and perhaps even within the world of the gentleman scientist who needs not scramble for grants and negotiate with university politics, but rather show sufficient polish to be let into the rather club-like doors of the scientific establishment, it is not enough to pursue science in the real world of the late 20th century. For Alicia lives a fallen world of scientific practice. In order to even be able to engage in scientific research, Alicia—like many other of Benford's heroes—has to obtain tenure, apply for research funding, work her way around teaching obligations and nosy administrators, deal with any manner of things that are not epistemic but which make science possible, while all the time keeping her eyes on the prize and remembering that science is about scientific knowledge, not about power, notoriety, politics or money. In order to accomplish all of this, she needs the virtues of the modern scientific hero, starting with a no holds-barred commitment to finding out scientific truth, which ultimately translates into a rather libertarian attitude towards traditional morality. Which is not to say that Alicia is a bad person—she isn't. But Benford approvingly has Alicia cheat her way through legal formalities barring her access to laboratory time by knowingly submitting a series of bogus calculations regarding the safety of her experiment ("One of the beauties of involved numerical calculations was that if they looked reasonable, nobody was going to check details" 333). As her research moves forward, she continually sidesteps regulations in order to keep her research going (she actually steals the cosm from a government-owned particle accelerator). One might well say that she is a moral realist about science, as much an embodiment of Machiavellian *virtu* as disinterested gentleman scientist. According to Miranda Fricker, "trustworthiness" was "made socially concrete in the figure of the gentleman." Thanks to his "economic and social independence brought by social advantage," he was thought to be "free from the sorts of beholdenness that might be thought to, and might actually, provide motivations for deceiving others. Further, the question of

non-deception was sured up by a code of gentlemanly honour. Not only did his social privilege mean he was seen to have little to gain from deception; it meant he stood to lose a great deal if he were seen to flout the code—a noble track-record was worth protecting." (Fricker 2011) Yet if Alicia is no gentlewoman, she is also no Machiavel: at all moments in the narrative it is clear that all of her actions are subordinated to a single highest good, and a single teleological end, namely the pursuit of scientific truth. Thus, at least within the framework of Benford's text there is no ambiguity around whether or not this is a moral stance: it is indeed *the moral stance that must be assumed by the contemporary scientist*.

This point is brought to the fore if we compare Alicia with Benford's depictions of other figures within the scientific community, individuals who have abandoned the absolute commitment to epistemology as a path to scientific virtue and self-formation and who have, in consequence, fallen away from virtue more generally. The celebrity-seeking Saul Schriffer in *Timescape*, for example, is more interested in popular recognition than in scientific truth, and thus shows himself not only to be a poor scientist, but also reveals himself to be a poor friend. The myriad university presidents, department chairs, and self-satisfied scientific has-beens strewn throughout Benford's books, form another counter example to the virtuous scientist, for in giving up an overriding commitment to seeking truth they have assumed the mannerisms of the gentleman scientist without embracing its essence, namely an overriding commitment to truth itself. In consequence, they are depicted as the enemies of truth, always throwing up normative and nonsensical barriers to the pursuit of truth, putting the brakes on scientific progress by unwittingly missing the forest for the trees. These figures, one might say, suggest alternative options and self-formations within post-quantum science. The Schriffer's of the world are sardonic insofar as they perform their belief that uncertainty allows one to say anything, the administrators embody the belief that the only salvation for science is the institutional stabilization of uncertainty which can only occur through norm, procedure, and institution, while Alicia (and all of Benford's other scientist-heroes) embody the scientist-hero as the true believer, the figure who keeps the faith that scientific discoveries can be made certain, who embraces the belief that god doesn't throw dice despite the absence of evidence.

The fictive exemplum that is *Cosm*, of course, does suggest that evidence can be found: only not on the level of epistemology, but rather on the level of social progress accomplished through the pursuit of scientific progress. The very fact that pursuing scientific truth does bring about the realization of social good in *Cosm* suggests a kind of physico-theological proof that an invisible providential hand is at work in the form of a divine intervener who magically squares the circle and (quite inexplicably) transforms the subject that adheres to the epistemic virtues into an exemplar of the sole absolute virtue in what is otherwise a world overrun by relativism.

Examples that Aren't

There is no such neat manifestation of the invisible suggested and sacralized in narrative to be found in the work of Ursula K. Le Guin. Everything is more complicated and paradoxical, yet it is quite clear and unambiguous that Le Guin's work responds, albeit differently, to the same crisis within the meaning of science and the scientist that inspires Benford.

The title of Ursula K. Le Guin's collected stories, *The Real and the Unreal*, echoes the words of physicist Niels Bohr: "everything we call real is made of things that cannot be regarded as real." It is perhaps a coincidence, but there is no doubt that Le Guin's work is deeply concerned with the meaning of science and being a scientist in a post-Einsteinian world. Indeed, Peter Koper has gone so far as to claim that the "role of science in society" is "the central issue in all of Le Guin's fiction," (1979: 67) and whether or not this assessment is justified, it is clearly true that much of her work testifies to a sustained engagement with the meaning of science. Yet if she is like Benford in this, there is a gulf of difference between their ways of representing the meaning of science.

In her 1985 *Always Coming Home*, for example, Le Guin very clearly takes up positions that come from the "sardonic science" camp of the science wars trenches. Unlike Benford, Le Guin does not directly mention these disputes, but her awareness of them is clear enough in passages like the following:

> *He learned arboriculture with his mother's brother... and with orchard trees of all kinds. We would be more likely to say that he learned from his uncle about*

> *orchard trees; but this would not be a fair translation of the repeated suffix* oud, *with, together with. To learn with an uncle and trees implies that learning is not a transfer of something by someone to someone, but is a relationship. Moreover, the relationship is considered to be reciprocal. Such a point of view seems at hopeless odds with the distinction of subject and object considered essential to science. Yet it appears that White Tree's genetic experiments or manipulations were technically skillful, and that he was not ignorant of the theories involved, and it is certain that he achieved precisely what he set out to achieve.* (1985: 275)

In this fictionalized anthropological treatise, White Tree's arboriculture is presented as the expression of a kind of science or alternative epistemology that is irreconcilable with western ideas about science, yet which is quite evidently held up as an example of a kind of science. Such an argument, or rather example as argument, resonates with one of the major battlefields in the science wars: disputes concerning the extension of the term science to alternative forms of knowing, including non-western, female, or situated epistemologies. While theorists like Harding, Gilligan, and Keller argued that recognizing a multiplicity of sciences was possible and even ethically and politically necessary, many mainstream philosophers like Rosenberg (2012) maintained that "we need not say "Western" science. For there is no other kind." Yet Le Guin's example demonstrates the inaccuracy of this statement: alternative conceptions of science exist but seeing that they exist requires stepping out of one's entrenched observer position, recognizing that some sciences are incommensurable and untranslatable into western paradigms of knowing, even if they do share one characteristic with the most successful western science: *achieving precisely what one sets out to achieve*. Note well that this is actually quite close to the pragmatic definition of science proposed by the post-colonial philosopher of science Susantha Goonatilake (1998): whatever "its social, political, psychological, or philosophical roots," science is ultimately "that which works."

The quantum revolution implies that scientific practice, at least in quantum physics, becomes self-consciously a project of making models about reality that are judged by their efficacy as approximations, and not, as in Newtonian physics, by the fact that they are simply statements about the absolute structure of reality. As Katherine Hayles (1984) has illustrated, this shift towards science as a practice self-consciously based

upon modeling has had massive impacts on both scientific and literary practice in the 20th century. Le Guin's work is no exception to this larger process, and her texts are both explorations into how to produce models for achieving what one sets out to achieve in the relativistic world and problematizations of complacent certainties that any model could do this. What Frederic Jameson has called Le Guin's "world reduction" and described as "operation of radical abstraction and simplification" (2007: 271) is precisely to be read as an attempt to produce models, thought experiments, explorations of the divination into what might work as one intends. With respect to the modeling of the meaning of science itself, Le Guin's most probing exploration is probably the 1974 novel *The Dispossessed*. This text was written before the outbreak of the science wars, and so unlike *Always Coming Home* it is not in direct dialogue with its debates around the nature of science and the meaning of being a scientist. Yet this fact, in a way, only renders *The Dispossessed*'s prescient treatment of the later more generalized crisis of the meaning of sciences the more remarkable.

Outwardly, *The Dispossessed* is in many ways comparable to Benford's *Cosm*: it too describes the life of a scientist-hero, Shevek, and his pursuit of a scientific discovery (a new theory of time.) Both are also clearly concerned with science paradigmatically imagined as physics (as opposed to, say biology or chemistry), and Le Guin even evokes Einstein in the text via the mention of a famous scientist named Ainsetain. Like *Cosm* too, *The Dispossessed* explores the way that power, culture, politics, gender and economics play a role within the happening of scientific discoveries, which is to say that the book explores the meaning of scientific truth with relationship to questions of moral goodness and the social good. Unlike Benford, however, Le Guin's text makes no pretention to realism or Geertzian thick description of contemporary scientific practice, but rather presents what Suivin (2016) would call a "cognitively estranged" universe, one that includes the depiction of not one but two opposed models or "reductions" of science as a social practice, and so two possible candidates for conducting science as a mastering of intention and effect. These two conceptually opposed alternatives are the anarchist 'utopia' Annares and on the capitalist 'dystopia' Urras.

The narrative of *The Dispossessed* revolves around Shevek's choice to leave Annares in order to further his research into a new theory of time, and

the narrative, with leaps back and forth between Annares and Urras and present and past narrations, forces the reader to consider the two examples comparatively. Annares, the birthplace of Shevek, is in conventional terms the more utopian of the two societies. It is held together by high moral values including a non-propertarian commitment to mutual aid, and it is likewise noteworthy for its commitment to gender equality, which has resulted in a scientific practice in which "about half" of the scientists are women, including the great Gvarab, "the only person [Shevek] had met whose training and ability were comparable to his own" (71). All of this stands in stark opposition to the values dominant on the capitalistic Urras, where the motive force of society is competition and the individual drive to gain, and the aim of science is to provide materials for economic and imperial expansion. In this society, the gender inequality in the sciences is such that Shevek's scientist peers on Urras greet his admonition that he has often worked with women physicists with astonishment: "You can't pretend, surely, in your work, that women are your equals? In physics, in mathematics, in the intellect? You can't pretend to lower yourself constantly to their level?" (17)

Yet if Annares seems like a more ideal society, the reality is much more complicated, particularly when science is contextualized within the larger ambit of social practice. Due to the constraints placed upon study and research by the egalitarian forms of life practiced on Annares, the school system and the research facilities on the planet can at best be described as mediocre. Paradoxically, within this egalitarian society Shevek is frustrated by lack of "equals," for he has no capable interlocutors on his own planet, no one trained in the latest science, and even if his peers possess the talent to acquire the foundations of the new physics, he and they lack the time "to take them far enough" (71) to make real discussion possible. Science on Urras, to the contrary, resembles research as it might be practiced at elite institutions such as Le Guin's own alma mater Harvard. The working conditions of the students and researchers are near-ideal, the students are described as "superbly trained," and Shevek finds multiple interlocutors capable of engaging with him as equals, a condition that is framed as being fantastically productive ("new worlds were born of their talking.") The reasons for the divergence between the two sciences are clearly linked to the larger social systems. On Urras "when [students]

weren't working, they rested. They were not blunted and distracted by a dozen other obligations. They never fell asleep in class because they were tired from having worked on rotational duty the day before." They are the products of an unjust social system that maintains its elites "in complete freedom from want, distractions, and cares." (127) Once educated, the researchers on Urras have (in Shevek's words) "so much to work with," beautiful laboratories, calm offices, apparently endless research budgets, and they "work with it so well." (85) Thanks to this freedom from want, the relationships between scientists in each system seem the opposite of the social relations that dominate in each culture. On Annares, Sabul, a "jealous" older rival to Shevek, a scientist become bureaucrat, rules at the "center" of the scientific institute at Abbenay and tries to block the publication of some of Shevek's papers while unjustifiably trying to take personal credit for others. On Urras, Atro, the equivalent figure to Sabul, jovially and earnestly begs Shevek for another book, "another revolution in physics" so that he can see "these pushy young fellows stood on their heads, the way you stood me with the Principles." (70) He (like the other members of the university faculty) expresses no resentment towards Shevek for his work, but instead celebrates the collective revolution in thought brought about by his thinking, caring more for the advancement of science than for the fear that he might be shown to be fallible. In short, the science on Annares is characterized by inequality, the abuse of power and censorship, while the scientific community on Urras is characterized by a joyous spirit of mutual intellectual sharing.

If it might seem that from the viewpoint of an absolute commitment to the search for scientific truth that the real utopia is Urras, let us recall that Shevek, the most gifted physicist in both words, is a product of Annares, and more importantly, he believes in and lives according to the core values of Annarian society (albeit in a critical and atypical way). Despite the benefits that he experienced from living on Urras, in the ivory tower he feels as if he has lost something of himself, "the flair which, in his own estimation of himself, he counted as his main advantage over most other physicists, the sense for where the really important problem lay, the clue that led inward to the center." In consequence, Shevek's work on Urras, the publication of three papers, is good scholarly work, but in his own estimation, "nothing real" (129). The real problem with science on Urras is not linked

to its stifling effect on Shevek's scientific creativity, however, it is linked to Shevek's dawning awareness of the ends to which science will be put in Urras. Shevek sees science as inseparable from ethics, proclaiming: "Our model of the cosmos must be as inexhaustible as the cosmos. A complexity that includes not only duration but creation, not only being but becoming, not only geometry but ethics" (226). Yet he realizes that pursuing such a truth is impossible on Urras, for despite his ethical intentions, his new theory of time will be used to fuel violence and imperial expansion (Le Guin may well be inspired here by the fact that Einstein's advances in particle physics were almost immediately employed in the production of atomic bombs). In order to accomplish science, and by this we mean achieving what he set out to achieve, unifying knowledge and ethics, Shevek must flee from Urras for Terra, and by his own efforts have his discovery in temporal simultaneity applied to the creation of the ansible, a device permitting simultaneous communication across all universes, which via this simultaneity cuts the cord that links the advancement of scientific knowledge to the acquisition of power and the augmentation of inequality and violence through knowledge.

Superficially, then, Le Guin's and Benford's depictions of the scientific ideal are similar, in that they exemplify a vision of a higher science that is able to reconcile epistemic and moral value. Yet if Benford offers a clear model to be followed as a matter of belief, the case is much less clear with Le Guin, precisely because all of the models that are offered are flawed, and Shevek himself emerges less as a model and more as a contradiction. More properly speaking, he is something like a negative or a dark example: it is not so much that we can see how to follow him, it rather that we see we can't follow him, that the search for examples to orient our comportment is ultimately vain or at least limited. Looked at with respect to the positive conditions that formed him, Shevek is a figure that makes no sense. The conditions that favored his emergence as a scientist seem to be the exact opposite of those that should have favored his emergence, for they are depicted as blocking the becoming of every other scientist on Annares. Meanwhile the science and scientists on Urras, otherwise so superior, are nevertheless, and for no clear reason, his inferiors. The most that one can say is that the example of Shevek suggests to Le Guin's readers that in the case of true science there really is no model, no perfect organization of science

and no perfect scientist, everything just depends upon... what works. As Paul Feyerabend put it in his 1975 *Against Method*: "*The only principle that does not inhibit progress is: anything goes.*" Which is not to say that Le Guin's text is to be read as an illustration of Feyerabend's scientific anarchism, but rather as an injunction, particularly to scientist readers, to recognize the ways in which the contemporary forms and norms of science don't work or perhaps aren't even science, and as scientists to seek discover singular and alternative sciences or ways of doing science that might be worthy of the name by doing the impossible, and making all that seems real and oriented towards systematic injustice be revealed as unreal and as means to collective well-being.

Climate Change and the Constitution of a New Paradigmatic Idea of Science

Today the conflicts that fueled the science wars seem stilled. These are in part due to works like Le Guin's and Benford's, to the stabilization of new senses of what it meant to be a scientist and do science that these works supply to their readers. But it is also the case that a new paradigm in the imaginary meaning of science has emerged, a new phase in the social history of ideas about science. As Andreas Malm (2018) has recently remarked, leftist thought in western society has recently undergone a paradigm shift: we are no longer in the Postmodern but in the Anthropocene. I take this to mean that we are no longer in a historical period dominated by the eternal return of the same—a post-historical and post-progressive period in which all truth is relative, so no truth is transformative—into a period in which the discoveries of climate science—if true—become historical in an absolute sense, literally suggesting that humankind is now being projected towards its catastrophic historical annihilation. The Anthropocene is then the era in which the meaning of science is bound up with acknowledging and avoiding this catastrophe. Suddenly figures who found themselves on opposite sides in the science wars find themselves united against climate sceptics, with the common aim of raising alarm over the meaning of climate science for the future of collective life. In this new paradigm, the politics of the minorities are tied to science according

to theories like Rob Nixon's vision of slow violence, and the bad guys are religious fanatics and fossil fuel company sponsored "merchants of doubt" (Oreskes and Conway 2011). Suddenly the idea that science could be twisted by corporations and governments to produce things like weapons of mass destruction is replaced by a vision in which the science-driven technological destructiveness has already been unleashed, but it is only science which can bring to light the facts of this ongoing crime, and science coupled with culture and politics that can alter the collective path before it is too late for humankind and much of the rest of the biosphere.

Within this shifting climate of the meaning and authority of science, the essential scientific breakthrough regarding climate change should be dated back to Svante Arrhenius' discovery of the greenhouse effect in 1896. Yet if this discovery is already more than a century old, the meaning of this discovery for the collective meaning science is still emerging. This is because Arrhenius' theory did not seem to matter for society given that the world did not seem to be warming meaningfully. Yet if science more and more rhymes with climate science in halls of government, it is precisely because data has been acquired, melting glaciers have been filmed, films like *The Day after Tomorrow* have spread alarm, and Cli-Fi, science fictions imagining and depicting horrifying post-climate change futures, have emerged as a genre. It is interesting to note that the seeds of climate consciousness can be found in the margins of both Benford's and Le Guin's texts. In *Timescape* (1980), another of Benford's explorations into laboratory life, the hero of the tale does not only bring to light a scientific discovery against the forces of mediocrity stifling science, but the discovery itself helps humankind to avoid the collapse of all life in the oceans. If Shevek is not an ecological hero, and if the abuse of science that he counters seems more akin to the Einstein's A-Bomb than to the slow shift set in motion by the steam engine, there is nevertheless a heightened ecological dimension in Le Guin's work. The emergence of this new idea of science, however, is only arguably ecological insofar as the paradigm of Anthropocene science is based on Arrhenius. For climate change as a product of modeling is really about historical rupture, and not about balance and interconnectedness. With respect to the past, the Anthropocene is about Co_2 entering the atmosphere and changing the weather to issue in a human activity-driven age, and with respect to the future the meaning of Arrhenius work is quite

simply that humankind will cease to exist of its own devices. Confronted with this already manifest existential threat to existence, few scientists and aspiring scientists today understand their vocation with no reference to questions of climate change and no desire to perpetuate human life. Science, technology, engineering, and mathematics (STEM) research and educational institutions everywhere are reorganizing in order to confront the anticipated challenges linked to climate change, striving to achieve a future that suddenly seems threatened, not merely some plastic phenomenon linked to relativistic particle science.

Conclusions

Science fiction is not always about science in the ways that the two texts that have occupied our attention here are. Yet many other texts might have been read, including works by Wells, Heinlein, Asimov, Miller, Robinson, and Lostetter. Science is not always informed by science fiction, and numerous are the members of the scientific community who have never read a line of science fiction. But there are enough texts and enough examples of the interchange between the two to suggest that it is worth broadening the discussion of the relationship between science and science fiction from the narrow focus on scientific facts and theories to a focus on representations of science and scientists. This could be limited to a focus upon geek-culture self-styling or the ways in which what Johnson (1993) has called the moral imagination as expressed in SF informs the ethical sensibilities that guide scientists (see Blackford's *Science Fiction and the Moral Imagination: Visions, Minds, Ethics* (2017) for an example of what such criticism might look like). I think, however, that scholars can aim higher, suggesting that ideas about the meaning of science transmitted in science fictions and other representations of science inform the whole of scientific practice, including the future discoveries that will be made in the sciences. That such change is indeed within the power of science fiction may not be evident from the examples that I have given above, moving as they do from purely theoretical breakthroughs to the broader politics of the cultural imaginary as they are enacted in fictions. Let us close now, with but a brief example of the causal feedback loop working in the other direction, which is to say a case in which science fiction as an imagination

of science and the scientist gives birth to concrete scientific discoveries. We needn't look far: for the case is nothing more than the emergence of what is oft called modern science in the work of Francis Bacon.

Readers of Francis Bacon's *New Atlantis* generally understand the book to be a portrayal of the future fruits of science, the future discoveries of the scientific mind. This is unsurprising, since these readers have been conditioned to look at the science in science fiction as an exemplification of future scientific theories. Yet out of the posthumous fragment's thirty-five pages, only about seven actually talk about science and its wonders, and most of that discussion is not about the discoveries themselves but rather about the institutions in which these discoveries occur. All the rest of the book is devoted to characterizations of the inhabitants of Bensalem, as well as descriptions of their politics, economic norms, and even sexual practices. The reason for Bacon's focus on society and scientists is simple, and it does not stem from his lack of theoretical vision. As a lawyer and courtier by trade (and as someone who himself made no important scientific discoveries), Bacon understood that the success and failure of science as an enterprise did not so much depend on scientific theories or discoveries, but on what people thought of science, and above all what people expected of science. Bacon was writing in a world in which experimental science had a bad name, for as Frances Yates (2001) has shown, its antecedents lay in alchemy and the dark arts, and one can hardly forget the fine reception that Galileo's discoveries received in the church. Like any good grant writer, Bacon understood that only a vision of science that was imagined as producing virtuous men and a virtuous society such as are depicted in *The New Atlantis* would receive patronage, inspire participation among the wealthy and the educated, and thus ultimately produce the genteel culture of science whose virtues, at least in part, were to be so vigorously defended in the science wars.

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