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**Kirsten Shepherd-Barr: Science on Stage**

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## The Tradition of Science Plays



In her book *From Faust to Strangelove*, Roslynn Haynes charts the major trends in the portrayal of the scientist in Western literature. She not only taxonomizes the many different manifestations of the scientist figure but also shows how such depictions directly or indirectly reflect societal perceptions and cultural beliefs about science and its professors, intricately linking science, literature, and culture. While her study does consider selected dramas, its main focus is on novels, short stories, and other fictive genres. Yet it is strikingly clear that within the long history of science in literature, the theater has been one of the most consistently prominent sites of engagement between the two cultures.

Although not an exhaustive survey, this chapter provides a taste of the way science and theater have intersected over the centuries and sets out the parameters for the tradition of science in the theater: not just identifying the representative plays but discussing how the science figures in them. Broadly speaking, science moves from the margins to center stage in the drama—from simile and metaphor to thorough structural and thematic integration. Setting out this development and furnishing a framework for the plays that are analyzed in some depth in later chapters will enable us to contextualize them better and to see not only how they relate to one another but how they correspond to the tradition and its trajectory. Plays that engage medical themes and motifs and/or depict doctor-patient relationships are also part of this tradition but will be considered in a separate chapter.

### From Metaphor to Performance

The way in which scientific themes and ideas have been engaged by playwrights and directors has become increasingly sophisticated. In Elizabethan examples, like Shakespeare's *Coriolanus* and Marlowe's *Doctor Faustus*, scientific and medical themes can provide handy illustrative metaphors. In the former, the metaphor of disease richly illustrates the politi-

cal problems of the main character, as the corrupt state is likened to a body with diseased limbs in need of amputation: “He’s a disease that must be cut away.”<sup>1</sup> Here, the science is used to make a metaphor that describes the situation or character. In general, earlier plays that deal with science do so in this literary fashion—borrowing images or ideas to make metaphors. While Coriolanus is likened to a diseased body, the common people are a “herd of—Boils and plagues,” on whom should descend “all the contagion of the south . . . and one infect another.”<sup>2</sup> The metaphor of disease is vividly used, but the form of the play is divorced from its content. In *Doctor Faustus*, science is incorporated into the play in a very different way: science itself, or the scientist, becomes the embodiment of the problem, not just a metaphor for it. The problem of human overreaching, of trying to know too much, is personified in the figure of Faustus.

From these two Elizabethan examples to the present day is a long leap, and a significant shift of emphasis occurs between earlier and later science plays in terms of how the science figures in the play. Later science plays—the ones that define the new wave of science playwriting in the 1990s and beyond—move toward a formal and structural integration of the science. The playwright structures his or her play according to the scientific idea at its core, making the piece performative in nature, as outlined in the introduction.

### From *Theatrum Mundi* to the Stage as Cosmos

The time-honored cliché of the stage as a microcosm of the world is perhaps best known from Jacques’s soliloquy in *As You Like It*, which begins:

All the world’s a stage,  
And all the men and women merely players;  
They have their exits and their entrances,  
And one man in his time plays many parts,  
His acts being seven ages.<sup>3</sup>

This was a favorite image of Shakespeare’s; for example, in the prologue to *Henry V* he conjures “a kingdom for a stage,” beseeching the audience to use its imagination and think of “this wooden O” (the circular Globe Theater) as the world, housing “vasty fields,” the perilous ocean, “mighty monarchies,” and advancing armies “within the girdle of these walls.”<sup>4</sup> Shakespeare may have made it globally famous, but this trope of stage as

world “can be traced back to the Middle Ages and beyond, to Plato—who already disliked the institution from which he derived the image.”<sup>5</sup>

By the twentieth century such imagery is well established in plays and firmly links the theater and the universe in the audience’s imagination. In the mid-twentieth century, Brecht has Galileo use the stage to show Andrea how the Copernican theory works in the opening scenes of *Galileo*, with an iron washstand as the sun and Andrea on a chair as the earth.<sup>6</sup> Thornton Wilder’s *The Skin of Our Teeth* (1942) and Ewan MacColl’s *Uranium 235* (1947–52) both in different but highly visual ways use the stage-as-world device to transform the stage into a living cosmological symbol. More recently, Stoppard’s *Galileo*—only recently published—and *God and Stephen Hawking* by Robin Hawdon posit the stage as the cosmos in miniature. Some of these examples will be discussed in greater depth later.

### The Scientist Sells His Soul

The ur-science play may well be *Doctor Faustus* in terms of both text and performance. As Mark Berninger points out, the “long tradition of dealing with science in the theater . . . goes back at least to the various dramatisations of the Faust myth.”<sup>7</sup> Marlowe’s *Doctor Faustus* helped (literally) set the stage for the science play by establishing literary roots and a theatrical model for the integration of science and theater. Between it and modern science plays lies some important common ground, but also some key distinctions and divergences.

Faustus’s bargain with the Devil sounds an ominous note as one of the first dramatic representations of the scientist; this negative image signals a distrust of science that becomes one of the defining characteristics of science plays for centuries. If “the relationship between science and drama has been predominantly one of opposition,” the tension surely begins here.<sup>8</sup> Marlowe’s Faustus is not a passive Everyman caught in the inexorable wheels of fate; he is solely responsible for his own demise, and yet in theory his desire for greater knowledge is admirable. The dilemma posed by this tension between wanting more knowledge and flying in the face of religious doctrine finds its way into later science plays, like *After Darwin*, *Galileo*, and *Inherit the Wind*.

*Doctor Faustus*’s central concern with the pursuit of knowledge and the use and abuse of that knowledge makes it the archetypal science

play, and this concern only gets stronger as the issues of modern science become ever more ethically complex. In particular, the theme of intellectual curiosity leading to Icarus-like overreaching recurs throughout the science play canon, but through the opposite idea of “underreaching.” Put simply, modern science plays, like Stephenson’s *An Experiment with an Air-Pump* and Brenton’s *The Genius*, often revolve around the idea of science having gone too far and created a hell on earth. They invoke the hell motifs of *Doctor Faustus* to convey the enormity of the implications of postwar science.

Most important, Marlowe foregrounds the illusionistic practices of the stage as he shows what comes of Faustus’s supreme knowledge: the ability to perform cheap tricks and sleights of hand that are more closely linked to the artifice of the stage than to the practice of science. The play makes an implicit connection between theatrical illusion and sham science. “Then in this show let me an actor be,” says Faustus in act 3 as he and Mephistopheles are devising their treatment of the pope, one of several metatheatrical moments in the play when Faustus acknowledges himself as a performer. Faustus’s daring and blasphemy do not get him the great power, riches, and unsurpassed knowledge that he envisions in the play’s opening scenes; instead, he becomes a theatrical impresario, able to conjure spirits (and grapes) and to play pranks on the pope. In this overt analogy to theater itself, which similarly pulls the wool over people’s eyes through artifice, it is as if Marlowe is cautioning that such longing for superhuman power leads only to shoddy theatrical tricks. All the while, of course, he is paradoxically validating theater as the site of the exploration of serious issues.

This “conscious theatricality”—Richard Allen Cave’s term to describe the strategy of Marlowe’s fellow dramatist Ben Jonson in *The Alchemist*<sup>9</sup>—anticipates the more overt performativity of contemporary science plays. Right from the start, science plays are conscious of the way form can enhance and convey theme, and surely the “liveness” that is unique to the theater plays a tremendous role here. From Marlowe to Thornton Wilder in *The Skin of Our Teeth* to the contemporary examples that are the main focus of this study, playwrights have used science specifically to probe the problem of human progress through the advancement of knowledge.

Not everyone thinks highly of *Doctor Faustus*. “What can be said in defence of *Faustus*?” despairs one reviewer of a recent revival. “Has anything else so ramshackle ever entered the Pantheon of masterpieces?”<sup>10</sup>

What some scholars claim is Marlowe's "supreme achievement," "a kind of enchantment,"<sup>11</sup> others find his "most famous if least effective play," which reads and acts like

a sequence of Monty Python sketches topped and tailed by a few speeches with flecks of poetry in them. The Germans should subsidize Marlowe for putting Goethe in so good a light. . . . *Doctor Faustus* is little more than a vulgarized morality play into which a young doubter and man-about-the-university has inserted some shallow notions of atheism. It lacks even the courage of its conventional defiance, always veering off into stereotyped repentance.<sup>12</sup>

The influence of the old morality plays, "whose remnants are ruinous in *Faustus*," along with the "clumsy kind of magic that fills" it, makes it poor drama.<sup>13</sup> Such views press the question of whether the play is as good as what it represents. Perhaps the play's literary and theatrical merits have been overblown, and its significance and continued relevance really rest with its status as precursor of "science plays."

At first glance, *Doctor Faustus* hardly seems like a "science play" because the science in the play is limited to a few passages about astronomy, and anyway the whole notion of what science was at that time is fundamentally different from how we understand it today.<sup>14</sup> But one can argue that it is not the quantity of the science in a science play that matters, but the quality of its integration: the way in which it figures both thematically and theatrically. A second point relates to the nature of scientific discovery. Much of science is highly progressive and therefore potentially subversive of the status quo, destabilizing norms by constantly questioning and changing what we know. By putting the archetypal scientist on the stage, Marlowe helped to establish a link between theatricality, science, and subversion that we find again and again in science plays. What the editors of the Revels edition of *Doctor Faustus* call the "subversive energy released by the theatrical experience of this play" helps to explain why so many writers have chosen theater as the medium to explore subversive ideas coming from science, since historically theater and science share this subversive, dangerous, and carnivalesque quality.<sup>15</sup> It is a natural fit, then, to bring them together.

As J. W. Smeed points out in his book *Faust in Literature*, two major changes happened in post-Marlowe depictions of Faustus. First, the idea of an *illicit* knowledge, that is, forbidden black magic and necromancy, gives way to a far more positive, post-Enlightenment notion of knowledge

not for the betterment of the individual but for the improvement of society. The leap from Faustus's declarations of his ambitions to rule the earth (linking knowledge with power of a personal, ambitious sort) to our concerns with the impact of scientific discovery on the common good is great and significant, casting the scientist in a far more positive light by stressing intellectual curiosity rather than overreaching hubris. Postwar science plays, beginning with the final version of Brecht's *Galileo*,<sup>16</sup> have become much more ambivalent about the motives of the scientist.

The second major change in the depictions of Faust, or at least his indirect descendants in literature over the centuries, is the largely Germanic-inspired emphasis on romance in the story, to the subjugation of science. An example of this is in Gounod's opera, with its reductive focus on the doomed love affair between Marguerite and Faust. What is striking is that modern science plays, with few exceptions, have followed Marlowe's example rather than Goethe's, focusing on the themes relating to science and its pursuit much more than love interests. In this way, science has remained at the core of contemporary plays about science. Love, when it exists at all, is secondary or tangential, for reasons outlined in chapter 2.

It remains to be asked: Would we have had a tradition of science plays without *Doctor Faustus*? Probably. But this play arguably sets up a paradigm of using theater as a place to unite the two cultures, by raising fundamental questions about the nature and ethics of scientific pursuit, the personality of the scientists involved, and the connection between the aspirations of the scientist and the theatrical terms in which such aspirations are framed.

### Pseuds' Corner: From Jonson to Ibsen and Shaw

Ben Jonson's *The Alchemist* features overreaching scientists of a very different character—fakes, pseudoscientists, and poseurs bent on exploiting the mysterious science of alchemy for financial gain, not for the sake of further knowledge. In *The Alchemist*, three sham scientists launch a dubious scheme they call the “venter tripartite,” in which Face, Dol, and Subtle pose as an alchemist and his assistants and entertain a steady stream of customers eager to buy what they believe the alchemists can purvey, from sexual prowess to wealth to professional success.

The play deserves inclusion in this discussion because the allure of alchemy lurks around the edges of the science play tradition, whether in

the form of actual alchemists, as in Jonson's play, or in more suggestive mode, as in Tony Harrison's theater piece *Square Rounds*, in which the real-life figure of chemist Fritz Haber furnishes an alchemical motif. As August Strindberg's "inferno" crisis illustrates (the period in the 1890s when he wrote nothing but papers about his often dangerous alchemical experiments), alchemy has continued to fascinate artists and scientists alike. There is something poignant as well as sinister in the alchemical enterprise, something fundamentally human, and playwrights from Jonson onward have used that dualism to great effect. And, as Gillian Beer has noted, alchemy is specifically linked to the theme of transformation, and to the theater's power to effect change.<sup>17</sup>

Jonson's satirical target is not the alchemists but their customers, the willing dupes whose vanity and greed drive them to seek the secret knowledge of the would-be alchemists. The kind of overreaching these gulls exemplify is, by implication, far worse than the rather imaginative and savvy sort displayed by the cozening alchemists. At least these alchemists have done their research. Jonson is thoroughly conversant with the technical jargon of alchemy. It is remarkable how in this polemical play—just as in Shaw's *The Doctor's Dilemma* three centuries later—even while the author inveighs against scientific fakes who dupe their unsuspecting followers, he shows a real grasp of the field that furnishes his dramatic material. As the sly alchemist Subtle quizzes his accomplice Face, Jonson's dialogue reflects—and has great fun with—his familiarity with Renaissance science:

SUBTLE: Name the vexations, and the martyrisations  
Of metals, in the work.

FACE: Sir, putrefaction,  
Solution, ablution, sublimation,  
Cohobation, calcination, ceration and  
Fixation.

SUBTLE: This is heathen Greek, to you, now?  
And when comes vivifacation?

FACE: After mortification.

SUBTLE: What's cohobation?

FACE: 'Tis the pouring on  
Your *aqua regis*, and then drawing him off,  
To the trine circle of the seven spheres.

SUBTLE: What's the proper passion of metals?

FACE: Malleation.

SUBTLE: What's your *ultimum supplicium auri*?

FACE: Antimonium.

SUBTLE: This 's heathen Greek, to you? And, what's your mercury?

FACE: A very fugitive, he will be gone, sir.

SUBTLE: How know you him?

FACE: By his viscosity

His oleosity, and his suscitability.<sup>18</sup>

Far from being gibberish, such language shrewdly satirizes “a broad range of popular superstitions and pseudo-sciences,” and it succeeds because Jonson knows the subject of his satire extremely well. He also knows his audience: “Queen Elizabeth and several nobles invested in alchemical projects, and its possibilities continued to fascinate learned men into the late seventeenth century.” Jonson knew the work of the mathematician John Dee, a possible model for Subtle, who also “practised alchemy and attempted to communicate with spirits.”<sup>19</sup>

Given that Jonson's target was the audience and not the alchemists, it is intriguing that the play was a “resounding popular and artistic success . . . one of the few Jonson plays which seems to have caused no trouble of any kind for its author.”<sup>20</sup> Perhaps he was simply very adept at flattering his audiences into thinking of themselves as the clever ones rather than the gulls. Perhaps the way he depicted the gulls made the audience want to think of themselves as the smarter, albeit unscrupulous, alchemists rather than their customers. Whatever the reason, Jonson succeeded in disguising some fairly harsh criticism of his audience, a subversive strategy rather akin to Oscar Wilde's similar success in marshaling the tools of Victorian theater to attack his audience's hypocrisy. The fact that *The Alchemist* was so well received by its audiences indicates how subtly Jonson's satire works.

In addition, the play offers a comical commentary on theater itself, complementing Marlowe's more sobering analogy. *The Alchemist* presents “a series of farcical characters each intent on realising a *better* self come in the clutches of a trio, consummate actors all, who in a mercantile age are choosing to sell illusion as a commodity. With the aid of a few tawdry props and appropriate foot-and-half-foot words they give their clients the chance to star in their various private scenarios—at a price, of course.”<sup>21</sup> The “tawdry props” are not so different from those employed by Mephistopheles and Faustus, with a similar purpose: to deceive and trick. As Cave points out, alchemy and theater coincide:

Jonson draws and sustains throughout the play a brilliant conceit relating alchemy, the refining of base metals into purest gold, with acting (the transformation of humble mortals into heroes). Subtle's alchemical laboratory we never see (patently it does not even exist); instead we watch the effects of the trio simply talking to their clients about its potential. All the magic is in the power of their words to feed each client's imagination until it invents a brave new world to its own satisfaction. By making these moments of self-transcendence plays within the larger play-structure, each carefully staged and paced by Face or Subtle, Jonson cunningly transforms a superb social comedy about Jacobean London into a serious disquisition on the nature of theater.<sup>22</sup>

Paradoxically, the power the three rogues wield lies in the suggestion of alchemy rather than its actual demonstration—their laboratory remains off stage, behind a curtain, forever mysterious and impenetrable.

We have seen that what Cave refers to as the “conscious theatricality” of the play applies equally to *Doctor Faustus*, to *Galileo* and other midcentury science plays, and to recent plays like *Copenhagen*, *Wit*, *After Darwin*, and *Arcadia*. Some scholars have found a connection between Jonson and Brecht in their respective use of metatheater; Cave, for instance, has argued that Jonson's “wholly purposeful theatricality” is concerned with creating “an ‘alienated’ audience, one made conscious (as Brecht would have his spectators) of participating in the shaping of an artifice the better to perceive the imaginative consequences signified by the performance.”<sup>23</sup> In fact, one of the hallmarks of science plays, especially the most recent ones, is precisely this attribute, as analysis of selected plays in subsequent chapters will show. Brecht's imprimatur is deep. In the tradition of science plays, the works that seem least effective are those that adhere most closely to a formulaic dramaturgy such as the well-made play (Brioux's *Les Avariés* is an example), while the ones that stretch and prod the norms of accepted theatrical modes have been most enduring and successful.

It should be noted that scientists and their laboratories crop up frequently in dramas throughout the Restoration and eighteenth century, mainly to provide easy targets for ridicule and fodder for satire, lampoons, and spoofs. As is well known, Thomas Shadwell's *The Virtuoso* (1676) lampoons the Royal Society and specifically the famously diminutive scientist Hooke.<sup>24</sup> The motif of the doctor or scientist as fossil collector, dry and out of touch with reality and closeted in his museum of useless curiosities, appears in plays like *Three Hours after Marriage* by “Scriblerus”

(John Gay, 1717). The former features Dr. Fossile, a charmless predecessor to Shaw's Dr. Walpole, who has one standard cure for any ailment: where Walpole unfailingly diagnoses blood poisoning and prescribes the surgical removal of the mythical "nuciform sac," Dr. Fossile repeatedly advises dosing his patients with "a Quieting Draught."<sup>25</sup> Science heavily influences this play; the dialogue is larded with medical and scientific jargon designed to raise a laugh, and the setting is a spectacularly cluttered "museum" or laboratory full of relics and curiosities collected by Fossile. *Three Hours after Marriage* sends up the notion of the intellectual in several scenes that show vain and smug scientists engaged in vigorous one-upmanship, surrounded by the useless curiosities Fossile has collected in his research and that now cram his cabinet—including an alligator. When it figures at all, science tends to be the subject of ridicule in the drama of this period, an interesting social commentary on its role within culture.

### Brecht, Galileo, and the "Conscious Theatricality" of the Science Play

Any discussion of science plays must include quite centrally Brecht's *Life of Galileo* (referred to hereafter as *Galileo*). Although there have been other dramatizations of the figure of Galileo, Brecht's is the best-known play about the great scientist. It is also highly controversial, a thorn in the side of historians and scientists who believe Brecht muddles history, biography, and science in a dangerously misleading way for political ends. I will address the play with regard to these ongoing questions about how Brecht used science and history, and consider why the play remains a watershed in the development of "science plays."

Brecht wrote several versions of *Galileo* over two decades, and they differ radically with regard to the depiction of the scientist. In his now famous introduction to the play, Eric Bentley—Brecht's English translator and champion, who did for Brecht in the English-speaking world what William Archer had done for Ibsen—summarizes how the drafts of the play changed and how the versions differ from one another. He notes that the play is remarkable in that it exists in "two broadly different forms," the version of 1938 and the version of 1947. The dates alone would suggest what happened between the two versions: World War II and the use of the atomic bombs on Hiroshima and Nagasaki. It is perhaps no surprise that Brecht's 1938 *Galileo* is a "winning rogue" who could sabotage and

subvert the dominant regime (a potent analogy with the resistance to Hitler), while the 1947 version was designed “to make the audience dislike him.”<sup>26</sup> Brecht himself put it thus: “The atomic age made its debut . . . in the middle of our work. Overnight the biography of the founder of the new system of physics read differently.”<sup>27</sup> The point in the postwar version of the play—the one that is most widely read and performed today—was “no longer to demand from the authorities liberty to teach all things but to demand from the scientists themselves a sense of social responsibility, a sense of identification with the destiny, not of other scientists only, but of people at large. The point was now to dissent from those who see scientific advance as ‘an end in itself,’ thus playing into the hands of those who happen to be in power.”<sup>28</sup>

This shift in the portrayal of the scientist is partly what makes *Galileo* a watershed science play. Generally, from hereon in, science plays either directly or indirectly engage this notion of the social responsibility of the scientist. The scientist is rarely the underdog anymore. In addition, *Galileo* broaches a host of important questions about the nature and pursuit of science, especially its relationship to society. It shares with *Doctor Faustus* an engagement with the themes of the scientist as overreacher, the clash of religion versus science, the scientist as hero or villain, and the application of scientific knowledge. Nowhere is this captured better than in Brecht’s depiction of Galileo as a sensual, earthy man who loves his food and wine and needs money to support these basic needs. To this end, in Brecht’s play, he is not above “modifying” (plagiarizing) the newly invented telescope and claiming it as his own work. The scene in which he unveils his discovery in public, performing before an admiring crowd, echoes the cheap tricks of Faustus aided by Mephistopheles. Where Faustus has Mephistopheles to help him stage the show, Galileo has his actual scientific knowledge.

Another theme Brecht’s *Galileo* introduces and that will become standard in later science plays is the tension between the desires of the individual and responsibility to the community. This is, of course, related to the theme of religion versus science. In *Doctor Faustus* and *Galileo*, the protagonists test their individuality against the dictates of the church to think of God and the community before the self. In both plays there is also the implication (much more outspoken in Brecht) that the church has a lot invested in keeping people in the dark, although Marlowe clearly seems to be more on the side of the church than does Brecht. But for both, the individual’s search for truth is problematic; Faustus and Galileo

are lone fighters for greater knowledge who ultimately isolate themselves. Although Galileo goes on to publish even more important findings than those he had to recant, he is all alone and in jail, blind, his health ruined, with few friends still in touch with him. Brecht wants to show the importance of social responsibility and the emphasis on the community rather than the individual. A similar impulse underpins *Doctor Faustus*: when Faustus deserts his community of scholars, they show concern, but he is already forging his pact with the Devil. It is as if to say, once the individual becomes more important than the group, he or she is lost.

Many other versions of Galileo's story have been written for the stage. In the 1940s, the air was thick with Galileo plays: the New York agent Audrey Wood declined to hear Charles Laughton read *Galileo* in a bid for her to produce it in New York because "she also represented a client named Barrie Stavis who had written a Galileo play entitled *Lamp at Midnight*."<sup>29</sup> While Brecht was working on the English version of his play with Laughton, Morton Wurtele, a scientist he had employed to advise on the scientific aspects of the play, came across a five-act tragedy about the life of Galileo written by the German playwright Arthur Trebitsch. Entitled *Galileo Galilei. Ein Trauerspiel in fünf Akten*, it was written entirely in blank verse and was published in Berlin in 1920.<sup>30</sup> This discovery did not seem to faze Brecht. Frank Zwillinger's 1953 play about Galileo depicts a happy ending: "The archbishop of Sienna assures him that, owing to a technicality, the Inquisition's ban on the teaching of the Copernican system is invalid, and hence such teaching is not heretical."<sup>31</sup>

In its fifty years of publication and production, Brecht's *Life of Galileo* has seen challengers, revisers, and adapters, as well as continuing commentary and analysis. In this regard, too, the play takes a special prominence in the tradition of science on stage, generating its own legacy of ongoing intertextuality. Several prominent playwrights have taken on the subject of Galileo, whether overtly responding to Brecht's depiction or not. David Hare and David Edgar have both adapted Brecht's play. Tom Stoppard wrote an unpublished version of *Galileo* (discussed later in this chapter) that was meant to be performed at the London Planetarium. In 1980 Howard Brenton wrote an English version of Brecht's *Galileo*, directed by John Dexter at the National Theater with Michael Gambon as Galileo, which Brenton calls "a production of great clarity and force."<sup>32</sup> Mel Gussow hails Gambon's "breakthrough performance" as Galileo in that production.<sup>33</sup> Philip Glass wrote an opera, *Galileo Galilei*, staged in 2001. The historian of science Lewis Wolpert has written a kind of dialogue called "Good Evening, Galileo," in which Galileo is interviewed

after seeing Brecht's play. Its main purpose is to criticize Brecht's version for historical inaccuracies and scientific distortion.<sup>34</sup>

Some of the authors of plays about Galileo simply want to write about this fascinating figure and the discoveries that changed the way we see the world. Others are bothered by the way in which Brecht used biography, science, and history, taking issue with his negative depiction of Galileo and his critical stance toward science itself. For example, Stoppard's research into Galileo's life and science led him to conclude that "Brecht's play was nonsensical in certain historical respects"; Stoppard wanted his version to be "essentially faithful to history."<sup>35</sup> To this end, throughout Stoppard's version a narrator tells the audience "when and how the play deviates from historical fact, thereby serving as a subtle rebuttal to the way Brecht manipulated the story to fit his own ideological ends."<sup>36</sup> While historians have been piqued at what they see as a misrepresentation of events, scientists especially have been quick to point out that Brecht's science is oversimplified, distorted, or simply wrong. Wolpert's Galileo says:

Brecht shows no understanding of science. In the first scene of the play he has me gabbling on about a new age, with everyone questioning old certainties. What nonsense. Then there is that line where someone says "we shouldn't have tried what is in the books, but should have looked for ourselves." What nonsense. Any looking makes it obvious that the earth stands still and the sun moves around it each day. No, science first requires a sound knowledge of mathematics and a special mode of thought. To deal with matters scientifically it is necessary to make abstractions from the concepts of weight and speed, which are infinitely variable. I would never have prophesised [*sic*]—as he has me do—that astronomy—a mathematical science would be discussed in the market place. Brecht just wants to see our new science overthrowing the established political order. The common man will never make contributions to science. It goes, unfortunately, against common sense. Even Aristotle understood this clearly when he said that the effect of achieving understanding is to completely reverse our initial attitude of mind.<sup>37</sup>

Such protests at a playwright's use of biography and history—dramatizing actual events and people—are now fairly routine and offer a fine parallel case study to Frayn's *Copenhagen* and the storm of controversy it has met, the implications of which are addressed in chapter 8. The objections to Frayn's depiction of Heisenberg echo those about Brecht's depiction of Galileo. In the former case, critics have felt the playwright makes the

character too sympathetic and endows him with moral qualms about the use of science where he had none; in the latter case, critics have found the scientist depicted not sympathetically enough. Above all it is Brecht's rather coarse Galileo himself that has irked many who find the emphasis on Galileo's very physical and sensual appetites distorts the truth and deflates the image of the great scientist. When he gives in to the threat of pain, he is simply being human. Yet many oppose this dramatic treatment, wanting Galileo instead to be upheld as a martyr, a hero for science.

In the case of Galileo, the discoveries he made helped to bring about a fundamental change in how we view the world, and Brecht tries to make this the focus of his play by deliberately withholding any dramatization of the courtroom scene that would doubtless form the centerpiece of a more traditional play about Galileo. Without the distraction of a classic courtroom scene, the play foregrounds much more sharply the paradigmatic shift Galileo's discoveries signify. Challenging or shedding old ideologies requires intense questioning of dominant discourses and institutions. The potential good of new scientific discoveries cannot be fully realized without concomitant advances or transformations in thought and perception.

In understanding Brecht's (or indeed any other playwright's) *Galileo*, the notion of paradigm shifts becomes highly relevant. Reading the play in light of Thomas Kuhn's work on the nature of scientific revolutions helps prevent the inordinate emphasis on biography that the Italian director Luca Ronconi laments (see this book's conclusion) and keeps the focus on historical forces and the progression of science. It helps to contextualize Galileo's struggles if one sees him as the representation of a new way of thinking that is up against not only entrenched and persistent modes of thought that need to be replaced or overthrown but also power bases such as the institution of the church that stand to lose a lot if the new thought is right. The conflict between science and the church in Galileo epitomizes Kuhn's argument that the only way science progresses is by one paradigm replacing another; it illustrates the inability of two conflicting paradigms to coexist.<sup>38</sup> We see this same idea dramatized in other science plays like *After Darwin* and *Arcadia*, although the latter cleverly subverts Kuhn's notion by having the representatives of the two clashing systems (Newtonian and Einsteinian) cohabit the stage toward the end of the play—two hundred years apart, yet all clothed in the same Regency garb. Characteristically, Stoppard employs theatricality as well as textuality to convey such a theme; a simple matter of staging instantly conveys a complex idea.

### The Influence of Brecht on Science Playwriting

The themes of science clashing with religion and the scientist as over-reacher can be found most powerfully embodied in the figure of Brecht's Little Monk, who is caught between the desire to pursue science and the fear of what it will do to people like his peasant parents and their faith. He argues with Galileo about the uses of science and the aims of the scientist. Why not simply limit what you investigate? You could still pursue science but focus mainly on applied science with a direct bearing on improving people's lives through practical uses, like irrigation. Galileo retorts, "How can new machinery be evolved to domesticate the river water if we physicists are forbidden to study, discuss, and pool our findings about the greatest machinery of all, the machinery of the heavenly bodies?"<sup>39</sup> Is it overreaching to study these things?

These questions inform two interesting plays written in the aftermath of World War II, *E = mc<sup>2</sup>* by Hallie Flanagan Davis and *Uranium 235* by Ewan MacColl, that will be discussed in chapter 3. Both of these plays ask the audience to weigh the pros and cons of nuclear physics. They first educate the audience about the science in an entertaining style, then dramatically end by placing the decision about how to use nuclear energy in the audience's hands: Which path will we choose? it's up to us. Both the mode of the questioning and the question itself are deeply influenced by Brecht.

*The Skin of Our Teeth*, by Thornton Wilder, also bears the imprint of Brecht in terms of both theatricality and themes, and provides an example of how a play can contain very little actual scientific detail yet still engage the ramifications of science in profound ways. Wilder's deeply antiwar play, premiered during "the darkest years" of World War II, takes a romp through the history of humanity and a bleak look at scientific progress and discovery. The Thomas Edison-like scientist-inventor, Mr. Antrobus, "is busy inventing the wheel, the alphabet, and the answer to ten times ten while the rest of the world struggles to survive an ice age, a war, murders, and general social breakdown."<sup>40</sup> Antrobus "has nothing to offer in such dire straits; science cannot help us in times of global catastrophe."<sup>41</sup> Instead, we need to survive through ordinary people's instinct for survival "by the skin of our teeth," the ingenuity, "resourcefulness and endurance of the ordinary individual multiplied over the whole population. This, Wilder believes, is how the human race has hitherto escaped extinction and will perhaps continue to do so."<sup>42</sup>

As with so many of the other midcentury American plays under discussion in this book, such as Flanagan Davis's  $E = mc^2$ , Wilder's model is epic theater, and he stylizes his work accordingly. The play is highly meta-theatrical and eschews identification through the device of Sabrina, the maid, whose wry, funny, and unemotional commentary, addressed directly to the audience, serves to preempt any temptation to empathy on its part. She constantly reminds the audience that she is an actress and they are in a theater and keeps us informed about how the performance is going (not well) and what is happening backstage (mayhem). She is, in a sense, the personification of Brecht's idea of *Verfremdungseffekt* (the alienation effect), by which audiences are prevented from identifying too closely with a character and are kept at an emotional distance. Alienation (or, more accurately translated, "making strange the familiar") is one of the cornerstones of Brecht's epic theater, his alternative to what he called (pejoratively) the "dramatic" or mainstream theater. Although one must be quite clear about the distinction between Wilder's agenda and Brecht's—the latter using alienation for directly political purposes—other Brechtian devices in *The Skin of Our Teeth* include an episodic structure, a plot that is epic in its scope (spanning the dawn of time to the present), constant interruptions, direct address to the audience (including invitations to them to go outside and smoke while the actors rehearse a scene), and the use of projections and other means of announcing and commenting on the action visually. It should be noted that all this adds up to a highly visual and entertaining theatrical feast, not at all textbook drama.

In the play's final act, time and philosophy are interwoven visually as a procession of philosophers comes forward, each bearing a number that corresponds to a specific time on the clock (itself a scientific construct). The conceit is that each one represents a point of our collective progression. Yet it is an incomplete clock; it has only the hours of darkness (or late morning, depending on your interpretation), with Spinoza as nine o'clock, Plato as ten, Aristotle as eleven, and the Bible (Genesis) as twelve. Whether we are to view the Word of God as the origination (in the beginning was the Word) or the culmination of human progress is not made clear. In the midst of arranging and explaining all this to the audience, an actor tells us that if all had gone according to plan, the stage would have been set up to mimic the solar system; unfortunately, the chorus that was supposed to carry this out has fallen ill, "so you'll have to imagine them singing in this scene. Saturn sings from the orchestra pit down here. The Moon is way up there. And Mars with a red lantern in

his hand, stands in the aisle over there—Tz-tz-tz. It's too bad; it all makes a very fine effect."<sup>43</sup>

There is a similar unperformed stage-as-cosmos scene in a later play that has only recently come to light: Tom Stoppard's *Galileo*, the manuscript of which is housed in the Ransom Humanities Center, was published in 2003, with a brief introduction by the playwright.<sup>44</sup> It is Stoppard's only "post-Rosguil [*Rosencrantz and Guildenstern are Dead*] stage play never to be produced," and it started out as a screenplay commissioned by Paramount Pictures.<sup>45</sup> Stoppard writes in his introduction to the published text: "I had the brilliant idea of turning it into a play to be staged at the London Planetarium, where the audience would see what Galileo was looking at—the 'new star,' the moon's dark luminescence, Jupiter's moons, the sunspots, the famous comet. The Planetarium people kindly showed me the set-up. But the brilliant idea turned out to be hopeless. Lighting the actors, even if one could and even if they could have found room to act in under the huge projector, would have washed out the night sky. So I gave up."<sup>46</sup>

In his book on Stoppard's plays, the theater historian John Fleming notes that "Stoppard deliberately crafted his script for the Planetarium because it had a projector that could create various sky effects appropriate to Galileo's story."<sup>47</sup> One can see why, despite its technical capabilities, the Planetarium did not consider the project feasible. The play requires "twenty-seven speaking roles (fifteen of which can be doubled) and at least ten supernumeraries."<sup>48</sup> At one point in the play the church officially censures and prohibits discussion of Copernican theory, and for this scene of the reading of the censure "Stoppard sought a difficult stage effect: 'As the Secretary reads, the eleven theologians are gently lifted into the air in a slow arc, like the arc the earth makes round the run [*sic*], and at the same time, they gently rotate as the earth does on its journey."<sup>49</sup> The theologians then "pass out of view" after the reading is finished. The first act was supposed to end with similarly spectacular effects: "with the dome of the Planetarium showing the night sky as it appears to the naked eye and as it appears through a telescope, thereby breaking down some of the mysteries of the universe, showing things not possible in the Aristotelian conception of the heavens."<sup>50</sup>

It is interesting that no audience has yet seen these accomplished playwrights' cosmic visions enacted; Wilder's scene is deliberately withheld and left to the imagination as part of his Brechtian ploy, and Stoppard's has simply never been performed. Yet these scenes show both playwrights devising similar ways of making the audience see the stage as the universe.

And both are keenly aware of the importance of theatricality; their plays reject straight, unexamined realism, or the illusion of it. We have already seen this in the kinds of techniques and devices Wilder uses. Stoppard's use of theatricality would have come primarily from a single effect of his choice of venue: "A bulky machine, the Planetarium's projector is a permanent fixture in the center of the intended semicircular playing space. Thus, Stoppard felt that it would sabotage any attempt at illusionism."<sup>51</sup> Having the audience see a play in a planetarium, with its vast, airy space and soaring night skies, is already such a radical departure from the norms of theatergoing that one would think that the choice of venue alone would have sufficed to provide the desired degree of self-consciousness. The additional presence of the large projector would have made it impossible for the audience to lose itself in the action—modern technology constantly intruding itself on, indeed at the center of, the action of this Renaissance setting.

### The Scientist as Underreacher

There is another sense in which *Galileo* serves as a watershed science play. Since *Galileo* (and the end of World War II) many science plays have explored physics and its consequences, with one theme in particular coming to the fore: the impossibility of "underreaching," or taking back knowledge once it is attained. In *Galileo*, the church is threatened by scientific advances; it is a problem of two institutions, two belief systems, clashing. Not surprisingly, ever since the bombing of Hiroshima and Nagasaki, the emphasis in science plays has shifted dramatically away from warring institutions to the survival of the planet. After *Galileo*, we see many science plays exploring the idea of limiting or indeed reversing scientific knowledge and its acquisition—underreaching rather than the old Faustian notion of overreaching.

In Friedrich Dürrenmatt's play *The Physicists* (1962), the focus of further analysis in chapter 3, an apparently insane physicist who calls himself Möbius has stumbled on the theory of everything and fears how it may be used in the wrong hands. He shuts himself up in an asylum pretending to be mad in the self-sacrificial hope that this act will "unknow" his discovery. "We have to take back our knowledge and I have taken it back," he says, explaining how he has destroyed his manuscripts—only to be outwitted by the evil doctor who runs the asylum and who has secretly

copied the material before it was destroyed. In the end, the defeated scientist must admit that “what was once thought can never be unthought.”<sup>52</sup>

A similar predicament dogs Leo Lehrer, the protagonist of Howard Brenton’s play *The Genius* (to be discussed in depth in chapter 3). We may remember in *Doctor Faustus* that although Faustus frequently shows some anguish and doubt over selling his soul, he refuses several chances to repent. By contrast, both Möbius and Lehrer see that they are on the path to hell and try to repent. This seems consistent with other modern science plays, as the scientists tend to be guilt-ridden and repentant about endangering humanity through their discoveries. Yet the crux of these plays is the very notion that is central to *Doctor Faustus*—that there are limits to human knowledge, and stepping over those boundaries leads to individual and mass destruction.

Another physics play that suggests the theme of “underreaching” is Frayn’s *Copenhagen*; the theme of trying to take back knowledge is prominent here, too. The scientists in the plays by Dürrenmatt and Brenton both want to unthink thoughts they have had, discoveries they have made. In *Copenhagen*, we are given three possible reasons why the German physicist Werner Heisenberg failed to lead his country to develop atomic weapons before the Allies. In one scenario, Heisenberg simply makes an incorrect calculation of the critical mass needed. But this would be a strange error in so brilliant a physicist. So, Frayn suggests in the play’s most controversial scenario, perhaps Heisenberg deliberately did not do the calculation because he knew—just like Möbius and Leo Lehrer—what it might lead to. This Heisenberg seems heroic in his self-sacrifice, his acceptance of the idea of limits to human knowledge.

### From Conscious Theatricality to Performativity

Since Brecht’s *Galileo*, there has been both a surge of new science playwriting and a distinct change in the way such plays are written and performed. This has to do with the idea of performativity and specifically with the integration of speech-act-driven dialogue into the contemporary science play.

Performativity emerged and evolved from its origins in speech-act theory as set forth by J. L. Austin in *How to Do Things with Words*, which “reminded us, especially, how vital to any successful act of communication are the interpretive conventions that govern it, and to which (to some degree intentionally) all parties to the act of communication must

agree.”<sup>53</sup> In this seminal book, Austin proposed different categories of “speech-acts,” depending on what action they accomplish in their utterance. The classic example of a speech act is the traditional Christian marriage ceremony’s exchange of vows. The marriage itself is performative in that it is achieved entirely through the language of the simple vows “I do.” Austin’s theories have interested a wide range of literary critics beyond the field of discourse analysis, some of whom have revisited the ambiguities and gaps in his original work in relation to literature. Both J. Hillis Miller and Annabel Patterson, for instance, have noted Austin’s omission of literary speech acts. Patterson observes that “while Austin himself excluded literary communications from the category of speech acts, as being non-serious or as pretenses from which no action follows, others have subsequently felt that the line between ‘real’ and ‘literary’ communications cannot be so sharply drawn. It seems clear that the act of promising, for example, is logically indistinguishable from that of declaring one’s intention, through the invocation of a Muse, to deliver an epic poem.”<sup>54</sup> Contemporary science plays seem to be powerful examples of how fraught the boundary is between the “real” and the imaginary, promised, communication. The concreteness of the scientific enterprise, with its basis in ocular proof and known facts, vies with the nebulous, internal, and often subconscious motives and intentions of the scientist. The tension thus created makes for electrifying drama, despite the often heavy textual emphasis of science plays.

Let us take the play *Copenhagen* as an example. At first glance, a play like *Copenhagen* hardly seems concerned with performativity, let alone conventional theatrical methods. It seems to privilege textuality over theatricality in a script that, startlingly, lacks any stage directions except intradialogic speech acts (such as when Heisenberg indicates, “I crunch over the familiar gravel,” or tells us that he is looking at Bohr and Margrethe). The lack of extradialogic stage directions seems to bear out the textual emphasis, as does the requirement that the actors mime opening doors and other actions that remove the play from the realistic performance sphere. Yet on stage, particularly under Michael Blakemore’s direction and with Peter J. Davison’s design and Mark Henderson’s lighting, the play demonstrates its dependence on performance for the fullest exploration and conveyance of its central scientific metaphor. This is also the case with *After Darwin*; like *Copenhagen*, it is a heavily verbal play, yet it too relies on performance not only to demonstrate its scientific ideas but to enact them in such a way that the science is both performed for us and transformed into metaphor on the stage.

Just what is the notion of “performativity,” and how is it relevant to science on stage? As Alisa Solomon, Jonathan Culler, and others have pointed out, the concept is frequently abused and misunderstood:

In recent years, “performativity” has become the buzzword of postmodern academic theory, invoked to describe the constructedness of a range of “marginalized identities” or “subject positions”: the particular phrase “gender performativity” has already become a hackneyed and much misused mantra of critical writing, its meaning becoming more diffuse even as the term acquires more buzz. As it has been seized by the critical industry, “performativity” has been uprooted from its origins in J. L. Austin’s work on the relationship between utterance and action, and has been whisked into the realm of theatrical metaphor. There, the performative—“the reiterative and citational practice by which discourse produces the effects that it names”—has been translated, like Bottom in his ass’s head, into a fancy synonym for performance.<sup>55</sup>

It is important to distinguish the performativity of contemporary science plays like *Copenhagen* from the simple demonstration of a scientific principle that can be found, for instance, in Brecht’s *Galileo*, when, Galileo uses the stage to illustrate for Andrea his theory of the heliocentric universe in the play’s opening scene, putting the iron washstand in the middle of the room to represent the sun and placing Andrea in a chair next to it to act as the earth. When Galileo picks up Andrea, chair and all, and moves him to the other side of the washstand, he neatly shows him (and the audience) how the Copernican theory works. A similar type of enactment, or literalization, occurs later, in the Street Scene (scene 9), as the Spinner spins around endlessly, mimicking the earth’s movement; similarly, the Ballad Singer’s wife dances around him, “illustrating the motion of the earth.”<sup>56</sup> In both cases, science is performed, but the demonstration is purely didactic and not integral to the structure of the play; nor does it serve a larger thematic purpose.

By contrast, both *Copenhagen* and *After Darwin* are performative in the classic Austinian sense that they do the thing they talk about; they bring into being a material enactment of an abstract idea under discussion through a speech act. Put simply, they reflect “how to do things with words”: in this case, words such as “evolution” and “the uncertainty principle.” Much of the dialogue is in the present tense and describes actions, thoughts, or intentions in such a way as to enact or bring them into being. This also applies to the science in the play. Essentially, the dialogue of *Copenhagen* is one long speech act that performs the uncertainty principle

in a way that only the liveness and immediacy of theater can bring about. Through their corresponding movement and speech acts the actors demonstrate that exact measurement of position and momentum is not possible, because the observer affects the act of measurement. The dialogue does not merely reflect the principle; it makes it happen, with the audience participating in that act of creation. This is why plays like *Oxygen* and *Proof* are not typical of the most successful science plays; the science (or in *Proof*'s case, the math) is superficially imposed on the play, so that the science and the theatricality bear no relation to each other and are not interdependent.

Speech-act theory is also relevant to science plays for another reason. J. Hillis Miller points out what he calls a “metalanguage” operating in Austin’s seminal book: “Austin has a habit of commenting on what he is doing, to some degree from the outside, as though he were two persons, the one doing it and the other watching the first doing it.”<sup>57</sup> Another term for this is Heisenberg’s uncertainty principle, which figures centrally in several recent science plays. While an exhaustive examination of the link between speech-act theory and theater is not possible here, the aim is to suggest the ways in which the two interact and complement one another, perhaps as a point for further exploration.

### **Music and Light: Science Musicals, Operas, Farces, and Comedies**

In recent years science plays have diversified into a wonderful array of styles and modes, and no discussion of the tradition of science playwriting would be complete without a mention of the significant number of new musicals and operas, as well as several farces and comedies, that deal with science. Most notable among these is *Fermat’s Last Tango*, a musical that depicts Princeton professor Andrew Wiles, the English mathematician who proved Fermat’s elusive theorem in 1992.<sup>58</sup> Like *Faustus*, he is pushing against the known boundaries of knowledge, in this case within his own field of mathematics. As the show opens, we see Wiles (called Professor Kean in the play)—refreshingly portrayed not as a stereotypical “geeky” mathematics professor, but endearingly genuine and “normal”—jubilant at having cracked Fermat’s theorem, and vowing to his wife to start leading an ordinary life again. He is then devastated to learn from Fermat, who visits him in his study in a vision, that his intricate proof is flawed. Fermat leads him to the mathematical afterlife (the “Aftermath”),

where Kean engages in witty exchanges with great mathematicians of the past: Pythagoras, Euclid, Gauss, and Newton. These eminent mathematicians come to Kean's aid in the face of Fermat's taunts that he will never iron out the "big fat hole" in his proof. The musical is notable for its successful integration of a surprising amount of "real" mathematics with a charming and witty score.

Several other examples exist of this sort of science and theater event that combines music with science in a lighter spirit than the straight science play (see appendix). Music has its own mathematics, and it has proved to be a powerful element in theater pieces that engage science and medicine. This is true of the collaborative work of director Jean-François Peyret and neuroscientists in France in which music features prominently and enhances the experience of the audience's sensing of the science (see conclusion), and also in *Viewing the Instruments*, a recent "medical and musical collaboration" between musician-composer Philip Parr, gastroenterologist Dr. Peter Isaacs, and artist Jane Wildgoose. This piece uses Marais's brief composition *Le Tableau de l'opération de la Taille* (1725) as the starting point for musing on the experience of the patient undergoing gallstone removal surgery, from the eighteenth century to the present.

### The Anatomy Theater and the Science of Performance

*Viewing the Instruments*, which was actually set in an old anatomy theater, raises the point that the interaction of science and theater is not confined to the stage. There is a tradition of "performing" science outside the formal venue of the theater: one thinks especially of the anatomical theater of the eighteenth and nineteenth centuries, with the literal staging of surgical procedures and scientific experimentation creating "a highly theatrical event."<sup>59</sup> This goes back even further. "Although dissection of human beings for anatomical study was revived in the late Middle Ages after a centuries-long hiatus," writes Mary G. Winkler, "the modern science of anatomy was born in the Renaissance."<sup>60</sup> Then, as David Knight notes, "in the anatomy theaters of Renaissance Europe, professors became performers."<sup>61</sup> It has been shown that the methodology of the anatomical theater was quite deliberately and self-consciously modeled on theatrical performance: "experiments that always worked" were rehearsed beforehand until they were sure to succeed, then "performed" as if the audience—which had paid admission for the show—were witnessing an actual experiment that had not been seen or tested before.<sup>62</sup> What attracted

audiences to “the bloody sight of a body cut open and dismembered”?<sup>63</sup> Perhaps it was the chance to witness a theatricalized probing of “the essence of humanity. . . . Dissection, like the dramatic theater, offered visual spectacle with a verbal lesson: Listener, learn thyself!”<sup>64</sup>

Another trend in the interaction of science and the stage can be found in the “scientificization” of theater by various practitioners who have developed theories and approaches to performance that approximate scientific models. This is especially true of Brook, Stanislavsky, Brecht, Meyerhold, Grotowski, and Boal, all of whom have set down and codified their ideas and strategies about performance. Systems like Brecht’s epic theater, Meyerhold’s highly stylized biomechanics and Stanislavsky’s “Method” of naturalistic acting all to some extent borrow the aura of authority vested in science.<sup>65</sup> This also extends beyond acting to areas like lighting and scenery (Adolphe Appia and Harley Granville-Barker, for example). Brecht had always been fascinated by science, though, as we know, his relationship to it became increasingly fraught as he was developing his later work such as *Galileo* during the war and after. He presents his theories about Epic Theater in a way approximating a scientific enterprise or experiment. The focus is on the results he wants to achieve in the spectator; the actor and the stage are mere conduits. Meyerhold devised biomechanics in a similar way but with a much greater concentration on the performer, and specifically the performer’s body. His understanding of the body’s physiology draws heavily on science.

Even the way in which theater scholars are trained to research and publish their work derives from and emulates the scientific model of hypothesis, investigation, and evidence to substantiate one’s ideas. In this regard, theater historians and practitioners are like artists in other media who have also attempted to turn their theories into a science. For example, a group of painters in the late nineteenth century closely related to the pointillists devised an elaborate system assigning desired emotional response to specific colors. The symbolists believed one could achieve a sort of synesthesia through the scientific analysis of the relationships between color, sound, and language. Bergson came up with a “science” of laughter. These developments all coincide with the rise of positivism (especially its direct impact on naturalism in the theater through Zola’s transmission of the ideas of Comte, Sainte-Beuve, and Taine) and the authority of science during the late nineteenth and early twentieth centuries, and also with the development of new sciences such as psychology and the other social sciences. Havelock Ellis, Freud, and others began to approach sex from a more scientific angle, for instance. One might de-

duce, then, that all these nonscientists were seeking to legitimize controversial or marginalized subjects by lending them the authority of science. This, in turn, reflects the increasing prominence and status of science within culture.

### Conclusion

Looking back over the tradition of science plays, we can trace specific currents in the emergence of the genre. Shaw, Brecht, Dürrenmatt, and other earlier playwrights take concrete problems and issues as the stuff of the scientific drama. Often, they are primarily concerned with the moral role of the doctor or scientist, the public responsibility as well as the personal pursuit of truth.<sup>66</sup> Many of the more recent plays, however, enlarge that pursuit by exploring other concepts, such as moral ambiguity and the unreliability of memory. In an age of remarkable advances in scientific knowledge, from mapping the human genome to elucidating brain mechanisms, contemporary playwrights seem paradoxically attracted to some of the scientific and mathematical principles that seem most mysterious and unstable, like uncertainty in quantum physics, chaos theory, and the neuroscientific basis of perception and memory. Plays about science tend to be quintessentially postmodern, in this respect as well as in their use of the stage. This is another aspect of science and theater that *Science on Stage* investigates.

There is no question, then, that science and theater have been interacting for aeons. But over the centuries, the *way* in which science has figured in plays has changed profoundly, and it is this aspect, as well as the sheer number of plays that deal with science, that is most interesting and significant. From Marlowe to the mid-twentieth century, we observe several tendencies that have helped to define the tradition. One is a “conscious theatricality” that keeps the audience aware of the connection between the form of the play and its content—between the theater and the science. This reaches a new level in the hands of Brecht, whose fusion of politically inflected scientific content and ideas with a theatrical form that helps to convey them serves as a milestone in the development of science playwriting. This in turn leads to a tendency to experiment with formal innovations that culminates in the newer science plays of the late twentieth and early twenty-first century.

Science plays have also traditionally shown an interest in depicting the conflicts inherent in scientific advancement, whether on the micro-

level of interpersonal relationships or on the macro-level of clashing institutions and systems of belief. Finally, a concern with “real” and substantive science over fantasy and over love interests is also a hallmark of science plays. Whatever the scientific field, the best science playwrights show a genuine familiarity with the ideas they are borrowing, a commitment to accuracy, and a willingness to risk departing from standard theatrical fare. Such flying in the face of received ideas about what audiences will and will not tolerate in the theater has often proved unexpectedly successful. The next chapter will explore the possible reasons for the popularity of “science plays.”