The Last Waltz: Tom Stoppard's Poetics of Science

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The argument between Science and Poetry as spheres of action and of sensibility is part of the Romantic inheritance. No doubt it found nourishment in that earlier argument between philosophy and poetry that Plato, for one, has still to answer for. But it took modern shape when "Natural Philosophy" evolved into "Science"; and Poetry (or Art in general) slipped into the sacred vestments that had been the exclusive wardrobe of Religion. So, Blake lambasted Newton; Dr. Frankenstein was progressively misread as the Monster; Thomas Arnold of Rugby declared, "Rather than have [Physical Science] the principal thing in my son's mind, I would gladly have him think the sun went round the earth, and the stars were so many spangles set in the bright blue firmament"; Wittgenstein declared, "Man has to awaken to wonder. . . Science is a way of sending him to sleep again"; and Raymond Chandler, trying to be conciliatory, wrote, "There are two kinds of truth; the truth that lights the way and the truth that warms the heart. The first of these is science, and the second is art."[1] In the university world one naturally deplores the argument, but acknowledges it in various ways, not least in that widespread offering for non-scientists called "Physics for Poets"—a kind of joke (not the course, but the title) that everyone is expected to get. The real joke is that it is getting harder every day to tell some kinds of science from far-out poetry—a difficulty that has not escaped the notice of that very noticing and intellectually omnivorous playwright, Tom Stoppard.

One thing I find interesting about Stoppard is how he has taken up this argument—so often lulled in Chandler's fashion, by assigning science and poetry to separate-but-equal (and equally necessary) spheres—and turned it into a dialogue that gets somewhere in coping with deeper questions about being and acting in the world, matters that trouble him more than one might have thought from the brilliance and buoyancy of his early comedy. And what I find equally interesting, from the point of view of playmaking, is how Stoppard embeds conceptions that have a scientific provenance, not simply in the talk, but in the shape and structure, the very bones and sinews, of some of his later plays. In this he is not altogether alone—witness Michael Frayn's laudable play *Copenhagen* (1998). And I dare say a case could be made that Sophocles and Beckett do something not so different with the scientific thinking of their respective times.[2]

As to the dialogue between science and poetry getting somewhere important—I think that happens for Stoppard in *Arcadia*, in my view his masterpiece so far; with *The Invention of Love* serving as a kind of elegiac coda, in which what is intractable in our divisions renews its claim, after the brief Edenic moment in the earlier play where everything comes together in the dance that brings Arcadia to a close.

The opening of *The Invention of Love* suggests the difficulty. Stoppard's play is principally about A. E. Housman, classical scholar and *fin de siècle* poet-author of *A Shropshire Lad*; and it opens on the banks of the River Styx where Housman, now old, is waiting to cross, and Charon the Boatman arrives to pick up his fare.

> Charon: A poet and a scholar is what I was told.
> AEH: I think that must be me.
> Charon: Both of them?
> AEH: I'm afraid so.
> Charon: It sounded like two different people.
> AEH: I know.
> Charon: [still suspicious] Give him a minute.
> AEH: To collect myself.

—Housman here indulging in that kind of play on words Stoppard so fancies, much easier said than done.[3]

Division takes another form with the appearance of the young Housman of Oxford student days, being rowed on the river with his friends (now not the Styx, but the Thames or Isis, overlaid as it were); and the two Housmans, young and old, eventually find themselves in conversation. Housman the classical scholar—one of the all-time masters of decapitation by footnote—practiced in that branch of the trade called textual criticism; which, as he explains to the young Housman in the play, is the means whereby

> . . . sense is made out of nonsense in a poem that has been read continuously since it was first misprinted four hundred years ago. A small victory over ignorance and error. A scrap of knowledge to add to our stock. What does this remind you of? 4 Science, of course. Textual criticism is a science whose subject is literature, as botany is the science of flowers and zoology of animals and geology of rocks. (38)

The old Housman (AEH for convenience) has in the long run repressed the poet in favor of the textual scholar—in contrast to his irrepressible former contemporary in the play, Oscar Wilde, a kind of anti-self or alternative life in both love and art. When the young Housman, who could go either way, asks with respect to the callings of poet and scholar, "Can't one be both?," AEH replies, "No. Not of the first rank." It is as if the two avenues to value and truth limit rather than complement each other. Housman himself, out

of the play, said on a formal occasion, "Literature is so alien from science that the literary temper in himself is a peril against which the scholar must stand on his guard. The aim of science is the discovery of truth, while the aim of literature is the production of pleasure; and the two aims are not merely distinct but often incompatible, so that large departments of literature are also departments of lying."[4]

I hope it will not spoil anyone's appetite for truth or for pleasure to say that Stoppard's plays are indubitably literature—in the broad sense, poetry. The two Stoppard plays in which science enters the action, and not only gets talked about but shapes and organizes the imaginative world, are the espionage thriller, *Hapgood* (1988), which had only a qualified success with its initial audiences and critics; and his instant masterpiece *Arcadia* (1993). *Arcadia* focuses on the early nineteenth century, the age of Byron, of the taste for Romantic landscape and the improved Newcomen steam engine; while *The Invention of Love* takes on the Victorian *fin de siècle* and the age of Wilde. But *Arcadia* also moves between two times, in effect switching between the early nineteenth century and the later twentieth, and coupling unnaturally the earlier birth of thermodynamics and cosmic pessimism with contemporary ideas about "complexity"— Nature's unexpected aptitude for plotting irregularity by the numbers, for pursuing randomness into structure, and for seeing the world (fractally) in a grain of sand. Or as some might argue of such a phenomena-saving account of the natural world, a belated Romantic science.

These are not the first Stoppard plays to touch on science. In *Jumpers* (1972), for example, Zeno's paradoxes of motion get a workout by the moral philosopher George Moore (not the George Moore); and George's wife Dorothy, a musical comedy star, is terribly disturbed by the technological triumph of British astronauts landing on the moon—and not just because of their reprehensible behavior. It is because of how being on the moon changes the way one has to look at Earth, and what that does to poetry. Pleading with George for aid and comfort, she tells him,

> Unfortunately, I don't feel so good today. . . . It'll be just you and me under that old-fashioned, silvery harvest moon, occasionally blue, jumped over by cows and coupleted by Junes, invariably shining on the one I love; well-known in Carolina, much loved in Allegheny, familiar in Vermont; *(the screw turning in her)* Keats's bloody moon!—for what has made the sage or poet write but the fair paradise of nature's light— And *Milton's* bloody moon! rising in clouded majesty, at length apparent queen, unveiled her peerless light and o'er the dark her silver mantle threw—And Shelley's sodding maiden, with white fire laden, whom mortals call the— *(weeping)* Oh yes, things were in place then!

> *(She weeps on GEORGE'S uncomprehending heart. . . .)*[5]

Rosencrantz and Guildenstern Are Dead (1966)—Stoppard's first great success—begins, notoriously, with a statistical curiosity, a coin toss that has produced ninety-two heads in a row; not impossible, the probability for tails on the ninety-third toss still being no better than fifty-fifty. Nevertheless, it suggests there is something odd in the state of Denmark. What is odd, of course, is that there is a plot in charge, the plot of Hamlet; and that raises the issue of moral responsibility in a determined world. It is significant that Stoppard's plot does allow for moral choice (the business with the letter), though his protagonists choose, predictably, wrong.

Despite such intimations of probabilistics and rocket science, science itself doesn't really come into the foreground before *Hapgood*. Before that venture, what does often come into play are borrowings from moral philosophy, aesthetic theory, philosophy of language, even metaphysics; but the only science actually at work in his dramaturgy is cognitive science, and that, it would seem, by intellectual predisposition rather than disciplinary engagement. From the beginning, Stoppard's playwriting game was cognitive uncertainty, inflicted on the audience, for its pleasure. It underlies his wit, in word or action, but it falls in beautifully with the counter-intuitive paradoxes of quantum behavior and observer agency that he later makes much of. The game, as he has played it from the beginning, incorporates a kind of systematic relativity, unfixing the standpoint of the observer, and withholding or implausibly doubling the cognitive frame of reference. In *Rosencrantz and Guildenstern Are Dead*, he unfixes the observer by exchanging on-stage and off-stage as the scene of the action. We see Prince Hamlet from the wings, as it were, through the eyes of these attendant lords.

Stoppard delights in that comedy of misconstruing where characters or audience are led to take one thing for another; where the frame of reference is missing, or concealed, so that the perceived phenomena invites misinterpretation, or just bewilders, or offers two equally plausible explanations or solutions, like a square root. In *Hapgood*, Joseph Kerner, a defected Russian physicist and possible triple or quadruple agent, asks Blair, the classically-educated British intelligence chief, "what is the square root of sixteen?"

> Blair: Is this a trick question?
> Kerner: For you, probably.
> Blair: Four, then.
> Kerner: Correct. But also minus four. Two correct answers. Positive and negative.[6]

Stoppard's openings notoriously fail to define the stage, as all respectable plays do first thing. Witness the opening of *Jumpers*. With a failed spot-lit performance by a star of the musical theater, and a striptease by a lady on a swing flashing between darkness and darkness, the scene is not likely to be read as taking place in a philosopher's living room. Nor will we understand the opening scene of marital collapse in *The Real Thing* (1982) as belonging to a play within the play until

later. At the broad end, Stoppard delights in the hoary device of the *quiproquo*, where the interlocutors mutually mistake what the other is talking about—as when George Moore in *Jumpers*, whose rabbit has gone missing, talks to Crouch the janitor, who has witnessed a murder the night before, and thinks Moore's wife Dotty is involved:

> George: Do you realize she's in there now, eating him?
> Crouch *(pause):* You mean—raw?
> George *(crossly):* No, of course not!—cooked—with gravy and mashed potatoes.
> Crouch *(pause):* I thought she was on the mend, sir. (76-77)

Language—which so depends on discursive context, where word and syntax are so temptingly polymorphous perverse—is of course Stoppard's prime instrument for keeping us thinking and laughing, for laughter curiously is a normal response to perceiving duplicity. On the level of action something similar can happen. As George Moore remarks, again in Jumpers, where the observable facts of the head-of-department's visits to Dotty Moore can be construed with equal plausibility as medical or extra-conjugal: "Meeting a friend in a corridor, Wittgenstein said: 'Tell me, why do people always say it was natural for men to assume that the sun went round the earth rather than that the earth was rotating?' His friend said, 'Well, obviously, because it just looks as if the sun is going round the earth.' To which the philosopher replied, 'Well, what would it have looked like if it had looked as if the earth was rotating?'" Such Einsteinian thinking moves him to the more radical thought, "if one can no longer believe that a twelve-inch ruler is always a foot long, how can one be sure of relatively less certain propositions, such as that God made the Heaven and the Earth . . . " (75).

Stoppard says he first came to the plot of *Hapgood* via mathematics and physics; but the fact is that the unstable world of cold-war espionage, like an Escher tile design that can flicker between rabbits and ducks, attracted Stoppard much earlier (1966), when he wrote a screenplay called *Neutral Ground*, whose main character, Philo, is a latter-day Philoctetes, in a plot, says Stoppard, concocted "out of Sophocles and John Le Carré."[7] Later (1982) he wrote a radio play, *The Dog It Was That Died*, where Purvis, a double agent, tries to commit suicide because he has lost track of which side he is on. Nevertheless, what led him to *Hapgood,* Stoppard says, was an idea that "had to do with mathematics," which then took him to the mathematics of physics, "grounded on uncertainties." Thinking "there's a play in that," but not finding it, "[i]n the end I realized that what I was after was something which any first-year physics student is familiar with, namely quantum mechanics. So I started reading about that."[8] The published play carries an epigraph from the late Richard P. Feynman on the quantum behavior of light. As Stoppard tells it, "I was fascinated by the mystery which lies in the foundation of the observable world, of which the most familiar example is the wave/particle duality of light. I thought it was a good metaphor for human personality. The language of

espionage lends itself to this duality—think of the double agent" (Delaney 180).

The plot of *Hapgood* is very complicated; as an espionage problem it has less to do with who is the mole in British intelligence than with how he does what he does. It opens in the changing room of a swimming baths with something like an animated shell game, the row of booths serving as the shells and a radioactively tagged and bleeped briefcase (one among several look-alikes) serving as the pea. The situation, an approved delivery, is a trap, designed to expose Joseph Kerner—a Russian physicist and spy now working on Star Wars and for British Intelligence—as still really working for the Russians; not a double, so to speak, but a triple. But the observers who set the trap, British and American agents, turn out to be the dupes, for the pea is somehow interfered with in the shuffle, and the trap is neutralized. Kerner it seems is clean; and the solution to the puzzle of how it was done (which Kerner likens to the famous problem of the seven bridges of Koenigsberg, his and Kant's native town: how to cross them all in a continuous path without crossing any of them twice) turns out to be twins. Otherwise—as Leonhard Euler, the great eighteenth-century Swiss mathematician had shown—there is no solution. In the *Hapgood* version, however, there is not just one set of twins, but two.

That second doubling is the hypothesis that has to be proven, to nail the real double agent, the mole, and to eliminate competing hypotheses. Several of these point to Hapgood herself, the cool and brilliant officer who plays boardless chess long distance, defends her joes (like Kerner), turns out for school rugby as a single mom, is two jumps ahead of everybody else including the CIA man who suspects her, and is an unmatched puzzle-solver. Kerner the scientist, however, is also the philosopher and indeed the poet who articulates the plot metaphors. His is the fascination with language, notably the esoteric jargon of the mirror world—safe house, sleeper, cover, blown, bug, bleep, joe. It is he who rhapsodizes on the oxymoronic complexities of quantum existence. He continues his conversation with Blair on the two correct answers to the square root of sixteen, "We're all doubles. Even you. Your cover is Bachelor of Arts first class, with an amusing incomprehension of the sciences, but you insist on laboratory standards for reality, while I insist on its artfulness" (62). He in fact has literary ambitions of his own. Liking spy stories, he contemplates writing one himself, but with a difference; and it is from his mouth that Stoppard takes his own account of the form of the plot. Stoppard said subsequent to the play, "In a normal spy thriller you contrive to delude the reader until all is revealed in the dénouement. This is the exact opposite of a scientific paper in which the dénouement—the discovery—is announced at the beginning. *Hapgood* to some extent follows this latter procedure" (Delaney 181). Kerner says it better: "If the author knows, it's rude not to tell. In science this is understood: what is interesting is to know what is happening. When I write an experiment I do not wish you to be surprised, it is not a joke.

This is why a science paper is a beautiful thing: first, here is what we will find; now here is how we find it; here is the first puzzle, here is the answer, now we can move on. This is polite. We don't save up all the puzzles to make a triumph for the author" (40). It is Kerner who explains the twins as the inspiration of a failed particle physicist in Soviet State Security; for "The particle world is the dream world of the intelligence officer. An electron can be here or there at the same moment. You can choose. It can go from here to there without going in between; it can pass through two doors at the same time, or from one door to an other by a path which is there for all to see until someone looks, and then the act of looking has made it take a different path. Its movements cannot be anticipated because it has no reasons. It defeats surveillance because when you know what it's doing you can't be certain where it is, and when you know where it is you can't be certain what it's doing: Heisenberg's uncertainty principle . . . " (40). He dismisses illustrations that show Bohr's atom as a little solar system. An electron, he says, is like a moth in an empty cathedral: "there a moment ago, it gains or loses a quantum of energy and it jumps, and at the moment of quantum jump it is like two moths, one to be here and one to stop being there; an electron is like twins, each one unique, a unique twin" (41). But if there is a master mystery in this plot, a fundamental conundrum unsolved and unsolvable by classical means, it is not the puzzle whose answer is the Russian twins, who are ordinary, not unique. Rather, it is to be sought in what Richard Feynman speaks of in the epigraph to the printed play as the experiment with two holes, the experiment with light which produces a wave pattern or a particle pattern, depending on where and how and whether you look. "The act of observing determines what's what," says Kerner. "You get what you interrogate for. And you want to know if I'm a wave or a particle" (10). In this phenomenon says Feynman, lies "the heart of quantum mechanics. In reality it contains the *only* mystery."

Actually, there is more to the plot than the ingenious demonstration that the mole is the man Ridley, Hapgood's hard-nosed number two. There is, for example, the revelation and complication that little Joe, Hapgood's child, is also Joseph Kerner's, her spy-world joe. There is Hapgood's seeming to be in a state of suspended possibility between several men, a suspense resolved by their moral choices concerning the endangerment of her son in the national interest. But the resolution of the main puzzle, the experimental verification of the Ridley-as-mole hypothesis, reaches deeper. It does so because it uses a quantum conception of personal identity to solve the physical problem of how one body could seem to be in two places at once, and how it could get from here to there without crossing the space between. The Ridley hypothesis itself, and the solution derived from the puzzle of the seven bridges of Koenigsburg, is strictly classical. That is, one Ridley couldn't do it. It takes two Ridleys to be in two places at once, or to get from here to there without an extra passage. There is no paradox of iden-

tity. But the instrument that effects the demonstration does not belong to classical physics; it is marked by the peculiar unfixing of the notion of identity that emerges in the quantum realm.

That quantum instrument is Hapgood, who becomes with weird but sufficient plausibility her own supposed twin sister, whom a Hapgood-inspired Ridley coerces, he thinks, into impersonating the *real* Hapgood, so as to allow her to be in two places at once. Hapgood Two is the wave form of Hapgood One—scatter-brained, slovenly, foul-mouthed, pliable. As she says, warning Ridley against Hapgood One while giving herself to him—his consolation prize—"I'm your dreamgirl, Ernie—Hapgood without the brains or the taste" (71).

The point, as far as it bears on identity, on the classical principle that a = a and evermore shall be so, is that Hapgood is not acting; she is not just pretending, impersonating. If she were, the audience might not believe she could get away with it. Indeed, there have been ample hints that, as her boss grumbles, "there's a little anarchist inside you" (54). Kerner says, "We're all doubles." As with the square root of sixteen, there are two correct answers, and even then, "we're not so one-or-the-other. The one who puts on the clothes in the morning is the working majority, but at night—perhaps in the moment before unconsciousness—we meet our sleeper" (62). As Stoppard said, speaking of the genesis of the play, "I was fascinated by the mystery which lies in the foundation of the observable world, of which the most familiar example is the wave/ particle duality of light. I thought it was a good metaphor for human personality."

With the physicist Joseph Kerner himself, matters are no less complicated. Kerner has in a way lost track of his working majority. Having played his part in fabricating the version of reality that forces out the Ridley twins, he is now going home, to Russia, and has come to say goodbye. "Paul," he says—meaning Blair, now Hapgood's ex-boss—"Paul thinks I was a triple, but I was definitely not, I was past that, quadruple at least, maybe quintuple." And a shocked Hapgood realizes, "They found out about Joe, didn't they? They turned you back again." Which means, in taking part in the Ridley charade, "You made up the truth" (76). But then as Kerner starts to leave, Hapgood despairing—"How can you go? she says. *"How can you?*"—his interest is snagged by the beginnings of the Rugby game. When she glances behind her, she finds that *"Kerner is still there*," observing, caught up in the action on the field; and she *"comes alive.*" Does he go, does he stay? Will the quantum Joseph Kerner jump, "one to be there, one to stop being here"? Who can say. In a quantum account of human character, to observe is never innocent, and prediction is a mug's game.

The third scene of *Arcadia* is set in the schoolroom of a very large country house in 1808, where Septimus Hodge, recent Cambridge graduate in mathematics and natural philos-

ophy, is giving instruction to his immensely talented thirteen-year old pupil, Thomasina Coverly, daughter of the house. Thomasina is engaged in an exercise of reverse translation, though she doesn't know it yet. She is turning Latin verses of Septimus's providing into English, and *having some difficulty:*

> Thomasina*: Solio insessa . . . in igne . . .* seated on a throne . . . in the fire . . . and also on a ship . . . *sedebat regina . . .* sat the queen . . . the wind smelling sweetly . . . *purpureis velis . . .* by, with or from purple sails . . . was like to— something—by, with or from lovers—oh, *Septimus!—musica tibiarum imperabat* . . . music of pipes commanded . . .
> Septimus: 'Ruled' is better.
> Thomasina: . . . the silver oars—exciting the ocean—as if—as if—amorous—
> Septimus: That is very good. . . .
> Thomasina: *Regina reclinabat . . .* the queen—was reclining—*praeter dscriptionem*—indescribably—in a golden tent . . . like Venus and yet more—
> Septimus: Try to put some poetry into it.
> Thomasina: How can I if there is none in the Latin?[9]

A little later, Septimus picks up the paper and tries his hand at it:

> . . . Yes—'The barge she sat in, like a burnished throne . . . burned on the water . . . the—something—the poop was beaten gold, purple the sails, and—what's this?—oh, yes,—so perfumed that—
>
> Thomasina: *(Catching on and furious)* Cheat!
> Septimus: *(Imperturbably)* '—the winds were lovesick with them . . .'
> Thomasina: *(Jumping to her feet)* Cheat! Cheat! Cheat! (39)

Why cheat? Because of course Septimus knew the English in advance, Enobarbus's great set-piece description of Cleopatra in Shakespeare's *Antony and Cleopatra*. But why then didn't it come out the same in Thomasina's reverse translation? Because after all this is poetry, with something singular about it; and Thomasina's difficulties are exactly what ours would be if the original had been lost.

In the interval between the two attempts, Thomasina is led into thinking about the burning of the great library of Alexandria in Caesar and Cleopatra's time, and she cries out,

> Oh Septimus!—can you bear it? All the lost plays of the Athenians! Two hundred at least by Aeschylus, Sophocles, Euripides—thousands of poems—Aristotle's own library brought to Egypt . . . How can we sleep for grief?

And Septimus consoles her by reminding her of what we have, what has survived, and with the thought that in fact nothing important is lost:

> We shed as we pick up, like travellers who must carry everything in their arms, and what we let fall will be picked up by those behind. The procession is very long and life is very short. We die on the march. But there is nothing outside the march so nothing can be lost to it. The missing plays of Sophocles will turn up piece by piece, or be written again in another language. Ancient cures for diseases will reveal themselves once more. Mathematical discoveries glimpsed and lost to view will have their time again. You do not suppose, my lady, that if all of Archimedes had been hiding in the great library of Alexandria, we would be at a loss for a corkscrew?" (38)

This is very beautiful, but there is a flaw in the reasoning when it comes to Sophocles; that is, when it comes to poetry and persons.

Later in the play, Valentine, a twentieth-century Coverly who is also a scientist, argues that neither Thomasina nor Septimus could have understood the true bearings of some of Thomasina's equations, because science doesn't work that way. "Because there's an order things can't happen in." Newton and Leibnitz could discover the Infinitesmal Calculus, or Fluxions, at the same time, but not before time. "You can't open a door until there is a house," Valentine says. And Hannah, his interlocutor, replies, "I thought that's what genius was." To which Valentine retorts, " Only for lunatics and poets" (79).

At issue at this moment is the second law of thermodynamics, or "entropy," and its implications for the heat of the universe. So after a moment Hannah recites the opening lines of a poem of the time, named "Darkness":

> Hannah: 'I had a dream which was not all a dream,
> The bright sun was extinguished, and the stars
> Did wander darkling in the eternal space,
> Rayless, and pathless, and the icy earth
> Swung blind and blackening in the moonless air . . .'
> Valentine: Your own?
> Hannah: Byron.

Byron figures largely in the play, though entirely offstage; as does a fictive Ezra Chater, author of *The Couch of Eros* and successively poet and botanist. "He was not much of either," Hannah says, "but he was both" (89).

If plot in drama can be described as the path of the action, the most striking thing about the path of the action in *Arcadia* is that it is split. It moves forward in two different time periods, one from 1809 to 1812, the other in "*the present day*" (1993). The action in the present day is retrospective, as in so many plots from *Oedipu*s to *Ghosts*, focused on recovering and construing the shape of the past. Here it employs three different kinds of historian: one of landscape and garden (Hannah), one of Romantic literature (Bernard, who

thinks he can prove Byron killed Chater in a duel), and one of grouse populations (Valentine, looking for the algorithm that lurks in their annual fluctuations in the estate's game books). The two eras alternate, scene by scene, so that we, the audience, can match the past as it happens against the constructions and misconstructions of the present, much to our amusement and delight, especially at the expense of the literary historian on the trail of Byron. The place remains essentially the same. "What triggered the [play], in a way," Stoppard told *The Village Voice*, "was the idea of having a room which doesn't change, and you see what happens in the room in the past, and you see what happens in the room 180 years later."[10] In the last scene the two times quite wonderfully converge, without explanation. That is, the two sets of characters are able to occupy the same space at the same time, oblivious of each other, the modern characters mostly in Regency clothing for a summer fête, and at the very end they dance, one couple from each period, to the music.

The temporal awareness kept lively by the period shifts is informed by the sciences that mark the two eras. In the earlier period, while the park outside the windows is suffering a transformation from its classically pastoral refinement and balance to Romantic irregularity and gloomy effect, Newton's balanced, homeostatic universe is giving way to one modeled in a bowl of rice pudding. That is, as Thomasina, the gifted thirteen-year old, remarks in the opening scene, "When you stir your rice pudding, Septimus, the spoonful of jam spreads itself round making red trails like the picture of a meteor in my astronomical atlas. But if you stir backward, the jam will not come together again. Indeed, the pudding does not notice and continues to turn pink just as before. Do you think this odd?" "No," says Septimus. Since time will not run backward, "we must stir our way onward mixing as we go, disorder out of disorder into disorder until pink is complete, unchanging and unchangeable, and we are done with it for ever" (5). These budding insights are reinforced in the play, when it reaches 1812, by the thump of an advanced Newcomen engine pumping out the lake, and scientific news from Paris on the propagation of heat in solids (81)—not yet Sadi Carnot on heat machines, but J-B. Joseph Fourier, whose 1811 prize-winning mathematical treatise included consideration of the diffusion of heat in infinite bodies—like the universe perhaps. What is happening—and what Thomasina before her lamentable death by fire brilliantly sketches in a diagram of heat exchange—is the birth of thermodynamics from the spirit of Steam. As she says, "Newton's equations go forwards and backwards, they do not care which way. But the heat equation cares very much, it goes only one way" (87). You cannot un mix the pudding—just as you cannot restore the lost poem by reversing its translation.

At the other end, in the modern period, another revolution is happening, which Valentine, the population biologist and present Coverly heir, celebrates as a vast new opening to the understanding of Nature—a revolution variously dubbed "chaos theory" and "complexity" and, as antici-

pated by Thomasina, "the New Geometry of Irregular Forms." For Thomasina, it is an escape from Newtonian reductionism and determinism; for Septimus, turned madman and hermit after Thomasina's death and obsessively working her equations, it is perhaps an answer to the inevitability and irrevocability of loss in an entropic world. For Valentine, it maps how "[t]he unpredictable and the predetermined unfold together to make everything the way it is. It's how nature creates itself, on every scale, the snowflake and the snowstorm" (47).

And it is how the play appears to create itself in its unfolding. The argument in the play between science and poetry is also one between generality and particularity, the inevitable and the accidental. Valentine doesn't think it is important who wrote what when, any more than it is important who got there first with the calculus. What matters is scientific progress; knowledge; not "personalities." All this infuriates the literary scholar, Bernard, who declares a preference for Aristotle's cosmos. "Quarks, quasars—big bangs, black holes—who gives a shit? How did you people con us out of all that status? All that money?" And he continues: "If knowledge isn't self-knowledge it isn't doing much, mate. Is the universe expanding? Is it contracting? Is it standing on one leg and singing 'When Father Painted the Parlour'? Leave me out. I can expand my universe without you." And he breaks out into a rendition of Byron's poem, " 'She walks in beauty, like the night of cloudless climes and starry skies, and all that's best of dark and bright meet in her aspect and her eyes' " (61).

At this point, we aren't getting much of a dialogue. What is missing is the recognition on one side (Bernard's) of what lies beyond subject and ego; and on the other of the value of what cannot be generalized. What is needful is a science that takes account of the fact that neither the logic of historical development, nor the laws of motion going forwards or backwards, nor the sheer weight of numbers as in a billion apes at a billion typewriters for a billion years, could have produced two identical *Antony and Cleopatras*, or two identical Thomasinas.

In *Arcadia*, the shape of the action, split into two streams, gives metaphoric form to how necessity and contingency, loss and gain, thermodynamics and complexity, the general and the particular (whatever is unique and irreplaceable), interact. The past is past, and the present-day project of recovering it, of knowing and understanding it, underlines the irremediable losses, not of everything—Hannah recovers a great deal— but of much that counts. Thomasina we learn will die young; Septimus will inhabit the ridiculous picturesque hermitage in the transformed park, wasting his life in manual calculation to prove Thomasina's insights. They are subject, with everything else in Arcadia, to Nature in its generality, to loss and decay and mortality in an irreversible tidal flow. Thomasina's immanent death at the end of the play, just short of her seventeenth birthday, on the brink of love,

in the first flowering of her genius, is all the more poignant for being retrospectively foreknown, and all the more immediate for its un-timeliness. But at the same time, the linearity of the action in the early nineteenth century is much complicated by its afterlife in the twentieth, by its unimagined presence, both as subject of inquiry and as a result fed back into the equation of life in that iterated algorithm that produces the shape of the present. As the alternation of scenes progresses, the relation between the two times and their populations, the two sets of Coverlys and attendant intelligentsias, becomes less a matter of difference (including an evident decline in language, style, and genius), less a matter of contrast, than of complex variation in similitude. When Valentine in the present actualizes Thomasina's equations for her New Geometry of Irregular Forms on his computer screen, he produces what he calls the Coverly set.[11] "See," Valentine tells Hannah as she presses the keys, "In an ocean of ashes, islands of order. Patterns making themselves out of nothing. I can't show you how deep it goes. Each picture is a detail of the previous one, blown up. And so on. For ever. Pretty nice, eh?" (76). It is that same verticality, an iteration in depth with no iteration exactly alike, that is suggested by the simultaneity in the last scene, and especially in the final image of the play, where the modern Gus Coverly, who resembles Thomasina's patronizing adolescent brother but is also Thomasina's gifted autistic avatar, and Hannah Jarvis, the present-day historian of place, awkwardly begin to dance, joining Septimus and Thomasina's fluent waltz.

"I rather think that science and theology will always find a way to dance together," Stoppard once said;[12] and latterly he might have added science and poetry. In his only novel, *Lord Malquist & Mr Moon*, published in the same year as the production of *Rosencrantz and Guildenstern are Dead* (1966), there is a telling verbal exchange:

> [Moon:] "But if its all random then what's the point?"
> [Lady Malquist:] "What's the point if its all inevitable?"

And the narrator comments, "*She's got me there.*"[13] But it would appear that in the features of what James Gleik described as "A New Science," Stoppard found an instrument for disabling this Hobson's choice, these intractable alternatives. He finds relief in the seeming paradox, in Valentine's words, of "how the unpredictable and the predetermined unfold together to make everything the way it is." "Everything" in this case includes precisely what it takes to construct a successful plot, which must be at once inevitable in its unfolding and surprising; fulfilling expectation through the unexpected; capable of accommodating complication and achieving its foregone conclusion through indirection. Science, in other words, has finally caught up with poetry, and adopted the dramatist's path of the action as the ur-plot of being and becoming. If at first science thickened the plot, in the end the plot thickens science— not just a plot, but the fundamen-

tal principle of plotting, whereby the unpredictable and the predetermined unfold together to generate the shape of the play, and also our understanding of the world.

NOTES

[1]Arnold, May 9, 1836, in *The Life and Correspondence of Thomas Arnold, D.D.*, Vol. II (1845); Wittgenstein, in *Culture and Value*, ed. G. H. von Wright with Heikki Nyman (1980), 1930 entry; and Chandler, in *The Notebooks of Raymond Chandler* (1976), as "Great Thought." Sample, courtesy of Robert Andrews, *The Columbia Dictionary of Quotations* (1993), s.v. "Science" and "Science and Art."

[2]I make such an argument in *When Science Thickens the Plot: Sophocles, Beckett, & Stoppard,* The Frank Tannenbaum Lecture, 1998 (University Seminars of Columbia University, 1998).

[3]*The Invention of Love* (London: Faber and Faber, 1997), 2.

[4]"Housman's Cambridge Inaugural" (1911), *Times Literary Supplement*, May 9, 1968, 476.

[5]*Jumpers* (Grove Press, 1972), 41.

[6]*Hapgood* (Faber and Faber, 1994), 62. This "Broadway Edition" trims and to some extent updates politically the original 1988 edition. In the earlier version some of the science is more fully articulated, at this point leading us from e=MC2 to the notion of antimatter. Stoppard's dramatic tropism towards two solutions for any given problem requiring cognitive investment appears in purest form in the farcical police procedural *After Magritte* (1970), where all solutions, however "plausible" or factual, are still wildly improbable.

[7]Introduction, *"The Dog It Was That Died"and Other Plays* (Faber and Faber, 1983).

[8]Interview with Shusha Guppy, *The Paris Review*, 109 (Winter 1988), Rpt.*Tom Stoppard in Conversation*, ed. Paul Delaney (1994), 179.

[9]*Arcadia* (Faber and Faber, 1993), 35-36.

[10]"Unstoppered Stoppard," *Village Voice* (April 4, 1995), 80.

[11]No doubt a version of the Mandelbrot set that Stoppard found illustrated in James Gleik's *Chaos: Making a New Science* (Viking Penguin, 1987). On Stoppard's use of Gleik, Delaney, 224, and Mel Gussow, *Conversations with Stoppard* (Grove Press, 1995), 308.

[12]Joseph McCulloch, "Dialogue with Tom Stoppard" (1973), in Delaney, 42.

[13]*Lord Malquist & Mr Moon* (Grove Press, 1975), 129.