Late Editions 6

Cultural Studies for the End of the Century

PARANOIA WITHIN REASON

A CASEBOOK ON CONSPIRACY AS EXPLANATION

George E. Marcus, EDITOR

1999
The University of Chicago Press
Chicago and London

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The University of Chicago Press, Chicago 60637
The University of Chicago Press, Ltd., London

Printed in the United States of America
08 07 06 05 04 03 02 01 00 99 1 2 3 4 5

ISBN: 0-226-50457-3 (cloth)
ISBN: 0-226-50458-1 (paper)

ISSN: 1070-8987 (for Late Editions)

The paper used in this publication meets the minimum requirements of the American National Standard for Information Sciences—Permanence of Paper for Printed Library Materials, ANSI Z39.48-1992.

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and social facts and fails to account for the reciprocal influences between economic facts and our perceptions of them. Soros uses his word *reflexive* to describe the active relation we have in perceiving and changing economic facts, but *dialectical* would do just as well. I suppose Soros, through his work in the Soviet Union, is a bit of what Hegel called a world-historical individual. What a mensch.

KADVANY: János, I'm sorry, I think we're running out of time for George Soros. It's been good talking with you.

RADVÁNYI: *Köszönöm szépen, Kadvany. Viszontlátásra.* [Thanks very much, John. See you again.]

Notes

1. Editor's note: Lakatos's writings have been published as John Worral and Elie Zahar, eds., *Proofs and Refutations: The Logic of Mathematical Discovery* (New York: Cambridge University Press, 1976); Worrall and Gregory Currie, eds., *The Methodology of Scientific Research Programmes: Philosophical Papers Volume 1,* and *Mathematics, Science and Epistemology: Philosophical Papers Volume 2* (New York: Cambridge University Press, 1978).

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ENTANGLED STATES: QUANTUM TELEPORTATION AND THE "WILLIES"

Beam to: Primary Coordinates—ISIS

Scan for: initial disorientation; a purloined letter; the willies

The daily mail arrives. The usual crap, plus one fat envelope from a respected and well-liked physicist colleague. A copy—"FYI"—of a multimillion-dollar grant application to the U.S. Department of Defense, proposing to develop a system for (among other things) more secure military communications on the electronic battlefield of the future/present. Appended is a "theoretical" paper, the subject of which might be called "unitary matrices," but "quantum teleportation" would be only slightly less correct. It is a paper which holds the key, says the grant's author, to making the proposed communications scheme practical. It is a paper with Herbert Bernstein's name on it, and the name of the institute on which we collaborate, the Institute for Science and Interdisciplinary Studies (ISIS); it is a paper for which we are, however indirectly and to varying degrees, responsible. It gets tossed on the desk, and both physicist and ethnographer sit stunned, four hands move to furrowed brows to rub above eyes squeezed shut, bodies squirm and then freeze to chairs and only mouths move to voice a habitual guttural utterance.

A haunted feeling. Something's wrong here, this can't be happening. Is someone watching? Are we imagining things? Can't put a finger on it. A communication returns, read and altered, and desire rebounds as guilt. This is not what we intended. The willies: a palpable, bodily state in which flesh crawls, a chill runs through the blood, a tingle up the spine. The forceful certainty of an adrenaline rush would be welcome, prompting action, but there's only a vague dis-ease.

Beam to: *Scientific American,* February 1996

Scan for: scrambled genres; technological promises; need for ontology

An advertisement from IBM for—*something*—appeared on the inside front cover in the February 1996 *Scientific American* (fig 4.1). With the right decoding apparatus, one might read here promises for the technological overcoming, via "quantum teleportation," of the mutating, perilous state, cultural differences, geographical distance, and perhaps even the problems of aging as the body's recipe begins to become unreadable after so many years of use.

In the following weeks, Robert Park from the American Physical Society sent out a series of messages on his electronic newsletter *What's New,* covering developments in science:

> *IBM Science: Beam Me Up Scotty, It's Getting Crazy Down Here* "Stand by. I'll teleport you some goulash. . . . An IBM scientist and his colleagues have discovered a way to make objects disintegrate in one place and reappear intact in another," according to an ad in February's *Scientific American.* Tipped off by a *WN* reader, I sent an e-mail to "askIBM" requesting more information. "Hello Bob," came back. "This is still under development and no further information is currently available. Thank You for using askIBM. Roseann." Are they having trouble with the di-lithium crystals?
>
> *IBM: Too Much Paprika Leaves Scientists with a Bitter Taste* The "goulash" ad (*WN* 26 Jan 96), which ran in magazines ranging from *Scientific American* to *Rolling Stone,* claims "IBM scientists have discovered a way to make an object disintegrate in one place and reappear intact in another." Do you believe that? Well, neither does IBM! An article in *IBM Research Magazine* says, "it is well to make clear at the start that teleportation has nothing to do with beaming people or material particles from one place to another." So what's going on? There are several theories. One reader noted that many research scientists, disintegrated at IBM labs, have been observed to reappear intact at universities.
>
> *More Goulash: National Examiner Decides to Use Its Own Recipe* In an article that raises the important question of what happens to the soul when a person is teleported, the supermarket tabloid quotes "IBM's top genius, Charles Bennett" as saying, "Mankind is at the dawn of a new era, solid matter will be teleported through space and time and reassembled." Bennett, of course, said nothing of the sort. He told the *Examiner,* "teleportation of macroscopic objects would be impossible for the foreseeable future." If an IBM ad can't get it right (*WN* 2 Feb 96), why should the *Examiner?*[1]

Park's basic complaint seems to be the familar, truth-in-advertising one: quantum teleportation isn't what the ad says it is. The ontology of "quantum teleportation," what it *is,* appears to have been withheld, if not lied about. So is the true ontology of quantum teleportation lying about somewhere, waiting to be found and uncovered?

Beam to: Author's Brain, Somewhere Near the Fissure of Sylvius

Scan for: authorial intention

So the question, once again, is, What is it? The problem is not one of misleading advertising, however, and this present account takes the perspective that the ontological question about "quantum teleportation" (QT) is not answerable in these authoritative terms. What QT *is* is spectral, spooky, ghostly, phantasmatic, and just possibly ghoulish, if not goulash, and one can read this shaky ontology in every possible register, from the physical to the cultural. What "is" "true" of any of the shifting subjects of this paper—quantum teleportation, conspiracy, moral responsibility—is that "one does not know what it is, what it is presently. It is something that one does not know, precisely, and one does not know if precisely it is, if it exists, if it responds to a name and corresponds to an essence. One does not know: not out of ignorance, but because this non-object, this non-present present, this being-there of an absent or departed one no longer belongs to knowledge. At least no longer to that which one thinks one knows by the name of knowledge" (Derrida 1994, 6). It is for reasons such as these that if we want to learn about QT and how to respond to it, it will be "necessary to learn spirits":

> Even and especially if this, the spectral, *is not.* Even and especially if this, which is neither substance, nor essence, nor existence, *is never present as such.* . . . To learn to live *with* ghosts, in the upkeep, the conversation, the company, or the companionship, in the commerce without commerce of ghosts. To live otherwise, and better. No, not better, but more justly. . . . And this being-with-specters would also be, not only but also, a *politics* of memory, of inheritance, and of generations. . . . It is necessary to speak of the ghost, indeed *to the* ghost and *with* it, from the moment that no ethics, no politics, whether revolutionary or not, seems possible and thinkable and *just.* (Derrida 1994, xviii–xix)

The ghost story here, an ethnographic tale from and of the crypt, a tale of coded messages and haunted remains, is a hurried whistling walk through four ontological graveyards.

One, the model of the physical world which QT employs, a model founded

For years, she shared recipes with her friend in Osaka.

She showed him hundreds of ways to use paprika.

He shared his secret recipe for sukiyaki.

One day Margit e-mailed Seiji.

"Stand by. I'll teleport you some goulash."

Margit is a little premature, but we are working on it.

An IBM scientist and his colleagues have discovered a way to make an object disintegrate in one place and reappear intact in another.

It sounds like magic. But their breakthrough could affect everything from the future of computers to our knowledge of the cosmos.

Smart guys. But none of them can stuff a cabbage.

Yet.

IBM

Solutions for a small planet

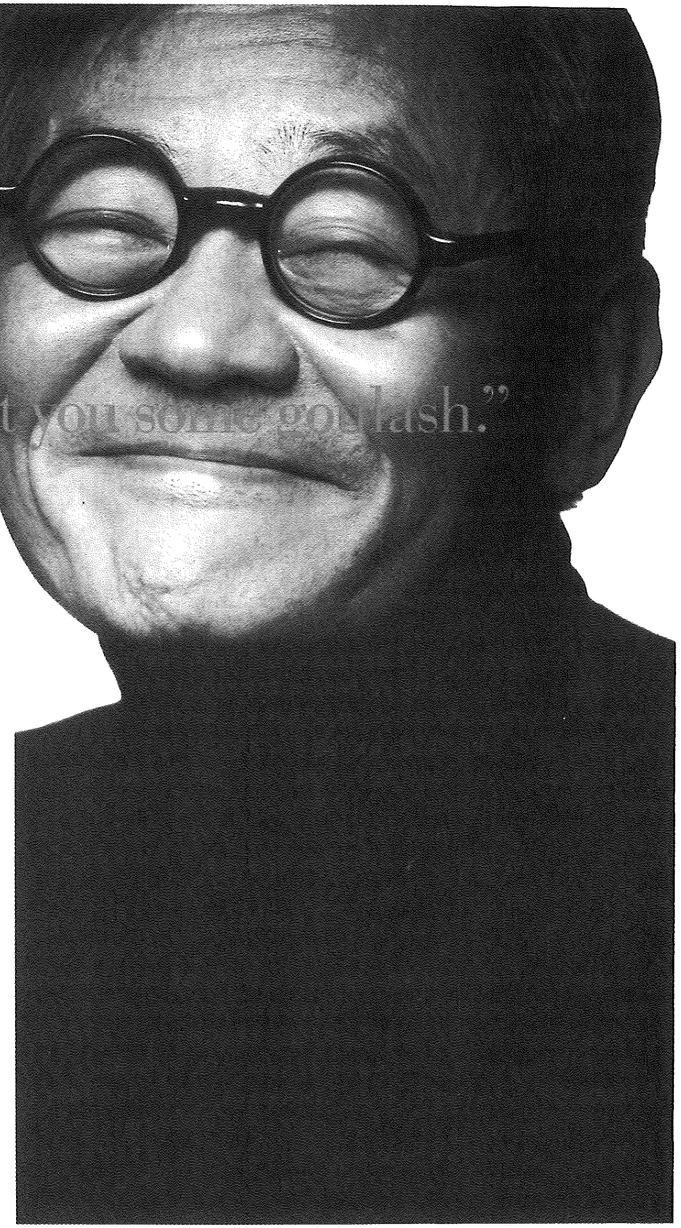

Fig. 4.1 © IBM. Reprinted with permission.

on what Albert Einstein over fifty years ago called "spooky action at a distance": a world consisting of what the physicists call entangled states, where the "real" physical properties of particles are muddled with other physical and nonphysical properties (to use very unghostly, quaint, and completely inadequate terms).

Two, the entanglements between these fields of quantum physics and the literary, cinematic, and tabloidish phantasms of popular culture where, as already glimpsed, the stable genres of science and science fiction become transmigrating souls that periodically take possession of more corporeal presences.

Three, the entanglements between these entangled scientific and cultural domains with the ghostly possibility of conspiratorial politics, located institutionally (perhaps) in the National Security Agency (NSA), operating through the disciplines of cryptology and cryptography. In this graveyard one can also find historians and philosophers of science, other wandering mediums trying to establish contact with the spirits that "guide" modern physics, at least since World War II.

The fourth graveyard is called ISIS, the Institute for Science and Interdisciplinary Studies, where the author/ethnographer works with the physicist/institute president, Herbert Bernstein. ISIS invents new ways of both questioning the sciences and deploying them to address current problems such as cleaning up the military's toxic legacy, developing aquaculture techniques with the indigenous people of the Amazon basin in Ecuador, and advancing the field of sustainable agriculture. Bernstein, then, is both informant and collaborator, and it's through him that I keep up with the doings of a group of about a half-dozen scientists working on QT. It wouldn't be wrong to say, "Bernstein works on QT"; he might prefer to say he works on "unitary matrices" or "multiparticle interferometry," but it is the entanglement between these fields that is at issue here.

It's certainly legitimate to say that his work gives him the willies, and I try in this essay to account for how Bernstein—who is, by any definition of the term now available in science studies, a "socially responsible scientist"—arrived at those space-time coordinates wherein his work became of interest to the military, and he got the willies. If something like moral outrage, a change of heart, a new spiritual or political resolve is the response to the presence of a conspiracy, then the willies is the response one has to the presence/absence of conspiracy. In a slightly different articulation, if an ethics answers to the ontological contours of a fully plotted, fully present conspiracy, then the hauntology of a present/absent conspiracy calls for a different kind of response, which for now might be put under the name of a "moral responsibility"—albeit an impossible moral responsibility.

Thus I also try in this essay to account for how Bernstein and the author tried to figure out what might be the "responsible" or "moral" thing to do, through

a series of staged events. In one of these events, Bernstein graciously subjected himself to a trial—or rather, a parody of a trial, since what he was charged with was never clear, and the outcomes of "guilty" or "innocent" were excluded from the start.

Beam to: Primary Coordinates—ISIS

Scan for: paralegalism

We staged "The Trial of Herbert J. Bernstein, Physicist" at the Hampshire College twenty-fifth anniversary alumni reunion, 25 June 1995, where ISIS is located and where Bernstein teaches physics, among other subjects. In attendance in this makeshift, parodic courtroom in the "Kiva" in Hampshire's library were about fifty Hampshire alums, many of whom were former students of Bernstein's, including a few who had actually gone on to become certified, working physicists. A cabal of three other alums and former students of Bernstein's presided: the ethnographer cast himself in the role of judge, but his identity multiplied further still when David Gruber (a member of ISIS's board of trustees) was unable to attend and perform his role of prosecuting attorney; Michael Mann undertook the pro bono work of defense attorney.

The intent was to use the trial format as a dramatic device for a public discussion about science and social responsibility. Among the things we hoped to accomplish was a demonstration of the inadequacies of the binary logic of guilt or innocence, and precisely where and how these categories and other similar ones break down in the territory of questioning "pure science."

> *Judge/prosecutor/ethnographer:* This court is now in session. I am the presiding judge, and I have to say I'm also, more or less, the prosecuting attorney *[laughter]*—convenient!—since David Gruber is ill and was unable to come. The defense attorney, some of you may know, is Michael Mann, from the Securities and Exchange Commission *[laughter].* And we are dealing today with matters of security and exchange.
>
> This is "The Trial of Herbert J. Bernstein, Physicist." We had thought of entering it in the dockets as "In the Matter of H. Joseph Bernstein," but that would have been too close an allusion to "In the Matter of J. Robert Oppenheimer"—and look around you: is this the 1950s? No. Is there a widely perceived communist threat? No. Is there any single, identifiable enemy in what we might call "the military"? No. So the allusion does not quite hold, and we're challenged both to find out exactly what Bernstein is charged with *[laughter],* and once we've established that, whether he, under our judicial system, can be rendered guilty, innocent, or some other third term, perhaps.
>
> Let me tell you what the trial is about. "Experimental Realization of

Any Discrete Unitary Operator": a paper published in the *Physical Review Letters*—very prestigious journal, perhaps the most prestigious journal in physics—Fourth of July 1994, Independence Day. The authors are Michael Reck and Anton Zeilinger, from Austria; Herbert J. Bernstein and Philip Bertani, from Hampshire College—Phil Bertani was an undergraduate at the time he helped write this. The paper comes out of research funded by the National Science Foundation, a grant which Bernstein administers here. This was the only NSF grant that Clifford Shull, the most recent Nobel laureate in physics, was an advisor to, putting Herbert J. Bernstein's face in all the local newspapers. It is an "algorithmic proof that any discrete finite dimensional unitary operator can be constructed in the laboratory using optical devices."

What does this mean? We'll have to ask the defendant to clarify. But this paper does not stand by itself. It is in fact attached to exhibit A: a funding proposal submitted to the U.S. Department of Defense by an electrical engineer in California, for developing "spread-spectrum coding, which presents a new opportunity for optical communications. The huge bandwidth is put to use for security and intercept immunity." It has uses for the intelligent battlefield of the future/present.

The question is, What is the relationship between Bernstein's beautiful piece of pure, theoretical physics, and this submission to the Department of Defense? This is what the charges revolve around.

Beam to: Nature

Scan for: The socio-crypto-logic of error

If the dominant effect of the willies is to leave one's skin crawling, and if the dominant effect of QT comes from the realm of an obscure hauntology, it is appropriate to start again, before we go any further with the seance that would conjure a visage of QT for all of us gathered around the table to see, with an image of what QT might do to the body.

Almost exactly a mere three years before IBM advertised the shape of teleportation-to-come, the scientific paper which announced the theoretical possibility of teleportation was published in the prestigious *Physical Review Letters.* The event of publication was itself covered by *Nature* magazine, and the illustration which accompanied that story demands to be read (see fig 4.2).

How to read this body, misassembled? At first pass, it plays jokingly on the anxiety of the technical error: "Didn't quite get all the sequences matched up properly, heh heh. You know how it is: trying to do several things at once, ignoring those panel lights that seem to indicate something wrong, and pretty soon you've put your foot in your mouth, or at least on your arm. Well, that's life in the age of smart machines. Get Engineering to run a full diagnostic

Fig. 4.2 Reprinted with permission of Andrew Birch and *Nature* magazine.

on the new biofilters, and let's try it again." Such a reading can in fact be quite productive, providing glimpses of the new logics of the body that are the narrative engines not only for *Star Trek* episodes and films like David Cronenberg's remake of *The Fly,* but for the production of science as well.[2]

But read again. Rather than machinic logic, read it for what we might call the socio-crypto-logic. In the following pages we will see how physical research is a process of becoming, and the physicist in process *will be disrupted.* More specifically, we'll see how the physicist's *will* will be disrupted. She didn't ask to have, say, the National Security Agency at arm's length, but there it is, jammed into the socket. Those were supposed to be her feet down there, moving her resolutely across the ground under a solitary sky—but they're the hands of liminal colleagues whose thoughts and acts impel her own, while her own blood circulates through them to flex their distant fingers. In addition to these phantom limbs, time is also out of joint: 1935 is grafted onto 1993, the 1950s and 1960s sink their tendons into the present, and that haunting presence whose best referent is "the future" sends us impossible nonrelativistic signals, faster than light. Employing other analytic phrases that have been conspiratorially spliced into my own neuronal patterns: the physicist is always already

teleported; always already an in/appropriated other. The experiment is up and running before we know the outcome, or even how to do it.

Beam to: Primary Coordinates—ISIS

Scan for: enlisting; (pre)science; imperatives and implications

Judge/prosecutor/ethnographer: Let me just read a few quotes from an article by the defendant, from his book *New Ways of Knowing,* coedited with Marcus Raskin—on sale from ISIS after these proceedings are concluded. In Herbert J. Bernstein's article "The Idols of Modern Science and the Reconstruction of Knowledge," he writes as follows: "If the typical scientist were an individual seeker of externally given truth, an isolated genius working alone on his or her specialized problem, then perhaps the moral implications of scientific work would be mitigated. Indeed, the dispensation of knowledge could then be closely controlled by its inventor, and the act of publishing would more fully bear the moral weight. But as we have seen, modern science must always be perceived in the context of a scientific community; that subsociety is supported, nurtured, and utilized by the larger society, or by its ruling elite, for reasons far from those motivating scientists themselves."

In this situation we are presented, as Herbert J. Bernstein goes on to argue, with a number of moral imperatives. "In every case, the motivating human impulse—the childlike wonder of the scientist, the playfulness of the artist—is enlisted for some moral purpose and social good: satisfying people's material needs, organizing our society openly and equitably, even delighting our aesthetic sense. . . . Without requiring perfect prescience or a crystal ball, where purpose intended justifies the search, purpose attained is a legitimate measure of the moral implications of today's science. And while scientists do not believe they steer their research toward production of technology, they are quick to seek new technologies for use in their experiments."

Later in the essay, Herbert J. Bernstein goes on to bust Joshua Lederberg for conducting experiments in 1951 with *E. coli,* which thirty years later would result in great social dilemmas of recombinant DNA research—busting Joshua Lederberg by writing, "If all the considerations of ultimate purposes of biological research had been weighed, perhaps we would all be safer now."

Can we not bust Herbert J. Bernstein for not thinking through the next thirty years to where "Experimental Realization of Any Discrete Unitary Operator," what effects this is likely to have thirty years down the road, once it becomes institutionalized within the U.S. Department of Defense?

With that said, we will now hear from the defense attorney.

Beam to: 1993/96/35

Scan for: science/fiction; long-range correlations

In 1993 Charles Bennett, a physicist at IBM's Watson Laboratory, published a coauthored paper which appeared as the lead article in *Physical Review Letters* (and whose announcement in *Nature* inspired the artist's rendering of fig. 4.2). Titling their paper "Teleporting an Unknown Quantum State via Dual Classical and EPR Channels," the authors—whose corporeal bodies might be located from time to time in Yorktown Heights, Montreal, Paris, Haifa, and Williamstown—explicitly borrow from a genre other than physics: "We call the process we are about to describe 'teleportation,' a term from science fiction meaning to make a person or object disappear while an exact replica appears somewhere else" (Bennett et al. 1993, 1896). Never mind the fact that *Star Trek* viewers or even members of the *Enterprise* crew may not agree with this definition of teleportation as destruction of the original and creation of a replica. We could imagine a more technically oriented term for Bennett et al.'s proposal, such as "remote quantum spin transfer," but we would be deluding ourselves to think that the empirical could, or even should, be stripped of the imaginary. Nevertheless, the authors go on to write that the "net result of teleportation is completely prosaic: the removal of [a particle state] from Alice's hands and its appearance in Bob's hands a suitable time later."

The identities of Alice and Bob will be left to emerge over the course of this writing. Their gendering, however, obeys the same powerful polarities that show up in the "goulash" ad three years later, suggesting that Alice/Bob might be the future anterior of Margit/Seiji. Shortly after the goulash ad appeared in print, Web crawlers could find a "quantum teleportation" page nested within the site coded http://www.ibm.com. This so-called location contains a nice photograph of the six coauthors of the 1993 paper, and a good description of quantum teleportation. Further down the page, quantum teleportation is contrasted to "classical facsimile transmission," which exhibits a Platonic logic: a kind of parallel universe containing an "original" is scanned for data by a photocopy, fax, or more humanoid cave-dwelling machine, which upon further treatment yields a cheesy simulacrum of the intact original (see fig. 4.3, the author's facsimile of IBM's diagram). The page also provides various hypertext links to other information sources, including the "original" paper of which this cyberspace version might be said to be the "approximate copy" and, in a particularly nice touch, a recipe for goulash.

In the middle of the page is a diagram of "quantum teleportation" (reassembled by the author as fig. 4.4) and an accompanying descriptive narrative. Again, the reader is asked to be patient; it takes time to establish communication with such apparitions, and we are still firmly within an hauntological realm.

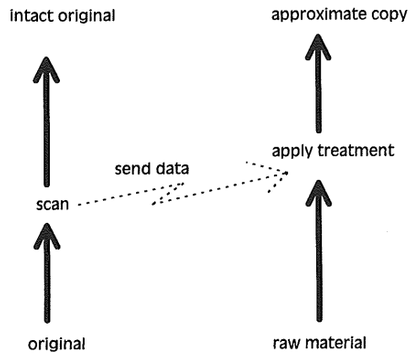

Fig. 4.3 Classical facsimile transmission

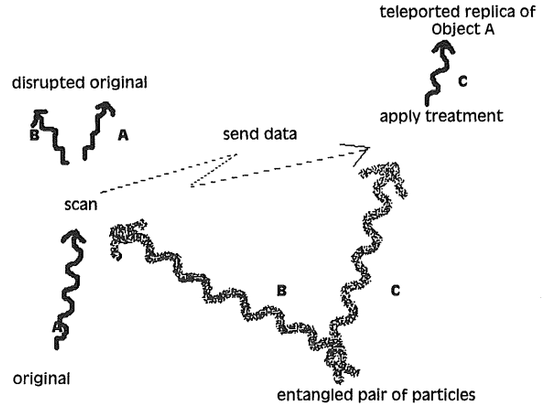

Fig. 4.4 Quantum teleportation

If we have to make the mistake of identifying the "heart" of this scheme, then it lies in the "entangled pair of objects" dominating the lower center of the diagram. These particles exhibit what the text names as " 'Einstein-Podolsky-Rosen correlation' or 'entanglement.' " The name refers us back to 1935, when this trio of physicists coauthored a paper which would haunt quantum theory for the next sixty years.

Beam to: Quantum Litter

Scan for: desiring full presence; living/dead cat; hidden variables; nonlocality; experimental and cultural proliferation; zombie kittens

Because this text can't go fast enough for the relativistic time-dilation effect to kick in, what the reader gets here is the table-rapping, cheap conjurer's version of the history of quantum mechanics and its philosophical conundrums.

The 1935 paper in the *Physical Review* by Albert Einstein, Boris Podolsky, and Nathan Rosen (usually collapsed into the initials EPR) can be characterized as the traditionalist, realist response to the radical, constructivist writings/interpretations of the Copenhagen school, symbolically led by Niels Bohr. EPR maintained that physics had been and should continue to be concerned with developing "one-to-one correspondences" between elements of physical theory and elements of the real physical world; a theory about the physical world had to be *complete,* and the stringencies of such a requirement left little or no room for chance and indeterminism. Bohr and his associates defended just as energetically the view that physics was about the performative acts of measurement and calculation, and that when these acts were performed at the quantum level, language constructions such as "the real physical world" were out of place, and indeterminacy had to be acknowledged as ineradicable.

Each group was probing and mapping the limits of its own philosophical/physical theories, and would invent elaborate *Gedankenexperiments* to see what contradictions emerged at those limits. Crudely, the EPR thought-experiment involved two correlated particles at some distance; measurement on one particle would, by the new logic of quantum mechanics, exert an unexplainable and therefore unacceptable "spooky action at a distance" on the other particle. The physicist must be missing something, and quantum mechanics couldn't be "complete."

Another quantum conundrum introduced that same year involved Schrödinger's cat, a thought-experiment whose crucial component was the conjunction of the microworld of quantum physics, where information is always incomplete, statistical, and phantasmatic, with the macroworld of the flesh, where information is visibly and grossly final. Like Einstein, Erwin Schrödinger desired a physics whose goal was the perfect and complete representation of the real world. In this thought-experiment, the physicist places a cat into a box which also contains a radioactive atom, a hammer, and a cyanide capsule. This box is closed, so that the physicist has no further information about what goes on inside. If the radioactive atom decays, it triggers a chain of events: a signal is sent, the hammer falls, the cyanide capsule breaks, the cat dies; if the uranium atom doesn't decay, the cat continues to live. When a time

corresponding to the half-life of the radioactive atom has elapsed, it has a 50-50 chance of having decayed or of remaining intact. According to quantum mechanics, however, the physicist, without opening the box, can only speak about the probability state of the wave function that corresponds to the uranium atom: in theory, the atom is not *either* decayed or intact, but *neither* decayed *nor* intact, or *both* decayed *and* intact. Which is fine for atoms, or for their wave functions, but not very acceptable for cats. If quantum logic carried the day, crossing the boundary between the micro- and macroworlds, the cat would be a zombie: neither dead nor alive, but both dead and alive, suspended in a twilight zone. More importantly, it seems that what the physicist does with this apparatus makes him "responsible" for whether the cat, in the final analysis, lives or dies.

Since then, theorists and experimentalists alike have been puzzling over these conundrums, taking a number of very interesting and productive tacks which can only be referred to here in shorthand terms. David Bohm, a physicist who was both hero and friend to Bernstein, theorized in the 1950s and 1960s about "hidden variables" in an "implicate order." In the 1960s and 1970s, J. S. Bell did some of the most important theoretical work in this area. "The 'Problem' then," he puts it in one article, "is this: how exactly is the world to be divided into speakable apparatus . . . that we can talk about . . . and unspeakable quantum system that we can not talk about?" (Bell 1987, 171). (In the IBM quantum teleportation diagram introduced above, the dark lines and the acts called "scanning" and "applying treatment" make up the speakable part of the apparatus, while the spooky correlations of the EPR particles in the fuzzy lines represent the unspeakable part.) The early 1980s brought a set of experiments and papers, whose principle author was Alain Aspect, which "considerably diminished . . . the feasibility of bizarre conspiracy theories, designed to salvage the E-P-R reality criterion" (Mermin 1985, 146).

What is the situation in the 1990s? One available tracking device is in the genre of popular physics writings and one of its eminent practitioners, John Gribbin. In 1984 Gribbin wrote *In Search of Schrödinger's Cat* (Gribbin 1984). The title reflects that stage in the practice of quantum theory and experiment in which one could engage in those puzzling metaphysical musings about a single cat, or a superimposition of a number of cat-probabilities, how weird cat-reality was and how the physicist was "responsible" for making a dead or a live cat "real." Gribbin's most recent book is called *Schrödinger's Kittens and the Search for Reality* (Gribbin 1995), and the title effectively captures the changed situation: the cat is out of the bag, it has reproduced, disseminated itself, the subject of an unruly multiplication.

Bernstein is in part responsible for this situation marked by proliferation. He is a coprincipal investigator and the administrator of a National Science Foundation grant that supports one of the more productive groups of physicists

working in the field of "multiparticle interferometry." Their work and that of others in the same field was the topic of a *Newsweek* article in 1995, which opens with a scenario of genre scrambling similar to those already cited, and exacerbated by high-speed technological forces:

> Say you're the editor of a science journal deciding whether studies arriving over the transom deserve to be published—or forwarded to "The X-Files." And say that this morning's FedEx delivers a paper reporting that a beam of light traveled faster than—how to put this?—faster than the speed of light. Then your e-mail brings a paper describing how a particle of light—navigating an obstacle course of slits and detectors—"knows" what lies ahead of it. At quitting time, your fax shrieks with an arriving P.S.: in that last experiment, the authors add, you can change the past.
>
> Fodder for "The X-Files"? Not in today's physics. (Begley 1995, 67)

An accompanying graphic suggests that photons possess an anthropomorphic awareness of what to them must appear as a very conspiratorial setup: "It's as if they know they're being watched." The article concludes with a reference to another favorite figure of conspiracy theorists: "For now . . . quantum mechanics is the only game in town. Nonsensical, counterintuitive, crazy—sure. But as Henry Kissinger has said about less abstruse matters, 'It has the added virtue of being true.' "

So in 1998 it seems incontrovertibly true that the physical world is both riddled with indeterminacy and fundamentally unspeakable. In any quantum operation, there are always unspeakable remains, something that continues to be inaccessible, and along with the remains of dear departed cats, these remains go into the crypt. But it also appears that in 1998 that what is so encrypted can be conjured up again, and even if these remains can't be made to speak, they can be made to write.

Beam to: Primary Coordinates—ISIS

Scan for: spreading spectrums; amplifying viruses; getting out of the matrix

> *Defense attorney:* We're here to judge Herbert Bernstein. The charge is treason. Good versus evil, as the prosecutor would make it sound. It's somewhat anomalous to be here defending Herbert Bernstein, because he confessed before he committed the crime, according to my esteemed colleague. The basis for the confession is a paper that he wrote that you've heard quotes from, but the quotes that you've heard are relatively confusing to me because what they really point up is that science is always filled with dilemmas: how far to go, and how science

should be used. And I think if you really look at the essence of the paper, and I point to two quotes in particular, you'd see that what Bernstein was getting at is the fact that we've lost the original connection between scientific truth and social good. And he saw a lack of moral inclusiveness in society today, and in science today, and that is the essence of what you the jury must judge Herbert Bernstein for. That is the whole question that's here for us to discuss. The grant paper that we've heard selective readings from—and I'll spare reading you Herb's whole paper, because for all I know, you'd find it really interesting. The description of what a Hermitean matrix is could take us the better part of the afternoon. But the fact is that Herb has found a way out of that matrix, and the result is that today, we can look at a grant proposal that is, granted, something that was submitted to the Department of Defense, but something that created a communications system that was potentially highly secure. Again, turning to Herb's paper, one of the worst evils is when scientists stop communicating. When information is controlled by the government. When people don't have security for their own ability to give their ideas and have a free flow of ideas.

The point here is that the use of a "spread-spectrum" does not necessarily have any effect on whether we strengthen or weaken the military. In fact, and I think you'll see no evidence submitted of this today: one can argue that by making battlefield communications secure, you actually improve the deterrent and reduce the ability of a first strike. And therefore, the invention in fact could be improving security on the battlefield.

Now, I won't belabor this, because we want to get on to the real guts of this discussion. Higher security versus better definition of radio images, versus being able to transmit information over longer distances, is it a military art, is it civilian?—these are questions that we'll leave to you the jury to decide. But before you do, we want you to think about this question of guilt and innnocence. The key questions, and really what makes this not just good theater, but interesting discussion material, that I would posit you have to decide before you decide the guilt or innocence of Herbert J. Bernstein are, Is there any basic research that can't be used for evil? And if you decide that there isn't, then you have to decide: should basic research cease, because it's more important to avoid evil? If the answer is basic research should cease, I offer you Herb Bernstein's head. But if the answer is that you end up with good and evil, and that that is the natural outcome of every scientific discovery, then we're not arguing that science is neutral, but we're arguing that a scientist has a special role in society, that it just doesn't begin and end with basic research, but that it means being involved in the very discoveries and their applications. What was talked about in the essay about mitigation, I think is really

wrong; it doesn't go far enough. What we're talking about is amelioration. We're talking about the ability of a scientist to introspectively scrutinize his own studies, his own discoveries, and his own work, and come to a conclusion about how it should be pursued.

I'll give you an example that's very easy to consider, that's outside of physics. We've read a lot about the Ebola virus in the last couple of months. The Ebola virus, obviously, has come out of the jungle and has been found now in cities; in Africa, people worry about it being transmitted in monkeys that are being brought to the United States. A scientist doing research on a vaccine for the Ebola virus is clearly, I would argue, doing something good for society. He or she should also understand that the minute a vaccine is created for that virus, it makes the virus a weapon. Because anybody who holds the vaccine also holds the ability to inoculate themselves and infect others. So there is a clear effect of that good, basic research that's going on, that could end up in the devastation of a population. I would say that person is no more guilty than Herb Bernstein is, for having done work on the spectrum. Herb did not do what others in society are doing today, figuring out how to amplify the Ebola virus. That person is clearly guilty.

So you can't say we haven't given you a standard to think about the problem. The question is, What is the role of a scientist? And the story we think we should tell today is the story of a scientist, and how a scientist chooses their work, but also how magnified the effect can be in a very fast-moving society. So with that, we should move on.

Beam to: The Open Conspiracy

Scan for: patents; corporations; war; secrecy/openness; moral luck

The ghosts of two other physicists, Leo Szilard and Niels Bohr, deserve at least a brief channeling.

The name of this beam site comes from H. G. Wells's book *The Open Conspiracy: Blueprints for a World,* which, when published in 1928, made a deep impression on Szilard, the nomadic physicist often ranked by his descendants as among the most "socially responsible" because of his ceaseless petitioning, his political activism, and his constant efforts to inject questions of political and moral responsibility into the discourse of physicists (Lanouette 1992, 96). His tactics within particular historical circumstances, however, were not without their contradictions. A staunch advocate of full and open communication (Wells's influence), Szilard attempted to create an agreement among French, British, and American physicists to keep fission experiments secret in 1939. Szilard had also patented his ideas for a chain reaction, without knowing which

element could be used in such experiments (he thought beryllium might be the ticket), and tried to get General Electric and the British army interested in supporting his experiments.

Szilard's proposed solution to the social/moral problems created by scientific research—full disclosure—was echoed by Bohr, who, despite his recognition of the failures of language to perfectly describe the world, believed that international openness was the only possible answer to the moral problem of physicist-created nuclear weapons. In an "Open Letter to the United Nations," published in 1950, he wrote:

> Without free access to all information of importance for the interrelations between nations, a real improvement of world affairs seemed hardly imaginable. . . . The ideal of an open world, with common knowledge about social conditions and technical enterprises, including military preparations, in every country, might seem a far remote possibility in the prevailing world situation. . . . In the search for a harmonious relationship between the life of the individual and the organization of the community, there have always been and will ever remain many problems to ponder and principles for which to strive. However, to make it possible for nations to benefit from the experience of others and to avoid mutual misunderstandings of intentions, free access to information and unhampered opportunity for exchange of ideas must be granted everywhere.
>
> Any widening of the borders of our knowledge imposes an increased responsibility on individuals and nations through the possibilities it gives for shaping the conditions of human life. The forceful admonition in this respect which we have received in our time cannot be left unheeded and should hardly fail in resulting in common understanding of the seriousness of the challenge with which our whole civilization is faced. . . .
>
> The efforts of all supporters of international cooperation, individuals as well as nations, will be needed to create in all countries an opinion to voice, with ever increasing clarity and strength, the demand for an open world. (Bohr 1950, 293, 295–96)

These messages are channeled here because their terms—open communication in an open world (but be strategic: patent, persuade, try to cut deals) as the antidote to the destabilizing forces of scientific progress and political conspiracy—will still be seen to operate forcefully in the imaginaries of many people called upon to respond to these questions at Bernstein's trial.

Wait, wait, just a moment. Szilard's spirit has something else to add through the medium of his biographer, something about "moral luck":[3]

> Ironically, he said later, he helped keep Germany from winning World War II. If he *had* raised the money and painstakingly tested all seventy

elements, Szilard concluded, he could have discovered as early as 1935 or 1936 that uranium released neutrons—a fact not recognized until 1939. Such a discovery could not have been kept secret, and Germany, then planning for war, would likely be quick to apply this knowledge to building an A-bomb. After the war, Szilard said jokingly that he, Fermi, and other physicists should receive the Nobel Peace Prize for *not* having conducted uranium experiments in the mid-1930s. Had they done so, Szilard said, Hitler might have conquered the world. (Lanouette 1992, 155)

Beam to: Primary Coordinates—ISIS

Scan for: unitary matrices; perfect secrets; complete security

Defense attorney: I call Herbert J. Bernstein as a witness.

Dr. Bernstein, could you explain this discovery of yours to us in a few words? "Experimental Realization of Any Discrete Unitary Operator"—sounds to me like the breakup of the Baby Bells.

Bernstein: This paper is about—for me—solving a problem in quantum mechanics. It's one very close to a number of the things that I talk about in my class that a number of you have taken, "Quantum Mechanics for the Millions." My esteemed defense attorney has characterized it as a discovery, but that gives you the idea that there's something waiting out there to be found, and I prefer to think of it as something that we "worked out." We played around with ideas about "what can be measured." In the microscopic world, everything that can be measured has to come out with real answers, because when you make a measurement, you get a certain real number. And the mathematics of real numbers are operators that are called Hermitean. So there's a long-standing question: Can you make a measurement for anything that you can write down, that will give you a real number as the answer? Nobody knew if you could or you couldn't. What we "discovered" is that you could take an optical table—a slab of marble—and stack things in there in a triangular array that would take any number of beams in that you wanted, and send them out, and in effect—by fooling around with the devices, putting some glass and mirrors in there—you could make a measurement, in that system, of anything you could write down mathematically. That was one of the fundamental things.

The second fundamental thing that was "discovered" was that you could make any transformation—these two things go together—the same kind of theory of what happens on the microscopic scale. A photon coming in on any one of the beams might change around, might change around as time went on and go out in a different state. That transformation from a single photon coming in, to the possibility

of a photon being anywhere along five or six different lines, has to be a unitary transformation. What we "discovered"—that is, what we worked out, is how to put little pieces of glass and mirrors on the table so that you could have any transformation—any possible evolution of the state of the photon—that the mathematics told you of what was going to go on. So we basically solved a couple of fundamental problems in quantum mechanics by giving—and this is the kind of work I like to do—by thinking clearly mathematically, and giving actual experimental details.

And that's where the problem comes in. Since there's no opening statement from the missing prosecutor, I'll start prosecuting myself.

The problem is, when you're working that closely with devices, you have to remember the stuff that I wrote in the book *New Ways of Knowing,* and have to really think through very carefully what the devices can be used for.

Defense attorney: I object!

Judge/prosecutor/ethnographer: Sustained!

Defense attorney: But how can it be used? Because the prosecutor has basically said this is only useful for the military. He's said that the people who really found this and thought it was a good thing were people who were going to go to the defense department for money.

Juror A: Who funded your research?

Bernstein: My research was funded by the National Science Foundation. And also, two of our colleagues were in Austria, and were funded by the National Science Foundation of Austria.

Defense attorney: How can it be used?

Judge/prosecutor/ethnographer: Isn't it true that you also work with people who talk about "quantum teleportation" and "quantum cryptography"?

Bernstein: Oh, yeah. It can be used for quantum teleportation, or quantum cryptography, or quantum computation. Each of those needs some explanation. Basically, quantum teleportation is a set of processes where an unknown state comes in from a hole in the wall—somebody's out there sending the state. Actually, I should introduce new characters: the original story was about Alice and Bob. Alice takes the state that comes through the wall and measures it, together with one of these weird-ass particles in quantum mechanics, where two electrons with opposite spins to each other, or two photons with opposite polarizations. They can fly away from the mutual region where they got that condition, and then when you measure one of the particles way over there where Jonathan is, then where Jeffrey is on this side of the room, the properties of the other one are kind of predetermined by what you chose to measure. But they're unknown until that measurement is done. Anyway, you've probably heard about Bell's inequality, or "spooky action at a distance." You can use that now, through quantum teleportation—we're actually working on quantum teleportation—I'm getting in worse trouble all the time. Anyway, Alice over here captures the particle that comes through the wall, whose state is completely unknown to anyone, except maybe Charles, and Alice measures that: looking at reality, and creating, in my mind, creating the reality by doing the measurement—together with a particle that's one of these spooky ones. So Alice, by measuring the relative state that's coming throught the wall, can determine one of four things to say to Charles, four messages: nothing, *x, y,* or *z.* And Bob over there takes the particle that he has, one of these weird particles that has no properties until you measure it, and if Alice told Bob "zero," he does nothing. And if Alice told Bob "*x,*" then he turns that particle 180 degrees around the *x* axis. And if "*y,*" he turns it 180 degrees around the *y* axis, and so on. So there's only four messages, two bits of information that have to be transferred. And the entire quantum state reappears for Bob. That's quantum teleportation.

The device is very important for quantum computers. Quantum computers have recently been shown, in theory, to be able to solve problems faster than any classical, mechanical problem-solving computer. And quantum cryptography can provide a way, using these same weird-ass particles, to send a secret code, a string of symbols that's identical to Alice on one side of the room and Bob on the other side of the room, in a way where if any eavesdropping is done, it can be detected. And if any eavesdropping is not done, the code that's sent is automatically completely and provably random, and the two codes are guaranteed to be identical. That's why it's a perfect secret code.

Defense attorney: Is what you're saying, I'm not sure I completely understand this: if you want to communicate with another scientist, and the govèrnment wants to spy on you, if you're using this code, you can actually have a secure way of communicating?

Bernstein: Well, it probably wouldn't be the first application.

Judge/prosecutor/ethnographer: What *would* be the first application?

Defense attorney: I object!

Judge/prosecutor/ethnographer: Overruled. The witness will answer the question.

Bernstein: Banks in Europe have commissioned a four-year project to implement quantum—it's so silly—quantum cryptography for communications between a teller's desk and a central computer.

Defense attorney: So your account is completely secure?

Bernstein: Completely secure, no problem whatsoever. It's guaranteed by quantum physics.

So basically it has some uses for the cutting edge of technology. By the way, these are three different effects. And teleportation of this kind is not like Star Trek teleportation. *[Groans of disappointment]*

Defense attorney: So basically what you're saying is, this can be

used in a variety of ways, but that basically what it ends up doing is enhancing the ability to communicate information, for whoever is using it.

Bernstein: Yeah, with a very heavy dose of the spy metaphor introduced, instead of just privacy.

Juror A: What is the responsibility of the scientist in directing who gets this information? What is your responsibility, given what you can imagine, obviously? What do you feel your moral responsibility is, and what will you do?

Bernstein: What I do is try to work out with my Austrian colleagues how you're supposed to write it up. And we didn't come to complete agreement, so part of the way that I look at this problem isn't totally disclosed by the paper. But the ethics of science, which are really what's under scrutiny today, are to publish fully and frankly and let the other physicists in the world know what it is that you have discovered. And so far I haven't really completely done that, because I've been a little bit—

Beam to: Cryptography's Crypt

Scan for: invisible forces; the moon's other face; Black Chamber; homelessness

At some distant, unknown location a laser scans a rapidly spinning disc and converts the information encoded there into an electrical signal which, again transduced, is beamed into a spreading electromagnetic wavefront, picked out of numerous others by the antenna and tuner in the rental car, and converted to sound waves so that we can hear a track from Pink Floyd's *Dark Side of the Moon,* an uncanny presence as we drive toward the National Security Agency. The quite explicit directions that we downloaded from the World Wide Web would take us there from any direction of the compass: "From Washington, D.C.: take the B/W Parkway (Rt. 295) North towards Baltimore. Take the exit for Rt. 32. When you reach the light at the end of the exit ramp, make a left, towards Columbia. Take the first right onto Colony 7 Rd. Go past the Shell station to reach the museum." After the Shell station the road turns rough, hardly fitting for an approach to a national museum, until it ends a short distance later in a parking lot. The chain link fence has a small sign, Colony 7: we're in the right place, whatever that—Colony 7?—is. We're at the National Cryptologic Museum.

This memorial to the extremes of secrecy, paranoia, and conspiracy may only exist because of a fear of the homeless and the policy paralysis that they elicit. The NSA had bought what was once a small motel, which sat vacant and unused while various factions within the agency haggled over what should be done with it. A new federal policy required any unoccupied government building to be used as a homeless shelter, so the NSA historians, ready with a plan to build the museum, saw an opportunity and took it.

At least, this is what we were told by one of the museum's guides, a woman dressed in simple, everyday clothes, looking ready to jump in the minivan and drive to the PTA meeting or pick the kids up at soccer practice. She had worked at the NSA for ten years, and was now even allowed to say she worked at the NSA; up until a few years ago, she would only say that she worked for the Department of Defense.

She became an intermittent presence as we slowly wandered around the various exhibits. There are some heroes depicted in photographs and print: Herbert Yardley, of course, founder of the Black Chamber, MI-8, whose legacy would become the NSA; William Friedman, geneticist turned cryptologist (a short turn); a number of Choctaw and Navajo Indians utilized as "code speakers" during WWII. There are some villains: Julius and Ethel Rosenberg and Klaus Fuchs, caught sending secret atomic messages to the Soviets; Kruschev with the remains of Gary Power's U2.

And there are a lot of machines, from "primitive" coding machines consisting of wooden or ivory wheels, to modern—well, things seem to stop around World War II. But despite the overwhelming emphasis on displaying machines and information, it's striking how the body always has to be exhibited, too. The absent body: mannequins with a variety of military uniforms. The assaulted body: a poster of a schematic brain inundated by phrases, mathematical formulas, technologies, trying to discern what is secret and what isn't. The imprisoned body: photos of four heads, displayed behind a foreground of steel prison bars, listing the numerous consecutive life sentences they are serving for divulging secrets. The hyperbody: a time-lapse video showing the assembly of a "data storage tower" to the frenetic soundtrack of a classical fugue. Calculated and sacrificed bodies: an old newspaper article tells of how Churchill, having decoded information that Coventry would be bombed, made the difficult decision to do nothing, since evacuating the town or mounting an extraordinary air defense would reveal that the British had cracked the German Enigma code. The state cultivates cryptology so it can know the secrets of other states, but then can't show that it knows these secrets; better for the greater, long-term good to assign other remains to crypts.

We ask about the posters. The NSA, the guide says, has an entire office devoted to turning out these cheesy propagandistic reminders that—she is too young to remember this from direct experience, but who needs direct experience in this area anyway?—"loose lips sink ships." "You don't notice them after a while," she says, "until a new one appears and grabs your attention briefly." Then it, too, will fade from memory, and the security urge must be reinstilled in bodies again. The guide goes on: "There was one at Christmas with Santa Claus with a finger over his lips, checking his list twice"—that

primitive code written into bodies at a very early age: naughty, nice. For the fiftieth anniversary of WWII, one poster displays another poster from that time with a new message written underneath: "The message is still the same."

The back wall of the museum is rather enigmatic, until you realize it, too, is about the body. Three large panels taking up a lot of seemingly valuable space relate the episode of the USS *Liberty,* a vessel conducting surveillance in the Mediterranean during the 1967 Arab-Israeli war. A picture shows one wounded NSA employee, and the text mourns another who was killed. The message, says the guide, is that all us spies don't just sit here at Fort Meade, but some of us put our bodies on the line defending the country. (It's also the only part of the museum dealing explicitly with post-WWII events, although this may change as materials become declassified at a faster rate in the next few years. But for now, no Korean War, no Vietnam War, no public key cryptography, no Clipper Chip.)

The exhibits on Enigma are the most compelling. They show the patents for the original German machines, used by corporations and banks, and narrate their modification for military purposes. A small Enigma with a blank white pad stands available for interaction. K. punches in a message on the typewriterlike keyboard, the coded letters light up, the encrypting wheels turn, and K. writes down the scrambled message. Seemingly drawn by this iconic activity, as though tapping on the Enigma machine has created this intense vortex into which swirls the entire museum's tropology, the guide comes to look over K.'s shoulder and asks her if she "needs help." She "helpfully" resets the wheels and then K. types out the coded letters to reveal the original message: Why are—the guide starts to chuckle good-naturedly at the obvious message—we here.

We leave the museum, reeling, standing stunned in a violent wind. A bad, bad case of the willies. The key calls the subcompact Ford Escort into life again, and "Washington's classic rock" station is now in the middle of decoding Golden Earring's "Radar Love" from yet another laser disc:

> When I get lonely and I'm sure I've had enough
> She sends her comfort comin' in from above
> We don't need a letter or phone
> We got a thing that's called radar love
> We got a line in the sky

Beam to: Primary Coordinates—ISIS

Scan for: fooling around with pencil and paper; splitting beams; megalomania

Bernstein: Some of you were here—John Woodell in this audience is actually working away on this problem. In 1974 I had studied the unitary matrices and looked at a certain way of trying to fool around with them to get them to perform; that had some interest for physics. And I did it because we wanted to find out: if you have a mirror that's only partially silvered, and kind of splits the beam in two—you know those one-way mirrors? They're actually partially silvered—and if you shine light on a partially silvered mirror, some of it reflects and some of it goes through. So if you have it at an angle you can take a beam and actually split it. We were sitting around in my colleague's apartment in Boston one day, with our intoxicants of choice, pencil and paper, and I said, Well, what about a device where instead of being a splitter, it was what we called a "tritter," where a beam shines in and it comes out of three holes? And of course, there'll be two other input holes, and they also split equally. And it also turns out that these devices work backwards, so if you shine it in the output, you get the three inputs. We found, within the afternoon, that there was, and then we asked if there were higher dimensional "critters": I called the four-dimensional one the "quitter"; its name is now the "quarter."

Anyway, we were interested in generalizing the beam splitters.

Juror B: This is where it starts to get—this scene with guys there with intoxicants, raises the question—your example of the virus: there's a clear and present means that causes the question to be asked. But why are you guys asking these questions?

Bernstein: Oh, that's a great question. But I might get in trouble, right? What the hell.

Defense attorney: What he means to be asking is, What did you think this would contribute to society? *[Laughter]*

Judge/prosecutor/ethnographer: Leading the witness!

Bernstein: First of all, a lot of you know that I'm a real cheap date: there weren't a lot of intoxicants involved. The thing that I was after, and I'm always after, and the reason I was playing around with guys doing things maybe closely connected with spies and computers and junk like that, is the whole idea that when you look at an object, at the microscopic scale—when you take physics down to where it's at its roots, its reductionist roots—it seems like the phenomena that you study are being created. And it seems like it's important to know why you study the things you do. There may be even a moral question at the level of what you choose to measure. In the story of Alice, what makes her able to teleport Charles' particle over there to Bob—Alice has to look at the world as if it's totally connected. Even though she knows she's got a particle connected to the one Bob has, she has to imagine that the one coming through the wall is also connected. And when she does that, she creates an image—sets up her apparatus that allows her to teleport a huge and complicated quantum state. So it seemed to me that that was a great place to start. And it's not so—you're right. It isn't practical, like punching a cure for the Ebola virus, or the multiplication of the virus. And this may be a bit of megalomania, but the theoretical physicist today serves our society the way

storytellers and mythmakers—in the sense of pattern stories that are summaries of the moral fibers of a nation or a people—the songster of ancient Greece, rather than the philosopher who was the person who gave out the story of the gods and reality—and the theoretical physicist, especially as played by the popular press, serves that function. So that also raises for me the question of what is the moral relevance.

But I'm concerned that maybe I've missed the instrumental truth, the instrumental application. I was thinking about these other things, and how could I get a device that I could study, that would tell you how Alice's looking at the world as connected, ended up with her able to do this powerful trick of teleportation.

Oh, I know what I wanted to say before: this kind of teleportation doesn't go faster than light, and it doesn't go from the USS *Enterprise* down to a specified coordinate. It goes slower than the speed of light, for sure, and it goes to wherever Bob is. You print in the *Daily Hampshire Gazette:* 0, *x, y,* or *z.* And Bob, with his particle in the box, can then turn it into that quantum state. It's very different, and much more possible, in accord with current science, and quantum teleportation will probably take place within the next couple years.

It's really creepy how science fiction can become science, and how theoretical and experimental physicists are involved. And me being sort of right at that juncture of theory and experiment, I want to find out how experiments create reality. And how can I hope, or help, everybody in the sciences and in society recognize that as an important factor in modern science. Both in something as esoteric as quantum mechanics, and also throughout science in a much more generally accessible way. When you look at something, you create what you're studying. When you use science, you set out a field; that field becomes important, it's highlighted out of everything else that's going on, and there's a strong moral implication of what we choose to study becomes the thing that turns out to be most real. If you are guided by the fact that numbers are important, and you throw out the unquantifiable, a lot of stuff that I hold very dear is going to be left out of what we all consider real and therefore important.

Beam to: Aye Spy

Scan for: secrecy; encrypted bodies; nonlocality

A quick check of the computer logs from previous beaming operations: this account has been going back and forth between two papers published in *Physical Review Letters,* trying to map the (possible) entanglements between them. The paper which Bernstein coauthored and which was the focus of the trial dealt primarily with the mathematical properties of "unitary matrices"—properties which could be experimentally realized/verified through an apparatus which splits and recorrelates beams of photons. What is under question is the relationship between this paper and, on the one hand, possible devices with military (and commercial) applications and, on the other hand, to other literature in physics.

The other physics article, the 1993 teleportation paper by Bennett et al., lays out some remarkable accomplishments in physics through the story of its two characters, Alice and Bob. Quite simply, Alice and Bob are trying to communicate clandestinely and accurately. In their most general form, the entanglements of EPR particles "assist in the 'teleportation' of an intact quantum state from one place to another, by a sender who knows neither the state to be teleported nor the location of the intended receiver. . . . Suppose one observer, whom we shall call 'Alice,' has been given a quantum system . . . prepared in a state $|\phi>$ unknown to her, and she wishes to communicate to another observer, 'Bob,' sufficient information about the quantum system for him to make an accurate copy of it" (Bennett et al. 1993, 1895).

We are dealing, then, with neither human bodies, cats, nor tonight's dinner, but only particle states. This is more or less equivalent to saying we are dealing with information. If Scotty, Tabby, and goulash are on the future's distant horizon, what is on the more immediate horizon is simply the Message.

In the diagram of quantum teleportation in figure 4.4 we see that what this turns out to schematize is a method of sending perfectly uneavesdroppable, unbreakably coded messages. This perfect security is an effect of the "unspeakable" part of the apparatus, the entangled EPR particles in the lower center of the diagram. Because these particles are correlated at the "nonlocal" level, and because the particle properties—or, if you prefer, the particles themselves—don't exist in the usual, stable ontological sense, but only in the spectral hauntological sense, they can in theory constitute a perfect signaling system. Somewhat paradoxically, their very spectrality and "unspeakability" results in their being able (with the assistance of the physicist, the experimental apparatus, and perhaps some other terms) to literally write themselves into reality—a writing that is without a trace of difference. A perfect transmission because it's not a transmission at all, but a re-creation of the world, a writing of the real. A perfect code because the only intermediary term, in the gap between the destruction/reading and the making/writing of the world (that is, particle state), is an incommunicable ghost.

But now entangle this reading of the diagram at the level of microphysical processes with another reading at the level of the socio-crypto-logics. What remains outside the frame of this diagram, which may or may not be the space of conspiracy, is the answer to the question, Who prepares the unknown quantum state for Alice? Where does A come from? One possible answer is the National Security Agency, that government agency which has tried the hardest

to remain in the spooky realm of the unspeakable, and been fairly successful at it.[4] But as the court transcript shows, other answers cannot be dismissed, such as: banks sending information about *your* monetary transactions.

Because Bernstein's coauthored paper, according to the socio-crypto-logic reading, might be represented by the fuzzy line C in the zone of the unspeakable, it is entangled with these other ghostly presences of the teleportation paper, and by extension, with the fields of cryptography and the out-of-frame workings of the NSA. One of my roles as ethnographer has been to try to help Bernstein communicate with these scary half-presences, and the machinery of this text has been geared primarily toward that more spectral side of the diagram.

But together, at ISIS, we have tried different genres, to see what different effects we would get. The "trial" is the one that this text has been beaming back and forth to, but in each case, the central issue was the problem of what it means to be a socially responsible scientist in this kind of entangled situation. For a variety of reasons, that question gravitated mostly to the zone represented by the upper righthand corner of the diagram, the speakable realm of future application: should Bernstein consult for the Defense-funded engineer? In that more public realm, where time is limited and available discourses leave something to be desired, questions of application, ethical use, control of devices, good and evil, guilt and innocence, and so forth become much more manageable. They seem to make much more sense: "We can understand how you might be worried about how your ideas will get used, but worrying about the theory you're creating, the form of knowledge you're participating in? That's crazy! Those are ghosts!"

The opening section of this essay was drama, a literary device to warm up the apparatus before starting the experiment. While it was not wrong for us to focus in public events on the military application of Bernstein's work as willies inducing, it's neither ethnographically precise nor the entire picture. Long before he was asked to consult on the military grant, Bernstein felt the willies. Not knowing what exactly was wrong or what bothered him about these references to "Alice" and "Bob" cropping up in these papers in associated physics literatures, he could only say, "It just gives me the willies." What makes the willies the willies is that Bernstein sensed something within the most "abstract" theory, with no application in sight. It's as if he knew that his present work was tuned in telepathically to the future—an indeterminate future that nevertheless had some ghostly effect on the past with which it was correlated, just like the EPR particles—and knowing at the same time that telepathy is crazy and impossible, and that he was worried about nothing.

When the trial proceedings strayed more toward this ghostly side, I think the transcript shows (because I perversely preserved it by not cleaning up the transcript) Bernstein's encroachment into the realm of the unspeakable: he stammers, grasps for phrases, falls back on worn and inadequate notions. My own rearticulations here are no less stammering and, ultimately, inadequate. It is, as the saying goes, the nature of the territory.

Beam to: Primary Coordinates—ISIS

Scan for: garbled transmissions; cats out of the bag; patent or lobotomize?

Juror C: I have a question. Your defense apparently is, while you really think there is, or at least the possibility, that the results of your research may be used for military purposes, but your defense is that the scientist's job is just to report the findings in a public way to the rest of the scientific community. Does that defense work for those who discovered the atomic bomb, the machine gun, or any discovery, no matter what the result is?

Bernstein: That's a great question. It comes from my poor presentation. I said that putting your ideas into a paper like this are what the usual scientist would say is their responsibility. I don't believe that, and this stuff about finding out my role as a mythmaker and so on is only part of what the answer is. I believe that we don't know the replacement for the story that your only responsibility is to publish. What we do know—and I don't know whether I would cite the same examples you did—but we do know at this point, so late in the twentieth century, that more has to be done by the scientists, about thinking and doing something with respect to what the applications are. And what I personally do is spend a great deal of my time with ISIS. And it should be no real mystery to the people in this audience, who are so closely associated with Hampshire, that all scientific projects have some kind of social conditions around them, both in the input and in the output. What are the effects going to be, who gets to fund it—when you're taught at Hampshire how to read a scientific paper, you read between the lines: who paid for the funding, where are the people, what are their previous researches, what are the social conditions of science? What I do is I think about that all the time, I work with people who are actually applying science at the same time, and I should be thinking about the applications of my own science. Publication is not the end of it. What I was saying is, that's what is usually presented as the defense of science. For me the real defense is that you don't know what science is going to be used for. If you're really engaged, if you love the stuff and you want to do it, if you want to find out something, you've got to ask, Who are you working with, what are they doing with it, what are you doing with it, what can someone imaginably do with it, and how did you come to it? And you the scientist have to ask it. You can't turn it on and off, like between

eight and five you're doing your science and afterward you sign the petitions.

Juror D: I have an objection. I've heard this same line for a long time. And it comes back to this exact same point, right here, where it ends with: "and you have to ask all of these questions." That avoids the responsibiliity of actually *doing* anything. The responsibility, the time wasting, taking you away from the science that you want to do as a scientist. The responsibility of following the path on all the elements that you've developed, developing a corporation to take control of it, and propagate it, and control its use. Which will take over your life.

Bernstein: Not necessarily.

Juror D: How will we know unless we've tried?

Defense attorney: So are you positing that the only way a scientist can really protect his science is to patent it?

Juror D: Not necessarily, but it's clearly not the end of the road when you say, "Aha, it's out in the world." Because there's this other stage that a bunch of people are now going to go through to apply it. You're not divorced from that, you're not powerless, you don't have to sit back and say, "Oh, well, there it goes." Because you have an advantage that no one has: you knew it first. You have a leap. You can exploit it. You may not be successful. But that's not relevant.

Bernstein: But you also have other responsibilities.

Judge/prosecutor/ethnographer: Let me ask this witness a question. Dr. Bernstein has been contacted by the person who submitted this grant, and who actually got this grant from the Department of Defense. He called Dr. Bernstein up, said, "Please come consult with me. There are a few things that I don't understand about your proposed piece of technology. Perhaps you can help me work those out." Do you think Dr. Bernstein should go and consult with this person? If so, how would that consultation proceed? Or if not, what are the consequences of that?

Juror D: Clearly he should talk to him and find out what it is he's actually talking about. And also I would say that the way you have a table-top device which is close enough to an algorithm that you believe it could essentially be duplicated in silicon or in some other medium, then you have a patentable thing. . . .

We have all this marvelous technology, and stories about how people gain control of them and keep control of them through economic means. And I think there are worse—there are times when the cat's out of the bag, and forget it, once it's out, you can't control it. But there are other things where you come very close to designing a piece of technology, you're right there, and you have a lot of options.

Juror E: If you're trying to define the responsibility of a scientist as being held responsible for the applied use, or the potential, I just think that's ultimately impossible. Because you're trying to predict

one small factor *[tape ends]* technology. And in genetics alone, it's just not going to happen. So I think trying to take control of that behavior through things like patents—it's trying to control far beyond what you can do. And I also don't think that trying to sift through, predicting that outcome, is doing good science.

Bernstein: But it may be good literary analysis. Maybe you could deconstruct your own paper.

Juror E: Yeah, it may be good literary analysis, and it's good for discussions like this, but it isn't good science.

Defense attorney: Do you think if you do identify some bad use of the information, or some way that you wouldn't be able to control it, you should not have the idea?

Bernstein: Not have the idea!?!?

Judge/prosecutor/ethnographer: The court orders a lobotomy!

Defense attorney: Okay. Do you think you shouldn't write it down?

Juror F: That's the same idea as destroying it by measuring it.

Juror G: A more abstract and concrete example of that is the people who invented group theory, who were very proud of the fact that it had absolutely no conceivable use, or that there would ever be any earthly use for group theory. It turned out to be absolutely essential to crystallography and also to the atom bomb. So you may think that you've explored all the possible uses, but you're guaranteed you won't.

Juror H: [Inaudible] what I was planning to. Some of the things *[inaudible]* you seemed to talk a lot about *[inaudible]* things that are going to be empowering, especially around communications *[inaudible],* the telephone, and the radio, and the television *[inaudible],* and all the applications *[inaudible].* And I was wondering whether, never mind just the possibility *[inaudible]* of something you want to pursue, and on the other hand, it seemed that all of the things, the ability to communicate has become cheaper, now you can get a cellular phone for nothing. The ability to create a cellular phone has become much more *[inaudible]*—you can't do that anymore: you have to go to Texas Instruments, you buy their packaged chips, you put it on a circuit board. It's very cheap for me to do that, but only Texas Instruments *[inaudible]* created those chips; only AT&T *[inaudible]* have the committee to set the standards for which *[inaudible].* And now we're talking about quantum mechanic materials that I don't have the *[inaudible]* to create on my tabletop—I know you have, with some help from NSF.

Judge/prosecutor/ethnographer: The prosecution did fail to mention that we've organized this trial around the military as the problem. But in fact, section 5 of this proposal is a commercialization strategy: "it can be used on the information superhighway and multimedia environment, where immense image and video data need to be processed and transmitted in real time." And there are supporting letters

from the chief executive officers of various corporations who are ready to commercialize these devices. So perhaps the military is no longer the real evil in the world: it's transnational capital that Herb is aiding and abetting! *[Laughter]*

Defense attorney: Fortunately, that's not what he's on trial for!

Juror I: Did you talk to this guy?

Bernstein: Yeah, sure.

Juror I: And what was the outcome?

Bernstein: It's a little bit scary, actually. There are a lot of people that I like in the world that have no qualms about working for the military or transnational capital or whatever. And I have my own qualms about working for the military. But he's a really nice guy, walked us around campus, made sure my family had some drinks on a hot day, and a place to sit while we were talking. But he is the son of Russian émigrés, and like some of my Austrian colleagues, tends to think that the U.S. Army is one of the world's greatest gifts, because of what its presence did to the social and political structure of their countries: breaking up various forms of tyranny and saving Austria from becoming part of the Eastern bloc, and so on. So he gave me this speech about how great it was that it could be sold as part of the battlefield of the future, to these guys who were so far removed from research that they didn't even have a copy of *Physical Review Letters* in their whole institution—he had to staple my paper on the back, because when he called them while preparing the proposal—he's a physicist, they're physicists, they don't even have the main journal in our field at their fingertips. It was recently published, maybe they get it late. Or maybe they're actually engineers. But anyway, his story was that just like we're discussing now, this stuff is great, as he saw my ideas, in an application that I hadn't foreseen, according to him, which is to do the same thing for lightwave communications that you would do for radio in what is called spread-spectrum communication: you have different channels, each of which is a *combination* of different frequencies, unlike ordinary radio where each channel, each station, is one frequency. You put this stuff in a triangular-array device inputting different colors, it mixes them together, and you have one white-light pipe that holds all the signals. It's called multiplexing. But it's really the same thing as having different radio stations on your dial, making these bits appear more rapidly and having coding for different messages, but you gotta do what you do on the airwaves: mix the frequencies together.

It's really remarkable, in this trial setting, people have come to this: that that's what's behind this, that the patenting is what's important, and the capital flows are interesting, and that the ideas are probably more connected to our current social and cultural environment. Mike alluded to that: this isn't a witch hunt for commies versus capitalist, or militarists versus nonmilitarists. It's more like, What is our current economic and social circumstance going to do with this? And as you probably suspected, it's going to be big-time communications stuff.

And there's always this thing: a lot of my colleagues say, "Look, it's going to be secure"—this is what my defense attorney was saying—"That means you'll have privacy." No, that means the government will want to screw up your idea, don't worry about giving it out to your colleagues. But then the literary analysis is important: when you have a paper that's written about teleportation and it talks about Alice and Bob, and those are characters in all of the spy literature—that is, not spy novels, but in cryptography—you have Alice and Bob instead of A and B.

Did I answer your question?

Beam to: Dear Old DoD

Scan for: driving history, under the influence; nonlocal conspiracy

How massive military funding for basic physical research in the period since World War II has affected the kinds of knowledge produced by physicists accepting these funds, and how it has affected the discipline of physics as a whole, has been subject to more theorizing by historians and philosophers than can be covered fairly here. Again, I select a few examples noteworthy for the force which they have exerted within their disciplines.

Paul Forman, an historian of science at the Smithsonian Institution, has provided one of the most thoroughly documented empirical studies of defense spending in the physical sciences in this, the postwar period. While not explicitly endorsing anything like a "conspiracy theory," its title, "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940–1960," carries a fundamental conspiracy trope: behind the veil of appearances lies an unseen yet powerful controlling force, which may be an institution or a logic. The basic narrative is that physicists once had "control" of their discipline but, as a result of the political-economic realignments of World War II and new patterns of federal and industrial spending in the sciences, lost control by ceding it to the military (and industry). Thus there is no room for any third or higher term in the analytics of control: it resides either with the physicists or with the military. Even if that latter term is multiplied into the suggestive phrase "military-industrial *complex*," the logic of control still remains at a noncomplex level: if *we* don't have it, *they* do. In terms that physicists themselves have been prone to use: someone had to be "calling the tune," and that someone was increasingly the national security state.

Exactly what methods these songsters employ remains hazy, however. How is the tuning, directing, steering, or guiding accomplished? What, in short, is the conspiratorial *telos* and mechanism for attaining it? The textual presence of Forman's article itself—eighty journal pages crammed with extensive, copious

footnotes; an army of charts, tables, and graphs of federal, industrial, and military research and development spending; and numerous quotes from physicists, political figures, and military officials—suggests that an almost obsessive documentary strategy is required if one wants to see what lies behind physics, and particularly its branch of quantum electronics which produced such devices as the laser, the maser, and the atomic clock. It is a noble attempt to *locate.*[5] Forman concludes, however, on a fairly nonlocalizable note: "Though they have maintained the illusion of autonomy with pertinacity, the physicists had lost control of their discipline. They were now far more used *by* than using American society, far more exploited by than exploiting the new forms and terms of their social integration" (Forman 1987, 229).

It appears, then, that if "control" has gone anywhere, we might look for it in something called a form. The term may come from philosopher of science Ian Hacking, whose frequently cited article titled "Weapons Research and the Form of Scientific Knowledge" Forman quotes earlier in his own article. Hacking discusses how what he calls the form of knowledge, as opposed to content, might be connected to military funding. He admits that the concept "form of knowledge" may be too vague to be useful, a ghost that analysts might chase after futilely, but offers it as an experiment to replace the metaphor of autonomous knowledge with one that "admits that possibilities are constrained in a manifold of complex ways at a particular time." At the end of the article, he explicitly disavows any type of "conspiracy theory":

> I would altogether deplore an inference from this paper, that forms of knowledge connected with research that is primarily funded by the military are wittingly created by those who are responsible for weapons research. Such ideological paranoia is absurd, if only on the ground that, contrary to what I write, the concept of a form of knowledge may be either inexplicable or when explained, empty. I am more concerned that we have no idea of what we are doing in the overall directions of our conceptions of the world. There is no monolithic military conspiracy in any part of the globe to determine the kinds of possibilities in terms of which we shall describe and interact with the cosmos. (Hacking 1986, 259)

Such reservations and cautions notwithstanding, the language of conspiracy remains present as Hacking tries to reformulate terms:

> But our ways of worldmaking, to use the phrase of Nelson Goodman, are increasingly funded by one overall motivation. If content is what we can see, and form is what we cannot, but which determines the possibilities of what we can see, we have a new cause to worry about weapons research. It is not just the weapons . . . that are being funded, but the world of mind and technique in which those weapons are devised. The forms of that world can come back to haunt us even when the weapons themselves are gone. For we are creating forms of knowledge which—spinoffs or not—have a homing device. More weapons, for example. (260)

It would seem that conspiracy theory itself has a kind of "homing device," an internal guidance mechanism which allows it to keep on haunting even after it has been killed and exorcised. There's no need for a "monolithic" military conspiracy because it has been shrunk down and implanted into the body of knowledge, a tracking device that keeps signaling even after the guys in the control room have stopped paying attention or can no longer dominate the complex informatic systems, and even though "we have no idea what we are doing." Along with Hacking we have arrived in a territory of deep paradoxes: "We have no idea what we're doing"—but here are one or two ideas about that. Remote control from an infinite distance—but with no control, exercised by no agent, through the haunting possibilities of "forms of knowledge."

Beam to: Primary Coordinates—ISIS

Scan for: genies; global positioning; timing is everything; ya gotta have heart; dichotomies and beyond

Juror J: What makes you think that you can control information once it's released, whether you have a patent or whether you attempt to control it yourself? Now that the information is out there in a journal, this physicist already saw it and said, "Oh, let's do this with it." He doesn't quite understand exactly how you got there, but can't he figure it out? Once you've let the genie out of the bottle, is it possible to say, "I've got it, don't worry, I've got my thumb on it here."

Bernstein: I like the guy because he's smart; he's definitely going to figure it out whether I go and consult with him or not. But he might not be able to figure out this jumbled mess of physics, and just where the thread that I work on was, that I think is really quite powerful. And I really am in a position where I can try to stop people from doing that particular analysis, rather than going ahead and writing about it in Austria next week or in Italy the week after that. So I do have a decision to make, and I'm kind of leaning to not going out there—the guy got $500,000, and it was nice to talk to him in Baltimore last year, but I don't have to go and talk to him again. I'm concerned that I can't get alignment with him as to how—you see, when you pick a problem to work on, you're steering it. You may not know all the consequences. You may have things that many years later are going to have consequences, and you can't quite foresee it, you may not be able to foresee it at all. But you can figure out where you are now, and who you're working with, and who their allegiances are to. If my program is to investigate reality and morality and all that kind of stuff, then I have

to be careful who I work with. I mean, the other guys should be careful if they're in favor of military applications of hardware, that they don't work with peaceniks.

[The Defense calls Aristotle to the stand]

Defense attorney: You have a book with you, Aristotle?

Aristotle: My *Ethics.*

Defense attorney: Aristotle, I know it's been a long time and you've been very patient, and we won't go over many of the things that have already come up at this trial. But it would be very useful if you could talk about your physics, and the types of things that you did in your time, and the observations you made.

Aristotle: Well, way back when, I did a lot of research. A lot of it had to do with everything falling into its natural place. Objects would fall down because it was natural for them to fall down. Likewise, the heavenly bodies would move on these great spheres that they were attached to, perfect circles. Nowadays I'm told you don't believe this anymore. Nonetheless, this was the basic research that I was involved in two thousand some-odd years ago.

Defense attorney: How did people use that research in a practical way?

Aristotle: Well, for example, the applications of my research into the perfect circles that the heavenly bodies traveled on could then be generalized for navigational purposes. One could use the skies to chart where one was going, and where one was. In the short time that I've been here, I've heard about something called the GPS: the global positioning satellite. This is the current result of my basic research into the spheres, mine and Ptolemy's, the founding of the basic science of navigation. The GPS is the ultimate result of what started out as really unapplied, basic research.

Defense attorney: Now, Aristotle, isn't it true that this GPS is also for the precision guiding of missions in our modern battlefield.

Aristotle: Sadly, it is so.

Defense attorney: And when you were sitting back in your shop, two thousand years ago, did you think about this? Did you worry about the fact that attached to some grant proposal that some guy submitted to the Department of Defense of the United States there was the possibility that your very science of those perfect spheres could be used this way?

Aristotle: I didn't know what a United State was back then.

Defense attorney: Well, what impact does it have on your thinking about your science today?

Bernstein: You're making him jump out of character.

Defense attorney: No, he's prepped. Unlike you.

Aristotle: It is troubling to see applications such as these guided missiles being helped by my research. However, there is little I feel I could have done about it. I did not stop doing basic research, because

I thought these weapons would be falling out of the sky. However, I did not just do research. I wrote my *Ethics [slaps book]* and made them available to all. And in doing so, I made a guide which could be used to understand how to best use this research.

Juror K: But what should we do today?

Aristotle: Perhaps the founding of an institute *[laughter]* that combines science and interdisciplinary studies. Perhaps this would be the modern-day equivalent, combining both doing research and attempting to control where it is used.

Bernstein: [reading from ISIS brochure] Military Nuclear and Toxic Waste Project, Seminars on Socially Repsonsible Science, Science for Survival, Scientists' Dialogue Initiative, Science Education Programs, and Foundation of Physics and Biology.

Juror K: I don't think the Romans are going to attend these seminars.

Juror L: Isn't it elitist, in the same way that you publish a book when, what, one-tenth of one percent of your population could read? Isn't it elitist to create an organization that's strictly among scientists?

Judge/prosecutor/ethnographer: Bailiff, remove this woman from the courtroom!

Juror L: —have a responsibility to the general population, instead of being a great white father? *[Applause.]* Sorry, Aristotle.

Juror M: Don't worry; he's been prepped, remember?

Aristotle: I think it might be troubling that such an elitist configuration occurs. However, would one not publish a novel because it might not be accessible to those at an eighth-grade reading level? Is that not elitist? That which is known and is not communicated, that is elitist. Because it is holding to oneself, and that is the greatest elitism of all. If you know it and communicate it with others, then you're spreading the knowledge. If it cannot be spread to everyone, that is not a reason not to spread it to anyone.

Bernstein: Your preparation just fell apart.

Defense attorney: One last question. We've had a lot of discussion about your physics and its use for gobal positioning satellites. Is your physics correct or incorrect by today's standards?

Aristotle: It is incorrect.

Defense attorney: Thank you. Your honor, the two thousand years that it took for the realization of a global positioning satellite was a very long period of time. But in the time of a scientist today, one minute or ten minutes can be the equivalent of two thousand years. You can't predict how your science will be used. You can only try to direct your science so that it's used in a productive way. On that, the defense rests.

Judge/prosecutor/ethnographer: At this point I would normally ask the jury for a verdict, but perhaps they would like to make a few last points.

Juror N: I'd like to ask Herb the question I asked Aristotle, who essentially dodged it. Could you, realizing what you wanted the conclusion of the experiment to be before you attempted it, could you from that point analyze and determine if it could be used for illicit purposes? And if so, did you make that attempt before you began the experiment?

Bernstein: Boy, that's a good question. I did think about applications, and I did not have the idea of the battlefield of the future in mind, or of spread-spectrum multiplexing. And I don't think I did a great job of thinking that this was going to be an appealing device, and the diagram of the triangular layout was going to attract somebody just because it was so cute. That's probably one thing I could have done, to say, This is a real, new, interesting technological device. What the guy did, actually, was replace the mirrors with fiber optic couplers. And with fiber optic couplers you can just turn a screw and it's like varying how much silver you have on the mirror. And then when he showed me the proposal he said, "I don't want to give you another copy because all of the devices in there are wrong." And he told me basically no light would get through any of these devices, because they're not very efficient.

Juror O: I'm completely baffled by why you think this is even a moral question. I mean, at least take the money off him.

Juror P: Obviously, you're not doing this just to make money, or you would be soliciting grants from the military and build it direct. I think the court agrees that knowledge is power, and that it's dangerous. And yet we also seem to agree that the most moral and conscientious and careful scientist cannot conceivably cover every single base. Forming ISIS is a good step toward that, a good step to communicate, to educate, to share your ideas. But ISIS is a form of communication, not a police force. How do you deal with scientists who are in it specifically for the bucks, who are going to be lurking around the edges of the research, always waiting for the opportunity to take it where you don't want it to go? And in the middle of the paranoiac power struggle, how do you do scientific research?

Bernstein: The answer that I would suggest is that science doesn't stay still. It seems to be that every time I talk about this stuff, I learn more about how old and old-fashioned I am and my views are, and how the notion that "you just don't work for the military," which may have been okay even in the eighties, when I wrote that stuff in *New Ways of Knowing*—it really may not be that the military's so bad. Maybe the military is evolving into one of these rapid-deployment humanitarian forces—I doubt it. I still won't take the bucks, but I did when I was a kid work for the Navy for summers in college, and I didn't feel as good, ever, as when I found out that the project I was working on had been canceled. And it was a great project: I got to fly on the centrifuge that was imitating a rocket, and subject myself to

five and a half G's, and feel what it was like to be going up in the space shuttle. And I loved that. But the moment I really discovered how I really felt about doing that kind of research was when I read in the paper, about four weeks after I had left, that they had canceled this Dyna-Soar project, the forerunner of the Shuttle, and I suddenly felt tremendous relief. Because the project I was working on was a fractional-orbital bomber.

But I think other people would make very different moral judgments, and I alluded to that. Some of my colleagues have life histories, where they think working for the U.S. Army is great.

Juror Q: Herb, insofar as you didn't look far enough ahead, how do you feel about it, really?

Bernstein: Well, I feel much better, right now, about this, than I did in my senior year, when I found out what it meant to have been working on a weapons system. But I feel really on the edge about what I'm going to do. Because I'm going to these scientific conferences in a few days, and I don't know if I'm going to be talking fully and freely and happily about my research, knowing what just happened to the last piece of it. And knowing that these are the guys, who I'm going to be with, who if I give them the mathematics in the way I would—that is, in the way that *didn't* come out in the paper—it's really going to click and it will take off in a direction *[inaudible].* I don't know what I'm going to do about it.

Juror Q: Let's just *[inaudible]*—one is, you spill your guts *[inaudible; major courtroom disturbance: laughter, voices, gavel banging].* On the other hand, if you don't tell them, you only buy a delay, and it ain't that long a delay—I could measure it in hours, but months might be a better frame. So the question is, if you don't tell them, what do you do with the months you buy? That's the real question, that's the only real question here. And obviously my sort of take on that is if you want to buy some months—and that's really all you can do—then you can go out and do something: patent, or take some more control, or follow the research along—if you don't believe you've really found out what's going on here—following along some more. All you need to do is buy time. That's almost the only real practical thing here, because you don't work alone in a vacuum. So what you get is you get these lead times: in practical cases in modern science, what you've typically got is lead times. I mean, you can exploit that.

Juror R: But you do lose something: you lose the high. The high of getting up there and banging heads with people that have the same high as you. I mean, it's part of what you want.

Juror S: We're gathering around a scientist to talk about what scientists do with their work, but I'm struck by that—this discussion is moot, without knowing more about the motivations of other people which you perceive to be evil. And so if you were to disclose to this group here everything you know, and even if we were all physicists,

chances are that we wouldn't do anything bad with that information, because we're not motivated to do anything socially unconscious, or unconscionable. And the grist of this entire mill is the motivation of other people to do things which are exploitive or damaging. Yes?

Bernstein: Well, no. If you were in a room of physicists this large, there would be at least one or two totally bought into things that I don't like.

Juror S: My point is only that you're trying to control for something which—which I'd rather sort of intervene on that other variable, rather than try and isolate and control for.

Bernstein: I think this suggestion is right: you work on all of those fronts, but what hasn't come out here is that you actually do start to get transformed when you do a science that involves the other people. When you are working—I haven't made the connection, admittedly, in quantum mechanics, of trying a new thing this year, which is to get students up to speed to have a community that I do trust and talk with about which direction it should go. But ideally, I think having a large variety of people in on the science, and talking about what it might be used for, and more thought in advance about devices and mechanisms *[inaudible]*—that the more people you get to talk to, the less it is just a group of physicists in the room, the more, uh, the, you know, direction you get, the more real connection to, uh, some, uh, better, more complete, more inclusive—

Juror S: It makes it harder to isolate it from the heart.

Bernstein: Yeah, exactly! *[Gradually trailing off:]* The more combination between the heart, the head, and something else.

Juror T: We've been hearing a lot about the reasons that you might not want to let the information out, and about what you think are socially irresponsible misuses. And I'm just curious as to what you consider the socially responsible use is for your research. What's the potential good?

Bernstein: That's a good question. The stuff that I think that device can be used for includes—there are additional transformations of it—it includes ways to change pictures, or information, or images, but what I want to use it for is to investigate these questions about how do you make reality?

Juror T: Pure research.

Bernstein: It's not pure research to me, because that question is a burning social question: How do you make reality when you do science? I want to use the device to think clearly with, to tell people about, to show—actually, what I want to do is to show people how physics creates reality—and that doesn't sound like a practical application, but it might be one of the most practical applications—that this device gets closer to the heart of the things I've been working on, and there's a practical—that's why I look at that boundary between

the theory and experiment. If it's a real live device, and you can describe or show something very interesting *[tape ends].*

Juror U: We've been focusing on what is the potential evil, but we haven't been looking at what the potential good is. And isn't there a responsibility, to the extent that we can predict, shouldn't we be balancing the potential good against the potential evil, rather than just saying, because it's potentially evil we should think about it.

Bernstein: I think we've gotta go beyond these dichotomies. I think the whole purpose of ISIS—the reason for mixing the practical together with the theoretical in such a strong way, is to break that dichotomy. But another part of our program is the whole idea that it can be used for good and it can be used for evil—the use/misuse dichotomy—is going to be superseded, for sure, in fifty years *[inaudible]*—it's under question at this current time. I think it's possible that that's up for grabs right now. If so, we want to work in a much more nuanced, much more complicated way, than to try to predict either of those. And by focusing on "the misuse of Herb's latest paper"—big deal! The point is, we don't know, whether looking at use or misuse and trying to balance it, helps you one whit. We don't know whether looking at the military funding versus the corporate funding—which is good, which is bad? Nobody knows. So you've gotta do something active, you know?—you have to think clearly, and act nicely or purely or goodly or whatever you want to call it. And I think you do that in concert with bunches of other people, including a lot of people who haven't been included—look at this, it's all white males. The idea of decentering the discussion—you know, we picked something you could polarize around: duh, Herb's bad, Herb's good! But by shifting the whole arrangement *[inaudible]*—

Juror V: I mean, maybe this is cynical, but even if you educate 98 percent of the population to be conscious about science, it's still the other 2 percent that's gonna sneak up on you and *[inaudible]*—

Defense attorney: Well, 2 percent is better than 4.

Juror W: People talk about scientists when they want to scapegoat, or otherwise empower a bunch of people with something—I don't know what. The fact of the matter is, the community of so-called scientists which used to in some way exist because it was small, and it came from common roots, no longer exists. And in fact the real problem is not so much how scientists relate to the rest of the world, because they don't relate to each other. And they can't take from their community outward to anyone else, because they don't have a community. And until they do—they don't speak with one voice.

Juror X: I don't know if any of you have heard the story of the Chinese farmer who didn't know the difference between good luck and bad luck. He had a really good ox that he could plow his field with, and one day his ox ran away. And the neighbors came to him

and said, "This is very bad luck; your ox has left you." He said, "Good luck, bad luck, who knows?" The ox went up in the mountains, the ox came back the next week with an entire herd of oxen, and he was now rich. And the neighbors all came and said, "It seems like good luck this time." He said, "Good luck, bad luck, who knows?" Well, the next week his son was riding on the ox, fell down and broke his leg. And he said to them again, "Good luck, bad luck, who knows?" The week after that the army came in and conscripted all the young men in the village. They went off: all killed in the war—except his son, because of his broken leg he wasn't conscripted. So that's why I urge the innocent verdict for Bernstein: he couldn't have known.

Judge/prosecutor/ethnographer: Well, as many of you, being former students and colleagues of Herb's—I think you probably all knew coming in here today, as I did, that really the only possible verdict in this is: not guilty by reason of temporary insanity. *[Laughter, applause]*

The case is not closed, but court's adjourned.

Beam Decoherence Approaching Critical Levels

Scanners Off-line

General System Failure Imminent

Conspiracy relies on an ontology, a firm delineation of forces, a clear and present danger that, however remote, however inaccessible, at least suggests strategies of control, however unrealizable and far in the future those might be. It is a diagnosis. Conspiracy diagnosed allows one to write a prescription, perhaps for the new genetically engineered drug Will-Ease, the pharmakonic poison/cure for the willies: "Tired of that nagging conscience? Is your will overexercised, stiff, and aching from an exertion that finds no simple outlet in our complex world? *[Animated graphic of head slice with throbbing lurid colors permeating every cerebral fissure]* Try the new night time cold medicine for today's Cold Night Time: Will-Ease. It knows what ails you. Now with calcium and vitamin E."

What have I offered here? A list of symptoms that might or might not cohere into a syndrome, but certainly holding out no inoculative or curative possibilities. Like those things which are sometimes called "psychosomatic conditions," the willies occupies a half-world, a between-state of undecidability. I read this in the data present to me, whether empirical or theoretical—but these terms I know (really, I do *know* this) are fully entangled in a conspiracy of their own, sending super, natural messages to each other through the medium of the

and: empirical *and* theoretical. It is a conspiracy we locate now, for good reasons, in language:

> It is language that is "cryptic": not only as a totality that is exceeded and untheorizable, but inasmuch as it contains pockets, cavernous places where words become things, where the inside is out and thus inaccessible to any cryptanalysis whatsoever—for deciphering is required to keep the secret secret. The code no longer suffices. The translation is infinite. And yet we have to find the key word that opens and does not open. (Blanchot 1986, 136)

The willies can't be fully diagnosed, nor can it be adjudicated. It permits no final decision, but only a continual deciphering generating more ciphers. When does randomness aggregate into conspiracy? Where does innocence shade to guilt? What marks the fall from pure to applied? How does the local harbor its own outside? Why does the impossible seem possible? How should one respond to the call of responsibility? When does one stop asking the unaskable? And yet we have to find the keyword that opens and does not open.

* * *

The French poet and novelist Théophile Gautier coauthored the book for the great classical ballet *Giselle,* inspired by Heinrich Heine's telling of the story of the Wilis. The Wilis were girls "who were engaged to be married yet died before their wedding days. . . . Endowed with unearthly gifts of movement, their ghostly forms seemed never to touch the ground." The Wilis, both "real and unreal at the same time," are among those entities with the qualities of the uncanny or sublime: "The Wilis were so beautiful that it was simple for them to attract young men into their midst. But they were as dangerous as they were irresistible. They danced with the young men who came only to trap them: their suitors were compelled to dance until they died" (Balanchine 1954, 194–95).[7]

* * *

Another mail delivery, more recent. An envelope arrives at ISIS, addressed to Herbert Bernstein. The printed return address reads "Department of Defense, National Security Agency," penned above in black ink, only what seems to be a mail stop, "M322." The brown envelope is empty, there's nothing inside.

Notes

1. The *What's New* electronic newsletter is now archived on the Internet at http://www.aps.org/WN/toc.html.
2. These topics are beyond the scope of this account.
3. On the most fortunate concept of "moral luck," see Williams 1981. As Spivak points out, moral luck is "an after-the-fact assignment," a transmission from the future

to the past (1993, 296 n. 18). For another exposition on what it means to be "after-the-fact" in the pursuit of the sciences, see Fortun and Bernstein 1998.

4. The sole account of any length and detail remains Bamford 1982. See in particular pp. 344–49 for an account of the history of entanglement between the NSA and IBM, and how IBM turned a cipher system named "Lucifer" into the "Data Encryption Standard" (appropriately weakened to facilitate NSA eavesdropping) for all telecommunications.

5. My ascription of "nobility" to Forman's article is quite sincere. Forman's work and that of other historians, sociologists, and philosophers of science has been an enormously productive and important response to what Forman here calls the "inevitability" argument: that the development of physics follows an inevitable and internal logic, unaffected by funding sources or other external, "conspiratorial" forces. For an earlier attempt to locate the military conspiracy (or "legacy") in such a vein, see Fortun and Schweber 1993.

6. Aristotle was played by Matthew Malek, a Hampshire alum-to-be who was studying physics with Bernstein at the time.

7. Deep thanks to Laurel George for putting me in touch with these spirits.

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