INTRODUCTION

WHAT IS SOLID STATE PHYSICS AND WHY DOES IT MATTER?

Solid state physics sounds kind of funny.
—GREGORY H. WANNIER, 1943

The Superconducting Super Collider (SSC), the largest scientific instrument ever proposed, was also one of the most controversial. The enormous particle accelerator's beam pipe would have encircled hundreds of square miles of Ellis County, Texas. It was designed to produce evidence for the last few elements of the standard model of particle physics, and many hoped it might generate unexpected discoveries that would lead beyond. Advocates billed the SSC as the logical apotheosis of physical research. Opponents raised their eyebrows at the facility's astronomical price tag, which stood at $11.8 billion by the time Congress yanked its funding in 1993. Skeptics also objected to the reductionist rhetoric used to justify the project—which suggested that knowledge of the very small was the only knowledge that could be truly fundamental—and grew exasperated when SSC boosters ascribed technological developments and medical advances to high energy physics that they thought more justly credited to other areas of science.

To the chagrin of the SSC's supporters, many such skeptics were fellow physicists. The most prominent among them was Philip W. Anderson, a Nobel Prize–winning theorist. Anderson had risen to prominence in the new field known as solid state physics after he joined the Bell Telephone Laboratories in 1949, the ink on his Harvard University PhD still damp. In a House of Representatives committee hearing in July 1991, Anderson, by then at

Princeton University, testified: "Particle physics is a narrow, inbred field, and it is easy for the particle physicists to create an external appearance of unanimity of goals."[1] This was not a smear against the intellectual viability of the SSC—Anderson conceded that the science it would enable would be unimpeachably sound. Rather, it was a reaction against the tendency of some particle physicists to equate their subdisciplinary priorities with those of physics writ large. It was a challenge to the position high energy physics had enjoyed as the most prestigious branch of American science for much of the Cold War.

The opposition Anderson and his like-minded colleagues mounted against the SSC throughout the late 1980s and early 1990s, which played out in congressional committees, scientific publications, and popular media, laid bare deep divisions that had remained largely hidden to nonphysicists up to that point. Physicists simply did not openly oppose funding for a project championed by colleagues in a neighboring specialty, especially an undertaking so high profile as the Super Collider. That reality had preserved the illusion that physicists were unanimous in their goals for decades. Anderson and his allies, by exposing rifts within the physics community, shattered that illusion. They introduced policymakers and the American public to solid state and condensed matter physics.[2] These fields, although they had represented a healthy plurality of physicists since at least the early 1960s, had nevertheless remained comparatively obscure. So, therefore, had their interests. Increased visibility of solid state and condensed matter physics in policy circles heightened awareness of their distinct perspective on the identity and purpose of physics, which differed substantially from the one politically savvy nuclear and high energy physicists had been selling in the halls of power, with considerable success, since the end of the Second World War.

The standoff between the SSC's advocates and its critics was just the most recent and most public encounter in a long, intricate, and often troubled relationship between those physicists who investigated complex physical systems and those who probed the minutest constituents of matter and energy. Anderson's testimony cut to the heart of the controversy behind the SSC: the high energy physics community, which wielded its intellectual prestige to sway patrons and policymakers alike, was wont to assume that its parochial interests represented the common mission of all of physics. But physics in the second half of the twentieth century was far from monolithic, and, from Anderson's perspective, could not be adequately served with monolithic laboratories.

This book tells the story of how solid state physicists, by developing an identity and a set of intellectual priorities that suited their professional goals, redefined the boundaries and mission of American physics during the Cold War. The research program to which the SSC belonged was rooted in a pure science ideal dating to the late 1800s, which had motivated the founding of the American Physical Society (APS) in 1899. But, almost from its inception, the APS was beset by demands that it do more to represent those physicists who plied their trade in industry. Solid state physics grew from a tension at the heart of American physics between the pure science ideal and the needs of industrial and applied physicists who constituted an increasing proportion of its membership as the twentieth century wore on. Once established within the APS in the late 1940s, solid state grew rapidly into the largest subfield of American physics, developing a set of interests, outlooks, and goals that at times aligned with and at other times clashed with the ideals dominant in other areas of physics. Those interests, outlooks, and goals helped define the scope of American physics and shape the identity of American physicists through the Cold War.

WHAT IS SOLID STATE PHYSICS?

This deceptively simple question has some deceptively simple answers: solid state physics is the study of the physical properties of solid matter; it is a subfield of physics, the most populous in the United States for much of the later twentieth century; it is the branch of condensed matter physics that studies solids with regular crystal lattice structures. Those answers are true within their respective domains, but they gloss over a bevy of bedeviled details. Research into the properties of solids has a long history, but it was not until the mid-twentieth century that physical research on solids became the focus for a new discipline. Yes, the physicists who founded solid state physics and built it into the largest segment of the American physics community were primarily concerned with understanding the behavior of regular solids, but that casts only the palest illumination on those factors that make the field worthy of historical attention. Solid state physics is notable for what it is not as much as for what it is. When it formed in the 1940s, solid state physics defied deeply rooted ideological presumptions—most centrally the pure science ideal—that the American physics community held dear. As a result, it helped redefine the scope of physics itself in a way that would shape its role in Cold War America.

Solid matter—rigid though it is—was ill-adapted for building the boundaries of a discipline when solid state physics emerged.[3] The physical concepts, theoretical methods, and experimental techniques used to investigate solid matter were often just as readily turned to not-so-solid matter—superconductivity, observed in some solids at low temperatures, is closely related to superfluidity, another low-temperature phenomenon. A semantically strict definition of solid state physics would include the former, but not the latter (a nettlesome inconsistency that would contribute to the rise of "condensed matter physics" as a preferred term in the 1970s and 1980s). Furthermore, the vast expanse of questions physicists could ask about solids, and the equally diverse range of techniques they could use to investigate those questions, made for a diffuse field that lacked a set of central motivating questions or techniques to provide conceptual cohesion. As the editors of *Out of the Crystal Maze: Chapters from the History of Solid-State Physics* noted in 1992: "The field is huge and varied and lacks the unifying features beloved of historians—neither a single hypothesis or set of basic equations, such as quantum mechanics and relativity theory established for their fields, nor a single spectacular and fundamental discovery, as uranium fission did for nuclear technology or the structure of DNA for molecular biology."[4]

The argument that the solid state of matter is itself a discrete physical phenomenon carries some prima facie plausibility, but it did not appear that way from the standpoint of physical theory in the 1940s. Although solidity was an easily identifiable trait of some material aggregates, the properties of solids could not be reliably characterized by a consistent theoretical approach. Whereas Maxwellian electrodynamics served as a single framework with which electromagnetic phenomena could be addressed, and physicists could reach for the laws of thermodynamics anytime they wanted to discuss heat, solids were a medium in which electromagnetism, heat, and most other physical phenomena might persist. It would be plausible to suggest that quantum mechanics provides a basis from which it is possible to understand, or even derive, most if not all the properties of solids. However, such an enterprise was unfeasible in the mid-1940s. Investigating solids instead required employing a number of theoretical approaches, both quantum and classical. Solids invited a similarly colorful array of experimental techniques. Physicists explored their properties at the extremes of low temperature and high pressure. They zapped them with neutrons, electrons, and various frequencies of electromagnetic radiation. They chemically doped them and blasted them with ultrasonic waves. They poked and prodded them with other solids. Solid state physics was a big tent, both theoretically and experimentally, and so the impetus for its formation cannot be found by searching for a consistent set of techniques or practices.

Because it could not claim an origin in any one research tradition or regime of practice, solid state was, by the traditional standards of discipline formation, an unusual category. Before the Second World War, physics was understood to be divided into phenomenological categories like thermodynamics, acoustics, optics, mechanics, electromagnetism, and quantum mechanics.[5] After the Second World War, a field appeared that claimed as its domain thermodynamics, acoustics, optics, mechanics, electromagnetism, and quantum mechanics *in solids* (and sometimes in other phases of matter too). Isidor Isaac Rabi's exclamation upon learning of the discovery of the muon—"Who ordered *that*?"—is perhaps a more fruitful starting point for gaining purchase on the slippery history of solid state physics.[6] Whose interests did a field with such an unorthodox constitution serve? What changes in the physics community allowed it to form? How did that formation come about? Given the field's rapid growth into the most populous segment of post–Second World War American physics, what consequences propagated as a result of its heterodoxy and the changes that permitted it? In short, why did the field come to exist at all and how did it influence physics as a whole? Addressing those questions reveals that solid state physics was much more than a provincial subfield, subsidiary to the primary narratives of American physics. It was integral to negotiating the identity of physics and essential for maintaining its prestige in Cold War America.

Telling this story requires trading in some well-worn categories, of which historians tend to be rightfully suspicious. Categories like pure science, or basic and applied research, are problematic. A great deal of work has shown that so-called pure science was adulterated with worldly interests, and that the artificial and not altogether coherent distinction between basic and applied research fails to hold in practice. But historians also recognize the power these categories possessed as regulative ideals that guided the way scientists organized their professional lives. Mario Daniels and John Krige have shown how "basic" and "applied" research functioned as political tools for Cold War scientists, permitting them some control over the circulation of knowledge in a context governed by military secrecy regimes.[7] I approach these categories from a similar perspective and show how pure science, basic and applied research, fundamental research, and other value-laden designations were tools for disciplinary as well as national politics, and therefore reveal the ideals and convictions that gave meaning to physicists' active efforts to systematize their professional lives.

THE PROMINENCE OF PHYSICS IN COLD WAR AMERICA

Taking solid state and condensed matter physics as a central object of historical inquiry requires approaching old questions from a new perspective.[8] A great deal of historical work addresses the question of why the Superconducting Super Collider failed, for example, but it might be more appropriate to ask why it ever had a chance to succeed in the first place.[9] The US government had spent over a billion dollars on a scientific project before, but the Manhattan Project was principally an engineering endeavor, single-mindedly focused on a military objective during a time of war.[10] How did it even become conceivable that a single facility dedicated to uncovering abstract knowledge might consume similar resources in peacetime? It would be tempting to answer this question by pointing to the considerable prestige and influence physics garnered from the Manhattan Project. High energy physics, which emerged from nuclear physics, had earned the latitude to pursue abstract research. Nuclear physics, after all, was exceedingly abstract, even into the 1930s, and it had resulted in the most fearsome weapon the world had ever seen by 1945.[11]

This familiar story reflects aspects of the exalted heights physics attained in Cold War American society, but it neglects what most physicists were actually doing. For all its visibility, high energy physics, which cast itself as the intellectual heir to nuclear physics, constituted only around 10 percent of the American physics community at the time of the SSC's cancellation. Most physicists were not probing atomic viscera at cathedralesque accelerator facilities; they were investigating the properties of the type of matter that surrounds us and finding new things to do with it. Historians require a fuller accounting of those activities before claiming a perspective capable of explaining the place of physics in Cold War American society. It is easy to see how the historical trajectory of fields like solid state physics depended on its relationship with nuclear and high energy physics. Less obvious is the fact that this dependence was reciprocal, and that solid state—a diverse, messy field with a complicated and shifting set of conceptual dependencies—in some respects better represents physics as a whole than do its more revered siblings.

After the Second World War, solid state physics, plasma physics, polymer physics, and other specialties devoted to complex matter grew rapidly. Physicists working in these fields quickly came to dominate the American physics community, at least numerically. Nevertheless, the smaller proportion of physicists who studied the elementary components of matter and the most distant celestial objects capitalized most fully on the postwar prominence of physics. They were the most recognizable to the public, wielded the greatest influence in government, commanded the bulk of the considerable intellectual prestige physics enjoyed in the postwar era, and nurtured intellectual ideals that reinforced those advantages. The contrarian spirit apparent in Anderson's testimony against the SSC emerged over decades as a response to this attitude, becoming central to the identity of American solid state physics.

In addition to exposing long-standing disagreements about the mission and purpose of physics, the demise of the SSC symbolized the end of the era in which physics reigned as the undisputed sovereign of American science. As the SSC faltered, the Human Genome Project gathered momentum on promises that it would revolutionize biology and medicine, and surpassed physics in both public approbation and policy influence.[12] The exalted position physics had held during the Cold War is nonetheless a remarkable historical phenomenon. Even toward the end of the Second World War, American physicists worried that their field was little known beyond a small group of professionals. The exceptions to this rule were iconic figures like Albert Einstein, whose fame was bound up in the legendary unfathomability of his theories.[13] After the war, leaders in the physics community gained national celebrity and became familiar faces in Washington, DC, as they assumed powerful advisory roles, shaped national policy, and shepherded in an era of generous government funding for science.[14] The question of how physicists first attained this position is somewhat different from the further question of how they then maintained it for half a century.

An appeal to the Manhattan Project, and other wartime contributions, does provide a powerful answer to the first of these questions. The $2 billion the United States government invested in the Manhattan Project went in part toward developing a physical infrastructure that provided the template for the national laboratory system.[15] The psychological immediacy of nuclear weapons helped figures such as J. Robert Oppenheimer and Freeman Dyson position themselves as public intellectuals.[16] The urgency of the nuclear arms race created opportunities for physicists to become deeply engaged with weapons policy, which in turn gave them clout on a wide array of public policy issues.[17] The success of wartime nuclear research, which quickly turned abstruse knowledge about the submicroscopic world into a weapon that irrevocably reconfigured geopolitics, goes a long way toward explaining the exalted position of physics in early Cold War American politics and society.

This explanation is less than sufficient, however, to account for the continued prominence of physics through the early 1990s, which included the growth of high energy physics, a field that claimed little economic, technological, or military relevance but nonetheless commanded billions of taxpayer dollars to build and operate research facilities of unprecedented scale. "Megascience," as Lillian Hoddeson, Catherine Westfall, and Adrienne Kolb have christened it, became the standard mode of research for the most visible physics research after the Second World War.[18] From the vantage point offered by a quarter century's distance from the SSC's demise, however, megascience seems like a Cold War fever dream. For how long is it reasonable to assume that the memory of the Manhattan Project sufficed to convince policymakers that high energy physicists should continue to enjoy a blank check from the Atomic Energy Commission (AEC), and later, the Department of Energy, especially when they routinely denied that their work came with practical offshoots?

The remarkable history of nuclear physics in the 1930s and 1940s no doubt contributed to the rapid growth of high energy physics soon after the Second World War. As Audra Wolfe explains in her history of Cold War science and technology: "High-energy physics thrived within the institutional culture of the Cold War because the AEC—the agency that bankrolled it—believed in the inherent relevance of nuclear science to the national interest. What nuclear physics wanted, nuclear physicists got."[19] This explanation captures the psychology of the 1950s and early 1960s, but it becomes less adequate later in the Cold War. Although they claimed the same ancestry, nuclear physicists and high energy physicists had formed distinct communities by the late 1960s. The former was deeply intertwined with the interests of the national security state, whereas the latter was uncompromising in its commitment to pursuing knowledge with no evident applications.[20] The more high energy physics established its bona fides as a field unsullied by practical concerns the less it should have been able to trade on the promise of relevance to national defense, even though it represented an investment in national prestige. What explains the continued—and indeed ostentatious—success high energy physics enjoyed with federal patrons that ended only with the SSC's demise in 1993?

Missing from previous accounts is the contribution of solid state and related research to the image and identity of physics. As Anderson observed when he lamented the unanimous front high energy physicists presented, those viewing physics from the outside were often not equipped to distinguish between the various subfields and research communities of which it was composed. To many policymakers, physics was physics. It generated arcane knowledge about the natural world *and* it produced fantastic gadgets. Those two functions were connected in some way; therefore, the field was deserving of support. Policymakers generally accepted the judgment of the most esteemed representatives of the field as to how that support should be allocated. Sarah Bridger's *Scientists at War* recounts the recollections of New Mexico senator Clinton Anderson, who admitted weighing scientific evidence based on his instinctual trust of the individual expert delivering it, rather than on an attempt to understand the scientific content of the evidence.[21] Habits such as these ensured that the politically best-placed physicists enjoyed considerable sway over the image of the field, which shaped federal funding priorities.

High energy physicists' success maintaining high levels of federal support, however, depended on provinces of physics with less political clout continuing to churn out research with near-term technological and economic relevance. The military made rapid and expedient use of semiconductor-based electronic components and improved materials. The burgeoning American consumer culture eagerly embraced the technological products of physical research such as transistors, integrated circuits, and improved bakeware and stereo equipment. American industry found uses for lasers, superconducting magnets, nuclear magnetic resonance techniques, and bespoke alloys. These originated in solid state physics and allied fields, but as long as high energy physicists succeeded in presenting their work as archetypical and policymakers remained incurious about the field's internal diversity, the benefits of such advances accrued to its more prestigious branch. High energy physics, in short, maintained its success in part because the accomplishments of solid state physics continually renewed in the minds of federal patrons the association between physics as a whole and the technical, economic, and military benefits of a few of its endeavors. A thorough appreciation of the growth of solid state physics through the Cold War is therefore a prerequisite for understanding physics as a whole in one of the most auspicious eras in its history.

THE SCOPE OF THE BOOK

In 1899, the year the American Physical Society was established, its founding president Henry Rowland wrote: "Where, then, is that person who ignorantly sneers at the study of matter as a material and gross study? Where, again, is that man with gifts so God-like and mind so elevated that he can attack and solve its problem?"[22] He referred to late nineteenth-century struggles to understand the structure and behavior of atoms and molecules. The sentiments he described nonetheless colored physical investigations of solids and other complex matter throughout the twentieth century. Solid state physics often drew sneers from those who fancied that their own studies attained a greater degree of elegance and looked down their noses at "Schmutzphysik," or "squalid state physics." These pejoratives, the stuff of water-cooler banter rather than published invective, are attributed to Murray Gell-Mann and Wolfgang Pauli, respectively. In addition to serving particle physicists in their efforts to exalt their own studies, they provided a rallying point for solid state physicists, who found motivation in opposing such condescension.[23] Far from being the grimy and inelegant enterprise high energy physicists derided, they insisted, solid state physics posed gnarly conceptual and practical problems that inspired noteworthy leaps of theoretical imagination and experimental virtuosity.

The great irony of the derision directed at solid state physics is that the things that offended other physicists' sensibilities—its focus on complex, real-world systems, its connections to industry—were the very same things that helped renew the warrant for blue-skies research so valued by those hurling the insults. This book offers a history of the American solid state physics community with the goal of illuminating how attention to it and similar fields can reveal dependencies of this type and thereby enrich, and perhaps even reform, our understanding of twentieth-century physics. It presents a story about the organizational structures of American physics and the ideas that shaped it, following the professional societies, journals, laboratories, and political interventions, as well as the discourses and disagreements that influenced what forms they took. These structures both reflected and reinforced what it meant to be a physicist in the eras in which they were built, and they changed in response to shifting ideas of professional identity and disciplinary purpose. Changing them was often a way to enact a vision of the field, of where it should go, what it should be, and whom it should serve. Through each of the changes traced here, solid state took another step toward reshaping American physics in its own image.[24]

Appreciating how solid state physics changed the collective identity of American physics requires understanding what came before. That is the goal of the first two chapters, which describe the dominant ideals of American physics that were established in the first half of the twentieth century. Chapter 1 charts the rise of the "pure science" ideal, which Henry Rowland mixed into the mortar of the American Physical Society. Rowland saw the society as a refuge for unfettered, curiosity-driven scientific inquiry that would insulate physicists from questions of technological applicability or economic relevance. The centrality of this ideal for the power brokers of the American physics community ensured that industrial physics, as it grew throughout the 1920s and 1930s, was relegated to the periphery. The increasing relevance of industry to the physics community, however, led industrial physics to seek professional satisfaction. A slew of new societies and publication outlets filled needs that the APS and the *Physical Review*, its flagship journal, deigned to address.

Industrial physicists were not content to suffer their near exclusion from the key institutions of American physics in silence, however. Chapter 2 follows the machinations they undertook as mid-century approached, while the physics community at large set about consolidating the resources and influence it had won with its wartime labors. Improving the position of industrial physicists required crafting a new understanding of what physics was and how it should be organized. Whereas traditionalists viewed physics, and its boundaries and subdivisions, as founded in the structure of the natural world, advocates of industrial representation instead viewed disciplinary boundaries as affairs of convention that could be restructured at will to meet contemporary needs. The rise of this latter attitude paved the way for the emergence of solid state physics, a category that made little sense according to the traditional way of looking at physics in terms of discrete classes of phenomena and the practices used to investigate and explain them.

The pure science ideal remained a potent force in American physics through the remainder of the twentieth century, and solid state physics emerged from the industrial insurrection against it. Chapters 3 and 4 chart the discipline as it established its first institutions and grew into the largest constituency of American physics. In chapter 3, I introduce the "group of six," an alliance of physicists determined to create institutional space for industrial and applied researchers within the APS. Led by General Electric's Roman Smoluchowski, the group of six organized to form what would eventually become the Division of Solid State Physics (DSSP), the first institutional expression of the field. They would not succeed without stirring up considerable controversy, however. The push to found a new APS division that would be friendlier to industrial researchers led some to worry that such efforts would compromise the society's purpose, and therefore the unity of American physics. Those tensions persisted in spite of attempts to resolve them within the DSSP, and the push and pull between a desire for unity and a need for more specialized professional representation would define the field's early years.

The physics discipline's rapid growth through the 1950s presented pressing challenges, and these are the subject of chapter 4. Solid state physics outstripped even the rapid inflation of the ranks of all physicists. The large pool of applied and industrial physicists who were underserved by the APS flocked to the new solid state division and helped establish the field's legitimacy. The journal infrastructure, which struggled to accommodate expansion across physics as a whole, felt the greatest pressure from solid state's rapid growth. Discussing the publication problem offered a means to negotiate lingering disquiet about the identity of solid state physics. Some favored establishing new publications and building stronger alliances with chemistry and engineering, whereas others fought hard to keep the field ensconced in physics. The latter view would win out and solid state's commitment to securing its place within American physics ensured that the discipline as a whole would come to embrace constituencies that challenged the strong pure science ideology that defined its early decades and engage more fully with the military, economic, and industrial needs of the Cold War.

The resolution of this issue and the beginnings of a stable professional identity for solid state physics came just in time for conditions that would test it. Chapters 5 and 6 both explore the influence on solid state physics of the mid-1960s funding crunch. The US government, especially the military, had funded all manner of scientific research in the immediate post–Second World War years with a generosity that bordered on the haphazard. In the mid-1960s, funding for science began to tighten. Conditions that had favored indiscriminate growth gave way to an era of red-in-tooth-and-claw competition that sowed bitterness between disciplines competing for the same dwindling funds. The tensions between those who sought to explore solid state's technical potential and those who wanted to position it as a source of fundamental physical knowledge had not resolved, even as the field's institutional situation had stabilized. These two chapters consider how this tension led different research groups to find different niches in the shifting funding ecology. Chapter 5 examines the possibility presented by following the lead of high energy physics and pursuing large facilities for basic research, such as the National Magnet Laboratory at the Massachusetts Institute for Technology. A somewhat different opportunity, discussed in chapter 6, came in the form of materials science, which remained a generous font of federal funding and provided an outlet for solid state's applied ambitions.

Chapter 7 introduces a sharp reaction against the technological legacy of solid state physics: the philosophical defense of emergence developed by Philip W. Anderson. Anderson, responding to the subordinate professional position solid state physicists occupied in the physics community, penned "More Is Different," a 1972 *Science* article challenging the reductionist picture of the physical world that had become gospel within particle physics. The reductionist position maintained that the most fundamental knowledge, and therefore the most important, was to be found among the smallest constituents of matter and energy. Anderson's argument that fundamental knowledge could be had at all levels of physical complexity became a rallying cry for the solid state community. The battle for intellectual recognition would lead some to distance themselves from solid state's industrial roots, heightening internal tension between the requirements of funding solid state research and a quest for intellectual esteem. Acknowledging the intellectual value of the concepts that were necessary to appreciate the behavior of complex matter, solid state physicists argued, would necessitate rewarding their field with both greater esteem and financial support that was not linked to technological deliverables.

This strategy led some to abandon the name solid state physics in favor of a new designation, condensed matter physics. Quantum mechanical treatments of complex matter had developed considerably by the 1970s. They could by then be more successfully applied to fluids—such as liquid helium—amorphous solids, and other systems that did not submit to simplification so readily as regular solids than they could in the 1950s, when solid state physics formed. The growing importance of these research areas made the field's nominal restriction to solids increasingly uncomfortable, providing all the more reason to favor a name change. Chapter 8 traces the transition to condensed matter physics. The new name aimed to delineate a field that could claim the accomplishments of solid state and could make a more serious case that it belonged within the intellectual core of physics.

Public debates over the merits of the Superconducting Super Collider, the focus of chapter 9, prompted both solid state and particle physicists to defend their intellectual and professional ideals in a high-stakes context. Particle physicists relied heavily on the reductionist rhetoric that had served them so well during the Cold War. Conscious, though, that the context had changed, many of them also embellished this justification with sometimes immodest claims about the spin-off benefits of large-scale accelerator research. Solid state physicists rallied in opposition to what they considered an extravagance. They made an aggressive case that basic research funding could be better spent in their own backyard. Opposition to the SSC rested on the claims that solid state was just as fundamental as particle physics, that funding exploratory solid state research with no strings attached would produce more socially and technologically valuable results as a matter of course, and that the concentration of federal physics funding in large facilities damaged other areas of research. This view complemented the vision of physics that had been incubated in American solid state and condensed matter physics, and that aimed to synthesize the physics community's long-standing pure science ideal with a commitment to its technological and economic relevance. The SSC's demise, because it marked the limits of the big science program that had dominated physics spending for decades, represented a public victory for an alternative to the hard-line pure science outlook that had been maintained in part by the technical contributions of solid state physics throughout the Cold War.

The original *Star Wars* trilogy tells the story of a ragtag band of misfits, many of whom are adept at manipulating a force pervading everyday matter, who ally to mount an insurrection against the established order and help destroy a giant, partially built beam machine. The history of American solid state physics, as chronicled in these chapters, followed much the same plot. The field was cobbled together from a diverse assortment of research traditions, the only common element of which was a focus on the forces governing the matter that surrounds us—and how to manipulate it. Its formation represented a rejection of the traditional power structure of the American physics community, which exalted pure science and held applications in lower esteem. And it came to public prominence when many of its influential practitioners mobilized to help bring down the SSC. (The Super Collider, admittedly, was not designed for the express purpose of destroying planets, but some on the fringes have suggested that similar machines might have just that effect.)[25]

Many solid state physicists adopted a rebel mindset, marginalized as they were by the low status accorded applied physics and their more powerful colleagues' derision of their intellectual efforts. Their professional machinations were calibrated to challenge this status quo. It is in this sense that the establishment and growth of solid state physics constituted a form of rebellion. Much like political uprisings, the solid state insurrection responded to specific grievances. It reflected the interests of industrial physicists, who railed against the predominant ideals of American physics and its traditional modes of professional organization. Subsequent efforts solid state physicists mounted to rearrange the institutions of American physics sought freedom of disciplinary association, or more equitable distribution of resources. It would be a gross exaggeration to say that solid state physicists threw off the hegemony of the pure physics ideal, but this need not weaken the metaphor. Insurrections, after all, do not always lead to overthrow. They can also involve a new integration, one that brings into the center groups whose interests were previously on the peripheries. The conclusion of this book reflects on how we can understand the history of American solid state physics in just that way.