yond a mere summary of the growth of scientific ideas, although that does not justify largely omitting scientific ideas from this volume—omitting, as it were, the science from the history of science.

Lankford's *American Astronomy*, aimed at scholars, presents a quantitative case study of some 1200 US astronomers active between the beginning of modern spectroscopy in 1859 and the historical watershed of World War II. This book pitches the author squarely into the "science wars" or "culture wars" currently being fought in the academic community, pitting those scientists who claim for their truths a privileged position against those historians who denigrate scientific knowledge as a social construct without objective foundation. Lankford's position is closer to the latter than to the former.

Lankford asserts that his emphasis on community as a fundamental unit of social historical analysis produces a more nuanced reconstruction and explanation than do more conventional histories. His insight into professional tensions between the old astronomy and the new astrophysics, however, is not more profound than that available elsewhere. All the discussion of methodology and overarching theoretical constructs struck me as pretentious.

In that it overlooks scientific achievement, Lankford's history is incomplete. He is unable, for example, to explain the extraordinary efforts to retain Otto Struve at the Yerkes Observatory (Struve's value lay in his scientific achievements.) Also, the focus on the American astronomical community leaves Yerkes' rise to greatness a mystery. (It was accomplished largely through the recruitment of meritorious foreign scientists.)

Perceived scientific achievement can be an important factor in any history of science, even in social histories. Achievement has been known to advance careers, and it often translates into power within a scientific community. Whatever an author's personal belief may be regarding the epistemological and social foundation of scientific knowledge, the fact is that scientists believe they produce valuable objective knowledge and act accordingly. Any analysis of community, careers and power that ignores the major professed value of the community it purports to study—as Lankford's book does—is problematic.

Also problematic is Lankford's attempt to revive quantitative history, which includes tallying up the geographical and social origins of community members, their highest earned degrees, gender balance and anything else capable of being counted. Quantitative history, which typically does not include ideas, was largely abandoned in the 1970s, after much effort and expense had uncovered in great masses of data little of historiographical significance. Nor are inferences from numbers always compelling. For instance, a disproportionately large cohort of astronomers in the National Academy of Sciences from one particular state, California, led Lankford to conclude that geography was as important a criterion for election as scientific merit. There was, to be sure, some political maneuvering for positions and awards, but within narrow limits set by scientific merit. The Californians, for all their power, could not have elected a mediocrity. Their numbers are better explained by the concentration in their state of large telescopes and corresponding scientific achievement.

Lankford concludes that the evidence he discusses in his book weighs heavily against the view of science as a meritocracy. Indeed it does, but only because he has eschewed discussion of the merit of scientific ideas and discoveries. He may bring fuel to the science wars, but little light.

What Lankford does offer, in both books, is a valuable widening of our field of view of what constitutes the history of science. The books have severe limitations, mainly of his own choosing. What he chooses to do, however, expands the world of other scholars.

In the spirit of diversity and pluralism, scientists and historians should declare an armistice in their culture wars and welcome Lankford's contributions to the ongoing debate over the nature of science and the nature of the history of science.

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The Inflationary Universe: The Quest for a New Theory of Cosmic Origins

Alan Guth
Helix Books (Addison-Wesley), Reading, Mass., 1997. 368 pp. $25.00 hc ISBN 0-201-14942-7

Inflation is the panacea for all, or almost all, of the puzzles that have plagued modern cosmology since the time of Georges Lemaître, the first physical cosmologist. Inflation posits that an early phase transition, occurring at the breaking of grand unification symmetry when the universe was barely 10^{-35} seconds old, resulted in a vacuum energy density that persisted for long enough to dominate the energy density of the universe. This phase transition has the effect of producing a de Sitter phase of expansion that briefly takes over from the Friedmann–Lemaître expansion and boosts the causal horizon of the universe into exponential growth.

In *The Inflationary Universe*, Alan Guth, recognized as the founding father of inflationary cosmology, recounts the trials and tribulations, and the glorious successes, that accompanied his breakthrough in the understanding of the cosmos. He is also generous in giving credit to others, most notably Andrei Linde, whose similar theories, developed before Guth's, failed to have as significant an impact on the field, as much for political reasons as for scientific ones.

Observational cosmologists measure to within a factor of three or so the balance between the universe's kinetic energy and its gravitational potential energy. It is by no means inconceivable that the difference between the large gravitational energy and the large kinetic energy in the universe is precisely zero. Indeed, many theoretical cosmologists believe that this is the universe's most natural state, from the perspective of all possible initial states. Of course, physics requires that energy be conserved, and so the universe would then have begun with zero energy.

Inflationary cosmology justifies, and indeed predicts, that the universe has zero energy, but it also tells us something quite new: that the universe began when both its gravitational energy and kinetic energy were arbitrarily close to zero. It literally began from nothing, or so near to nothing as to make no difference. Virtually all memory of initial conditions is erased. Exponential growth results in the ultimate free lunch.

Inflation was initially seen as a means of removing a disastrous consequence of quantum electrodynamics applied to the environment of the early universe, namely that the universe should be full of heavy magnetic monopoles, in contradiction to the observed dominance of normal matter. Inflation removed almost all of the monopoles and explained as well why the universe is as large and as isotropic as it is. Inflation's greatest impact on observational cosmology, however, has been in its prediction of density fluctuations.

The universe today is highly structured. However, the cosmic microwave background radiation, which provides a snapshot of the universe a million years after the Big Bang, is smooth to a few parts in 10^5. Galaxies evidently formed via the gravitational instability of primordial density fluctuations. But prior to 1980, and the positing of inflation, the origin of these seeds of structure was a complete mystery.

In this account, Guth describes the intense excitement generated among cosmologists by the first predictions by inflation of density fluctuations with a distribution of amplitudes that was independent of mass scale. Inflation, it was hoped, would resolve the problem of structure formation.

However, the original inflation model led to a disastrous prediction: The fluctuations were too large by many orders of magnitude. Cosmologists rushed back to their notepads, and shortly thereafter several groups produced differing solutions by modifying the original inflationary hypothesis in subtle ways. At present there are dozens of variants of inflation, all of which are viable in terms of generating structure.

Most, but not all, inflationary models predict a scale-invariant distribution of primordial density fluctuations. In 1992, the Cosmic Background Explorer satellite provided a dramatic confirmation of the spectral prediction: The Differential Microwave Radiometer aboard COBE measured temperature fluctuations in the cosmic microwave background that were independent of the angular scale being sampled, to within the experimental errors. Perhaps even more significant for inflation, the universe was demonstrated to be very close to the Friedmann–Lemaître cosmological model—highly isotropic as well as highly homogeneous. Noninflating universes would surely have had gross deviations from isotropy as well as homogeneity, but these are not seen. In hindsight, this consequence of inflation may provide the greatest tribute to Guth's prescience.

I recommend *The Inflationary Universe* as a delightful guide to inflationary cosmology for the nonexpert. Guth does not hesitate to explain the most relevant physics with clarity and conciseness. At the same time, he succeeds in capturing the excitement of the hunt for what might turn out to be the ultimate theory of cosmology.

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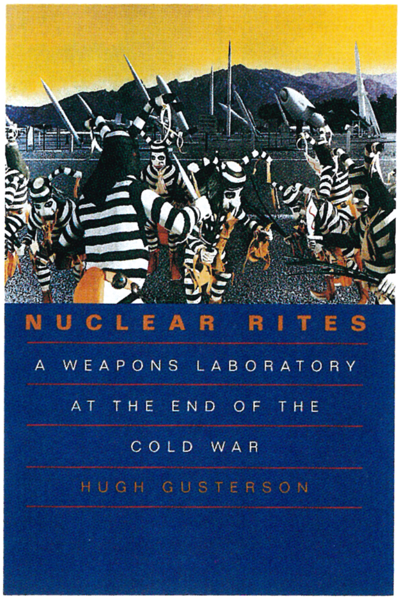
Nuclear Rites: A Weapons Laboratory at the End of the Cold War

Hugh Gusterson
U. Calif. P., Berkeley, Calif., 1996. 351 pp. $39.96 hc
ISBN 0-520-08147-1

In Hugh Gusterson's *Nuclear Rites*, nuclear weapons scientists at Lawrence Livermore National Laboratory are ob-



served by an articulate young anthropologist. Emulating John Donne's comment, "I observe the physician with the same diligence as he the disease," weapons scientists and others may wish to read this book, which describes the perception of their rational worldview of science by an influential—and in some cases, militantly antirational—culture.

The cover of the book has a sardonic picture of a painted, half-naked tribe doing a ritual dance in front of a display of rockets and cruise missiles. Early in his book, Gusterson comments: "My basic argument here is that the laboratory is a high-tech version of the secret societies that anthropologists have traditionally studied all over the world, and that the process of investigation for clearance is a bureaucratic variant on classic initiation rituals found throughout the ethnographic record." An annoying thing about the book is that many provocative observations like this one are uncomfortably plausible.

As part of his research for a doctorate in anthropology, Gusterson lived in the town of Livermore, California, for more than two years. He made a largely successful effort to get to know as many people as possible: the scientists themselves, their spouses, their religious leaders and their local critics. Gusterson is at his best when summarizing personal interviews, which capture the diverse views of laboratory scientists—though perhaps not with the same sympathy as in his interviews with their critics. For example: "The laboratory's Susi Jackson was in the middle of a presentation about the low statistical risk of cancer associated with the planned incinerator when Karen [last name not given] interrupted. Momentarily rendering the speaker speechless, in a way that was savored by antinuclear activists for days after the meeting, Karen called out from the front row, 'This is what makes people angry, the way you use numbers to say nothing. What does this mean? Have you ever seen anyone die of cancer?'" Nice rhetoric, but one should also consider the possibility that numbers can say something useful.

From time to time, Gusterson lapses into his own discipline's jargon, which may be hard for some physicists to follow. For example: "As well as offering a constructivist alternative to the policy positivism that has informed much writing on both sides of the nuclear debate, the book has also, allying anthropology with recent neoliberal critiques in international relations theory, broken with the radical separation of the domestic and international levels of analysis that has been a defining feature of dominant thinking in international security studies, especially (neo)realism." In keeping with its origin as a PhD dissertation, the book has 39 pages of notes, a 53-page bibliography and a fascinating 14 pages of comments from weapons designers, antinuclear activists, religious leaders and others.

There are extensive references to cultural leaders who are little known to the average physicist but are perhaps worth learning more about. For example, Michel Foucault—not the rationalist Foucault of the pendulum and the knife-edge test, but the social critic of human power structures—is given three times as much space in the index as Ernest O. Lawrence, whose style is still recognizable at Livermore. Commenting on Michel Foucault, Gusterson writes: "Foucault argues that we live in the age of the expert wherein the past cultural hegemony of 'general intellectuals'—men like Voltaire—has been supplanted by that of experts or 'specific intellectuals,' Foucault's prototype of which is [Robert] Oppenheimer, the scientist behind the first atomic bomb. These new specific intellectuals, 'strategists of life and death' as Foucault calls them, police the exchanges of power and knowledge that pulse through the circuits of contemporary technocratic societies."

On balance, I found the analysis of the antinuclear movement, its origins and alliances to be more thorough and useful than that of the weapons laboratories. However, the book is not unfair to the talented scientists and engineers who have dedicated their professional careers to nuclear weapons. One of them quotes Charles de Gaulle: "Hope though we may, what reason have we for thinking that passion and