Vignettes: The Hierarchy of Sciences

The change in the mode of scientific production, its loss of criticality, and its subjugation to the laws of commodity production, are features of the sciences most closely integrated with the reproduction of social and economic power. The physical sciences, above all physics itself, are at once the most arcane and the most deeply implicated in the capitalist system of domination. At the same time, the industrialized sciences more or less successfully exclude any more than small numbers of women. They also appear to be highly resistant to feminist reconceptualization; the success of feminist theory has lain in areas such as history, philosophy, sociology, and primatology—all characterized by little capital equipment per worker and by craft methods of production.

—*Hilary Rose*, in *STS Education: International Perspectives on Reform* (Joan Solomon and Glen Aikenhead, Eds.; Teachers College Press)

In the numerous conversations I have had with scientists about social constructivism, gravity is invariably brought forward as the great counterexample showing that science is not culturally constructed. A rock falls to earth regardless of the dominant language or ruling class. Yet even the pervasiveness of this example indicates that it is culturally encoded, for it is linked to a specific history in which Newton's formulation of the law of gravity was an epoch-making event. More subtly, the example is marked by a certain cultural position because it presupposes that mathematics and physics are the core sciences rather than, say, biology and ecology. Many scientists (especially physicists and mathematicians) will say as much explicitly if pressed. They regard physics as the archetypal physical science because, as Norbert Wiener put it, physics manages largely to escape the "messiness" of "tight couplings" between the observer and the observed. The same presuppositions that inform objectivism as a philosophical position also create a hierarchy of sciences that places physics and mathematics at the top, home economics and animal husbandry near the bottom.

—*N. Katherine Hayles*, in *Reinventing Nature? Responses to Postmodern Deconstruction* (Michael E. Soulé and Gary Lease, Eds.; Island Press)

ample, Jane Addams became a garbage inspector for the city of Chicago, while fellow Hull House resident Alice Hamilton investigated the cause of a typhoid epidemic in the surrounding neighborhood.

A second theme is the political economy of cleanliness. Hoy makes clear that urban sanitation involved, most fundamentally, a willingness to collect taxes for public services such as sewer and water systems. She also acknowledges that educating women about the bathing and feeding of infants meant little if they lacked ready access to bath water and a means of purchasing healthy food and that campaigns against flies had little relevance for people living in crowded, filthy tenements. At the same time, it must be said that the book's treatment of the political and economic issues surrounding America's physical, intellectual, and cultural response to dirt is often hasty.

Hoy draws from recent histories of medicine, immigration, domestic life, public health, advertising, and women to weave a complex story of the transformation of a literally dirty nation into a clean one. Eschewing a statistical approach, she offers personal testimonies gleaned from diaries and other documents to make her points. We read graphic descriptions of the dirty bed linens, bedbugs, and other vermin encountered by 19th-century travelers, of tenement-house privies shared by early-20th-century immigrants, and of farm wives hauling water daily so they could scrub diapers in a metal tub and hang them on the line to dry.

The narrative is carefully balanced with case studies of leading historical figures. We meet George Waring, "the most conspicuous anti-contagionist, environmentalist and propagandist of the late nineteenth century" (p. 66), who built sewers in cities across America. And we are introduced to his disciple, Caroline Bartlett Crane, who tested the Waring model in Kalamazoo, Michigan, and became a nationally known "municipal housekeeper." Other prominent figures discussed include Booker T. Washington, Lillian Wald, and Walter Kohler—the plumbing manufacturer who offered his foreign-born workers courses in civics and hygiene.

The breadth of *Chasing Dirt* is both its greatest strength and its most significant liability. Often the author seems to raise important subjects only to rush on to the next topic, public figure, or private comment. What is, we are left to wonder, the precise link between the emergence of an urban middle-class culture and a culture of cleanliness? To what degree is the American experience unique? Other industrial nations built sewers and embraced ideas of personal hygiene—did Americans chasing dirt simply go farther? go faster? or did they take a different path and, if so, why? While *Chasing Dirt* displays the virtuosity of the author as researcher, writer, and synthesizer, it also raises some profound and provocative questions that it leaves for others to pursue and answer. Nevertheless, Hoy has delivered on her promise to provide us with an introduction to the American pursuit of cleanliness. Readers will never look upon their surroundings or their personal hygiene habits in quite the same way.

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The Dynamo Problem

Lectures on Solar and Planetary Dynamos. M. R. E. PROCTOR and A. D. GILBERT, Eds. Cambridge University Press, New York, 1995. xiv, 375 pp., illus. $69.95 or £50; paper, $29.95 or £19.95. From an institute, Cambridge, UK, Sept. 1992.

Solar and Planetary Dynamos. M. R. E. PROCTOR, P. C. MATTHEWS, and A. M. RUCKLIDGE, Eds. Cambridge University Press, New York, 1994. xii, 366 pp., illus. $49.95 or £35. From an institute, Cambridge, UK, Sept. 1992.

Magnetic fields are essentially everywhere in the universe. By virtue of Ampère's law, they are almost always associated with electric currents. Since hardly any of the matter in the universe is superconducting and very little is ferromagnetic, these currents, if not maintained by energy conversion from other sources, would decay in times short compared to the lifetime of the aggregations of matter in which they reside. Aggregations of electrically conducting fluid that do work to maintain the currents and fields against this decay are called hydromagnetic dynamos. The fluid interiors of the Earth and major planets, as well as the sun, are the main examples of dynamos in our immediate environment. It is now known that many other stars have dynamo-driven magnetic fields, some

rather similar in behavior to the sun, others quite different. And recently attention has turned to the possibility that whole galaxies are maintaining their magnetic fields through dynamo action.

These volumes record, respectively, the 11 invited lectures and 46 contributed papers presented at a NATO Advanced Study Institute on the dynamo problem. Though the full range of objects in the universe with magnetic fields is mentioned, the institute understandably focused primarily on the solar and planetary cases, about which we know so much more. Extended workshops and institutes on the dynamo problem that draw together astrophysicists and geophysicists as well as applied mathematicians really do work, because there is so much physics in common in the different dynamos. For example, rotation is a crucial component, which increases the complexity of fluid motions in ways that enhance dynamo action. It is no coincidence that the sun, the Earth, Jupiter, and Saturn, all of which have pronounced rotation, have relatively strong magnetic fields. In particular, rotation tends to generate helical motion and differential rotation, the combination of which is particularly conducive to dynamo action, including the production of dynamo "waves" and magnetic field reversals. Thus particular attention must be given to the hydrodynamics of rotating fluids in the interactions with magnetic fields, which these books do.

One of the fascinations and frustrations of dynamos is that they must be studied either in nature or on the computer. Laboratory models of simply connected fluid dynamos are extremely difficult to produce, because spatial scales are too small to avoid very fast dissipation of the currents. But the dynamo problem is a "laboratory" for chaos theory. The nonlinear dynamics of dynamos includes bifurcations, limit cycles, and strange attractors in abundance. Magnetohydrodynamic turbulence is a prime component of the theory as well. Because of the richness of its physics and mathematics, the dynamo problem tends to hold the interest of applied mathematicians for long periods. For example, Paul Roberts, whose lectures provide an overall introduction to these volumes, has productively devoted decades of his career to it. In the 1950s, when dynamo theory as a mathematical construct was first developing, the subject was regarded as somewhat treacherous because promising series-expansion solutions often diverged when more terms were added. Now, highly truncated systems (well represented in these volumes) are studied with abandon. The problem was that the motion fields considered in the early days did not have enough of the relevant physics, such as rotation, in their structure to produce rapidly converging solutions.

Much progress in basic understanding of dynamo processes is represented in these volumes. The interactions among rotation, magnetic fields, and thermally driven motions such as convection are subtle and complex and require particularly careful analysis. These topics are well represented. But it cannot be said yet that there exists anything like a true predictive theory for either solar or planetary magnetism. Some solar dynamo theorists thought they had found one in the 1970s, but that was before the reality check of full hydromagnetic dynamo calculations, as well as inferences of the interior rotation of the sun from the new techniques of helioseismology. Roberts correctly warns that kinematic dynamo theory, in which the motions are assumed rather than predicted from physical principles, can go very wrong if the guess of the motion fields is poor. Now the solar theorists have gone "back to basics," but with a new emphasis on the boundary between the solar convection zone (the outer 30 percent of the sun) and the radiative interior. And no one has yet devised a quantitative theory to explain the sporadic reversals of the Earth's field, reversals that have probably had significant influence on the evolution of life because of the likely massive increases in solar particle fluxes reaching the lower atmosphere and surface during the reversal phase.

So the applied mathematicians and fluid dynamicists still have plenty to work on. I have myself recently returned to research on the solar dynamo and related problems following more than eight years as a full-time administrator. The "pull" of this problem, like the pull of opposite magnetic polarities to each other, was just too great to resist, especially given the development of new observations of the solar interior. These volumes are providing me with a valuable reference on the overall state of the subject, as well as on current concerns and who is actively contributing. The lectures are particularly comprehensive and should provide useful tutorials for newcomers to the area. Most also contain extensive historical references.

I see the future of this subject lying heavily in the area of theories of transition regions, whether between the convection zone and interior of the sun or between the core and the mantle of the Earth. The details of these regions are probably crucial to understanding the dynamics that drives the respective dynamos. I would thus expect to see increased emphasis on boundary layer dynamics, mixing, and local and global waves, as well as effects of topographic features in the case of the Earth, with perhaps some de-emphasis on dynamos driven by convection in the bulk of stars and planetary interiors. It will be interesting to see whether another workshop on dynamos held in, say, 2002, will verify this shift.

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Cell Death and Immunity

Apoptosis and the Immune Response. CHRISTOPHER D. GREGORY, Ed. Wiley-Liss, New York, 1995. x, 416 pp., illus. $89.95 or £69.

Conceptual theories only rarely have a strong impact on experimental fields. One case occurred in 1959, when the concept of natural selection was applied at the cellular level to the development of immune responses, and modern immunology emerged as a consequence. F. Macfarlane Burnet, who is largely responsible for this clonal selection theory, proposed it in part to account for the phenomenon of self-tolerance, the tendency of the immune system not to react with the body's own molecules. To explain self-tolerance, Burnet proposed that antigen-specific cells with potential self-reactivity are "readily disposed of by assuming that—at this particular stage of embryonic life—contact with the corresponding antigen pattern results in the death of the cell" (*The Clonal Selection Theory of Acquired Immunity* [Vanderbilt Univ. Press, 1959], p. 58). The importance of cell death in other developmental systems had been recognized a few years earlier (A. Glucksmann, *Biol. Rev.* **26**, 59 [1951]), and active cell death formally became "apoptosis" in 1972 (J. F. R. Kerr *et al.*, *Br. J. Cancer* **26**, 239). Arguably, though, it was when Burnet's clonal deletion (now called "negative selection") became a focus of study 30 years after the formulation of his original theory that interest in apoptosis in the immune system revived. Since the late 1980s interest in apoptosis has had an explosive growth, mostly because its molecular regulation appears to be accessible to our probing.

Now a collection of reviews discussing apoptosis in the immune system has been compiled by C. D. Gregory. All but two of the papers focus on apoptosis in T and B lymphocytes, and only one (an excellent review of apoptosis in hematopoiesis) considers cell death in any other cell type. Topics covered include apoptosis in immature and mature T cells, in normal B cells, in B lymphomas, and in $CD5^+$ B cells and apoptosis in HIV infection. There are two reviews on the Fas/CD95 molecule and a welcome review on the recognition and phagocytosis