gious. But research in recent decades shows that "everyone" is wrong, report economist Iannaccone, of Santa Clara University, and sociologists Stark and Finke, of the University of Washington and Purdue University, respectively.

Despite the explosive growth of science and the increase in average education levels during the last half-century, the rates of religious belief and participation in the United States have stayed about the same. It is true, Iannaccone and his colleagues say, after examining extensive surveys from the period 1972–90, that professors and scientists are less religious than the general public. Nineteen percent of the learned professionals reject religion entirely, compared with only seven percent of the public. But, the authors add, most academics "*are* religious—81 percent say they have a religion, 65 percent believe in an afterlife, 64 percent feel near to God, and 61 percent (claim to) attend church at least several times a year."

Moreover, the gap between the professors and the general public is no wider than it is between men and women, or between whites and blacks. Thus, 37 percent of academics pray daily, compared with 57 percent of the public—but that 20-point difference is less than the 23 points between men (43) and women (66) who pray daily. When sex, race, and other traits are taken into account, the authors note, professors and scientists—overwhelmingly white, largely male—appear only slightly less likely than other people to pray daily. Outright rejection of religion remains more common among academics, however, but that may be because the irreligious are more drawn to the academic life, not because higher education reduces religious belief.

What's more, observe Iannaccone and his colleagues, a 1969 survey of nearly one-fourth of all the college faculty in America indicates that by church attendance and every other measure, the professors in the "hard" sciences such as physics and mathematics are more religious than their social science counterparts. Those in psychology and anthropology, the two fields most closely associated with the idea that faith is irrational and doomed, "emerge as towers of unbelief." Just a coincidence?

SCIENCE, TECHNOLOGY & ENVIRONMENT

On the Global Warming Front

A Survey of Recent Articles

Environmentalists and others who hailed the 1997 Kyoto accord as a promising first step toward averting catastrophic global warming, and have been disappointed since by the lack of progress toward implementation, took heart from the results of a two-week conference in Buenos Aires last November. Negotiators from more than 150 countries agreed to set operational rules for enforcing the Kyoto pact by late 2000, and Argentina and Kazakhstan became the first developing countries to announce they would voluntarily adopt restrictions on their emissions of heat-trapping carbon dioxide and other greenhouse gases.

Yet while the Clinton administration formally signed the accord in November, the pact still faces intense opposition in Congress. The administration no longer expects even to submit it to the Senate for ratification before a new president is elected in 2000. Without U.S. approval, the Kyoto treaty will not go into effect.

But how serious a step toward controlling the buildup of greenhouse gases in the atmosphere would the Kyoto agreement really be? And is a first step, big or small, even necessary? Is there, as President Bill Clinton has asserted, "virtually unanimous opinion among scientists that the globe is warming at an unacceptably rapid rate"?

In the accord reached at Kyoto, Japan, in December 1997, the United States and other industrialized nations pledged to slash their greenhouse gas emissions between 2008 and 2012 by certain percentages (seven percent in the U.S. case) below 1990 levels. The agreement permits international trading of emissions "credits"—countries that emit less than their quota of gases can sell to other countries the rights to the balance. No restrictions are placed by the accord on developing nations.

Harvard University economist Richard N. Cooper, writing in *Foreign Affairs* (Mar.–Apr. 1998), contends that this approach is bound to fail. Global warming could not be subdued without the participation of the developing countries, which by 2010 are expected to contribute 45 percent of total greenhouse gas emissions. But China, India, and almost all other developing nations are unwilling to sacrifice their economic development and could not afford to buy emissions credits. A better way to bring manmade climate change under control, in Cooper's view, would be for nations to tax private-sector greenhouse gas emissions.

Responding in *Foreign Affairs* (May–June 1998), Undersecretary of State Stuart Eizenstat, the chief American negotiator at Kyoto and Buenos Aires, dismisses the tax idea as impractical. "Energy taxes are anathema in the United States," he points out. While agreeing that Kyoto pact "cannot succeed . . . unless key developing countries participate," he says that Cooper is "overly pessimistic" about the chances of that happening. The subsequent developments at Buenos Aires seemed to lend some credence to Eizenstat's optimism.

Byron Swift, director of the Technology Center at the Environmental Law Institute in Washington, also is optimistic. Emissions trading "could be attractive" to a developing country, he maintains in *Issues in Science and Technology* (Spring 1998), "because its sale of allowances could generate capital for projects that help it shift to a more prosperous but less carbon-intensive economy." Still, he acknowledges, "most developing countries, led by China and India, are opposed to trading."

The Kyoto agreement's "crash program" approach is too short-term in orientation, argues Rob Coppock, who was staff director for the National Academy of Sciences' 1991 report, *Policy Implications of Greenhouse Warming* [see *WQ*, Winter 1992, pp. 154–155]. Writing in the same issue of *Issues in Science and Technology*, he points out that even under the Kyoto accord, "the concentration of greenhouse gases in the atmosphere will double by the end of the 21st century." The resulting climate changes will be manageable, Coppock believes. It's what happens *after* that point that poses the biggest challenge, he says. Rather than being required to spend "excessive amounts of money for costly short-lived retrofits to meet an arbitrary deadline of 2010," he argues, companies should be allowed to achieve low emissions later, by investing now in research and development, and phasing more efficient (and more expensive) technology in as existing equipment reaches the end of its useful life.

But are scientists really sure there is a problem? Writing in *SAIS Review* (Summer-Fall 1998), Brett Orlando, climate change program officer at the International Union for the Conservation of Nature, cites a 1996 report by the Intergovernmental Panel on Climate Change (IPCC), a "mainstream" UN-affiliated group of some 2,000 scientists from around the world. The IPCC reached the "landmark judgment," he says, that "'the balance of evidence suggests a discernible human influence on the global climate.'" The previous scientific consensus, he says, was that the observed warming—about one degree F. over the last century—could just reflect natural climatic variability.

When the IPCC report was issued, however, Frederick Seitz, chairman of the George C. Marshall Institute and a past president of the National Academy of Sciences, charged in the *Wall Street Journal* (June 12, 1996) that it had been skewed to produce that "landmark judgment." After the scientists involved had reviewed and accepted the apparently final text, Seitz asserted, changes were made "to remove hints of the skepticism with which many scientists regard claims that human activities are having a major impact on climate in general and on global warming in particular."

In short, despite all the environmental alarums and international conferences, it appears that the scientific debate about global warming—and therefore the political debate about what, if anything, should be done—is far from over.

Paradigm Reversal

"The Revolution That Didn't Happen" by Steven Weinberg, in *The New York Review of Books* (Oct. 8, 1998), 1755 Broadway, 5th fl., New York, N.Y. 10019–3780.

In Thomas Kuhn's theory of scientific revolutions, postmodernist critics of science have found the perfect paradigm. Too bad for them that Kuhn's radical notions are "quite wrong," according to Weinberg, a Nobel Prize-winning physicist at the University of Texas at Austin.

In his 1962 book *The Structure of Scientific Revolutions*, Kuhn (1922-96) described the history of science as cyclic: periods of "normal science," in which a particular consensus view ("paradigm") prevails, alternate with revolutionary times that give birth to a new consensus. In Kuhn's famous phrase, the paradigm shifts. Thus, Newtonian physics, which had gained wide acceptance in the 18th century, was supplanted by the theory of relativity in the early 20th. So great is the gulf between successive paradigms, Kuhn maintained, that scientists adhering to the new model find it all but impossible to understand what their predecessors could have been thinking. And since there is no common standard by which to judge the respective theories, a theory can be called "true" or "false" only within the context of a given paradigm. Science progresses, Kuhn believed, in much the way that Darwinian evolution does—but not, he maintained, toward objective truth. Since all past scientific paradigms had proven false, the current one was bound to give way, too. All this, of course, is catnip to the postmodernist critics who have lately insisted that scientific theories have no more intrinsic validity than, say, astrology or shamanism.

But Kuhn was mistaken in thinking that after a paradigm shift, scientists cannot understand the science that went before, Weinberg points out: "In educating new physicists the first thing that we teach them is still good old Newtonian mechanics, and they never forget how to think in Newtonian terms, even after they learn about Einstein's theory of relativity." Kuhn was also wrong, Weinberg says, in maintaining that the revo-

A New Natural Philosophy

Lee Smolin, a physicist at Penn State University, writes in *Oxymoron* (1998) that we are in the midst of "one of the great transformations in the history of science."

We are abandoning the idea that the organization and beauty of any system, whether it be biological, ecological, economic or cosmological, is imposed from the outside, in favor of the conception that they arise internally by natural processes of self-organization. This is why Darwin's so important. Before the discovery of natural selection, there were only two ways in which the organization of the world could be explained: either a god had imposed order on chaos (as in Plato's myth of the reversing cosmos) or the order was the manifestation of mathematical laws (as in Galileo and the subsequent developments of physics). Darwin taught us that there is a third alternative: natural processes, readily accessible to our comprehension, can cause a system to evolve from a less to a more organized state. I believe that we are seeing the gradual incorporation of this insight into all the sciences that study the organization of systems, from cosmology and fundamental physics to the organization of human societies. This leads to the replacement of explanations in terms of absolute principles which are held to be eternally true with explanations that are historical and recognize the tremendous variety of possible outcomes of processes like natural selection.