

Mainstream scientists respond to creationists

During the last few months it has become apparent to many physicists that the movement that calls itself creation-science is addressing scientific matters outside biology and is threatening to transform science education in this country. The standard creationist position—that *Genesis* taken literally describes but does not provide evidence of the creation of the Universe—disputes more than evolution. Creationists are proposing ideas that require that geological and astronomical phenomena usually held to have occurred over millions or billions of years must be telescoped into 10 000.

Legislation. Last December—50 years after the Scopes trial—a Federal court in Arkansas adjudicated on the teaching of creationism. The previous spring—under reported pressure from the Moral Majority—the Arkansas Legislature hurriedly passed a bill that as of September 1982 would have required educators to give creationism “equal time” whenever evolution was taught and whenever many topics in earth science and astronomy were taught. Lectures, textbooks, even library books “taken as a whole,” would have been required to give “balanced” views. While evolution appears in Arkansas science classes because scientists and educators think it is accurate and illustrates the scientific method, creationism would have been introduced in the science curriculum by state law. Members of the clergy, parents and educators in Arkansas, joined by several religious and educational organizations, challenged the law in a suit filed by the American Civil Liberties Union.

The ACLU argued that the law would violate the separation of church and state required in the First Amendment because creationism is religion and not science, that it would violate the academic freedom of students and teachers, and that it was unconstitutionally vague.

Although in January Judge William Overton ruled the law unconstitutional on the ground that creationism is religion, an appeal is expected. The case, widely covered by the national press, pointed to the power of the creationists



John T. Scopes on trial in Tennessee, 10 July 1925. He is in the center of the picture, sitting at the table in shirt sleeves. His lawyer, Clarence Darrow, is sitting on the desk.

and gave them the legitimacy of advocating one side of a controversial issue.

The bill, drafted by Paul Ellwanger, head of Citizens for Fairness in Education, was also passed in Louisiana, where it is also being challenged. Ellwanger told us he has had it introduced or found legislators to introduce it in 25 other states. He also expects a member of Congress to introduce a bill early this year that would require “fair play” on the subject of origins in national parks and museums and in Federal support of research. The bill could affect research fields outside biology—geology and astronomy, for example—and “could mean a complete cessation of current activity in origins in any direction because it is a logical place to save bucks,” says Ellwanger. He feels very strongly about saving taxpayers’ money that is spent now on “indoctrinating” the public to evolution, which he maintains is the dogma of such religions as humanism and atheism, which would “collapse if evolution was refuted.”

Even if creationists lose their cases in court, they can succeed. Local school boards in several states have already required the introduction of “creation-science” in biology courses. In turn, textbook publishers are introducing

books that discuss creationism and abbreviate treatments of evolution, books that might outlive the current challenges to evolution. Several large mainstream publishers recently released biology textbooks that omit “evolution” or “Darwin” from their indices or present discussions of creationism, according to William V. Mayer, director of the Biological Science Curriculum Study.

Scientific societies. During the month before the trial, the Council of The American Physical Society and the American Geological Institute joined other scientific societies, such as the National Academy of Sciences and the National Association of Biology Teachers, in attacking the teaching of creationism as science in public schools. The American Geological Institute opposes giving equal time in science teaching to creationist beliefs on the ground that they are religious and they ignore that life has been evolving on Earth for billions of years. The APS Council opposes it on the ground that it is not science. The APS Education Committee, whose chairman, Bernard Silbernagel of Exxon, wrote the first draft of the statement the APS Council passed, is planning a symposium on

APS statement on creationism

The Council of The American Physical Society opposes proposals to require "equal time" for presentation in public school science classes of the biblical story of creation and the scientific theory of evolution. The issues raised by such proposals, while mainly focused on evolution, have important implications for the entire spectrum of scientific inquiry, including geology, physics, and astronomy. In contrast to "Creationism," the systematic application of scientific principles has led to a current picture of life, of the nature of our planet, and of the universe which, while incomplete, is constantly being tested and refined by observation and analysis. This ability to construct critical experiments, whose results can require rejection of a theory, is fundamental to the scientific method. While our society must constantly guard against oversimplified or dogmatic descriptions of science in the education process, we must also resist attempts to interfere with the presentation of properly developed scientific principles in establishing guidelines for classroom instruction or in the development of scientific textbooks. We therefore strongly oppose any requirement for parallel treatment of scientific and non-scientific discussions in science classes. Scientific inquiry and religious beliefs are two distinct elements of the human experience. Attempts to present them in the same context can only lead to misunderstandings of both.

creationism to be held at the APS meeting in Washington in April and the publication and distribution of a primer on creationism that would point out the weaknesses of creationist arguments. Other possible actions include publishing bibliographies and question-and-answer sheets for school teachers. Silbernagel expressed a point of view many of us spoke to shared: that it is no longer appropriate to withhold a reaction to the creationists in order to deny their arguments the dignity of a scientific refutation. It has instead become apparent that they threaten to undermine students' understanding of topics in physical as well as biological sciences, and perhaps more important, their comprehension of the methods scientists use in discovery.

In defense of having their beliefs presented in public-school science classes, creationists we spoke to said they want students to get a fair hearing of both sides of scientific controversies so they could make decisions for themselves. However, as Stephen G. Brush (professor in the department of history and in the Institute of Physical Science and Technology at the University of Maryland) wrote in the *Science Teacher* (April 1981), "creationism, when judged as a scientific theory, is extremely weak. . . . To require teachers to give serious consideration to creationism is as unjustified as requiring them to teach other doctrines—such as astrology, alchemy and phrenology—that have been overwhelmingly rejected by professional scientists."

Nevertheless, creation scientists have been at work attempting to rest their beliefs on scientific foundations. The Institute for Creation Research is one of the busiest resources for this activity. In addition to publishing a popular magazine that 75 000 people receive and providing lecturers and staging debates for local organizations around the US, it publishes textbooks and original work by members of its

staff and other scientists, several of whom were recruited as witnesses for the defense of Arkansas' equal time law. We spoke to several such scientists and also to physicists, some of whom assisted the ACLU, for comments on creationist ideas.

Creationist arguments. Russell Akridge, who earned a PhD in physics at Georgia Institute of Technology and who is currently teaching math and science at Northside Christian Academy outside Atlanta, was one of the creationists gathered but not called to testify for the Arkansas defense. Akridge described how it could be that the light reaching us from stars and galaxies more distant than 10 000 light years does not indicate these objects are more than 10 000 years old. He said the best explanation he has been able to come up with is that when the Universe was created, light from distant objects was created "en route to us." He argues that according to Gauss's law, a point charge cannot exist even at the instant of its creation unless its field extends to infinity. If a charge were created surrounded by a zero field, then the field would expand outward at the speed of light. The surface of this field's volume would constitute a layer of charge, according to Gauss's law, traveling exactly at the speed of light. But no electric charge has ever been observed traveling at the speed of light. Therefore, each charge must always be surrounded by its field, which extends to infinity.

In response, Harold Morowitz (professor of biophysics and biochemistry at Yale University), who assisted the ACLU, compared Akridge's explanation with a discussion of whether Adam and Eve had belly buttons or whether the trees in the Garden of Eden had growth rings. "The matter isn't science. It doesn't represent an experiment and can be neither verified nor falsified."

Earth's magnetic field was discussed

by Akridge and also by his colleague, Gerardus Bouw, another witness for the defense in Arkansas who was not called to testify. Bouw received a PhD in astronomy at Case Western Reserve University but only taught in his field one semester. Now, while he teaches computer science at Baldwin Wallace University in Berea, Ohio, he participates in research in the field he was trained in—astronomy—as a creationist. These men are not satisfied with the evidence for the reversing of Earth's magnetic field because they are not convinced by the explanation afforded by the dynamo theory for such reversals. They maintain that the magnetic field has been decaying monotonically since Earth's creation.

David Helfand (an assistant professor of astronomy at Columbia), who also assisted the ACLU, replied to this. He told us that crystalline sediments in the mid-Atlantic ocean floor provide virtually irrefutable evidence—"you couldn't ask for anything more beautiful"—for the reversals. Rocks that formed over millions of years as the continents drifted apart show stripes of reversing polarity. In addition, he notes that a mechanism similar to that generating Earth's is thought to generate the Sun's magnetic field, which is observed to reverse in polarity every 11 years.

We asked of Duane Gish, who is one of the founders and the vice-president of the Institute for Creation Research and holds a PhD in biochemistry from Berkeley, for positive evidence of a young, created Universe. Gish said "a coercive, absolutely compelling evidence for creation was provided by the science of thermodynamics." He said that the Universe could not have evolved from its chaotic beginning to its present highly ordered state without violating the second law of thermodynamics if it is an isolated system. Therefore it must not be isolated, but have been created by an agency outside it.

However, standard big-bang cosmology recognizes that the Universe was at a low entropy at its outset and undergoes entropy increases globally through each step of its evolution. When a star condenses or when a galaxy forms, there is a local ordering and a great release of heat. The second law is not violated because the decrease of entropy in one place is offset by a far greater increase somewhere else.

Another piece of positive evidence Gish claimed for a young Earth is given by studies of meteoritic dust particles that have been settling on Earth since it was formed. Gish maintains these are falling at such a rate that they would have covered Earth with a layer 50 to 150 feet thick in several billion

years. Understanding that the dust wouldn't just pile up to be observed amid the clutter of geological events, creationists have looked for evidence of the dust in concentrations of nickel in deep-sea sediments, whose major source of nickel is the dust, they say. From the concentrations of nickel reported they calculate an age of Earth of only around 9000 years, even including other sources of nickel.

However, Edward Anders (professor of chemistry at the Enrico Fermi Institute of the University of Chicago) told us that Gish must be using an old, discredited value for the meteoritic influx that is several orders of magnitude too high. A reliable value, determined in 1968 by Anders and John Barker from the iridium and osmium contents of deep sea sediments, is $(9 \pm 4) \times 10^{-9}$ g/cm² year, which gives a layer of 5 cm, not 50–150 feet, over 4.5 billion years. Very similar values have since been obtained by analyses of Antarctic ice and lunar soils and interpretations of photographic meteors and interplanetary dust measured by satellites.

Anders notes that Gish must be making another error by a factor of 10^5 , probably by neglecting the thickness of the sediment column, in deriving an Earth age of only 9000 years. Gish's assertion that most of the nickel in deep-sea sediments (about 5 g/cm²) is meteoritic, implies a total deposit of about 500 g/cm². The accretion of this amount in only 9000 years would entail a meteoritic influx rate of 6×10^{-2} g/cm² year, about 10^7 higher than the current values.

Is it science? A great deal of the evidence creationists gave us for a young and created Universe in fact only disputed the theories most scientists find convincing in these matters. Gish says there are only two models on origins; so any evidence against evolution is evidence for creation. Ralph Alpher (General Electric Research Center), a contributor to big-bang cosmology, has pointed out that creationists, lacking coherent and consistent theories, instead supply *ad hoc* arguments against their opponents' theories. Brush points out in *The Science Teacher* that creationists fail to see how theories are used by scientists to organize information and stimulate new research.

At the core of many critics' objections to creationist arguments is one that Helfand expressed to us: While theories in science are falsifiable, creationist beliefs are not. When the empirical data don't offer the desired result, God can be understood to be as inventive as any creationist imagination: He has been understood by them to vary the speed of light and the decay rate of radioactive materials and to create anything else needed to bring the *Gene-*

sis account into apparent accord with present-day reality.

Bouw, pressed for positive evidence after he mentioned problems he says disenchanted him with evolution, told

us with more honesty and humility than his critics usually find in creationists' arguments: "If I had to point to one positive aspect, one that convinced me most, it was the Bible." —DG

Physicists contribute to MX debate

President Reagan announced on 2 October his five-point program to "revitalize our strategic deterrent." A pivotal part of this program is the decision to modernize land-based missiles by developing the MX. In this plan the "shell game" concept for deceptive deployment of 200 missiles in 4600 silos advocated by the Carter administration has been cancelled. Instead, Reagan has recommended placing from 18 to 40 MX missiles in existing Titan or Minuteman silos that have been superhardened with concrete and steel to withstand overpressures of up to 5000 psi. Meanwhile, further research would be conducted about other basing options for the balance of the 100 missiles scheduled to be purchased. Funds would also be invested to upgrade command, control and communication systems.

As they have in the past, a number of physicists have assisted the executive and legislative branches in evaluating technical and strategic aspects of the MX. Both the Townes Commission (composed of scientists and technical and military experts selected in the spring of 1981 by the Secretary of Defense to advise him on strategic missile applications) and the Jason group were given access to classified data to use in formulating their advice. The report of the Townes Commission (which included physicists Solomon J. Buchsbaum of Bell Labs, Michael May of Livermore, William Nierenberg of Scripps Oceanographic Institution and Albert Whelan of Hughes Aircraft) remains classified. The Congressional Office of Technology Assessment was asked by Congress in May 1980 to conduct a study of basing modes for the MX. The OTA, which included on its advisory panel Sidney Drell (SLAC), Henry Foley (Columbia) and Jerome Wiesner (MIT), had access to much of the same material, and their report was released in September.

Reactions to plans. Commenting to us on the Reagan announcement, Charles Townes (Berkeley), chairman of the Townes Commission, felt that its report had been important in the formulation of the President's program and said "Reagan's program is pretty much in accord with the Commission recommendations. I am particularly pleased with the decision not to deploy the MX in the shell game scheme in Western deserts and the emphasis on improving

command, control and communications for defense."

Not everyone has been equally pleased. General David Jones, Chairman of the Joint Chiefs of Staff, while expressing his overall support for the Reagan program, testified on 5 October at hearings before the Senate Armed Services Committee that he personally preferred the shell game and that missiles in hardened silos might not be able to survive.

Following Reagan's decision, his plans for the MX were subjected to the vicissitudes of the budget process as DOD appropriations were determined. In the House, the Subcommittee on Defense of the Appropriations Committee, led by Joseph Addabbo (D-NY), voted in October to withdraw funds for the MX until Reagan had made a commitment to one basing mode. In the Senate, an amendment sponsored by William Cohen (R-Maine) and Sam Nunn (D-Ga.) to prevent the Pentagon from spending research dollars on the interim plan to put MX missiles in hardened silos, was passed on 2 December by an overwhelming 90 to 4 vote. The two Houses of Congress subsequently passed appropriation bills that included differing amounts of funds for the MX. After conferring, a compromise appropriation bill with an FY 82 defense budget of \$200 billion (the largest in history, up \$28 billion from FY 81) was passed by both Houses on 15 December. The MX was funded with \$1.9 billion and command, control and communication needs were funded at \$20 million.

These actions are the most recent part of a continuing debate about the MX that has centered around the selection of a basing mode and its ability to address the vulnerability of current silo-based ballistic missiles. Specifically, what will the MX contribute to the strategic defense of the United States? How will the means of deployment chosen increase or decrease the MX's effectiveness and survivability?

Defense strategy. The defense posture of the US has evolved to rely on what is known as the "strategic triad," composed of land-based missiles, submarine-launched missiles and bombers. The MX is slated to upgrade the land-based leg of the triad by replacing Minuteman III missiles with a more modern version with more warheads, thus allowing aging Titan missiles to be