

## Are cosmic ray antiprotons primary?

Cosmic rays have been studied for about 70 years, and for all that time their origin and the mechanism that gives them their energy have both remained mysteries. There are several theories but no evidence that permits choosing one above the others.

Now there is yet another cosmic-ray mystery: Where do the antiprotons come from? Cosmic rays are overwhelmingly protons with a small sprinkling of heavier atomic nuclei. Two years ago an American observing team, S. L. Golden et al. (SN:10/27/79, p. 277), and a Soviet one, E. A. Bogomolov et al., found a small flux of antiprotons. It amounted to a bit more than 2 antiprotons in 10,000 protons. A small number of antiprotons had been expected. They would be produced as the ordinary protonic cosmic rays struck atoms of the interstellar gas in their movements through space. However, the numbers measured seem a bit higher than would have been expected from this "secondary" production.

Therefore, Andrew Buffington and Stephen M. Schindler of California Institute of Technology resolved to make a measurement of the antiproton/proton ratio in cosmic rays with a tenth of the energy of those measured by the other groups. In this energy range the antiproton/proton ratio was expected to be also about a tenth of that at the higher energies, but in fact, Buffington and Schindler report in *THE ASTROPHYSICAL JOURNAL* (Vol. 247, p. L105) it comes out about the same, 2.2 antiprotons per 10,000 protons.

This large discrepancy at low energies prompts Buffington and Schindler to suggest that "a primary antiproton hypothesis cannot be ruled out." Primary antiprotons might have been made in the big bang and stored somewhere. They might be made in a part of the universe that is dominated by antimatter as ours is dominated by matter. Or they might come from some exotic source yet to be described. The breath-taking consequences of adopting any of these hypotheses lead other people in the field to want to explain the antiproton flux by secondary production, but that requires rethinking some of the theory of how ordinary cosmic rays behave.

## Gravitational radiation from the stars

In Einstein's theory of general relativity, gravitational radiation occupies the same place that electromagnetic radiation (radio waves) occupies in the ordinary theory and practice of electricity and magnetism. If gravity waves exist—and there has been some controversy over that—material bodies should experience them as cyclically fluctuating forces. The conduction electrons in a radio antenna experience the radio waves the same way.

Many years of attempts to detect gravity waves in what seem like properly designed antennas have yielded nothing definitive. Failure is blamed on the minuteness of the effect, and so observers now turn to astrophysical systems.

According to theory a binary star system should radiate gravity waves. As the waves carry away energy, the system's orbit should decay. An analysis of orbital decay of a class of binary star known as "hydrogen-rich cataclysmic variables" convinces B. Paczyński and R. Sienkiewicz of the N. Copernicus Astronomical Center in Warsaw that these stars are radiating gravity waves (*ASTROPHYSICAL JOURNAL*, Vol. 248 P.L27). The main point is that theory, under the assumption of gravitational radiation, predicts that the periods of these binaries will never go below a minimum of 81 minutes. Observation finds that is indeed the cutoff. This is the second astrophysical support for gravity waves. The first was an analysis of a binary pulsar by J. P. Taylor and P. M. McCulloch (SN: 2/24/79, p. 116).

OCTOBER 3, 1981

## Execution by injection

When, and if, convicted Oklahoma murderer "Sunny" Hays is injected with a lethal dose of drugs, much of the nation will be watching. Paying particularly close attention will be members of the medical profession, because non-physicians will insert the catheter and empty the vial; officials at the Food and Drug Administration, because the injected drug has not been approved for use in executions; many state Department of Correction officials, to see if the general public finds this new form of execution more palatable than others; and 179 other death row inmates, all of whom face a similar fate.

Between 1977 and 1979, Oklahoma, Texas, Idaho and New Mexico all legislated death by injection. Hays, whose stay of execution expires Oct. 9, would be the first prisoner in the United States to die this way. No new execution date has been set; the case is currently being appealed before the circuit court in Denver.

Amnesty International, the NAACP, and other human rights groups staunchly oppose the injection method. "This is the latest in a long line of so-called 'humane' ways of killing people. The public is uncomfortable with guns and electric chairs. They feel better knowing that someone can just be put to sleep, like a pet dog or cat," says Jim Liebman, attorney for the NAACP.

Michael Nelson, M.D. of Amnesty International, U.S.A. says, "It's the prostitution of medical procedures, techniques, equipment and drugs. These were all designed to relieve people of pain, not execute them." Liebman and Nelson contend that the convict—strapped down in a stretcher, tied around the chest, arms, and legs and then turned to face witnesses—suffers severe mental anguish. An incorrectly administered drug would produce pain, and at worst, they say, cause the person to witness his own slow suffocation.

Even the drugs themselves (sodium thiopental to depress the central nervous system, and tubocurarine chloride, succinylcholine chloride, and potassium chloride to paralyze the muscles of the diaphragm) are the focus of controversy. Unlike animal euthanasias, these drugs have never been proved "safe and effective" for execution under the FDA's Drug and Cosmetic Act.

State governments can use approved drugs for whatever purpose they wish, say FDA officials. Although the Agency will not approve drugs for this specific purpose, it says that it is not illegal to use an approved product for an unapproved purpose.

Even with the legal strictures lifted, logistical ones remain. The American Medical Society has resolved that although a physician can make a legal determination of death, he is "a member of a profession dedicated to saving lives when there is hope of doing so, [and] should not be a participant in a legally authorized execution." The American Psychiatric Association, American Nursing Association and American Public Health Association all take similar stands.

The word "participant" has not been defined by the AMA; in Oklahoma, although a non-M.D. phlebotomist will prepare the hypodermic syringe, insert the needle, and start the flow and an executioner will close the IV line containing sedative and saline dextrose and open the line with the paralytic drug, a physician will actually prescribe the drug and make a determination of death.

A phlebotomist or any other type of non-physician is capable of conducting this kind of execution, according to the AMA. "Any attempt to make this a medical issue is terribly far-fetched," says AMA attorney William Smith. "Execution involves only mechanical actions, and the AMA does not prohibit anyone from using a specific mechanical action."

223