ity had dropped by a factor of two, the density had increased and the temperature had increased by a factor of two. Wolfe thinks this was the result of the interaction of the streamers as they bumped into the slower-moving solar plasma.

A surprise to Wolfe was where he saw the interstellar material entering the solar system—on the plane of the ecliptic at a right ascension of 240 degrees. This is about a 15-degree difference from measurements taken in 1968, and 15 degrees, in cosmic terms is a lot, he says. The measurements could be in error, or the interstellar medium could be a lot more turbulent than thought.

Three instruments on Pioneer 10 monitor cosmic rays. One surprise is how little the flow of low-energy rays changes as the spacecraft moves away from the sun. The variation was far less than expected. Frank B. McDonald of the Goddard Space Flight Center had expected to see 50 to 60 percent more of the low-energy cosmic rays. What he saw was about a five percent increase per a.u. This suggests, he says, that the solar effects go out much farther than thought. "At three a.u. the solar influence should have been negligible."

His most laudable comments, however, were about the spacecraft, built by TRW Inc. "I feel this spacecraft represents one of the most outstanding achievements of our space program."

Jupiter, as seen from the spacecraft, is now about one-tenth the size of the sun as seen from earth. Pioneer 10 will begin taking measurements of the planet Dec. 3. "God, OMB [Office of Management and Budget] and Congress willing, we will continue this exploration for the rest of the century," says John Naugle, head of space science at NASA. Pioneer 10 will continue sending back signals to earth until it has reached the orbit of Uranus at 20 a.u. in 1979.

Pioneer 11, the backup to Pioneer 10, is scheduled for launch in April. □

Map of Mars

Last summer when SCIENCE NEWS reproduced on two pages a detailed map of Mars prepared from Mariner 9 photographs (SN: 8/12/72, p. 104), a number of readers expressed a desire to obtain the map. At that time it had not been printed in quantity and was unavailable. Last week the U.S. Geological Survey announced that the map is now available for purchase.

Send 75 cents to: U.S.G.S. Distribution Section, 1200 South Eads St., Arlington, Va. 22202. Ask for "Shaded Relief Map of Mars."

Making the deuterium fit the big-bang theory

The recent discovery of deuterium in interstellar space gives cosmologists a severe problem. It appears from the measurements that the relative abundance of deuterium to hydrogen lies in the range between 1 in 33,000 and 1 in 2,000. Since stars do not produce deuterium (in fact they use it up) any of it found floating in space is assumed to be a relic of a period early in the history of the big bang during which deuterium was formed.

The quoted figures on the deuterium abundance are compatible with a big-bang theory of the origin of the universe, but just barely. They would require a universe with a very low density, a density about the same as that now observed. Cosmologists, however, have been unwilling to believe that the matter seen is all the matter in the universe. To have things like clusters of galaxies hang together and to give the universe itself a closed curvature, a large amount of unseen matter must be present. The usual way of getting this is to postulate clouds of dark matter in intergalactic space. But the present deuterium abundance values would not permit the existence of such

Did lunar volcanism end 3 billion years ago?

Evidence seems to be mounting in favor of a moon that has been relatively inactive for the last 3 billion years. That is the general consensus of some geologists studying the returns from Apollo 17. The Taurus-Littrow site was thought to be an area where both old and very young material—perhaps younger than a billion years—would be found (SN: 11/25/72, p. 346).

Now Oliver Schaefer of the State University of New York at Stony Brook has announced the age of the famous orange glass (SN: 1/6/73, p. 7) found at Shorty crater. It is 3.71 billion years old. The age is a disappointment. "It can now be reasonably stated," he said last week, "that volcanism on the moon was a phenomenon which ended about 3 billion years ago." Schaefer, Liaquat Husain, Gerald Barber and Theodore Ludkewitz, all of Stony Brook, have dated returns from all the Apollo sites. For the Apollo 15 mare basalts, for example, they obtained ages of from 3.25 billion to 3.40 billion years.

The Stony Brook group also dated a basalt returned from the mare near Shorty crater. Its age is 3.76 billion years.

The orange glass formed part of the ring around Shorty crater. At the time of discovery, geologist-astronaut Harrison Schmitt commented that it looked like a fumarole alteration (SN: 12/23/72, p. 414). A fumarole on earth is a gaseous vent that occurs in volcanic regions during the last phases of volcanism. The gas comes through the vent and alters material around it in a zoned fashion. The orange glass was thought to be part of that alteration. Now Schmitt's hypothesis seems unlikely.

"I don't see how it [the orange glass] could be the result of a fumarole," says William C. Phinney, head of the preliminary examination team at NASA's Manned Spacecraft Center in Houston. "The orange glass is not related to the surrounding material. It is a beast entirely unto itself."

The orange glass was brought to the surface about 30 million years ago. That is the exposure age—the length of time the material has been on the surface—calculated by the Stony Brook group.

How the material was formed 3.71 billion years ago, probably in a layer in the moon, and got to the surface only 30 million years ago is an intriguing problem. "It's a very unusual situation," says geologist Farouk El Baz, now of the Smithsonian. He says Shorty crater is the result either of explosive volcanism which brought up the orange glass or of a low-velocity impact explosion which also brought up the glass. The crater lacks all the characteristics of usual impact craters.

"It's strange, whatever it is," says Phinney.

The last hope, perhaps, of finding very young material lies in the age-dating of the dark mantling material from the site. El Baz thinks this dark mantle was extruded after the major volcanic filling of the area. The dark material has been distributed to scientists, and the age-dates may be available in time for the Fourth Lunar Science Conference, March 5-8 at Houston.

But Phinney and others at Houston think the dark mantling will not turn out to be young. "It'll probably be about the same age," he told SCIENCE NEWS. The material is strikingly similar in chemical composition to the Apollo 11 basalts. They dated about 3.7 billion years old.

The chances of contacting extraterrestrial civilizations seem poor

The possibility of life, and especially intelligent civilizations, on other planets has stimulated many people's imaginations. Science-fiction writers have made it a stock of their trade. Technology is now capable of sending or receiving interstellar messages, and the possibility of intelligent civilizations on other planets now stirs the imaginations of sober scientists as well. In 1971 both a summer study group at the Ames Research Center in California and an international conference at Byurakan in the Armenian Soviet Socialist Republic (SN: 10/2/71, p. 223) recommended that a search be made.

In the Feb. 9 NATURE James C. G. Walker of Yale University studies the possible parameters of such a search and comes to some pessimistic conclusions.

One way to search is entirely passive. Antennas are set up to listen for signals produced by other civilizations. Walker supposes, however, that a more active form of search would be tried: that of sending out a signal in the hope of a reply.

Our present technology could not send out a signal in all directions with the hope of its being heard 100 light-years away; it would take more than the earth's total energy production to do it. So, Walker concludes that the search would be done by beaming signals toward stars that appear to promise the possibility of inhabited planets.

The chances of getting a reply would depend on the number of habitable planets within a given distance and on whether all or only some of them were occupied by intelligent civilizations. Walker provides estimates of the average distance between communicative civilizations under different assumptions about the fraction of habitable planets that are occupied. If all habitable planets are occupied, the average separation of civilizations is 24 light-years and the probable duration of the search is 1,400 years. If only one planet in a thousand is occupied the separation is 240 light-years and the probable duration of search 14 million years.

Walker concludes that these figures may limit any search for extraterrestrial civilizations to passive listening for signals from a super-civilization, one with a technology advanced far beyond ours and capable of blanketing the galaxy with a recognition signal.

material between the galaxies.

One way out of the dilemma is to look for plausible means of deuterium production that could have been at work during the history of the galaxy. If there were such production, the deuterium injected by it into the interstellar medium would be part of what is now seen. This would lessen the amount attributable to primeval production and in turn permit a more dense universe.

In the Feb. 9 NATURE Fred Hoyle and William A. Fowler of California Institute of Technology propose a method involving energetic outbursts in helium-rich celestial bodies. Bursts of radiation with tremendous energies of 10^{55} or 10^{56} ergs would come out of the centers of such bodies. The helium in the outer portions would be driven by the radiation and form a shock wave proceeding at very high speed. Within the shock the helium would be shaken apart into its constituent neutrons and protons. The protons would then capture neutrons to form deuterium. Free neutrons decay radioactively in a time on the order of 1,000 seconds. Crucial to the operation is that the density in the shock be not so small that the neutrons decay before being captured by protons and yet be small enough that the deuterium formed can get out of the shock wave before it too is shaken apart.

Hoyle and Fowler calculate that such conditions could in fact exist. If the deuterium abundance of 1 in 33,000 is characteristic of the galaxy, then this method could have produced all the deuterium in interstellar space. The deuterium dilemma would be solved. □

Environment message: A middle path

In the first of his series of State of the Union Messages, President Nixon last week lashed out at what he called the "advocates of defeatism" who take a "doomsday attitude" toward environmental issues. By radio he told the American people to stop "sanctimonious hand-wringing" and in his message to Congress urged them to stick to a "sensible middle ground between the Cassandras and the Pollyannas."

The President's environment program centers on resubmission of 19 bills that died in legislative limbo during the last Congress. These include a $170 million National Land Use Policy Act, a controversial proposal to establish new Federal requirements and guidelines for strip mining, an incentive tax ("charge") on sulfur oxide polluters, and legislation aimed at providing early identification and protection of endangered species.

Additional, newly submitted legislation includes a drastic reworking of farm subsidies toward an eventual free-market system for agricultural products, revision of the Federal Highway Trust Fund to allow use of these funds for mass transit, and establishment of Federal Wilderness Areas in ecologically restored regions of the eastern United States. Most of the nation's current wilderness areas are in the west.

The President pointed out that Federal spending for protection of the environment and natural resources has increased four-fold during his first term in office, and industrial spending for pollution control increased 50 percent last year alone. In America, he said, we are "well on the way to making our peace with nature."

Even before the message was released publicly, critics declared the President was not going far enough in providing environmental protection. Rep. John D. Dingell (D–Mich.) released a letter he had sent to Russell E. Train, chairman of the Council on Environmental Quality stating that the mining bill would "appeal to the mining interests, but not to the public." He accused the Administration of ignoring criticism by Environmental Protection Agency head William Ruckelshaus that "Congress will again set aside the Administration's bill if we fail to take a stronger stance." At a White House press briefing, Ruckelshaus denied his advice had gone unheeded. Secretary of Interior Rogers Morton added, "I don't see how this bill could be made much stronger than it is." □

NAS calls '75 standards technologically feasible

When Congress required automakers to meet strict new pollution standards in their 1975 and 1976 models, it assigned the National Academy of Sciences the job of determining whether or not the standards were technologically feasible in the time allowed. The Committee on Motor Vehicle Emissions of NAS has now released its report and finds that the 1975 standards are "technologically feasible" and that eventual achievement of the 1976 standards is "likely, but may not be attainable on the established schedule."

Automobile manufacturers disagree.