

tissue samples from the life forms which will be flown in the Soviet Union's own experiments.

Early in the year, NASA scientists will also offer suggestions for experiments on future Soviet probes. These could well be more elaborate than the first go-round, partly because of the available time, and are likely to in-

clude studies of gravitational and cosmic radiation effects, as well as demineralization and vestibular investigations.

The possibility of such invitational biology payloads has been an acknowledged one for a long time, but this is the first time it has been exercised by either side. □

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## Bad news for Brans-Dicke

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In spite of the adulation that surrounds his memory, Albert Einstein did not have the last word on theories of gravitation and general relativity. There are rival formulations, not the least of which is the one of Carl H. Brans of Loyola University and Robert H. Dicke of Princeton University.

In the choice between Einstein and Brans-Dicke the shape of the sun can make a difference. It comes about this way: One of the things Einstein's theory was designed to explain was an excess precession of Mercury's orbit, an amount of precession beyond what the previous gravitational theory (Newton's) could account for. If the sun is perfectly spherical, the Brans-Dicke theory will not predict the observed amount of excess precession, and Einstein has to be preferred. If the sun is oblate, the oblateness contributes to Mercury's precession, and that plus the prediction of Brans-Dicke theory can be made to yield the observed amount.

Some observations have seemed to show some oblateness. For years now Henry A. Hill of the University of Arizona and several colleagues have been running a check with observations that attempt a precise comparison of

the sun's polar radius to its equatorial radius to see if the latter is larger. Their results are in the Dec. 16 PHYSICAL REVIEW LETTERS, and they hold little seasonal cheer for partisans of Brans-Dicke.

The observation is not easy because it is not a simple thing to tell exactly where the sun's edge is. The sun sort of trails off, and the exact point to choose as the edge takes careful calculation and plausible argument. Another problem is that if the edge of the sun is brighter at the equator than at the pole, the extra brightness may give a false impression of oblateness.

It is the latter that Hill and collaborators now conclude is the case. Extra brightness at the solar equator accounts for the apparent oblateness seen by other observers. "The immediate impact of the current work removes the relevance of all earlier solar-oblateness observations to tests of gravitation theories," they write. And, in another place, "This removes the serious consequence [of previous solar-oblateness work] for Einstein's general theory of relativity."

It is cold comfort for partisans of Brans-Dicke, but it is probably not enough to make them give up yet. □

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## The noncosmic cosmic rays

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One of Pioneer 10's earliest and most surprising discoveries about Jupiter in 1973 was that some of what scientists thought to be cosmic rays from the sun and from outside the solar system were in fact coming from the radiation belts around the giant planet. Now a group of physicists has concluded that another fraction originates nearer still, in the radiation belts of earth.

The discovery came from a satellite, Interplanetary Monitoring Platform 7, whose rotation made it possible to determine which of the charged particles it was measuring came from which direction. It also carried a particularly sensitive detecting instrument, enabling it to measure about 10 times as many low-energy protons (hydrogen nuclei below 2 million electronvolts, the "cosmic rays" in question) in a given time as had been seen before.

Thus equipped, physicists Stamatis Krimigis and John Kohl of the Johns Hopkins University Applied Physics Laboratory in Maryland and Thomas Armstrong of the University of Kansas were able to compare the proton flux from the direction of the earth with that from the direction of the sun. They discovered that even during a time in mid-January 1973, when the sun was in a particularly quiet phase, the bursts of low-energy particles pouring out from the outer (Van Allen) radiation belts trapped by earth's magnetic field kept coming at a more or less constant rate.

"Although we had long made measurements in the vicinity of the earth," says Krimigis, "we never thought that our own radiation belts were the origin of this low-energy component in the interplanetary cosmic ray spectrum. It is now clear . . . that what was previ-

ously considered part of 'cosmic rays' has its origin much closer to home. . . ."

In addition, the researchers found that the bursts seemed to correlate well with magnetic disturbances in the belts, disturbances which would create waves that accelerate the ordinarily slow-moving particles. "This gives them a kick, as it were," says Krimigis, "to where they become fast-moving nuclei and break through the belt into interplanetary space."

Low-energy cosmic rays account for less than one percent of the total low-energy spectrum, most of which is from planetary magnetospheres, so reassigning still more to the magnetospheric side leaves a minuscule amount indeed. In fact, says Krimigis, "at energies below 2 MeV, essentially most if not all [of the charged particle spectrum] is magnetospheric in origin." It is even possible, he says, that there may be no really low-energy cosmic rays reaching the solar system at all—that the polarization of the interstellar electric field turns them away, leaving nothing but magnetospheric outpourings below perhaps 20 MeV. There are no actual data available yet to prove or disprove this idea, but Pioneer 11, successor to the probe that first re-assigned some cosmic rays to Jupiter (energetic electrons in that case—"cosmic rays" is a broad term), may find out as it arcs above the plane of the ecliptic on its way to distant Saturn. □

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## Shift toward a noncyclic universe

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The controversy over whether the universe is open or closed marches on. Basically the question is this: Will the observed expansion of the universe continue forever or does the universe possess enough matter so that the mutual gravitational attraction will decelerate, stop and reverse the expansion? The first case is called open; the second closed. In an open universe, the big bang happened once and for all; in a closed universe it can repeat periodically as each collapse generates a new explosion and a reexpansion *ad infinitum*.

It is not an open-and-shut case. There are many uncertainties in the different data that must be assembled to draw a conclusion, and the argument has simmered along for decades. The latest contribution, on the open side, is by J. Richard Gott III of California Institute of Technology, James E. Gunn of Caltech and the Hale Observatories, and David N. Schramm and Beatrice M. Tinsley of the University of Texas. Unlike many previous points in the debate, this one has in the last week or so gotten into