Meetings

Satellites: Manned and Unmanned

A conference on artificial satellites was held at Virginia Polytechnic Institute 12–16 August. The purpose of this meeting was "to assist in the interchange of information among scientists and engineers actively working in space research" and "to bring information and stimulation to scientists and engineers, particularly in educational institutions, who may not now be engaged in this field." The five major topics discussed were: the earth and its atmosphere, the near-earth environment, the solar-space environment, meteorological and communications satellites, and the manned satellite program.

Homer E. Newell (director, U.S. Space Sciences Program) reported that extensive plans are under way to determine the existence of life on the planet Mars, the most likely planet in our solar system to harbor extraterrestrial life. Late next year, the United States plans to orbit the first of several Mariner spacecraft to the vicinity of Mars.

Newell said, "Should life be found on Mars it is quite likely to be fundamentally similar to that on earth. Nevertheless, it may be sufficiently different to provide, by comparison, extremely illuminating information about the nature of physical life." Life on earth is based on the presence of carbon and water; studies indicate that both are present on Mars and that the planet has an atmosphere. Scientists previously considered Mars and Venus the only planets likely to have life. Newell said that the findings of Mariner II last year practically ruled out Venus because of the intense heat and the absence of a protective magnetic field of the planet. Nevertheless, Mariner II has at least whetted the scientific appetite about Venus and the other planets in our solar system. Intensive studies about the sun, Jupiter, and interplanetary space are scheduled.

John O'Keefe (Goddard Space Flight Center, NASA) theorized that the moon broke away from a rapidly spinning, cigar-shaped earth. As is well known, the earth is not a sphere. By virtue of its rotation, the poles of the earth have been flattened and the equator bulges. The calculations of how much the earth should be flattened by rotational forces do not agree with the true amount of flattening indicated by artificial satellites. "Around the center of the earth we seem to have an excess of mass; that is, the flattening [at the poles] is more than it should be." O'Keefe also added that artificial satellites have enabled scientists to obtain a more precise measurement of the depressions and elevations of the earth's mantle. The measurements, in turn, support the theory that these depressions of the earth are the scars of the moon.

O'Keefe speculated about what might have disturbed the internal symmetry of the earth. He said, "The earth should be stratified in its interior, but something upset it, twisted it." The behavior of planets indicates that the moon draws closer to the earth and the rotation of the earth also increases as one goes backward in time. The moon would have disintegrated 1½ billion years ago if the forces produced by the interreaction of the two bodies had been confined by them alone. Since rocks and other terrestrial signs indicate that no such crises occurred 1½ billion years ago, O'Keefe suggested that some of the force involved was transferred, in an undetermined manner, to the surrounding medium of space. This would allow the earth and the moon to rotate very rapidly and also enable them to exist very close together.

At the time the core was formed the earth was rotating once in 3 hours. As the mass of the earth cooled, iron separated from the mixed ingredients of the liquefied planet and formed the core. Previous to the formation of the core the earth was already at the point of instability. The formation of the core would push the planet to complete instability, thus forcing the earth to assume the shape of a cigar. The earth started to become flatter and flatter until eventually some of the mass broke off to start its own existence as the moon. The process of breaking off would retard the swift rate of rotation but would not retard it sufficiently to force the young moon back to the earth. O'Keefe cautioned that as yet, "These remarks cannot claim to be an established theory."

Discoveries about the density of the earth's atmosphere by satellite probes were noted by D. G. King-Hele (Royal Aircraft Establishment, Farnborough, England). He reported that the sun produces a profound effect on the density of the atmosphere; the effect becomes greater as the altitude increases. The density during the day is as much as 10 times greater than the density at night. Also, sizeable increases in density are caused by solar flares. King-Hele suggested that the sun increases the atmospheric density through the heating effect of its ultraviolet radiation and by streams of charged particles which are continually being emitted by the sun.

Wilmont N. Hess (Goddard Space Flight Center, NASA) interpreted the results of a high-altitude hydrogen bomb explosion as actually enabling scientists to obtain more knowledge about the atomic particles which make up the Van Allen belt. Many scientists thought that the scientific investigations of the Van Allen radiation belts would be greatly hindered by the high altitude nuclear explosion.

The controversial hydrogen bomb test was conducted on 9 July 1962, 250 miles over Johnston Island in the Pacific Ocean. The explosion created a man-made belt of radiation which superimposed itself over the natural "inner" Van Allen belt. Actually, the bomb explosion turned out to be a "controlled geophysical experiment" with great advantages for the scientists, according to Hess.

One of the problems which had baffled investigators was the time it took the radioactive particles at different altitudes to lose their energy and drop out of the belt. There was no starting time from which the rate of radioactive decay could be measured. The explosion of the bomb furnished a starting time, because the addition of new particles to the belt could only have begun at the time of the instant of the blast. However, scientists still needed a way to distinguish between the new man-made particles and the

older ones of the natural belt. This was rather simple because the "inner" Van Allen belt is predominately composed of protons. The bomb ejected electrons into the belt. While the inner belt also contains electrons, they have much less energy than those from the bomb.

Satellites were launched to watch what happened as the new electrons decayed or lost their energy, because the electrons would follow the same laws as the protons would under natural circumstances. In this manner it was discovered that the life of an electron varies from 4 months at the equator to 10 seconds at the poles. Data from three Russian test explosions were also included.

Hess discussed a similar "tagging" mechanism for exploring the behavior of particles in the outer Van Allen belt that extends as far as 4000 miles or more above the earth. Radioactive pieces of copper, positioned by satellites at an altitude of 16,000 miles, could inject an atomic particle called the positron into the outer belt. The outer belt is thought to contain no positrons, so there should be no difficulty in identifying them as newcomers to the area. According to Hess, some things which could be studied in this manner include any movement of the belt up or down, whether it ever changes its thickness, or whether acceleration forces ever act upon it.

Gerald S. Hawkins (Boston College Observatory) discussed the hazards of micrometeorites on future space voyages. The rate of bombardment of meteors, meteorites, and micrometeorites is the same for the moon as it is for the earth. However, due to the absence of a lunar atmosphere, there are more of these particles striking the surface of the moon than of the earth. Meteors burn up in the earth's atmosphere and meteorites and micrometeorites are stopped or slowed down.

Meteors normally are large objects resulting from the breakup of comets; the smaller meteorites are believed to have been created by the collision of asteroids in space. Many meteorites have been found on earth. Micrometeorites are best described as space dust, a mixture of solid fragments and fluffy objects. Some may be described as having the consistency of a cigar ash.

Hawkins said that if the U.S. Apollo moonship collided with a 1-ton meteor in space, there would be no chance of survival by the three pilots. But he said that on a 10-day round-trip to the moon, the chances of such a collision are only one in 100 billion.

The first concrete information about micrometeorites was obtained in 1961 in the "Venus fly trap" experiment which was conducted 100 miles above White Sands, New Mexico. A rocket fired a device which opened in the same manner as the petals of a flower and collected millions of these dust-like particles before closing. The device was then parachuted to the ground and recovered.

As an example of the effect of micrometeorites, Hawkins related a hypothetical situation of an astronaut walking about the surface of the moon for one week. At the end of the week every square inch of his space suit would be bombarded by more than a million tiny, fast-moving micrometeorites. A suit only .04 inch thick would protect him for that period, but the visor of his helmet would be so pitted that he probably would not be able to see through it. Eventually, the suit itself would erode under the sandblast effect of the nearly invisible space particles. Thus, space men planning long-term exploration of the moon will require protec-

tive shelters, which also must be fortified to withstand the eroding effect of micrometeorites, radiation, and the hot and cold temperature extremes of lunar days and nights.

Talbot A. Chubb (U.S. Naval Research Laboratory) discussed a relatively new branch of science called x-ray astronomy which is actually an additional tool for examining objects in interstellar space. X-ray astronomy had a rather firm beginning only a few months ago when a rocket was launched from White Sands, New Mexico, carrying aboard a "soft x-ray" detector. Soft x-rays are produced by low-energy electrons of about 1500 volts, whereas the x-rays used by medical doctors are produced by electrons with 40,000 volts of energy.

It has been only in the past year that an instrument capable of recording soft x-rays in space has been developed and used. The soft x-ray detector was developed by two scientists at the American Science and Engineering Company, Ricardi Giacconi and Bruno Rossi. The problem, Chubb said, was to build a detector that could be sensitive enough to distinguish between incoming x-rays and the cosmic ray background, yet having narrow enough view of space so that soft x-ray sources could be pin-pointed with reasonable accuracy. The first detector, an array of geiger counters, was flown by its developers a year ago last spring in an attempt to make x-ray studies of the moon. As the rocket tumbled through space, the detector picked up a source which Giacconi and Rossi later said was the center of the galaxy. The detector used by Chubb was a refinement of the first one and had a tighter field of view, thus allowing a greater accuracy in locating the source.

In Chubb's experiment, the soft x-ray detector made observations for 5 to 6 minutes at points 60 to 100 miles above the earth's surface. During six successive sweeps of the detector, six blips appeared on the graph-paper recording. Chubb said that this graph shows a source roughly 15 degrees from the center of the galaxy, near the Milky Way, which is emitting soft x-rays. If a second rocket flight confirms the location, then scientists can be sure that they are viewing an object which cannot be "seen" by conventional telescopes or by radiowave "telescopes" which listen to the noise caused by the activity of stars and other matter in space. However, the field of view of the detector in space still has not been

sufficiently defined to give scientists the certainty that they would like to have on the location of the unknown x-ray source.

"If this star is seen again in the same location by another x-ray detector, then we can expect that the location of the source has been confirmed," Chubb said. It is planned to check this observation with another rocket flight, probably next February. Verification will mean the start of x-ray astronomy which Chubb predicted would be similar to radioastronomy in that graphs rather than photographic techniques would be used.

It is possible that the source may be a star which has exploded only a short time ago, as astronomical time is measured. The closest known object to the supposed location of the x-ray source is Kepler's star, a supernova discovered in the 17th century. Even if the mysterious x-rays' source should be linked to a star which has been observed by a conventional method, the usefulness of x-ray astronomy would still have been proven.

Nancy Roman (NASA) related that observations made by a U.S. satellite indicate that it may be possible to predict flare eruption on the sun and thus schedule manned space flights around the period of intense solar activity. She said that x-ray detector devices aboard the Orbiting Solar Observatory are limited but very promising. The solar observatory showed that small microflares seem to occur in series with increasing or decreasing strength and with a predictable relation between both the intensity and time lag of each succeeding flare. "If this holds up during future information," she said, "it will be the first time we have been successfully able to predict any facets of flare activity." She reported, "With OSO we watch the birth and death of a series of small flares in the soft x-ray region. They occurred at equal space periods and we were able to predict when the next one would occur within one minute. Whether this orderliness also will apply to larger flares which are of importance to manned flight we can't tell now. But the initial OSO findings are certainly encouraging."

The next period of extreme activity will occur from 1967 to 1969 when the United States plans to send three-man Apollo spaceships around and to the moon.

Roman reported a second solar observatory is scheduled for launching later this year and will carry a corono-

graph, a device to produce an artificial eclipse of the sun. Roman also outlined space agency plans to launch a series of orbiting astronomical observatories to study the stars and other celestial bodies above the disturbing influence of the earth's atmosphere.

The chief of the Manned Spacecraft Center of NASA, Chris Kraft, related that one of the first steps in the upcoming Gemini space projects will be a rendezvous of a manned satellite with an unmanned satellite in outer space. The unmanned vehicle will rendezvous with a satellite containing two astronauts and will be used to alter the orbit of the manned craft. Both satellites will be launched from Cape Canaveral.

The Gemini project, which will get under way next year, will be followed by project Apollo which has as its end result a manned landing on the moon probably around 1970. However, Kraft said that no definite date could be set for a moon shot: "We'll land on the moon when we see it is feasible." At present, Kraft said, "we know all that is necessary to go to the moon," with one exception, a "knowledge of the surface of the moon." This information will probably not be learned until an actual lunar landing is performed. Two men will go on the moon trip and either or both will be able to walk from the space ship and explore the moon's surface.

Kraft noted that the actual purpose for making a moon shot is for its value in further space probes. The moon is "the first step to outer space," a "jumping off place" which will be the "key to open the door to planetary exploration."

Richard B. Kershner (Applied Physics Laboratory, Johns Hopkins University) reported that information received from the satellite Anna has confirmed earlier observations that the earth is shaped like a pear with its stem at the north pole, and that the earth's equator is elliptical instead of circular in shape. Anna has measured the true shape of the earth more accurately and faster than any previous observation. For example, three days of data from Anna could have confirmed the pear-like shape of the earth with greater accuracy than the original calculations which required 1½ years. Kershner added, "We get a fantastic amount of data compared to that which is available from optical observations." He also said that Anna has shown that the earth's ocean areas are farther from

the center of the planet than the land areas; the calculations were made from deviations from the satellite's orbit.

Satellite Anna is equipped with five winking lights. "The behavior of this light system has been a little odd," Kershner said. "They worked fine the first two months, then they cut to four, then we had three, and finally none." It appeared as though part of the electrical system had shorted out and the lights would wink no more. Then about 2½ weeks ago, the lights started flashing beautifully. This sort of thing is extremely hard to believe. The short must have burnt itself out. Kershner related that Anna was another example of a satellite that fixed itself while humans stood by helplessly on the ground. He went on to cite an occasion when Mariner II, on its journey to the vicinity of Venus, was struck by a tiny meteorite which apparently ripped some wires from the power supply. The records show a jolt to the spacecraft as if some object had struck it and show a corresponding power cut-off at the same time, he said. Yet the power eventually returned, meaning the wires must have soldered themselves back to their proper connections.

Both Telstar communication satellites have had mysterious trouble. Telstar I refused to obey commands from the ground on two occasions. The first time, Bell Telephone scientists fixed the satellite by remote control but the second time, in February, the situation looked hopeless until the satellite spontaneously began functioning again. In a humorous vein Kershner suggested, "Maybe it's space gremlins."

The conference was sponsored by Virginia Polytechnic Institute in cooperation with the National Science Foundation and the Langley Research Center, NASA.

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Forthcoming Events

November

26–30. **Endocrinology**, 16th meeting, Paris, France. (Secrétariat du Service du Dr. Albeaux-Fernet, Hopital Laënnec, 42, rue de Sévres, Paris 17)

29–30. **Biomagnetics**, intern. symp., Chicago, Ill. (J. F. Barnothy, Biomagnetic Research Foundation, 833 Lincoln St., Evanston, Ill.)

29–30. American **Mathematical** Soc., Cleveland, Ohio. (AMS, 190 Hope St., Providence 6, R.I.)