Helios, Science and the Sun: Data Delay

Helios, the instrument-crammed satellite that passed closer to the sun than any other manmade object (SN: 3/22/75, p. 188) has turned out to be a triumph for its German designers, surviving and observing in temperatures that would melt lead. Back on earth, unfortunately, the affairs of Helios have been far less successful. More than a year after the spacecraft's Dec. 10, 1974, launching, and with Helios B set to take off Jan. 15 from Kennedy Space Center, the program's team of solar researchers have only a tiny fraction of their data. The rest is struggling to emerge from a morass of antiquated computers, incompatible equipment and inadequate programming.

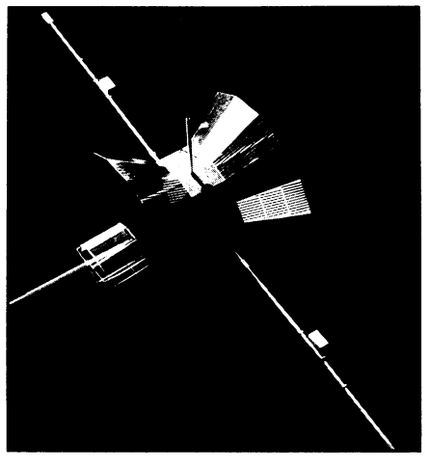
Ten months after Helios passed less than 46.3 million kilometers from the sun, its scientists have received, according to a source close to the program, "perhaps a couple of weeks of data," and that is a 100-percent increase over the amount that were available as recently as September. In the summer, Helios officials in Germany predicted that they would be through their already fat backlog of data by early December. Instead, the source reports, "they're only about a third of the way to their goal."

The computer originally made available for processing Helios scientific data was an old, germanium-transistor CDC 3600, hardly a state-of-the-art speed demon. New tape drives bought for it turned out to be incompatible, and when the system was uprated last summer it was discovered that there was timing problems in the data that the existing programming could not handle. Helios researchers reporting at an August conference were obliged to make do with sketchy, "quick-look" data of as few as two hours per day from the probe's 11 experiments. To help with the backlog, Helios officials have reportedly been using an additional computer rented from the National Oceanic and Atmospheric Administration in Boulder, Colo.

Fortunately, it's only a matter of time. None of the data, which are preserved on master tapes, have been lost, and by the time Helios B gets down to work in the spring, the processing should be flowing right along. It should be worth the wait.

Even the quick-look results are intriguing. Helios A has, for example, verified the spiral component of the sun's magnetic field structure as far as 0.3 astronomical units from the sun. A surprise—requiring more complete data for verification—seems to be that the field strength increases more slowly than expected as one approaches the sun, roughly proportional only to the decrease in distance, rather than distance squared.

Also unexpected were the high number



NASA

Helios A, booms out, stalks the sun.

and flux, or flow rate, of micrometeoroids—space dust—near the sun. (They seem to offer surprises at every turn: Detectors aboard the Pioneer 10 and 11 spacecraft showed virtually no increase in dust-sized particles as the probes passed through the asteroid belt between Mars and Jupiter.) Between earth and perihelion, Helios showed a 4-fold increase in number and a 15-fold increase in flux of dust particles heavier than 10^{-12} grams. Strangely, the particles seemed to have differing compositions, suggesting that perhaps they came from many different sources. In addition, the particle flux measurements were different for the ascending and descending sides of the probe's orbit. Perhaps, suggests H. Fechtig of the Max Planck Institute in Heidelberg, there is a symmetry effect about the solar equator rather than the plane of the ecliptic. Helios B, he points out, should be able to amplify on the subject, since it will be flown "upside down," thus letting the particles strike its detectors from reversed directions.

Much of the most interesting Helios A data, however, is still being processed. Spectral line-broadening, for example, is expected to yield valid information on turbulence as close as half a solar radius above the sun's surface. At least three major solar eruptions are on the tapes, according to James Trainor of the NASA Goddard Space Flight Center, notably including one in which bursts of particles, neatly collimated into angles as small as 20 degrees, are displaced by up to 60 degrees from presumably related X-ray emissions. As a bonus, the event occurred only three or four days after perihelion, putting Helios in a box seat.

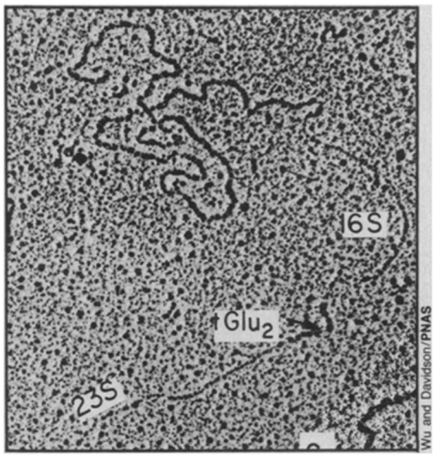
Helios B may go even closer. It will be aimed at a perihelion only .287 AU from the sun, compared to .309 AU for its predecessor. It will also carry an added experiment: a gamma-ray burst detector which, working in tandem with earth-orbiting probes such as the military Vela satellites, should enable long-baseline measurements for accurate locating of gamma-ray sources in the distant reaches of the sky. The only engineering change will be to the insulation on one instrument boom, a tribute to the designers' foresight in an untried environment. □

Mapping genes on DNA molecules

In a DNA virus, a bacterial cell or a mammalian cell, one or many DNA molecules are present. Parts of each DNA molecule make molecules of RNA. The RNA is then used to make proteins or to serve as transfer or ribosomal RNA. Thus, those regions of each DNA molecule that make RNA are genes.

Several years ago, Norman Davidson of the California Institute of Technology and several other scientists devised a technique to visualize, under the electron microscope, those areas of a DNA molecule that serve as genes. But the technique was insensitive, so that gene mapping was difficult. Now Davidson, along with Caltech colleague Madeline Wu, has greatly improved the technique so that gene mapping is much easier and can be done with greater confidence. Wu and Davidson report their findings in the November PROCEEDINGS of the NATIONAL ACADEMY of SCIENCES.

The original technique worked like this:



DNA strand under microscope. Thin stretches are genes; thick areas are not.

A DNA molecule consists of two strands, so heat was used to make the two strands fall apart. The mixture containing the two

strands was then placed with an RNA molecule of interest. The RNA formed a duplex with the area on one of the strands that would normally make the RNA. The material was then placed under an electron microscope. The RNA-DNA duplex was supposed to look thicker compared to the rest of the DNA strands. But the contrast was often too poor to see the duplex.

Then Wu and Davidson hit upon a particular protein that they thought could improve the contrast. It is called the gene 32 protein and is made by a virus known as T4 bacteriophage. The protein is normally used by the virus to help it replicate in bacteria. In Wu and Davidson's view, however, the crucial thing was that the protein had the property of binding only to single-stranded DNA, not to DNA-RNA duplex regions. And when it bound to DNA, it completely covered it.

"We say the protein is selective, which means it only goes to the single-stranded region," Davidson explained to SCIENCE NEWS. "It is cooperative, which means that one protein sits right next to the following one. It's like a row of cars parked along the curb bumper to bumper. In other words, you get a complete block of gene 32 proteins sticking consecutively along all parts of the DNA which are single-stranded."

This is how their improved technique works: An RNA molecule is duplexed to a DNA strand as before. Then the material containing the RNA-DNA duplex is mixed with gene 32 proteins. (The technique calls for as little as one hundred-millionth of a gram of DNA and a little more of the proteins.) The proteins stick to all parts of the DNA except where the DNA is duplexed to the RNA. The material is placed under the electron microscope. Those areas that now look thick are the single strands of DNA coated with proteins. The thin area is the RNA-DNA duplex.

Wu and Davidson have used this technique to visualize those areas of viral DNA that make several different RNA molecules known as 16S, 23S and 5S ribosomal RNA and a transfer RNA known as Glu_2. They have found that the thick and thin areas can be easily visualized. What's more, they were able to estimate the number of nucleotides present in each visualized gene, because the number of nucleotides can be worked out according to how long each gene is. For instance, the 16S gene contains 1,500 nucleotides, the 23S gene 3,000 and the tiny Glu_2 gene only 80.

One of the attractive aspects of the technique, Davidson points out, is that it can be used to map not only viral and bacterial genes, but mammalian genes, as long as RNA molecules from mammals have been purified. Aside from telling molecular biologists how different mammalian genes are arranged relative to each other, it should also shed new light on which genes are expressed during mammalian development and differentation and in cancer cells. □

Love among the monkeys

Harry F. Harlow, the father of the surrogate mother, is well known for his more than 40 years of research on primate development. His innovative use of terry cloth-covered wire monkeys as surrogate mothers helped explain the importance of contact comfort and warmth in mother-infant relationships. It had been thought that mother's milk was the prime factor in the mother-infant bond. Last month, Harlow was in New York to be honored with a $25,000 award from the Kittay Scientific Foundation (SN: 6/14/75, p. 383). He used the occasion to discuss some of his research and to describe another type of research mother—the monkey monster mother.

Primate emotional development, especially love and aggression, has long been a subject of investigation for Harlow and his colleagues at the Wisconsin Regional Primate Research Center. Their work has shown that external aggression, aggression directed toward others, develops relatively late in primates. In macaque monkeys, for instance, full-blown aggression is not displayed until the fourth year in males and later in females. This is equivalent to the midteens in humans.

In contrast, various types of love (mother love, peer love and the beginnings of heterosexual love) develop early in life and have a chance to become well established before aggression comes into play. "It is fortunate," says Harlow, "that aggression is a late-maturing mechanism. Were it otherwise there would never have been even one primate society. At an early age all the infants would have destroyed each other and societies without infants become societies without adults."

Experiments with monkeys isolated from birth show just how important it is to experience love and to learn loving ways before aggression develops. Infant rhesus monkeys were raised in total isolation for six months of the first year of life and for six months in partial isolation where they could see and hear other monkeys but not be with them. At the age of three, these animals were compared with mother-raised and peer-raised monkeys in their reactions to strange monkeys. The isolates threatened, pulled, bit and tore violently at the hair and flesh of the strangers to a significantly greater degree than did the others. In these isolates, explains Harlow, no ties of affection had had a chance to be formed prior to the opportunity for aggressive behaviors to emerge, and normal positive age-mate play had not been present to soften the sadistic sorties.

Outgroup aggression, or violence against strangers, is not too hard to imagine. The most dramatic expression of agonistic behavior in both monkeys and humans is aggression against their own children. This too can be created in the laboratory. Mother love can be almost perpetually prevented by withholding mother love from the mother-to-be, even if she isn't to be a mother for many years. Harlow and his co-workers illustrated the battered child syndrome with motherless mothers who proved to be monsters as mothers.

The motherless mothers were animals that had never had the chance to express love to a mother nor to exchange affection in play with age-mates. After giving birth,

Harlow/Wisconsin Regional Primate Research Center

Young monkeys cling to the warmth and comfort of a cloth-covered surrogate mother, only leaving for the nourishment provided by a wire surrogate. Later studies showed that motherless monkeys become monster mothers.