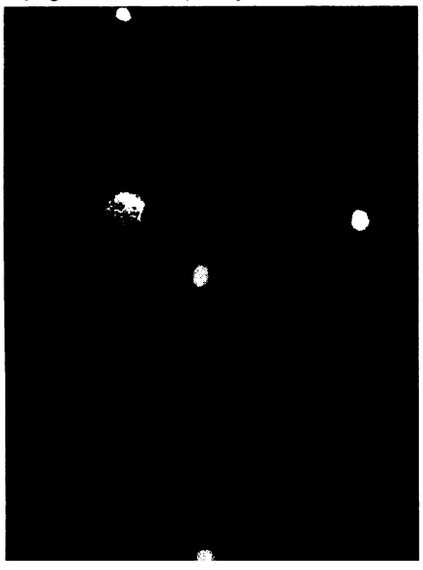
lem if Voyager 2's cameras are shifting around to photograph different parts of Uranus itself, its bizarre rings (known from earth primarily by their occasional blockage of the light from certain stars) and satellites. Adding to the problem is that the probe will be approaching Uranus at about 32,000 miles per hour (about one-third faster than its approach at Saturn and nearly twice that at Jupiter), so that it will be moving more quickly past its targets. In addition, the Uranian system is much smaller than those of the bigger planets, and the highly tilted orbits of its moons are nearly perpendicular to the oncoming spacecraft, instead of being laid out in a "flat" plane so that Voyager 2 would be flying across them. Both of these factors mean that the close-up measurements and photos will have to be compressed into a much shorter time, so that the flexibility of combining measurements from fixed and movable sensors would be welcome indeed.

In the last few months, fortunately, the Voyager engineers have devised a technique that they believe will let them use the scan platform after all, though perhaps only at its slowest turning rate (0.08° per second instead of 1° per second). Analysis and additional lab testing, expected to continue into September, has indicated that when the platform is about to jam, a pause will allow the lubricant to return to between the drive-gear and its shaft. And the engineers, says Charles Kohlhase of JPL, have found a way to see the jam coming. When the scan platform starts to get sticky, he says, the additional torque required is produced by longer electrical pulses in its azimuth drive motor. Under normal conditions, the pulses last about 100 milliseconds and provide more than adequate torque, but it is possible for commands to be radioed up from JPL to make the pulses so short that they are just barely long enough to let the platform move. At 6 msec, for example, it will move properly, but at 5 msec, says Kohlhase, it begins to drag a little. If the lubricant is starting to leak so that the friction of the system is increasing, however, it will take slightly longer pulses to overcome the drag—a warning of an impending jam.

The engineers thus plan to shorten the pulses for a few hours every few months as the spacecraft approaches Uranus, and then at lesser intervals as the time of the flyby nears. With the confidence inspired by this watch-dog technique, Voyager officials have decided to plan on using the scan platform after all—though there will be a set of commands ready for transmission at the touch of a button if it looks as though it will be necessary to switch to rolling the spacecraft.

Voyager 2 also has some other potential problem areas (SN: 2/6/82, p. 86), involving such aspects as the operating life of its narrow-angle camera, the fact that only one of its two receivers is working, and the loss of some small portions of its computer memory. But various remedies have been either planned or already implemented (except for the receiver, whose loss would cut Voyager off from further instructions from JPL), and none has deteriorated since the Saturn encounter. Expectations for the Uranus flyby are high, and if all goes well, Voyager 2 will head for Neptune in 1989. —*J. Eberhart*

Uranus (left, third from top) and its five known satellites—top to bottom: Umbriel, Miranda, Oberon, Ariel and Titania—photographed in infrared by William Sinton at Mauna Kea Observatory, Hawaii, will be Voyager 2's close-up subjects in 1986.



W. M. Sinton/Univ. of Hawaii

New biotech tool: Recombinant RNA

A novel laboratory method for producing large amounts of any selected RNA molecule has been announced by Columbia University scientists. They expect the technique to extend the already impressive power of biologists to analyze genes and cell processes and to produce proteins that are rare and valuable.

Previous work in gene splicing has employed methods to cut, recombine and reproduce molecules of DNA. Chemically DNA and RNA are distinguishable by only slight variations, but in cells they play very different roles. DNA is the archive of genetic information, whereas RNA implements the DNA-encoded instructions. In some viruses and in even smaller infectious agents, called viroids, RNA is the archival genetic material.

An RNA virus, Q beta (Qβ), provides the basis for the new technique. When it infects bacteria, its RNA acts as a template for Qβ replicase, which strings together RNA subunits. This enzyme rapidly produces many copies of the viral RNA, which get packaged to create a multitude of new Qβ viruses.

The trick behind the enzyme's proficiency is its exponential production of RNA molecules. Each RNA molecule produced can act as a template, along with the original Qβ RNA, for creating further RNA copies.

Although many researchers have tried to harness this enzyme's power, it was too specifically geared. In a cell the enzyme replicates only the Qβ viral RNA among thousands of bacterial RNA molecules. "The Qβ replicase needs to find its own template in a veritable universe of other RNAs," says Fred Russell Kramer of Columbia. The enzyme recognizes the Qβ RNA, and a few naturally occurring small RNAs (called variants) by a complex binding site in the center, and a specific region at the end also is necessary for replication.

Now Kramer, Donald Mills and Eleanor Miele report they have beguiled the enzyme to copy RNA of their choosing. They have developed two means of inserting selected RNA sequences into one of the small RNA variants that can serve as a template for Qβ replicase. The enzyme then replicates the insertion as well as the variant's sections.

In the first method, the scientists cut the variant at a point not crucial to its replication and add a selected piece of RNA, they report in the Dec. 15 JOURNAL OF MOLECULAR BIOLOGY. In more recent work they have constructed rings of DNA that encode the RNA of the variant. Then they can use the sophisticated recombinant DNA techniques to insert a gene or other stretch of DNA. This DNA ring can be converted to RNA and then immediately reproduced with the Qβ enzyme.

Three different RNA segments have been reproduced in quantity using these methods. "In a typical reaction 1 nanogram of RNA in one hour produces as much as 1 milligram of RNA, a million-fold amplification," Kramer says. "Size of the insert *per se* is not a problem, and the nature of the foreign sequence also seems not to be a problem." So far the largest insert, a segment from another virus, is 210 nucleotides (nucleic acid subunits), which is about the same size as the variant. "We haven't actually put in a 'monster' yet," Kramer says, "but there seems to be no reason why very large insertions can't be effective."

The Columbia scientists expect their technique to offer new opportunities for scientists to study, and to alter, the viruses and viroids that contain RNA as genetic information and to analyze the maturation of RNA in plant and animal cells. In addition, the recombinant RNA methods may allow scientists to make almost limitless amounts of RNA molecules that are unobtainable by current biotechnology methods, but that would allow laboratory production of yet more, commercially valuable biological products. —*J.A. Miller*