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Mission to Jupiter and Satellites

This issue contains first scientific reports of the Voyager 1 mission to Jupiter and its satellites. It also has a description of the telecommunication system that maintains two-way transfer of information between Earth and a spacecraft 700 million kilometers away. The excellence in communication equipment on Voyager 1 and the new results obtained mark the mission as a high point in this country's space effort. At a moment when unease and gloom abound, it is good to have evidence of continued competence among us.

To most people, the payoff of the mission is in the form of striking pictures of Jupiter and its satellites. For scientists, results from other observing equipment on Voyager 1 are also important. A smaller group is interested in how the results were communicated back to Earth and in the control of the spacecraft in its travels through space. The reception of large numbers of pictures and other information was made possible by advances in communications. On Earth some radio stations broadcast with a power of 50,000 watts, yet one's radio may not receive such a station 100 kilometers away. Voyager 1 transmits with a power of 10 to 30 watts, yet its signals are dependably received at a distance of 700 million kilometers. The circumstances in the two instances are quite different; nevertheless, the dependable reception of signals from deep space is a technological feat. Part of the trick is a good directional antenna at the spacecraft accurately pointed at Earth. Even so, the signal energy reaching Earth is less than 10^{-18} watt per square meter, and this weak signal is detected reliably in spite of all manner of background electromagnetic noise. This capability is the result of steady improvement over the past 15 years. The present system is a factor of 150,000 better than that used with the 1965 Mariner mission to Mars.

Substantial evolution has also occurred in spacecraft. Voyager 1 has incorporated many improvements over its Mariner predecessors. This is especially true of the computer systems on board. The changes reflect opportunities created by advances in microelectronics. They are also responsive to needs created when a spacecraft is far away. The transit time for a message from Earth to Jupiter is about 40 minutes. Onboard computers must control the functioning of Voyager 1, including the scheduling and pointing of its scientific equipment. It is also desirable to preserve flexibility to meet contingencies. For example, during the 18 months of travel from Earth to Jupiter, the planet's restless atmosphere was observed from Earth. To optimize picture-taking in the vicinity of Jupiter, it was necessary to reprogram an onboard computer by commands from Earth. This can be done only slowly but the flexibility proved to be very useful.

As can be seen in this issue, a large amount of information was accumulated about Jupiter and its satellites. Particularly striking were some of the 18,000 photographs of the Jupiter system including color pictures of Jovian clouds and images of Jovian lightning, auroras, and meteor trails. Jupiter, with its large magnetic field, energetic particles, electromagnetic emissions, and complex atmospheric motions, will continue to be a closely studied object. On this occasion, however, photographs and other observations of the Jovian satellites produced the most novel information. For example, the two outer satellites Ganymede and Callisto are ice-covered and show preserved craters, apparently formed 4 billion years ago when an intense episode of cratering occurred in the solar system. The satellite Io has no ice and impact craters, but has been the scene of volcanic activity which continues. Plumes of dust and vapor reaching up to 285 kilometers were noted. The internal heat in Io seems to be due to tidal friction rather than radioactivity, and the surface of the satellite is renewed at least every 10 million years.

Our generation is likely to be the first to understand how the solar system was formed. The Voyager missions move us toward that goal.

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