Inner Circles of the Solar System

Soviet and American probes are exploring the moon, Venus and the space around them.

RECENT MONTHS have seen various significant events in that Soviet shooting gallery, the solar system, and on the earth among those who are interested in solar-system exploration. On 3 Feb. the Soviet spacecraft Luna 9 made a successful soft landing on the moon and shortly thereafter began to send back pictures of the surface. On 1 March the Russians announced a hard landing on Venus by their probe Venus 3, which delivered at least a coat of arms of the Soviet Union.

Meanwhile the US National Aeronautics and Space Administration revealed plans. NASA announced early in January what it had been advised to do when it got to the moon. On 2 March Homer E. Newell, NASA's associate administrator for space science and applications, presented to the House Subcommittee on Space Sciences and Applications a status report on Surveyor, the long-standing US project to achieve a soft landing on the moon. On 3 March NASA announced the experiments that had been selected for its next Venus flyby mission scheduled to go in the summer of 1967.

Venus probes gone and going

The Russians launched Venus 3 on 16 Nov. Its companion Venus 2 went up on 12 Nov. and flew by the planet at about 24 000 km on 27 Feb. According to newspaper reports a successful midcourse maneuver on 27 Dec. enabled Venus 3 to hit the planet. Otherwise it would have flown quite wide of the mark. Reports from Moscow state that the last period of radio contact with Venus 3 did not take place. Furthermore, television cameras on Venus 2 did not photograph the sunlit side of the planet, and Venus 3 failed to eject a capsule intended to measure temperature and pressure on the planet's surface.

The next US Venus probe (Mariner 67), which is being managed by the Jet Propulsion Laboratory, is scheduled to go in the early summer of next year. It will carry seven experiments and will be aimed to fly within 5000 km of the planet. (The US has no plans for a Venus landing.) The chosen experiments are:

Ultraviolet photometry (C. A. Barth, J. B. Pearse and K. K. Kelly, U. of Colorado; and E. F. Mackey, Packard-Bell Electronics). Two photometers will attempt to obtain a temperature profile of the upper atmosphere of Venus.

S-band occultation (A. Kliore, D. L. Cain, G. S. Levy, JPL; S. I. Rasool, Goddard Space Flight Center). A study of the changes in the vehicle's 23 000 MHz carrier signal before and after it passes behind the planet will try to produce a density-altitude pro-

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SURFACE OF THE MOON. Photograph taken by the Soviet space probe Luna 9. The sun was at a low angle, and objects cast extra long shadows.

file of the Venusian atmosphere and ionosphere.

Dual-frequency radio occultation (V. R. Eshleman, A. M. Peterson, B. B. Lusignan, G. Fjeldbo and H. T. Howard, Stanford; R. L. Leadabrand and R. A. Long, SRI). Signals of two different frequencies will be sent to the spacecraft by the 150-ft antenna at Stanford. Effect of the planet's atmosphere on signals received by the spacecraft will yield information on the atmosphere. Two frequencies permit separation of neutral-atmosphere and ionospheric effects.

Trapped-radiation detection (J. A. Van Allen, L. A. Frank and S. M. Krimigis, State U. of Iowa). Particles of various energies will be observed in a search for trapped radiation belts around Venus.

Helium-vapor magnetometry (E. J. Smith, JPL; P. J. Coleman, UCLA; L. Davis, Cal Tech; D. E. Jones, Brigham Young U.). An attempt will be made to determine the strength and direction of the magnetic field of Venus and the flow of solar wind around the planet.

Plasma detection (H. S. Bridge and A. J. Lazarus, MIT; C. W. Snyder, JPL). A Faraday-cup detector will study density, velocities and temperatures of low-energy protons in the solar wind.

Celestial mechanics (J. D. Anderson, JPL). Tracking data from this mission and from the 1962 mission to Venus will be used to refine further the values of the astronomical unit (the mean radius of the earth's orbit), the masses of Venus and the moon, and the ephemerides of earth and Venus.

THE MAN IN THE MOON. NASA's model of the lunar surface showing a model astronaut surveying outside his model lunar excursion module.

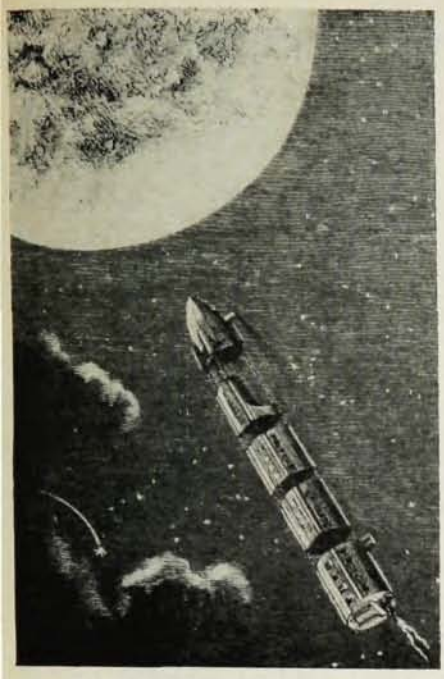
Meanwhile back on the moon

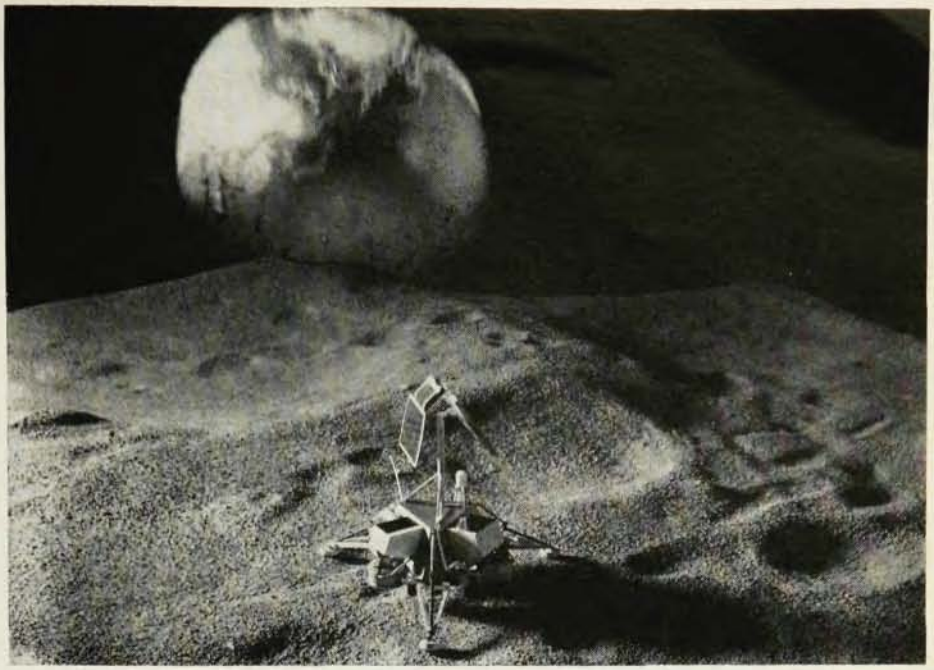
Luna 9 landed in the Ocean of Storms near the moon's equator. It carried a television camera that took pictures of the lunar surface from less than a meter away. The pictures were sent in an ordinary binary code at 183.538 MHz, and Sir Bernard Lovell was able to pick them up with the Jodrell Bank radio telescope and print them out with a Muirhead telephoto machine lent by the *Daily Express*. Later the Russians complained that Lovell's versions of the pictures were laterally condensed and issued versions in which the horizontal dimension was extended about two and a half times. The pictures show that the moon has an irregular, powdery surface on which balls of matter, presumably dust, are scattered.

In Washington a month later some American moon dust was presumably cleared away. The Surveyor program has been underway for some years, but in the last year information about its current state has been somewhat difficult to get. Homer Newell's presentation revealed that there have been reorganizations and reschedulings and gave an account of the present development of the hardware.

The project turns out to be far enough along that the first flight is expected to go before summer. It will carry a television camera to survey the area where it lands and strain gauges to infer the dynamic bearing strength of the lunar surface from the forces experienced by the vehicle's foot pads and struts during landing.

A somewhat heavier vehicle planned for use in the last half of 1968 will carry two television cameras, allowing stereo ranging instead of focus ranging and increasing the range accuracy by a factor of five over an azimuth of 120 deg. The vehicle will also carry two other experiments. A soil mehcanics/surface sampler will permit measurement of dynamic and static soil properties over an area of about two square meters and may eval-





GETTING TO THE MOON. Upper left, Jules Verne style: a (steam-driven?) train of projectiles. Upper right, NASA style: model of Surveyor on model lunar surface. Lower right, Soviet style: trajectory of Luna 9. The craft is sketched at the point of a midcourse correction. Earth is at bottom of picture, moon at top. Arrowheads show direction of sun rays.

uate soil properties to a depth of about 50 cm. By bombarding the surface with alpha particles and making use of Rutherford scattering, the alpha-scattering experiment will analyze the elemental composition of the lunar surface.

A ten-year plan

When NASA finally gets to the moon softly, what does it propose to do there? The organization celebrated the new year by making public some advice it had received on that topic from 65 scientists who assembled in conclave at Falmouth, Mass., last July. Overall, the group advised that NASA plan one or two manned missions to the moon and one manned lunar orbital mission for each year through 1974. The same mission rate would be kept up through 1979, but the astronauts would be expected to remain longer on the lunar surface, possibly two months.

Collecting and bringing back samples of the lunar surface has the highest priority among possible activities. Returned samples would be analyzed at a Lunar Sample Receiving Laboratory at the Manned Spacecraft Center in Houston. Other suggested experiments, in order of priority, are: a passive seismograph, a magnetometer and particle detector, a heat-flow measuring device, an active seismograph and an atmosphere-measuring device.

Along with longer astronaut sojourns after 1974, the advisors recommended development of a fixed-site lunar base with capabilities for deep drilling to study the surface and radio and optical telescopes to study the rest of the universe. A roving vehicle capable of taking a crew of three on an 800-km exploration journey should be developed. It should be able to support a two-month mission without returning to base at the end of it. Manned vehicles orbiting the moon were also proposed to provide opportunity for mapping and wide-range observation.

None of NASA's advisors suggested what it should do if it found Russians when it got to the moon. □