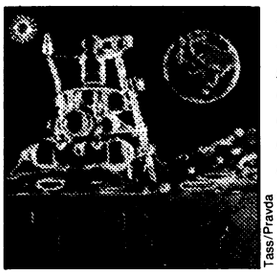
Lunar robot returns deep core sample


Tass/Pravda

Luna 24 is seen depicted on metal plug it left behind on the moon's Sea of Crises.

Russia's latest lunar robot has taken a deep sample out of the previously unexplored Sea of Crises and landed it safely in west Siberia. The soil core sample, which will be analyzed at the Vernadsky Geochemistry Institute of Moscow, contains undisturbed layers of lunar soil from as deep as 500 millimeters. The unmanned vehicle, Luna 24, successfully landed on the moon Aug. 18, nine days after its launch from the Cosmodrome in central Asia's Bainokur. It touched down in the southeast portion of the "sea" which is actually a large depression, several miles below surrounding terrain.

The Sea of Crises is an interesting location because it is one of five discovered in 1968 by the American Lunar Orbiter 5, the areas now called "mascons." These are regions on the moon with an enhanced gravitational strength due to an abnormal concentration of matter. These sites, scientists believe, were created from meteoric impact or volcanic processes. Either of these mechanisms could have introduced untypically dense material into the mascon regions to cause their supplemental gravitational strength.

The spacecraft, which remained intact on the moon for about 24 hours, is outfitted with a hollow-core drill about two meters long. It entered into the lunar soil at an angle and proceeded to bore out a cylindrical soil sample from an ever-increasing depth. At the arm's full extension, the drill head had burrowed to a depth of some 500 millimeters. According to the Soviet newspaper Pravda, the excavation proceeded "exactly like a knife through butter."

After the drilling was complete, the arm carefully returned the two-meter-long sample core to a container which was subsequently hermeticized. Several hours later, the spacecraft's upper portion took off with the sample, using the descent stage as a mini-launch pad. Mounted on the portion of spacecraft left behind is a square metal "plug" bearing inscribed drawings of the Soviet flag and Luna 24.

Three days after its launch from the lunar "mining site," the ascent stage of Luna 24 landed and was recovered in a swampy area of the Ob River, southeast of Surgut. Although the Soviets have apportioned to various countries a share of lunar samples retrieved by their previous robots (SN: 4/8/72, p. 149), no similar intention for this mission has yet been announced. The USSR had last received lunar samples, via Luna 20, in 1972. □

Soyuz 21 completes space experiments


Tass from Soyphoto

Zholobov and Volynov: 50 days in space.

After 49 days, the two orbiting Soyuz 21 cosmonauts returned this week to their spacecraft, ending their experiments on board the accompanying Salyut 5 space station. This ended speculation that the mission was going to surpass the space endurance record of 84 days set by the Skylab 4 crew in 1974.

After leaving the Salyut space station in an auto-pilot mode and transfering some equipment from their series of experiments, the cosmonauts undocked the two craft. On the 50th day, Aug. 24, they re-entered the earth's atmosphere and descended by parachute onto land. They were recovered on target in an area of Kazakhstan, 125 miles southwest of Kokchetav.

Soyuz 21, carrying Col. Boris Volynov and Lt. Col. Vitaly Zholobov, was launched on July 6. Two days later it docked with Salyut 5 (launched June 22). Once inside Salyut the cosmonauts conducted seven weeks of scientific and industrial experiments. According to the Soviet news agency Tass, "The entire program has been fulfilled completely." It gave no indications to support the suspicion that the mission was ended prematurely because of any illness felt by the cosmonauts. On Aug. 17, however, the Soviet newspaper Izvestia reported the cosmonauts were suffering psychological ills it called "a state of sensory deprivation, a sort of sensory hunger."

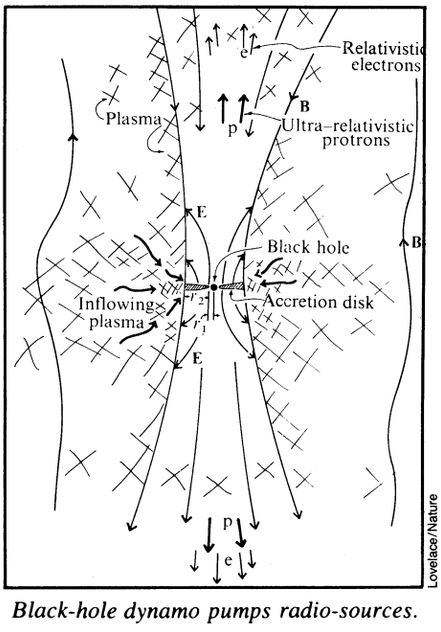
During their stay in the orbiting science station, the cosmonauts themselves were the subject of various medical experiments. Using variable electrical impulses delivered around the inner ear, each cosmonaut tested his equilibrium system for its threshold of sensitivity. They did exercises in specially designed suits fitted with "elastic bands" to simulate the pull of gravity.

Other activities included some "gardening" to test the effect of weightlessness on the germination period of certain seeds. Some shoots obtained from this experiment will return with the cosmonauts for further testing. Another experiment utilized exothermic chemical reactions as a heat source for soldering together two halves of a stainless steel pipe. The cosmonauts used a manganese-nickel solder. Still other experiments included studies (in weightlessness) of liquid and gas flows, crystal growth using pure and contaminated solutions of potassium and ammonia and numerous activities involving infrared photography of the earth and wide-band spectrography to determine the varying composition of the atmosphere with increasing altitude. Soviet scientists will analyze photographs taken of the USSR in the hope of locating areas of valuable natural resources. □

Black hole as radio-source pump

A decade or so ago it would have been difficult to find an astrophysicist who believed in the actual existence of black holes. Now they seem to be everywhere, and astrophysicists are holding black holes responsible for more and more phenomena. The latest thing to be blamed on black holes are the two-lobed celestial radio sources. The proposal is by R.V.E. Lovelace of Cornell University and appears in the Aug. 19 NATURE.

The radio sources in question are usually associated with a visible galaxy or quasar. Their structure is strikingly sym-



Lovelace/Nature

Black-hole dynamo pumps radio-sources.

metrical; they consist of two lobes of radio-emitting matter extending on opposite sides of the visible object. Just the geometry suggests that the radio lobes are material expelled from the visible galaxy, but by what mechanism?

Lovelace proposes that a heavy black hole, a hundred billion times the mass of the sun, located in the center of the galaxy, is ultimately responsible. Such heavy black holes in galactic centers have been repeatedly proposed by a number of astrophysicists.

The black hole will be surrounded by an accretion disk, a disk of matter drawn from neighboring stars by the black hole's extremely strong gravity. Matter from the inner edge of the disk continually falls into the black hole; new matter is continually added to the outer edge. Because everything in the neighborhood partakes of the rotation of the galaxy, the accretion disk rotates too, and its axis of rotation is more or less the same as that of the galaxy.

The matter in the disk is ionized (plasma). It carries magnetic fields with it, and from these, the rotation generates electric fields. So the whole thing acts as an electric dynamo that accelerates streams of protons to nearly the speed of light. The protons move in opposite directions along the axis of rotation. As the protons interact with the interstellar plasma that lies thickly in the region of a galactic center, they generate streams of relativisitic electrons that also flow out along the rotation axis. The energy of these electrons becomes the radio waves by the synchrotron process.

"With this model," says Lovelace, "it seems possible [1] to have a large, steady supply of energy to widely separated small radio components, [2] to obtain alignment and symmetry of the two radio components, and [3] to have a correlation between the axis of the radio components and the direction of the angular momentum of the parent galaxy." □

Hidden variables: Too well hidden?

Contemplating quantum mechanics, Einstein remarked: "God does not play dice." He was referring to the indeterminacy of microcosmic physics. A given unstable particle may decay in two or three ways. Quantum mechanics will give you the proportion of a large sample taking each route, but you cannot tag an individual particle and ask its fate. In a large number of unstable nuclei some decay sooner, some later. Quantum mechanics tells you the time when half will be left—the half-life.

Many more physicists than Einstein were dismayed by this quality of quantum mechanics. Classical physics is rigidly and individually deterministic. If a tennis ball has certain qualities of elasticity, weight, etc., putting those numbers in the equation that describes bouncing will yield a prediction of how that particular ball will bounce.

Philosophically, many wanted to redeterminize microcosmic physics, and to do it some physicists have invented so-called hidden-variable theories, which propose that there is a level underneath the quantum mechanics we see, which is deterministic, and that the quantum mechanical laws are merely statistical averages of that determinism and not indications of a fundamental indeterminism in microscopic physics. There are experimental ways to look for evidence of hidden variables, if not for the hidden variables themselves. The latest such attempt, reported by Edward S. Fry and Randall C. Thompson of Texas A & M University in the Aug. 23 PHYSICAL REVIEW LETTERS, gives a negative result. One of three previous attempts supported hidden variables, so the question is not yet entirely settled.

Hidden-variable theories bear a certain analogy to the laws of gas behavior. In principle, it should be possible to write down an equation for the behavior of each individual molecule in a sample of gas and sum them up. In practice, nobody wants to bother, and so gas behavior is represented by statistical laws that apply to the collective. Likewise, the hidden variables are supposed to be individually predictable, if only we could see them, and together they add up to the statistical laws evident in quantum mechanics.

But the hidden variables, unlike individual gas molecules, are physically undetectable, and so believing in them is like a religion, demanding faith in things unseen. Many physicists therefore reject them.

Unseen or not, it turns out that hidden-variable theories of the local variety can have observable effects. (Local theories deal with happenings in which the participants are close together or in contact; in contrast, action at a distance deals with such things as why the earth revolves around the sun.) The effect depends on a theorem published by J.S. Bell in 1965. In certain cases where pairs of photons are produced, as an atom goes from one energy state to another, quantum mechanics predicts a very strong correlation between the linear polarizations of the two photons. Bell's theorem says that if any local hidden-variable theory is correct, that correlation should be diminished.

Fry and Thompson's experiment used certain transitions of mercury 200 and found in favor of quantum mechanics. Of three previous observations, one using calcium found in favor of quantum mechanics; one using mercury 198 tended to favor hidden variables, and the third, using mercury 202, favored quantum mechanics. So the score is now three to one against. □

Dream more to remember better

People often have trouble remembering their dreams, but it may be that dreams help make memories. Recent research suggests that dreaming is a necessary process through which newly learned material is consolidated in the long-term memory. This finding was reported by psychiatrist Chester Pearlman of the Boston Veterans Administration Hospital at the International Congress of Psychology in Paris.

Pearlman has been investigating rapid-eye-movement or REM sleep, which occurs during 20-minute periods three to five times a night. This stage of sleep is believed to be closely associated with normal dreaming because subjects awakened during REM sleep almost always report that they were in the middle of a dream.

Pearlman trained pairs of rats in a cooperative method of avoiding electric shock to get food. Rats who were deprived of REM sleep after the training (awakened at the start of each REM period) showed no later memory for the training. French psychologists have demonstrated the same thing in rats, and Canadian researchers have shown that students who were learning well during an intensive language course had an increase in REM sleep. Those who were not learning well had no such increase.

While the role of REM sleep in learning and memory is still unknown, these findings suggest that during dreaming some of the events of the day may become part of the long-term memory. Animals and humans deprived of REM sleep may be unsuccessful in completely establishing learned behaviors and events in the memory. If this proves to be the case, staying up and cramming the night before an exam may be a mistake. Says Pearlman, "You introduce more facts than you can remember and you certainly will not be able to use any of them in the future—they are not part of you."

Other experiments by Pearlman and Ramon Greenberg suggest that the day's emotional experiments are also assimilated during dreaming, and that dreaming may help people cope with such experiences. Studies of the sleep patterns of psychiatric patients showed that pressure to dream was related to emotional stress experienced by the patient before going to sleep. Nonpatients showed an increase in the need for REM sleep after exposure to an anxiety-provoking film. (People have often reported nightmares following scary movies.)

While there is still much to be learned about sleep and dreaming, it may be that the memory and coping functions of dreaming are related. In both cases, dreams seem to help in the processing of newly acquired information. □