Navigation satellite carries atomic clock

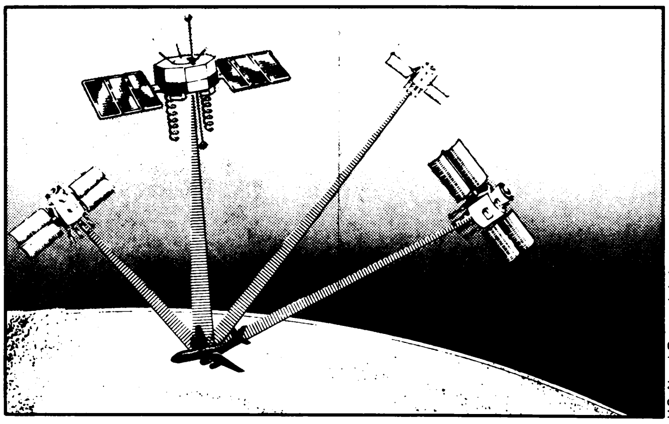
A satellite carrying a cesium-vapor "atomic clock," accurate to within one second in more than 150,000 years, was sent into orbit on June 23, the latest step in a planned worldwide navigation system for aircraft, ships and landbound users. The completed system will consist of 24 satellites expected to let users determine their latitude, longitude and altitude to within 10 meters or less, and their speed in all three directions to within 0.1 meters per second.

The satellite launched last week, called NTS-2, is the fourth in a series developed by the U.S. Naval Research Laboratory to test increasingly sophisticated "clocks" in orbit for the defense Department project, to be known as the NAVSTAR Global Positioning System. Launchings of the two dozen satellites for NAVSTAR itself will begin later this year, with the system scheduled to be complete by the early 1980s.

A user of the system would carry a receiver capable of receiving time signals from three or more of the satellites simultaneously, with a computer to integrate the signals to provide near-instantaneous position, direction and speed readings. The satellites will be arranged in three circular orbits, each in a different plane, with eight satellites in each orbit. This is intended to put users anywhere in the world within range of three or more satellites, 24 hours a day.

The first clock test was conducted with a satellite called Timation I, launched on May 31, 1967, carrying crystal oscillators accurate to within 3 parts in 100 billion, or 1 second in about 1,000 years. Timation II, launched Sept. 30, 1969, tripled the accuracy of its similar oscillators by the use of equipment to correct for atmospheric effects such as instabilities in the ionosphere. The success of the modifications was demonstrated in 1972 when the satellite was used to link atomic clocks at the Royal Greenwich Observatory in England and the U.S. Naval Observatory in Washington, synchronizing the two devices to within one two-millionth of a second. A year later, the experiment was repeated between the Naval Observatory and Australia's Division of the National Mapping—with a fivefold increase in accuracy.

From the crystal oscillators, it was onward to atomic clocks. Timation III, renamed NTS-1 (Navigation Technology Satellite 1), was lofted on July 14, 1974, carrying a rubidium-vapor clock with an accuracy of one second in more than 20,000 years (SN: 7/13/74, p. 27). It lasted only about a year, however, due to the darkening of the glass bulb holding the gas, a problem common with rubidium-vapor clocks. The cesium used in NTS-2 is free from this problem, although since it is a mercurylike liquid until vaporized, it may pose difficulties of its own due to the effects of weightlessness in orbit.



U.S. Naval Research Laboratory

Just launched NTS-2 statellite (second from left) will be joined later this year by satellites in the NAVSTAR system in the first tests of a worldwide navigation system for aircraft, ships and ground users.

NTS-2 will be used in tests with the first five NAVSTAR satellites, three of which will have rubidium-vapor sources with cesium sources in the other two. Meanwhile, the Naval Research Laboratory is planning the 1981 launch of NTS-3, carrying a hydrogen maser accurate to one part in 10 trillion, or a second in more than 3 million years. Many of the NAVSTARS will already have been launched by then, of course, but improvements will be incorporated as new satellites replace earlier ones.

The NAVSTAR program is primarily for military users—it has managers from the Air Force, Army, Navy, Marine Corps and Defense Mapping Service. But Defense Department officials have visions of reducing the system's cost by generating a substantial civilian market for the service. They are reported to have been briefing the Federal Aviation Administration, airlines and others, who would make use of a less-accurate open channel from the system while the armed services keep the highest-precision channel under restricted access. Besides aiding navigation, the system could find use as a collision-avoidance tool, if planes and ships could be guided according to a common worldwide reference system. □

New precursor to natural painkillers

One of the more exciting areas of biological research during the past two years has concerned natural peptide painkillers found in animal pituitary glands. These peptides, called endorphins (from "endogenous morphine"), behave similarly to morphine when tested in various biological systems, thus encouraging hope for development of nonaddictive painkillers.

These morphinelike compounds seem to be part of an extensive polypeptide family. The 5-amino-acid sequence of an enkephalin is contained within the 31-amino-acid sequence of beta-endorphin, which is itself part of a larger, 91-amino-acid polypeptide called beta-lipotropin. Beta-lipotropin shows almost no morphinelike activity.

Now a polypeptide about three times as large as beta-lipotropin has been added to the list, according to Roger Guillemin of the Salk Institute in La Jolla, Calif., and Sidney Udenfriend of the Roche Institute of Molecular Biology in Nutley, N.J. They reported last week, in separate talks given in San Diego at the Fifth American Peptide Symposium, that they find a pituitary polypeptide of approximately 30,000 molecular weight which, when hydrolyzed, yields smaller peptides with morphinelike properties. Further studies should determine whether beta-lipotropin, and other molecules with biological activity, lie within this new, large polypeptide.

Natural concentrations of the pituitary peptides provide clues to their physiological roles. For instance, in rat pituitaries that are frozen immediately after the animal's death, Udenfriend finds 150 times as many molecules of beta-lipotropin as of beta-endorphin. On the other hand, when the pituitaries are not quickly frozen, the ratio of lipotropin to endorphin decreases, suggesting that degradation has occurred. Cow, sheep, guinea-pig and rabbit pituitaries show qualitatively similar results. Large polypeptide chains may thus provide a way of storing smaller molecules in an inactive form in the pituitary. Upon receiving an appropriate signal, a storage polypeptide could be hydrolyzed to release beta-endorphin and other active molecules. □

Measuring melanin in the brain

Melanin—it's weird stuff. A black chemical glob that provides pigmentation in the skin of humans and animals, thus serving as a sunscreen. Some of the toughest material there is (even boiling it in acid does not change it). Its chemical structure is a mystery. Even more bizarre, melanin has been observed in the brains of various mammals, including humans. But no one has ever measured its abundance in the brain.

Now melanin has been not only measured but even manipulated in the brain by Abba J. Kastin and his colleagues at the Veterans Administration Hospital and Tulane University School of Medicine in New Orleans. Kastin also speculates on what melanin might be doing there.

Kastin and his co-workers became interested in brain melanin because they had extensively studied the brain hormone that may control its synthesis—MSH (melanocyte-stimulating hormone). They decided to try to probe its presence in the brain using a relatively new technique called spectrophotofluormetric assay.

As they report in BRAIN RESEARCH BULLETIN (1:567), they have detected melanin in numerous areas of the rat brain, but particularly in the midbrain and pons medulla. Melanin was present in the brains of albino rats as well, and in comparable concentrations. No major change in the melanin concentration of the brains of any of these rats was observed after the rats were exposed to constant illumination or darkness. Nor did removal of various brain and body glands that make hormones—the pituitary, pineal, adrenals, thyroid, testes and ovaries—alter the level of melanin in the rodents' brains.

The researchers also tried giving rats daily injections of MSH for five weeks to see whether it might change their brain levels of melanin. The results of their first experiment were negative. They have since altered the experiment, however, and this time it looks as if MSH may have some effects.

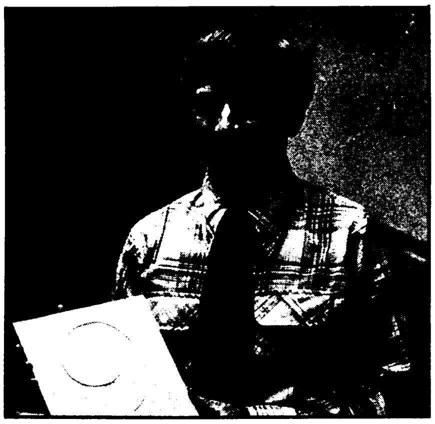
None of these results proves that melanin has a role in the brain, of course, but Kastin believes that it is probably there for some purpose. Living organisms don't usually make chemicals they don't use, and melanin is present in the brains of albino as well as regular rats. Furthermore, Kastin and his colleagues have found that melanin injected into rats' bodies seems to get into their brains far more rapidly than one might expect.

What might melanin do for the brain? Kastin is still far from sure. However, other scientists' results, he says, suggest that brain melanin may be a source of highly reactive chemicals known as free radicals or that it may serve as a semiconductor for converting and storing energy as heat and deactivating potentially disruptive electronically excited molecules. Or the purpose, he hazards, may be some behavioral influence. Because he and his co-workers have found that injections of MSH can influence attention and learning (SN: 9/25/76, p. 207), they will now inject melanin into rats' brains to see whether it might have some behavioral effects as well.

"Eventually we should have more hypotheses that we can readily test," he concludes. □

Light monitors tissue temperature

Transmission of light through a tiny prism is the basis of a new temperature probe. The value of this unusual thermometer is that it can accurately measure tissue temperature, even when the tissue is being bombarded with electromagnetic radiation. Normal thermisters and thermocouples use metal wires and sensors that can act as antennas, allowing radiation to cause errors as large as a factor of 10 in temperature measurements. Far better accuracy is needed, especially in investigations of microwaves as a cancer treatment and as a surgical procedure and also in some industrial drying processes.



Christensen with semiconductor sensor.

Douglas A. Christensen of the University of Utah described the new probe to the International Microwave Symposium in San Diego last week. The temperature sensor is a block of the semiconductor gallium arsenite, which Christensen polishes under a microscope to a prism shape 0.240 millimeters in diameter. The prism sits at the top of a bundle of optical fibers. When light of a specific wavelength shines through two of the fibers, it is reflected by the prism and transmitted along two other fibers. The amount of reflected light, detected by a photodiode outside the probe, indicates the temperature of the prism with accuracy of 0.2°C.

The amount of light absorbed by most semiconductors depends on the wavelength of the light and on the temperature of the material. Over a specific range of wavelengths, the light absorption by gallium arsenite drops steeply from 100 percent to about 10 percent. The wavelengths producing that sharp curve shift with temperature. By using light of a wavelength in the region of the shift, Christensen has monitored temperatures from 33° to 47°C.

The only nonmetal temperature probe now commercially available uses a liquid crystal at the end of an optical fiber bundle. The newly developed sensor will be less expensive, much more stable and so small that it can be implanted through the tip of a hypodermic needle, Christensen explains. He expects to have a prototype sensor ready for manufacturing in about six months. □

Earliest diapsid reptile identified

The oldest ancestor of most modern and fossil reptiles has been identified as a slender, delicately limbed lizard about the size of an average iguana. *Petrolacosaurus kansensis* ("rock lizard"), which lived during the Late Pennsylvanian period (about 290 million years ago), is an evolutionary link, relating the ancestral stem reptiles and the dawn of diapsids. Diapsids include the overwhelming majority of living (three of the four orders) and extinct reptiles.

It is currently believed that all reptiles evolved ("stemmed") from a single group, the stem reptiles during the Pennsylvanian period. *Petrolacosaurus* seems to occupy a key evolutionary position, more advanced than the stem reptiles, but at the fountainhead of all diapsids.

As an evolutionary bridge, the 3-foot lizard was not only morphologically similar to the earliest-known diapsids, says Robert R. Reisz of the University of Toronto, it bore a sophisticated resemblance to the romeriids. These are members of the family Romeriidae and prominent representatives of the stem reptiles.

Consideration of the four- to five-pound lizard's anatomical structure leads Reisz to suggest that it belongs in the order Eosuchia, together with all the other early diapsids. The idea was originally proposed in 1952 by the late Frank E. Peabody, whose superb fossil specimens formed the basis of Reisz's research. The initial hypothesis, however, was not generally advocated for lack of favorable evidence, says Reisz in SCIENCE (196:1091).

Petrolacosaurus's skull is perforated—like the skulls of other early eosuchians but unlike those of romeriids—by several well-developed fenestrae. Some of the animal's other "post-romeriid" features, including elongated vertebrae, massive pelvic girdle, hollow ribs, long bones and metapodials, are also evident in Late Permian (225 million years ago) and even Triassic (180 to 225 million years ago) eosuchians.

Having decided this state of affairs, says Reisz, there still remains a problematic gap between *Petrolacosaurus* and the first emergence of a variety of eosuchians during the Late Permian. He believes this evolutionary hiatus is partially a consequence of an early diapsid environment unsuited for preserving fossil records. □

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