

SCIENCE NEWS of the week

The Winds and Rocks of Venus

VEGA is an acronym, formed from the transliterated Russian names for Venus (Venera) and Comet Halley (Kometa Galley). And two Galley-bound VEGA spacecraft have now taken the latest steps in the Soviet Union's long-running, increasingly sophisticated Venera study.

By a substantial margin, VEGAs 1 and 2 are the most advanced members of the spacecraft fleet (including one European and two Japanese entries) bound for encounters next March with the world's most famous comet. Their trajectories were chosen so that, on the way, they would swing past Venus — subject of as many as 15 Soviet spacecraft missions — using the planet's gravity to direct them toward their cometary goal. On the way by, each craft would deploy a capsule, about 2.5 meters across, to give Venus yet another look by two extremely diverse methods.

Last week, as each capsule struck the atmosphere, the deceleration activated a timer that opened the capsule like a walnut, releasing a landing craft that continued on down to the surface and an automatically inflating helium balloon that bobbed along, about 55 kilometers up, while an elaborate network of tracking antennas on earth monitored them to trace the movements of the Venusian winds.

The VEGA 1 balloon and lander were deployed on June 10 (by U.S. time zones) and the VEGA 2 equivalents on June 14. The balloons, developed by the French, were tracked by an international array of antennas that included six Soviet facilities, the three stations of the U.S. Deep Space Network and 11 radio-astronomy observatories. Using Very Long Baseline Interferometry (VLBI), the system followed the balloons' exact movements by measuring the relative positions between each balloon and the flyby craft that had jettisoned

it, and between each flyby and Venus's center of mass. A similar experiment, though with far fewer ground antennas, was used in 1978 to track the four descent probes of the U.S. Pioneer Venus mission.

The Pioneer Venus probes, however, were basically just going down through the atmosphere, while the VEGA balloons each provided about 46 hours of data (before their batteries ran out) from their relatively fixed altitude. According to Robert Preston of Jet Propulsion Laboratory in Pasadena, Calif., control center for the Deep Space Network, each balloon traveled about 115° of longitude around Venus, crossing some 12,000 km of the planet's surface (the first two-thirds of it on the night side) at raging wind speeds of about 250 kilometers per hour. Vertical wind speeds were also measured by the three-dimensional VLBI technique, and Valery I. Barsukov of the Vernadsky Institute of the Soviet Academy of Sciences in Moscow described the early indications as "stormy." Producing detailed analyses of the complex experiment, however, may take six months or more, says Preston.

The 55 km altitude of the balloons' cruises was chosen to be in the most dense of the Venusian cloud layers, and each craft was also equipped to measure temperature, pressure, the amount of sunlight getting through and the sizes of the cloud particles.

Another major aspect of the clouds, however, is their composition, which consists largely of sulfuric acid, shown by Pioneer Venus experiments to be as concentrated as the acid in a car battery. Composition measurement of the droplets was the job of the landers on their way down, which they were reported to have accomplished successfully. In addition, the landers were instrumented to detect

flashes of lightning, inferred from past spacecraft data and cited by some researchers as possible evidence for ongoing volcanic eruptions. And at least the VEGA 2 lander, according to a French source with Russian scientific contacts, indeed detected lightning.

The key role of the landers, however, was to sample the surface, adding to the results from past Veneras. By one early reckoning, the VEGA 1 lander touched down at 7° 10' north latitude by 177° 42' east longitude, while VEGA 2 went to 7° 01' south by 179° 00' east, about 1,650 km away, placing both craft several hundred kilometers west of an elevated region known as Atla. Comparing the reported coordinates with past data such as the Pioneer Venus orbiter's radar maps of the planet, James Garvin of the NASA Goddard Space Flight Center in Greenbelt, Md., notes that the VEGA 1 site could be the best example yet sampled of the smooth, lowland plains that cover as much as half of Venus. VEGA 2, he says, may have gone to an area that is even smoother, but about 2 km higher, possibly analogous to earth's continents in comparison with the VEGA 1 locale on the "seafloor."

Both landers were also equipped to sample the surface material (though one early account suggested that VEGA 1's sampler may not have been successful). Both were also the first of their line equipped for both gamma ray spectroscopy (measuring uranium, potassium and thorium) and X-ray fluorescence spectroscopy (providing element-by-element analyses of silicon, aluminum, titanium, calcium, iron and other materials), clues to Venusian mineralogy. Past Veneras have measured only one or the other.

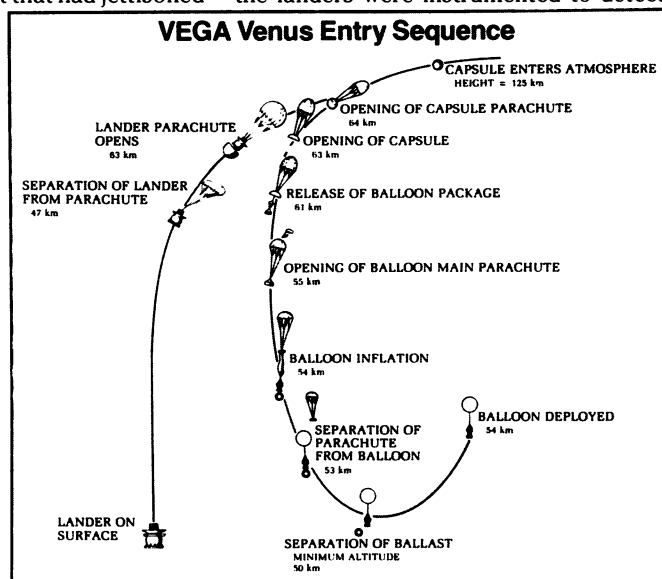
—J. Eberhart

Clocks test Einstein vs. Mach

It is almost 70 years since Albert Einstein published his general theory of relativity. The theory has become physicists' standard theory of gravity and the basis of modern cosmology. Yet that has not prevented a steady stream of physicists, discontented with some of its provisions or some of its principles, from trying to amend, rearrange or replace it. So far Einstein's theory has survived experimental tests. The latest test, done recently at the National Bureau of Standards (NBS) in Boulder, Colo., also corroborates Einstein's theory. The experiment concerns one of the foundation principles of the theory, Einstein's idea of the masses of material objects.

Mass is a basic property of material bodies and a number that goes into any calculation of their motions, but the working definition of mass that physicists use has never really satisfied philosophers of science. During the years in which Ein-

Flying past Venus on the way to March 1986 encounters with Comet Halley, each of the two VEGA spacecraft released a capsule that entered the Venusian atmosphere and separated into an instrumented balloon, which tracked the planet's wind movements for thousands of miles, and a landing craft that sampled the surface material and atmosphere.



stein was working up his theories of relativity, Ernst Mach, who was both a theoretical physicist and a philosopher of science, worked out what became known as Mach's Principle. As Mach was a philosopher, different commentators differ as to what it was he actually said, but in the most general sense Mach's Principle proposes that the mass of any body is related to the masses of all the other bodies in the universe. This means that if the geometrical relationship between a given body and the rest of the universe changes, the mass of the given body will change.

Some commentators say that Einstein disregarded Mach's Principle; some say that he interpreted it in a very special way that caused it to cancel itself out. In either case Einstein's theory denies any relationship between the mass of one body and those of others. Experimenters continue to test for such a relationship, however, one reason being that Mach based his principle on a philosophical question that still rankles: Suppose there is only one object in the whole universe; how do you measure its motion? You need other bodies against which to measure its motion, and from this necessity Mach deduced that the mass of one object has meaning only in relation to the other masses in the universe.

The NBS experiment, done by John D. Prestage, John J. Bollinger, Wayne M. Itano and David J. Wineland, tested a property of Einstein's theory known as Local Lorentz Invariance. According to Wineland, one possible way of applying Mach's Principle is to say that if there is a relationship between the mass of a body and its velocity with respect to a frame of reference fixed on other bodies (for instance, the fixed stars of our galaxy), then that mass ought to change as the orientation of its velocity changes with respect to the fixed stars. Local Lorentz Invariance denies that this will happen.

The experiment used two atomic clocks, one based on hydrogen and one on beryllium. The two clocks were located in the same place (expressing the "local" in Local Lorentz Invariance). As the earth turns, the two clocks have a velocity with respect to the fixed stars, and the orientation of velocity is constantly changing. If Einstein was wrong, the difference between the mass of the hydrogen nucleus and that of the beryllium nucleus should change also, as the two masses do not necessarily change by the same amount. The timing rates of the clocks depend in part on the nuclear masses, and so such a difference should change their rates of timekeeping with respect to one another. The experiment found no such change.

The experimenters say this test was 300 times as precise as the last test of the same principle, done in 1961. Wineland says they can thus say that Einstein's theory is good to a certain level. If it breaks down below that level, a more precise experiment must be mounted to find out. —D. E. Thomsen

Panel okays ECT, calls for U.S. survey

Although it is "the most controversial treatment in psychiatry," electroshock therapy is effective for a narrow range of psychiatric disorders, particularly severe depression that does not respond to drugs and other treatments, a National Institutes of Health advisory panel reported last week.

Electroshock, or electroconvulsive therapy (ECT), can cause persistent memory gaps for events that occurred during the months surrounding the treatment, adds the 14-member panel, which was composed of psychiatrists, psychologists, a lawyer and a consumer advocate. Their "consensus statement" notes that patients should be informed of risks and benefits involved in ECT throughout the course of treatment. A patient's decision to refuse ECT should be honored, according to the statement.

The panel also calls for a national survey to gauge the quality and extent of ECT use. Little is known about how ECT is administered in the United States and what training is received by those who perform the procedure.

The aim of ECT is to produce a brain seizure. A small electric current, typically lasting one second or less, passes through two electrodes placed on the patient's head. General anesthesia and muscle relaxants are administered before the current is applied, and oxygen is provided during ECT. Patients with severe depression generally receive ECT three times a week for two to four weeks.

It is unclear why brain seizures have powerful antidepressant effects. The panel recommends "much additional research" into how ECT works. Some researchers suggest that the key to ECT's effects lies in the biological process that turns off a seizure (SN: 1/26/85, p. 53).

Despite the mystery surrounding the way it works, the panel says that clinical studies demonstrate ECT to be at least as effective as antidepressant drugs in treating severe depression. ECT is also effective for some cases of mania (excessive elation or activity), say the panelists. The evidence is "not compelling" for using ECT with schizophrenics, they note, especially with those who are chronically ill.

ECT can cut depression short, but it is not a cure, cautions the panel. It is clear that symptoms decrease for up to four weeks after treatment, but long-term studies have not been conducted. Depressed patients who improve after ECT may gradually get worse without continuing medication or psychotherapy. Still, the committee says that ECT is often a valuable last resort for suicidal depressed patients who do not respond to medication.

ECT rarely causes death, notes the report. But it often produces "enduring or permanent gaps in memory" for events occurring an average of six months before and two months after treatment. The extent of memory problems and patients' reactions to them varies widely. The panel heard testimony from several patients treated with ECT: Some opposed the treatment and reported persistent memory problems; others regarded it as a lifesaving therapy.

ECT critics told the committee that the treatment has caused permanent brain damage in animals. The report says, however, that brain cell death has not been demonstrated in animal studies of ECT. Definitive studies of brain metabolism and tissue changes during the treatment have not been done.

Because ECT is a relatively complicated procedure, the panel says that medical schools and psychiatric residency programs should provide training in the technique. Facilities that use ECT should establish review committees to monitor the treatment, it adds.

The panel acknowledges that during the 1940s and 1950s ECT was often overused and misused with a variety of disorders. The best estimate is that 60,000 to 100,000 people per year now receive ECT in the United States, a sharp decline from several decades ago. The typical ECT patient is white, female, middle-aged and relatively well-to-do, with health insurance that covers a course of treatment. ECT is usually performed in private or university hospitals.

The quality of treatment from hospital to hospital is not known, underscoring the need for a national survey of ECT use in the United States.

In England, however, a 1980 survey of 100 ECT clinics revealed a disturbing state of affairs. Less than half met the minimum criteria of the Royal College of Psychiatrists for adequate ECT administration. Many patients were treated with too much electric current on obsolete or improperly maintained machines, and brain seizures often were not noticed by psychiatrists.

The English survey shows that although ECT can be effective when properly used, there may be some substance to public concerns about improper practice, says Max Fink of the State University of New York at Stony Brook. In the Feb. 1983 *AMERICAN JOURNAL OF PSYCHIATRY*, Fink, a longtime supporter of ECT for depression and mania, asks, "... is it not likely that inadequate facilities, poorly trained professional staff and missed seizures are features in many [U.S.] treatment centers?"

—B. Bower