

## Precise Measurement of Earth's Rotation

Measurements of earth's size, shape and rotation, as well as possible continental drift, could be made with an accuracy 10 times higher than possible today with a radio technique so new scientists are just beginning to explore its possibilities.

The technique uses the earth, itself, in effect, as a giant radio antenna.

The system has the rather formidable name of "long base line interferometry." Using it, the arrival of radio waves from far-away sources in the sky can be accurately timed—to within a billionth of a second—over distances as great as the earth's diameter, slightly less than 8,000 miles.

The first application of the new method was to measure the sizes of sources of radio waves in the heavens much more precisely than had previously been possible.

**Equally exciting** to scientists is the fact that the new technique makes it possible to take measurements of earth itself that were previously obtainable only by optical methods requiring months or years. These measurements, such as the precise determination of earth's rotation, can be made in hours or days with long-line interferometry.

Key to the new technique is precise timing of the arrival of radio signals from a distant source at two widely separated receiving antennas without a physical link between the two stations, either by cable or radio. This can be done with synchronized atomic clocks that tick at a rate dependent only upon the very stable frequency with which atoms vibrate.

Two commercial atomic clocks can be set simultaneously, then transported to distant stations to set even more accurate hydrogen masers, which are also atomic clocks, at each location.

Although the hydrogen clocks at each of the two sites would not necessarily show the same time to more than a millionth of a second, they would tick at the same rate for at least a day, just as two good wristwatches do for a certain length of time after they have been synchronized.

The time at which the source's radio waves are received at each antenna is recorded, usually on magnetic tape. The two records are then analyzed by a computer that calculates the time difference between them, which is an accurate yardstick of the distance between the two stations.

**The new method** of precise timing to link two widely separated stations could be used to:

- Check on continental drift. If the

receiving antennas were located on the West Coast and Hawaii, for instance, a change in the distance between the two of as little as one inch could be detected in a year.

- Measure how changes in the average wind patterns affect the weather. When such information is combined with data from satellites concerning earth's heat balance, detailed investigations of the causes of major storm systems could be made for the first time.

- Determine the twice-daily variation in the length of the day caused by oceanic tides. This, in turn, would tell scientists whether the earth is rotating at a constantly slower rate or if the slowdown fluctuates. How the earth's rotation rate is decreasing is an important factor in theories of the origin of the earth and moon, as well as the birth of the solar system.

- Measure the slight variations in when and by how much the earth is deformed. A rise and fall of about four inches at any station could be easily detected.

- Open up a whole new range of measurements of changes in the shape

of the earth itself, as well as its surrounding atmosphere.

What would be needed to make these measurements would be two pairs of 85-foot antennas, each set located a few thousand miles apart—on the East Coast and West Coast for most of the observations; across an ocean in the case of continental drift.

Dr. Thomas Gold of Cornell University's Center for Radiophysics and Space Research, Ithaca, N.Y., says that the new radio astronomy technique could be used to determine the variations in the speed of rotation of the earth to a precision possibly at least 10 times better than present optical techniques.

Dr. Gordon J. F. MacDonald, on leave from the University of California at Los Angeles as vice president for research at the Institute for Defense Analysis, Arlington, Va., suggests that the radio technique could be combined with optical observations of the moon by reflected laser beam to obtain information about both the earth's rotation and the moon's motion. The combined information would then give "basic dynamical data of the solar system." ◊

## TECHNOLOGY OR POLITICS

### Economists Debate Military-Industrial Concentration

Since former President Eisenhower warned against a military-industrial complex seven years ago, opposition to the defense industry has become something of a crusade.

Aerospace and other industries are described as captives of the Pentagon, incapable, or nearly so, of operating in the civilian sector. The military-industrial complex is seen as a Frankenstein's monster that threatens to control the state which created it.

**When American economists** gathered in Washington for their annual meeting, they heard such charges leveled against the Defense Department and its supplying industries. Several fiery addresses drew large, attentive crowds and inspired harsh debate.

Dr. Murray L. Weidenbaum, professor at Washington University, St. Louis, and former economist for the Boeing Company, claimed that defense industries have so lost initiative through close association with Pentagon management that they may not now be able to transfer efforts to such projects as upgrading ghettos.

Dr. Walter Adams of Michigan State University made an even stronger, more threatening argument when he said Government, through Defense, has created power concentrations which "tend to breed on themselves and to defy public control."

Both men discounted the notion of a conspiracy. Rather, says Dr. Adams, the defense complex represents a natural coalition of interest groups—including Government, industry, labor and legislators—with a stake in defense and space. The danger, he says, is lack of a strong counterforce to assure that the public interest prevails. "The danger persists that power will be coalescing, not countervailing, that the political cloakroom will displace the economic market place."

Dr. Seymour Melman, professor of engineering at Columbia and specialist in conversion to a peacetime economy, says the dangerous centralized power has already been realized.

"There has been fashioned, inside the Government," he said, "a true transformation of the essential character of Government and society," with peak economic and political power in the hands of the Defense Department—which points toward a "Soviet-type state capitalism." The DOD controls some \$40 billion a year, he said, and the result is a squandering of the nation's resources.

**Responding** to the heated arguments, Dr. George Stigler of the University of Chicago accused the speakers of muckraking with very little evidence to back them up.

"Not a single factual statement has