PHYSICS

Most Sensitive Analysis

A highly sensitive technique, discovered accidentally, for detecting trace amounts by activation methods may have wide applications in industry, medicine, biology and space.

➤ A MOST SENSITIVE technique for measuring some of the most widespread elements in nature, in trace quantities previously undetectable, has been discovered unexpectedly in fundamental research at the University of California Lawrence Radiation Laboratory, Berkeley.

Even crime detection and space exploration will benefit from the discovery. It is expected to have wide applications in industry, medicine, biology and other fields where many problems call for detection of the common elements at the trace level. The technique is the most sensitive ever found for such light elements as carbon, oxygen and nitrogen.

It uses the activation method. Helium-3 (light helium) nuclei from an atom-smasher change atoms being investigated into easily detected radioactive atoms.

Similar methods of activation, using neutrons as "atomic bullets" have found wide application for detecting minute amounts of heavier elements. But neutrons do not yield easily detected radioactive species in the carbon-oxygen-nitrogen range. Neutron transmutation of oxygen-16, for example, produces a stable non-radioactive atom of oxygen-17.

Helium-3, however, transmutes oxygen into radioactive fluorine-18.

Absence of a simple technique for measuring the light elements in trace amounts has been a handicap in many fields. For example, in such transistor metals as silicon and germanium, the presence of contaminating oxygen at levels of parts per million can make a big difference in solid-state conditions.

The method is capable of measuring oxygen in a thin foil of aluminum at a level of a part per billion. The absolute weight of detectable oxygen can be as low as about 0.0000000000001 ounces, or one ten-trillionth of an ounce.

Conventional techniques for analyzing for the light elements are complex and even then are not satisfactory below parts per hundred thousand level. Inability to detect in parts per million and lower ranges makes it difficult to study and understand important processes in, for example, solid-state materials.

The technique is non-destructive. This is an advantage because sometimes samples are so small and valuable that chemical analysis cannot be risked.

Although application of the technique is most dramatic for the light elements, which are so widespread and for which other satisfactory methods do not exist, it can also be used for elements as heavy as iron, depending on the energy of the atom smasher accelerating the helium-3 nuclei. Whereas neutrons may produce a number of radioactive products, helium-3 usually gives products whose signals come through the radioactive "noise" with readily identifiable clarity.

The method can be used to detect elements up to calcium with a small, relatively inexpensive cyclotron about the size of a large office desk, built especially to accelerate helium-3 ions to 8 million electron volts. Heavier atoms would require a more energetic accelerator.

Dr. Samuel S. Markowitz, assistant professor of chemistry, discovered the method when he was doing a complex experiment in nuclear reaction spectroscopy. Using the HILAC, Heavy Ion Linear Accelerator, in the Lawrence Radiation Laboratory, he was bombarding aluminum-27 with helium-3 nuclei. The radioactive atoms that result give off gamma rays, the number and energy of which are plotted as a curve on a graph.

A strange curve appeared on the graph, and Dr. Markowitz investigated. He found it could only be explained if trace amounts of oxygen clinging to the aluminum had been transmuted into fluorine-18 atoms. He recognized the great potential of the find, and then demonstrated its possibilities. He was assisted in his work by a graduate student, Rev. John D. Mahony, a priest.

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PHYSICS

Closed-Circuit Laser May Rival Gyro in Sea, Space

➤ A CLOSED-CIRCUIT laser that whirls counter-rotating beams of light around a ring to measure changes in direction soon may rival the gyroscope as an automatic guidance device for ships, planes, missiles and space vehicles.

Called a ring laser by its developers at the Sperry Rand Corporation, Great Neck, N. Y., it may make guidance systems simpler, cheaper to produce, more stable and more sensitive than present navigation systems that rely on the "inertial" sense of a gyro.

Sperry explained that the new laser is not a gyroscope, but a device whose sensing capability is based on a completely different physical principle: that of the constant velocity of light.

Light travels at a steady 186,000 miles per second, and it is this constancy that gives the ring laser its "sense of motion." This is unlike a gyro, which depends on the slower rotation of a small, machine-made wheel for its sense of motion. Even the best mechanical gyros are prone to slight errors, called drift, due to nature's inability to provide construction materials of perfect stability and man's inability to machine precision parts perfectly.

The new laser requires neither bearings nor other moving mechanical parts, the Sperry scientists said, and its light beams are immune to both gravity and changes in the speed of the vehicle it is helping to guide.

This is also the first time that the purity, or coherence, of a laser beam has been fully exploited, the scientists said.

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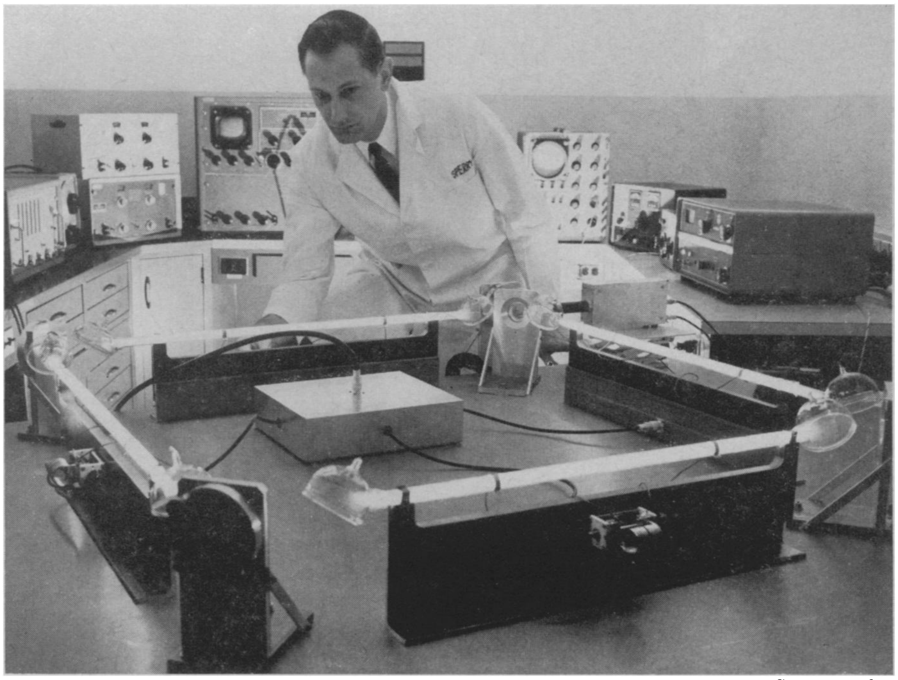

Sperry Rand

LASER GUIDANCE—The ring laser is shown with a light beam traveling at 186,000 miles a second around the square device. It measures changes in direction with an accuracy of one-fifteen-thousandth of a degree on a compass.