Medical

In the sixteenth century, William Gilbert thought magnetism was "the soul of the world;" we now know that humans have magnetic properties too. The strength of our magnetic signals is roughly a billion times weaker than that of Earth and are not measurable with conventional instrumentation. SQUID, however, are capable of detecting the magnetic signal generated by groups of nerve cells in the brain. This means they have the potential to become a major clinical tool in the diagnosis and treatment of ailments that are characterized by abnormal brain signals such as epilepsy, schizophrenia, Alzheimer's disease, Parkinson's disease, and alcoholism.

Current interests in neuromagnetism include the determination of the location within the brain of both the responses to external stimulation and the source of spontaneous signals. Researchers studying brain response are using multiple SQUID to determine where the processing of visual and aural signals takes place. A very important aspect of these instruments is that they are entirely noninvasive and do no damage to tissue. By contrast, the alternative methods are invasive requiring the placement of electrodes on the surface of the brain itself.

Using SQUID, New York University scientists have studied the response in the brain's auditory cortex to musical tones. In the early 1980's, they showed that the location of the brain response changes as the musical frequency is changed.

University of California at Los Angeles scientists have used multiple channel SQUID to study human subjects with focal epilepsy, a disease in which abnormal brain tissue responsible for seizures is confined to a small region called the epileptic focus. The fact that the epileptic source is localized makes surgical removal possible when the exact position of the focus is known. Using SQUID, the UCLA research team detected the magnetic signals generated when the seizures occurred and were able to pinpoint the epileptic focus to within a few millimeters.

SQUID have been used to identify the brain's response to pain, eye movement, and drugs. With these kinds of studies, SQUID are aiding in the production of a detailed map of the functions of the human brain. They also provide physicians with greatly improved means to test the brain itself for malfunction.

Geophysics

John Clarke and his co-workers at Lawrence Berkeley Laboratory employed SQUID for use in the field of magnetotellurics, a scientific word denoting methods of examining the earth's interior by measuring differences in the electrical resistance of the earth. Small electrical currents and changes in the magnetism of the earth occur in response to the naturally fluctuating magnetic fields propagating to and through the planet's surface from the magnetosphere. The magnetosphere is the electrically charged region above the earth that varies continually due to the interaction of Earth's magnetic field and the solar wind.

The process works well for finding geothermal energy sources. It is also effective in exploring for those minerals that affect rock magnetism and electrical conductance. Virtually all magnetotelluric surveys made throughout the world use SQUID and the procedures that were developed at Lawrence Berkeley Laboratory.

Astrophysics

Nearly 100 years ago the German scientist Heinrich Hertz demonstrated the existence of electromagnetic waves. Today astrophysicists are attempting to demonstrate by measurement a different kind of radiation—the gravitational waves that were predicted by Albert Einstein in his general theory of relativity in 1916.

The search has been unsuccessful so far because equipment must detect motions that are ten million times smaller than the size of an atomic nucleus! At present there are a dozen research groups worldwide trying to detect the pulse of gravitational radiation that is believed to be generated when a dying star collapses. The most popular type of detector for this work is a 5-ton aluminum or niobium bar cooled by liquid helium to within a few degrees of absolute zero. When the waves from the distant star (if there are any) pass by the bar, they are expected to cause the bar to vibrate and these oscillations would be detected by a SQUID. If this experiment proves the existence of gravitational waves, astrophysicists will have confirmed yet an-