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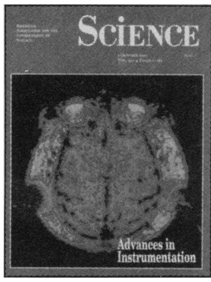

COVER Magnetic resonance image of a transverse slice of a monkey head through the eyes showing contrast based on blood microcirculation. This image was obtained from signals of tissue water, whose magnetic resonance properties were modified by a vascular contrast agent, 15 seconds after injection. See page 53. [Visualization by Geoffrey Sobering, In Vivo Nuclear Magnetic Resonance Research Center, National Institutes of Health]

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Instrumentation

Many, if not most, experimental scientists dream of performing a critical experiment using simple, inexpensive apparatus with results which are clear and unambiguous. Such experiments represent a Platonic ideal. In reality, many, if not most, of the critical experiments these days make use of elaborate, sophisticated, technology that is often so expensive that it must be shared among many investigators. In this issue of *Science* we will not look at the extremes of this one-of-a-kind approach, such as the Superconducting Super Collider or the Hubble Space Telescope. Rather, we look at a range of more accessible instrumentation which nonetheless reflects our increasingly powerful ability to examine the world we live in and to teach us new, fundamental things about that world.

Moonen, van Zijl, Frank, Le Bihan, and Becker describe recent advances in functional magnetic resonance imaging in medicine and physiology. These non-invasive techniques take advantage of powerful NMR imaging coupled with some ingenious "tricks," such as pulsed gradient methodology. In this approach, physiological processes such as blood flow in the brain can be seen by contrast enhancement. The occurrence of flow abnormalities can be used in detecting tumors.

Grant and Cooks describe the combination of new mass spectrometric techniques coupled with laser spectroscopy. The marriage of these two relatively self-contained disciplines has enhanced considerably the analytical usefulness of mass spectrometry, especially for large biomolecules such as oligonucleotides and proteins. The coupled methods also provide major new insights in physical chemistry; studies of the formation and reactions of clusters are an important example.

Abruña, Bommarito, and Acevedo describe the use of x-ray standing waves to study interfacial structure, composition, and distribution of chemical species at solid-liquid interfaces over a remarkably broad range of length scales. The level of detail that can be examined is extraordinary. Voltage-dependent changes in electrochemical systems can now be probed in ways not previously possible. These experiments are an important application of synchrotron radiation as a photon source.

Albritton, Tuck, and Fehsenfeld discuss instrumentation for global atmospheric chemistry. Real-time measurements of chemical species and atmospheric conditions in both the stratosphere and troposphere are now possible through a combination of ground-based remote-sensing and fast-response airborne instruments. These data are essential for the identification and characterization of chemical reactions and atmospheric processes, including the production and destruction of ozone. Indeed, our knowledge of atmospheric processes is increasing at an impressive rate, primarily because of new and better ways of collecting data.

Ellis describes the use of a variety of nuclear instruments for probing subsurface geology from oil well boreholes. Gamma ray scattering, neutron scattering, and neutron-induced gamma ray spectroscopy allow important inferences to be drawn about composition of the earth as a function of the depth in an extraordinarily intimate way.

Kim and Sessler provide a brief review of free electron lasers. These devices hold much promise for applications that require a coherent light source with wide wavelength tunability. The authors emphasize aspects that currently limit performance, and discuss applications, present status, and future prospects for the field. Free electron lasers represent an interesting example of a technological frontier where the creation of the instrumentation itself, because of intrinsic novelty, has provided much of the impetus for development. It remains to be seen what the impact will be when the technology is in hand and can be applied as a tool for the solution of scientific problems.

Instrumentation has a major effect on scientific research in many important ways. It makes new experiments possible, providing new information. It makes work much more efficient, often by keeping people from following false leads. It increases the rate at which new things can be learned because data can be accumulated and analyzed at a much faster rate.

In many cases, science breeds new technology which in turn becomes the basis of new instrumentation. Invariably, new technology begets new science. The instrumentation revolution in which we currently find ourselves must be among the most exciting things ever to have happened in science. It is a pleasure to marvel at it, to enjoy it, and to benefit from it. Its effect on our scientific lives is incalculable.—JOHN I. BRAUMAN