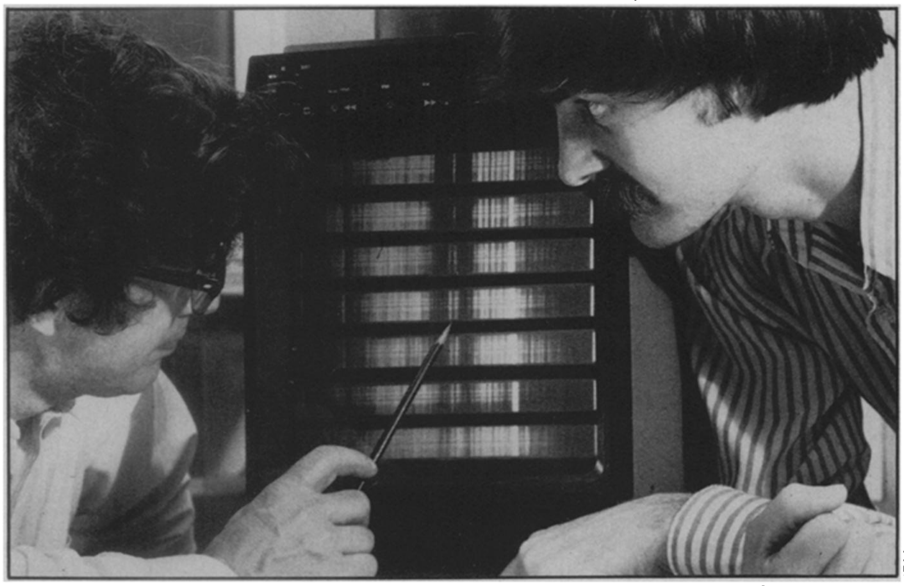
Quick look at fast reactions


IBM

Sorokin and Bethune examine "snapshots" tracing an explosive chemical reaction.

Split-second, but sophisticated, glimpses into chemistry are resulting from new laser techniques. For fast events, such as combustion in automobile engines, the action is over in a fraction of a second. One standard, but slow, technique to identify molecules and their fragments in various energy states is to observe the frequencies of infrared light they absorb. Now researchers at IBM Research Division in Yorktown Heights, N.Y., have developed a way to obtain a complete infrared spectrum from a single 5-nanosecond laser flash.

Peter P. Sorokin, Donald S. Bethune and collaborators have produced a series of infrared spectral "snapshots" that follow an explosive reaction — the molecular rearrangement of methyl isocyanide. The new technique involves two major innovations. The first is a method of generating the probe flash. The second is a way of shifting the resulting spectrum from infrared to visible light, so it can be recorded photographically.

The laser probe is a flash of infrared light with a broad, uniform range of frequencies. The sample absorbs energy from some of those frequencies, producing a characteristic spectrum. However, the infrared wavelengths of greatest interest for identifying molecules are too long to be recorded with photographic emulsion. Therefore, in the second phase of the operation the infrared spectrum is focused into a chamber filled with potassium vapor. A beam of higher-energy blue light is focused simultaneously into the chamber. Through interaction with the potassium atoms, energy from the blue light is added to the infrared, and the spectrum shifts into the visible region. The spectrum's shape, which contains the information about the sample's composition, remains virtually unchanged, the scientists report.

The IBM scientists believe that the technique, possibly using cesium or rubidium in addition to potassium, can be extended to include all of the most useful infrared spectral range. It may be applicable to studying processes in petroleum refining and other high-temperature reactions. The technique complements another recent "split-second" laser method — nanosecond X-ray investigation of the structure of biological or crystalline materials (SN: 5/19/79, p. 324). □

Uranus: Rings of gas?

On July 11, the Pioneer 10 spacecraft will cross the orbit of Uranus, some 2.9 billion kilometers from the sun. The planet, however, will be almost as far away from the probe as it can get, 172° around the sun and about 8.7 billion km across the solar system. The first spacecraft from earth to pass close to Uranus will do so no sooner than the tentatively scheduled 1986 encounter of Voyager 2.

Yet Pioneer 10 still has a contribution to make, studying the effects of the sun from greater distances than any probe before it. A major discovery would be the heliopause — the point at which the sun's influence ends, to be replaced by the interstellar medium. The 259-kilogram vehicle's nuclear power supplies are still healthy, so its radio signals may still be detectable with sensitive earth-based receivers when it passes Pluto's mean distance from the sun (nearly six billion km) in 1987. But some scientists (including some members of the Pioneer 10 team) believe that the heliopause is probably more like 15 billion km out, by which distance the spacecraft's messages may well be undetectable even if the probe survives that long.

Uranus, meanwhile, is a target of growing interest, though Pioneer 10 will not get a look at it. The planet is essentially tilted on its side — its "north" pole, defined relative to its direction of rotation, is actually pointed about 8° *south* of the ecliptic — and researchers are still puzzling over the improbable geometry of what appears to be a set of strangely dark rings discovered in 1977. Voyager 2's trip to Uranus is only a possible option (depending on the condition of the spacecraft and on the performances of Voyagers 1 and 2 during their encounters with Saturn in 1980 and 1981), but the rings have upped the project's interest.

A major issue regarding the rings is how they can exist at all. There seem to be nine of them, all extremely narrow (many of them perhaps as skinny as 1 km) and apparently less reflective than the blackest coal dust. The hitch, however, is that some seem to be elliptical while others are round — a strain on current understanding of celestial mechanics. One tentative suggestion to explain the odd arrangement has been that the rings may actually be interspersed among several small, yet-undiscovered satellites, whose gravitational effects might account for both the rings' thinness and their varied shapes.

Now another suggestion has been put forward, and it is, in a sense, as exotic as the first. Thomas C. Van Flandern of the U.S. Naval Observatory in Washington has raised the possibility that the "rings" are not rings at all in the conventional sense. Instead of being composed of numerous solid chunks, he proposes (in the June 8 SCIENCE) that perhaps they consist of gaseous material given off by an individual satellite in each "ring" orbit, much like the sulfur torus that follows the orbit of Jupiter's moon Io.

The most conspicuous difficulty with Van Flandern's proposal stems from the fact that the rings were discovered when they successively blocked off (occulted) the light from a star that was being observed in studies of Uranus itself. One of the original observers, Edward Dunham of the Massachusetts Institute of Technology, says that the star, passing behind each ring, dimmed to its minimum brightness in as little as one kilometer, seemingly a rather sharp cutoff to be ascribed to a cloud of gas. Van Flandern, however, believes that the effect is possible — not by the gas's blocking the star's light as would a solid object, but by "refractive defocusing" — essentially blurring the light until it disappears. "It is this defocusing effect," he says, "which causes the umbra of earth's shadow cast on the moon during a lunar eclipse to be more than 100 km larger in radius than earth's solid body. Even the tenuous atmosphere above 100 km, although it cannot absorb or scatter significant sunlight (nor be seen by astronauts), can still effectively defocus sunlight."