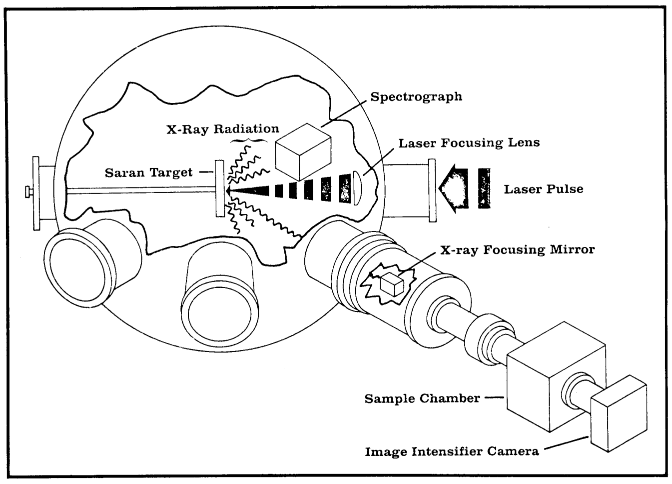
SCIENCE NEWS OF THE WEEK

X-Ray Diffraction and Biological Kinetics



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Solid crystals and many biological samples have structures that are too fine to form images in ordinary light. They are probed instead with X-rays. The diffraction patterns made by the X-rays after they are bounced off periodic elements in the structure, such as arrays of atoms or regularly repeating membranes, can be read to provide information about the dimensions of the structure.

Generally X-ray exposure times have been so long that substances to be studied have had to be frozen in time. One of the great difficulties in unraveling the sequence of DNA was the necessity of first crystallizing it without seriously altering its structure. Now there is promise of a method that makes X-ray diffraction patterns with exposures of a few billionths of a second. This could be used for kinetic studies of biological samples. It is described in the May 11 SCIENCE by Robert D. Frankel and James M. Forsyth of the University of Rochester.

An intense source of X-rays is necessary to get a reasonable exposure on such a time scale, and in this, as in so many other things nowadays, a laser comes to the rescue. This one is the Glass Development Laser, a neodymium:glass experimental laser that is part of the laser fusion project in the University's Laboratory for Laser Energetics. It can produce pulses between 50 and 600 picoseconds wide with a maximum energy of 160 joules per pulse available for the longer pulses. By using liquid cooled rod amplifiers that went up to the full width of the laser's nine-centimeter output aperture, the experimenters obtained a repetition rate of two pulses per hour. They say that is the highest of any such glass laser system. Excellent as they are for many experiments, glass lasers are slow to cool, and that limits their repetition rate.

The light from the laser was conducted into a vacuum chamber where it struck a target of saran, the plastic material out of which a number of household items are made. The light striking the saran generates an ionized gas. One of the advantages of such short laser pulses is that the energy doesn't have time to drift far from the point of impact and be dissipated by thermal means. Much of the energy comes back out as X-rays, and a lot of this will be line emission at fairly precise wavelengths so that filtering can select a particular one. In the actual experiments radiation from chlorine atoms ionized 15 times was used.

The X-rays are led into a camera where they bounce off the sample to be studied and where the diffraction pattern is formed on film. In the experiments dried rat spinal nerves and a powder of cholesterol were used. These are substances whose patterns and structures are well known, and they give those who know X-ray diffraction a means to compare the new method with old ones.

The experimenters think the results quite good. One promise of being able to do the job with nanosecond pulses is speed in getting data. More important, Frankel and Forsyth point out, is the possibility of doing kinetic studies. First the investigator would irradiate a sample with light calculated to stimulate it to do something. Then, after a delay of nanoseconds or even milliseconds, the laser would be fired, and X-rays would "interrogate" the sample, catching the change in progress.

The particular example for which that procedure is cited are the photoresponsive membranes of the purple microorganism *Halobacterium halobium.* Other possibilities include the postsynaptic membrane of the electric organ of the *Torpedo californica* electroplax, contracting muscle, or macromolecules in solution. This is not an exhaustive list. Biologists, chemists and other scientists will no doubt be encouraged to think up other examples. □

Multiple Mirror Telescope opens its eyes

Worldwide Photos

The Multiple Mirror Telescope is the first real departure from the 400-year-old tradition that a telescope is based on a single monolithic mirror. The MMT has six mirrors mounted and controlled so that they can be made to act as one, simulating a single mirror much larger than any one of them, or separately. Under construction on Mt. Hopkins near Tucson for about a decade, it was dedicated May 9.

The MMT is regarded by many astronomers as a prototype of future telescope design. It seems impractical to build rigid single mirrors much larger than those now in existence. Reportedly the world's largest single mirror, the 6-meter one at the Crimean Astrophysical Observatory, is experiencing severe problems with slumping, and other large mirrors all have some amount of difficulty keeping their shape against weight and weather. Larger telescopes, it seems, will have to have either floppy mirrors (in which active supports maintain the shape rather than rigidity of the mirror material), segmented mirrors (with independent motion for the segments) or arrays of fully shaped separate mirrors like the MMT. In any case, telescope designers expect the MMT to teach them much about the mechanics of possible future situations, and they will watch how it does astronomy. □