light replace circuits, may be the only feasible way of building such advanced capabilities. For Dr. Szabo, his powerful optical memory is the first clear demonstration of this potential, and promises to provide the storage capacity required by parallel-processing architecture.

His invention is based on the fundamental physical properties of matter and light. A prism, for example, demonstrates that sunlight contains the rainbow of colours or frequencies which make up the visible spectrum. Thus a leaf appears green because its chlorophyll reflects back the green light and absorbs the other visible frequencies.

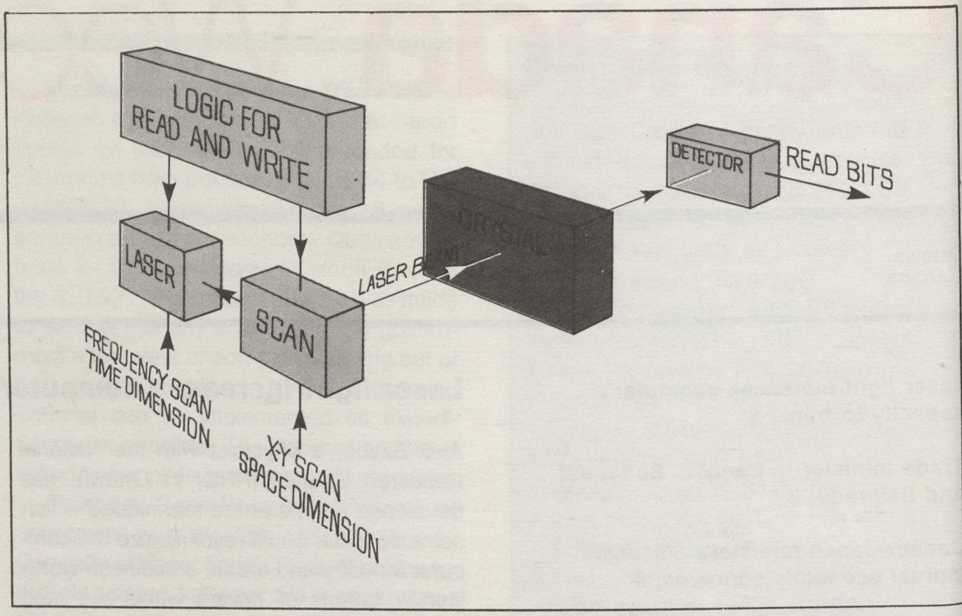
At the atomic level, the interaction of light and matter is more complicated. An atom can be considered to consist of a nucleus surrounded by electrons in discrete orbits or energy levels. If an electron is given the precisely correct amount of energy, it will jump to a higher energy level, absorbing the activating energy in the process. It is however unstable at the higher energy level. When it falls back to its ground state or original energy level, it gives off the energy it absorbed in the form of light. The precise frequency of this light will depend on the difference between the two energy levels. The clearest everyday demonstration of this is in fluorescent lamps, where electrical energy pushes electrons to a higher energy level and they emit light as they fall back.

Dr. Dzabo's optical memory relies on these basic physical principles of the electromagnetic spectrum and of atomic absorption and emission.

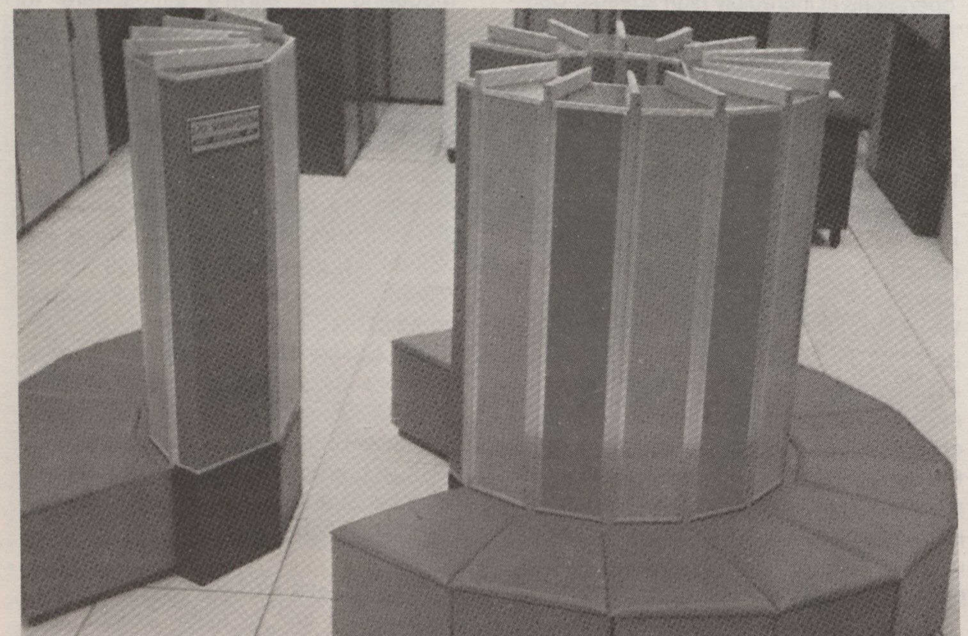
The first experiments by Alex Szabo began in 1970 when he shone light from a pulsed ruby laser into a ruby crystal and observed the fluorescence coming out.

To Dr. Szabo, this immediately suggested the analogy of an extremely high resolution colour photograph. Just as a photograph records colours, the ruby was able to store two very narrow and close frequencies of light. Moreover, once the electrons were in the excited state, he found that the ruby was transparent to a laser pulse of the same frequency. Rather than absorbing the light, it transmitted it.

As the phenomenon is analogous to burning a hole in a piece of paper with sunlight focused through a magnifying glass and then shining the light through the hole, Dr. Szabo called it "optical hole-burning". And since a photographic film is really a crude sort of memory, Dr. Szabo maintains that the similar but enormously higher resolution memory made possible by hole-burning could be used to construct a more sophisticated computer memory with additional power.



Crystal memory as it would be used in a fifth generation computer. Under the direction of the computer's read-write logic, a small laser scans the memory crystal, saturating tiny areas with its light. This is the "write" function. For the "read" function, the laser scans the crystal again; a saturated area or 'hole' transmits the laser light, while unsaturated areas do not.



Cray-1, *Canada's weather-forecasting supercomputer in Montreal, Quebec. One of the world's most sophisticated fourth generation computers,* Cray-1 *has large-scale integrated devices that give it extremely fast memory and processing.*

Computer storage capacities

The language of computers is binary — a 0 or a 1, known as a bit, is the basic unit. Eight bits, a byte, represent a letter or a number, e.g. 00101001. Two decades ago, computer data were commonly stored as holes punched in paper cards, with a capacity of about four bits per square centimetre. Gradually, this system has been replaced by magnetic tapes and discs, which can store some several hundred thousand bits in the same area.

Within the past couple of years, memories have taken another leap in storage capacity, with the introduction of video discs. These can store about 100 times more data per square centimetre than magnetic media. The bits are recorded by literally burning pits about one micrometre wide with a laser in a thin metallic film layer on a plastic or glass disc. But even this most advanced of current storage technologies pales in comparison with the capacity of as much as 1 000 trillion bits per square centimetre made possible by Dr. Szabo's invention.