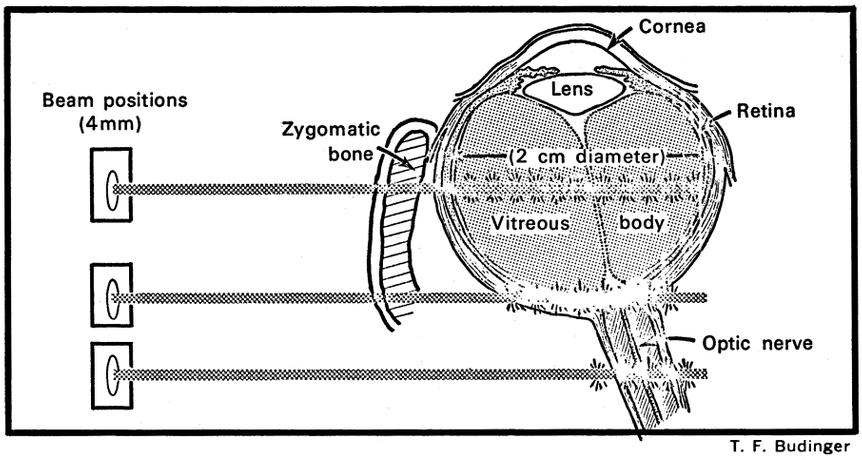


T. F. Budinger

*Ion-beam trajectories used to find the cause of the astronaut light flashes.*

ology and medicine. Experiments at LBL have already determined the cause of the strange light flashes seen by astronauts on space flights. Heavy ions from the cosmic rays were suspected as the cause, but it was uncertain whether the flashes represented Cerenkov light emitted as the ions passed through the vitreous humor of the eye or whether the flashes resulted from direct stimulation of tissue by the ions. Experiment found that human subjects saw the flashes only when the ion beams struck their retinas, indicating that impact of ions on retinal cells is the cause.

The general trend of biological experiments with heavy-ion beams will be to study the damage they do to cells, says Thomas F. Budinger, a physician on the LBL staff. Heavy ions cause a qualitatively different type of damage from other forms of radiation. Cells repair some of the damage, but what can be repaired and what cannot is not clear.

An important question is whether the repair mechanism returns the cell to the status quo or whether some genetic change occurs. In observing what happens one might see chromosome changes "like putting pink fenders on a black car," he says. If there are genetic changes, a knowledge of them could help interpret the past as well as predict the future.

One of the interesting questions in paleontology today is the relation of geomagnetic reversals to the evolution of biological species. A number of times in geological history the magnetic field of the earth has reversed its polarity. In the midst of each such change there was probably a period when the strength of the field was zero. It is the geomagnetic field and the atmosphere that prevent most of the cosmic rays—especially the heavy ions—from reaching the earth's surface. If the field was turned off, some of the heavy ions may have gotten through. The question is: Could they have been responsible for increased rates of mutation that may have happened at those times?

The question whether the cells can repair the damage at all will have important repercussions in space biology and space flight. Some of the heavy cosmic-ray ions get through the shielding of space capsules and strike the bodies of the astronauts. One of the questions is how many of them go through the middle of the brain and how much damage do they do there. Up to ten percent of brain-cell nuclei could be hit by cosmic-ray particles during a three-year flight. The extent of damage is unknown but can be learned by research with beams of heavy ions.

Finally, heavy ions have a therapeutic promise. If they damage useful cells, they will also damage tumorous ones, and they do it in a qualitatively different way from the X-rays that are commonly used in radiation therapy. X-rays deposit energy in sizable amounts all along their path through tissue, but the heavy ions deposit most of their energy at the ends of their paths. (How far a heavy-ion beam penetrates depends on its energy.) Thus the heavy ions may prove useful in treating deep-seated tumors where the use of X-rays might cause unacceptable damage to overlying tissue.

Budinger stresses that here is no potential cure-all for cancer. Such therapy would be useful only for the class of tumors for which radiation therapy is now used: compact, localized growths. "You couldn't hit leukemia this way," he emphasizes. Furthermore this class of tumors is also susceptible to surgical excision, and in current practice radiation therapy is usually resorted to only when surgery is not indicated—for example when large blood vessels are present that might bleed too much if they had to be cut.

Budinger points out that all these questions are still early in the basic research stage. It will be years before therapeutic applications are worked out and patients can be treated. □

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**DECISION-MAKING ON THE EFFICACY AND SAFETY OF DRUGS**—Joseph D. Cooper, Ed.—Interdisciplinary Communication Associates, 1971, 193 p., paper, $5.50. Proceedings of 1970 Conference on the Philosophy and Technology of Drug Assessment, a critical discussion of the issues by representatives of diverse professional backgrounds.

**IMPLEMENTING ORGANIZATIONAL INNOVATIONS:** A Sociological Analysis of Planned Educational Change—Neal Gross, Joseph B. Giacquinta and Marilyn Bernstein—Basic Bks., 1971, 309 p., $8.95. Using the case history of the failure of an elementary school to implement a major educational innovation it had accepted on paper, the study focuses on the crucial aspect in the process of organizational change—the extent to which the innovation is in fact in operation.

**INDIA'S GREEN REVOLUTION:** Economic Gains and Political Costs—Francine R. Frankel—Princeton Univ. Press, 1971, 232 p., map, $7.50. An analytical study of the political costs of economic growth in five of the original Intensive Agricultural Development Districts, weighs the impact of modern technology on patterns of income distribution and political cohesion at the local level.

**THE INTERSTATE COMMERCE OMISSION:** The Public Interest and the ICC—Robert C. Fellmeth—Grossman, 1970, 423 p., diagrams, tables, paper, $1.45. This Ralph Nader Study Group Report presents data and detailed analysis of the functioning of ICC as regulatory agency of the railway, trucking, shipping and pipeline companies under its jurisdiction.

**THE RADIO UNIVERSE**—J. S. Hey—Pergamon Press, 1971, 248 p., photographs, diagrams, $7. Covers the whole field of radio astronomy including radar astronomy, waves, telescopes, radio emission from moon and planets, the radio sun, galactic emissions, radio galaxies and quasars.

**RAND McNALLY COSMOPOLITAN WORLD ATLAS**—Rand McNally, 1971, enlarged ed., 408 p., full-color maps and photographs, $19.95. Expanded "Planet Earth" edition features some 40 new pages of exciting photographic maps from space, geological comparison maps, and maps of the ocean floors, includes updated reference material and statistics.

**SCIENTIFIC, TECHNICAL AND RELATED SOCIETIES OF THE UNITED STATES**—National Academy of Sciences—NAS, 1971, 9th ed., 213 p., $13.50. Lists 531 organizations with up-to-date information about principal officers, history, purpose, memberships, meetings, professional activities and publications. Includes cross-referencing of former names and mergers.

**SOVIET PLANNING TODAY:** Proposals for an Optimally Functioning Economic System—Michael Ellman—Cambridge Univ. Press, 1971, 219 p., diagrams, $10; paper, $4.45. Explains the proposals put forward by the Central Economic Mathematical Institute of the USSR Academy of Sciences, proposals for improving the Soviet economic mechanism and the methods of economic calculation.