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B. FUTURE PROGRESS IN THE DEVELOPMENT OF THE LIXISCOPE

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It was GSFC's interest in the imaging of hard X-rays and soft gamma rays that led to the development of the Lixiscope. High spatial resolution imaging devices capable of single-photon counting in this energy domain of the electromagnetic spectrum will find important applications in the fields of astrophysics, solar physics, planetary physics and in studies of weightless effects in the space environment. The directions that the research in the GSFC laboratory will take in the future development of the Lixiscope with respect to these objectives are summarized below.

The end-point in the research related to the investigations in astro-, solar, and planetary physics is the development of a hard X-ray/soft γ-ray telescope. It is hoped to use the Lixiscope as a position-sensitive detector placed at the focal plane of such a focussing or collimating X-ray/γ-ray telescope. The Lixiscope properties which are important and need to be developed for such a focal-plane device are single-photon counting with the capability of energy sensitivity as far into the γ-ray region as possible. GSFC has demonstrated the pulse-counting capability as well as simultaneous pulse counting and position sensitivity. These methods are described in the Reference, where the limited pulse-height, or energy resolution of a proto-type high-gain microchannel plate (MCP) tube, is also described. A number of different scintillators are now being tested in order to extend the Lixiscope energy sensitivity. The scintillator of specific interest is CsI. GSFC is also looking at cellurized scintillator screens which may improve spatial resolution at higher γ-ray energies.

GSFC is not presently involved in developing X-ray and γ-ray optical systems, but hopes to use the results of recent research in this field. Both collimator and pin-hole systems show great promise for application in the development of a gamma ray telescope. Fan-shaped collimators might be used to study spatially extended sources. However, collimators are rather limited in terms of mapping large regions of the sky. Pin-hole camera approaches permit mapping of larger regions with good spatial resolution. Single pin-hole systems reduce the flux at the focus of the imaging detecting device (possibly the Lixiscope) to such an extent that extremely long counting times would be required to obtain statistically significant results. On the other hand, multiple pin-hole systems (the Dickey Camera) are capable of focusing images with about 30 percent transmission of the incident flux. Rather complex mathematical methods are required to reduce image confusion due to the multiple pin-hole optical system. Both digital and analog methods are being used to perform the required mathematical transformations.

Finally, many of the phenomena to be studied are time dependent. The excellent time resolution of the Lixiscope detector should be ideally suited for such studies. The time resolution should only be limited by counting statistics.

In studies of biological effects due to weightlessness (Zero-g), the Lixiscope would be used as a fluoroscope. An example of such a study is the observation of the increased inter-costal spacing during weightlessness. This effect is most dramatically demonstrated by the fact that the astronauts become about 3 inches taller during space flight. This growth may be attributed to the increase in inter-costal (space between bones) spaces during space flight. This effect in small animals may be studied with the Lixiscope during some of the Space Shuttle flights. The general effect on skeletal structure due to calcium demobilization can also be studied. Growth phenomena in zero-g and away from wall effect can also be studied.

Based on the foregoing discussion, it is indicated that the Lixiscope has various applications to the basic problems in space research. The Laboratory for Astronomy and Solar Physics is planning a research and development program in which those properties of the Lixiscope most applicable to space flight research will be studied and explored.

Reference

Yin, Lo I, J. I. Trombka, and S. M. Seltzer: "A Low Energy γ-Ray Imaging Detector", Space Science Instrumentation (In press), 1979.