LETTERS TO THE EDITORS

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The Flying-Spot Monochromatic Ultra-Violet Television Microscope

Attention has been directed by Young and Roberts[1] to the advantages of utilizing the flying-spot technique for the production of absorption images of living cells at 2600 A. These advantages are the immediate visual presentation of the image and a great reduction in the amount of ultra-violet radiation necessary for the production of the image, the latter advantage being due to the much greater quantum efficiency of photocathodes over photographic emulsions.

Practical realization of these advantages has now been made possible because of the utilization of new deep ultra-violet scanning cathode-ray tubes and ultra-violet photomultipliers of high quantum efficiency, in conjunction with certain recent developments in technique we have devised. These developments consist of the employment of 4-sec. frame-sweep speeds, 60-cycle line presentation on a radar (cathode-ray) tube, and photographic integration of the image on the monitor tube. The purpose of the 4-sec. frame, 60-cycle line is to reduce the amount of radiation received by the specimen while at the same time obtaining the maximum signal-to-noise ratio on the presentation tube; photographic integration then allows for a further increase in the signal-to-noise ratio and is obtained by exposing the photographic plate to several successive frames. The image then builds up in proportion to the number of frames, while the statistically random distribution of the noise allows it to build up as the square root of the number of frames. The limits of this integration process are: (*a*) the signal-to-noise ratio of the specimen image on the monitor tube should be sufficient to allow for ease in focusing the microscope; (*b*) the total integration time should be short when compared to particle movement within the living cell; in the case of mitosis this would perhaps be of the order of one minute or less. In the observation of non-living material (*b*) does not apply, and integration may be virtually infinite. Improved ultra-violet scanner tubes are in the process of construction which will provide a greatly improved signal-to-noise ratio; the necessity of photographic integration will be minimized and may be obviated, dependent on the image-forming characteristics of the specimen.

Flying-spot ultra-violet television microscopy should show considerable advantage over television-camera ultra-violet microscopy since the television camera tube has a considerable background of noise, not due to statistical arrival of photons; and the lack of really high gain between its photocathode and the associated amplifier means that the first valve contributes noise. Neither of these disadvantages applies to photomultiplier tubes.

The accompanying illustrations demonstrate the principle of photographic integration. The specimen is a tissue-culture preparation of the Hela strain of human cancer cells, mounted between 'Vycor' cover slips. The specimen was scanned by a monochromatic ultra-violet spot at 2600 A. with a band-width of 100 A. The photographs show identical absorption images of the same living cells, and differ only in the number of frames integrated. Fig. 1 is the result of exposure of the plate to one frame, Fig. 2 to sixteen frames, and Fig. 3 to sixty-four frames.

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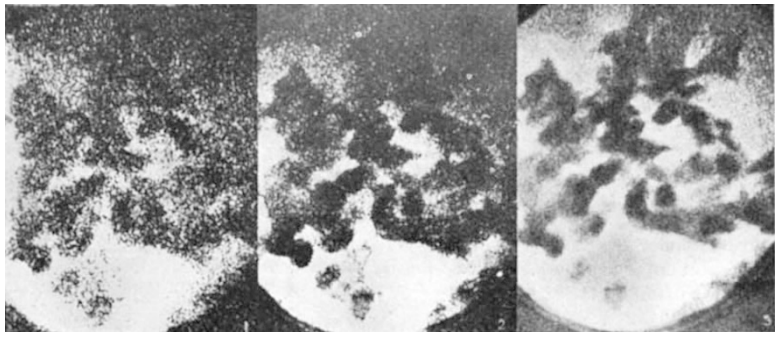
[1] Young, J. Z., and Roberts, F., *Nature*, **167**, 231 (1951).



(1) One 4-sec. frame. (2) Four 4-sec. frames. (3) Sixteen 4-sec. frames. Monochromatic ultra-violet absorption images of living Hela cells at 2600 A., bandwidth 100 A.

Micro-analysis by a Flying-Spot X-Ray Method

The point-by-point investigation of a surface by analysis of the characteristic X-ray line emission has been initiated by Castaing[1]. He obtained an electron spot of the order of 1 micron in diameter with an electrostatic lens system and moved the specimen under the fixed spot; the point examined was identified by means of an optical viewing system. Analysis is greatly facilitated if the electron spot is scanned across the specimen and if a counter is used for collecting part of the emitted X-rays. The signal from it can be transferred to a cathode-ray tube scanned in synchronism, so that a picture is displayed of the part of the surface under investigation. Such a system is similar to the electron scanning microscope[2]. It differs appreciably from that proposed by Pattee[3], in which an electron spot scans a thin target of a pure metal next to which is placed the specimen to be examined, so that image con-