A. A. Vazina. *Investigation of the dynamics of structural changes in biomolecular systems by methods of high-speed diffractometry with synchrotron radiation.* Work on the use of SR to investigate the structure of biopolymers was started in our country in 1971 at the inititative of G. M Frank by the Institute of Biological Physics, which used the "ARUS" synchrotron of the Erevan Physics Institute. In 1973, these studies were conducted systematically on the VÉPP-3 storage ring in collaboration with the Institute of Nuclear Physics of the Siberian Division of the Academy of Sciences of the USSR.

A technique for high-speed small-angle x-ray diffractometry was developed using VÉPP-3 SR, a focusing collimation system, and highly sensitive detectors. Small-angle diffractometry makes it possible to obtain information on large periods of the structure, a feature that is especially important in the study of biological objects such as membranes, the motor apparatus of protozoans, and muscles. The exposure times, which are ordinarily measured in hours, were shortened to tenths and hundreths of a second.[1-3]

The short exposure times made it possible to attempt investigation of structural dynamics during the realization of biological functions, e.g., muscle contractions lasting tenths of a second. Working with the IYaF (Institute of Nuclear Physics), we developed a diffractioncinematography technique for use in investigating the change in muscle structure during a single contraction with high time resolution of the order of a few milliseconds.[4] The method made it possible to register 64 diffraction patterns (frames) separated by intervals of 1–100 msec; the experiment was computer-controlled, and a block diagram appears in Fig. 1.

Single contractions of frog sartorius muscle were investigated in an isometric regime. From 30 to 100 single-contraction cycles were summed to obtain good diffraction-pattern statistics. The experiment followed the variation of the meridional diffraction lines governed

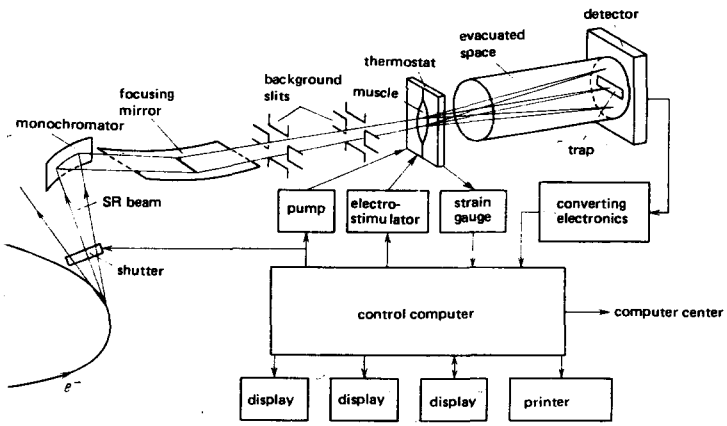

FIG. 1. Block diagram of diffraction-cinematography technique.

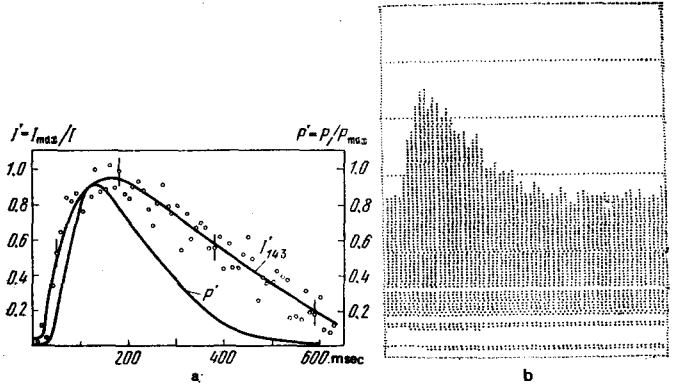

FIG. 2. a) Variation of intensity of meridional reflection of 143 Å during development of single contraction (film No. 17, meridian, 10 July 1977), time for frames 0-63 10 msec, isometric regime, frog sartorius muscle); b) histogram of intensity ratio of equatorial 10 and 11 reflections.

by the structure of thick myosin filaments (most characteristic reflection 143 A) and the equatorial lines governed by the hexagonal packing of thick and thin filaments (reflections of 10 and 11 planes). Figure 2 shows integral-intensity time curves of the 143 Å meridional reflection (a) and a histogram of the intensity ratio of the equatorial 10 and 11 reflections (b). Figure 2 shows that the structural curves are similar in nature to the contraction (P) curve: latent period, linear growth phase, maximum, and slow decline. The curve fronts are shifted insignificantly, the structure curve leading the contraction curve; the tails diverge farther. These curves provide a striking demonstration of the relation between structure and function and constitute experimental proof that it is the observed structural change that is responsible for the development of muscle contraction. This is pioneering work: work on the dynamics of nerve structure during passage of an action potential has been started at Stanford; the procedure registers 2 frames corresponding to the states of rest and excitation.[5]

[1]A. A. Vazina *et al.*, Biofizika 20, 801 (1975).
[2]A. A. Vazina, in: Molekulyarnaya biologiya (Molecular Biology), VINITI, Moscow, 1976, Vol. 8, Part 2, p. 242 (Advances in Science).
[3]V. P. Gimanov *et al.*, Biofizika 23, 393 (1978).
[4]A. A. Vazina, Vestn. Akad. Nauk SSSR, No. 8, 15 (1978).
[5]N. Webb, SSRP No. 7, 21 (1976).