particles (tens, units, and fractions of electron volts) with solids.

2) Bombardment of solids with atomic particles having energies in the hundreds of thousands and millions of electron volts.

3) The action of multiply charged ions on matter.

4) Interactions of laser radiation and slow positrons with the surfaces of solids.

5) Construction of a consistent and rigorous theoretical interpretation of the electronic and atomic emission processes and phenomena that are studied and used, as well as of processes on the surface and in the superficial layer.

É. I. Adirovich. Major Research Trends in the Fields of Physics and Astronomy at the Institute of the Uzbek Academy of Sciences.

1. The general expressions for the photoelectric voltage in a homogeneous semiconductor (photodiffusion, or the Dember effect) and in a semiconductor with a conduction-type junction (the photo-voltaic effect at a p-n junction) imply that V_{ph} cannot exceed the forbidden-band width E_g. Anomalous photoelectric voltages (APV) had been observed in thin PbS layers ($E_g = 0.4$ eV, $V_{ph} \approx 1-2$ V[1]), but this phenomenon (the APV effect) aroused great interest only after $V_{ph} \sim 100$ V was reported in[2] for CdTe films. It was shown that the APV effect is not peculiar to some narrow class of semiconductors, but can be produced on films of any semiconductor material (Ge, Si, GaAs, SiC, GaP, InP, ZnTe, $GaTe_3$, Sb_2Se_3, and others[3]). Maximum values of $V_{APV} \approx 6000$ V were obtained on chalcogenide films in[3].

The lux-volt V(B), temperature V(T), spectral $V(\lambda)$, polarization $V(\varphi_{pol})$, kinetic V(t), and other characteristics of the APV effect have been studied experimentally. The results of these investigations contain a large volume of information on the properties of APV films, but cannot give a definite answer concerning the nature of the APV effect. Two dilemmas must be resolved for this purpose: 1) is the APV film a single photocell or a battery consisting of a large number of microphotocells; 2) what is the mechanism of the elementary processes leading to the appearance of the APV effect (photodiffusive or photovoltaic).

The photocell theory[4] is based on the assumption of nonuniform distribution of the trapping levels in the APV film, resulting in the appearance of localized-photocarrier space charges. The inconsistency of this model is pointed out in[5], which gives a general theoretical proof of the necessity that V_{APV} be formed as a sum of small photoelectric voltages generated in individual microphotocells. Adirovich et al.[6] propose an experimental method that serves as the crucial test for establishment of the nature of the electronic processes in the individual microphotocells. It embodies the idea that the sign of V_{ph} should be reversed upon change in the angle of incidence of the light in the case of the normal Dember effect, but should remain the same in the photoeffect at the p-n junction and in the anomalous Dember effect. The photovoltaic and anomalous Dember effects are discriminated in short-wave excitation, when the anomalous Dember effect goes over to the normal one. Combined studies of the angular and spectral relations made it possible to establish that the APV effect is governed by the photodiffusive mechanism in films of Ge, Si, and GaAs, and by the photovoltaic mechanism in films of CdTe, GaP, and chalcogenides.

2. For V_{APV} to appear in a multilayered p-n-p-n-...-structure, it is necessary that the p-n and n-p junctions be unequally illuminated. Figure 1a shows that this is the case in APV films. This model is equivalent to a one-dimensional multilayered structure with a screen that leaves the p-n junctions exposed and shades the n-p junctions (Fig. 1b). Unlike the photoelectric voltages, the photomagnetic voltages across the p-n and n-p junctions do not subtract, but add[7,8]. In APV films, where the difference photoelectric effect is anomalously large, the additive photomagnetic effect across the p-n junctions should therefore be all the more enhanced.

This reasoning led to the discovery of the anomalously large photomagnetic effect (APME) in semiconductor films, which ranges into the tens and hundreds of volts[9]. Measurements of V_{APME} and I_{APME} on CdTe films up to B ~ 300 000 lux and H = 80 kOe showed agreement between experiment and theory. The $V_{APME}(B)$ curves take the form shown in Fig. 2 (curves 1–6 and 8–10 represent $V_{APME}(B)$ for H from 20 Oe to 3.5 kOe; curve 7 is that of $V_{APV}(B)$). The $V_{APME}(H)$ dependence is linear up to $H \approx 50-60$ kOe, when $\mu H/c \ll 1$. Combined study of the photomagnetic and Hall photoelectric effects makes possible direct measurement of the carrier mobility ($\mu \sim 100$ cm²/V-sec) and the number of micro p-n junctions in the APV film ($N \sim 10^4-10^5$). Spectral, temperature, and kinetic investigations were also carried out, and it was established that the carrier mobility is $\mu \propto T^{-2.1}$, that the lifetime in the band is $\tau \sim 10^{-10}$ sec, and that the lifetime at the trapping levels is $\tau_s \sim 10^{-6}$ sec.

The sensitivity of the photomagnetic effect in APV films is ≈ 5 mV/Oe, which is more than an order higher than the sensitivity of the Hall effect.

3. The APV effect and the APME effect in films are of interest not only for semiconductor physics, but also for optoelectronics, for which the problem of finding new physical principles for the transformation of light and optical signals is a very urgent one[10]. The optron with APV film used as a light receiver is based on the photogenerative rather than on the photoswitching principle, and therefore does not require an electric-power supply.

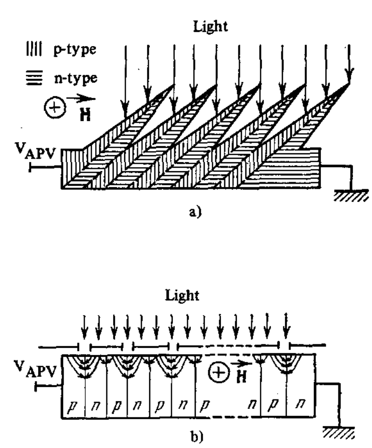

FIG. 1

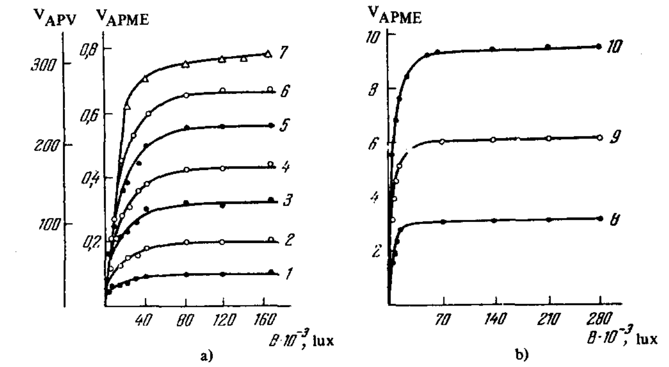

FIG. 2

The APV-film matrix unit described in[10] accomplishes transformation of an image into an electrical potential relief. Use of APV films enables us to use light signals not only as information signals, but also as control signals in optoelectronic devices. The APME effect can be used to create a miniature self-contained (not requiring an electric-power supply) magnetic-field transducer far superior to the Hall transducer in sensitivity.

[1] J. Starkiewicz, L. Sosnowski and O. Simpson, Nature **158**, 26 (1946).

[2] L. Pensak and B. Goldstein, J. Appl. Phys. **30**, 155 (1959).

[3] É. I. Adirovich et al., Fiz. Tverd. Tela **6**, 3180 (1964); **7**, 3652 (1965) [Sov. Phys.-Solid State **6**, 2540 (1965); **7**, 2946 (1966)]; Dokl. Akad. Nauk SSSR **155**, 1286 (1964); **181**, 1090 (1968) [Sov. Phys.-Doklady **9**, 296 (1964); **13**, 779 (1969)]; Fiz. Tekh. Poluprov. **2**, 1020 (1968) [Sov. Phys.-Semicond. **2**, 848 (1969)].

[4] H. W. Brandhorst and A. E. Potter, J. Appl. Phys. **35**, 1997 (1964).

[5] É. I. Adirovich, V. M. Rubinov and Yu. M. Yuabov, Dokl. Akad. Nauk SSSR **164**, 529 (1965) [Sov. Phys.-Doklady **10**, 844 (1966)].

[6] É. I. Adirovich, V. M. Rubinov and Yu. M. Yuabov, ibid. **168**, 1037 (1966); **174**, 545 (1967) [**11**, 512 (1966); **12**, 477 (1967)].

[7] I. K. Kikoin and I. N. Nikolaev, Zh. Eksp. Teor. Fiz. **41**, 1692 (1961) [Sov. Phys.-JETP **14**, 1203 (1961)].

[8] Yu. I. Ravich, Fotomagnitnyĭ éffekt v poluprovodnikakh i ego primenenie [The Photomagnetic Effect in Semiconductors and Its Applications], Soviet Radio, 1967.

[9] É. I. Adirovich, É. M. Mastov, and Yu. M. Yuabov, Dokl. Akad. Nauk SSSR **188**, 1254 (1969) [Sov. Phys.-Doklady **14**, 994 (1969)]; Proc. of the Intern. Conference on the Physics and Chemistry of Semiconductor Hetero Junctions and Layer Structures (Budapest, October 11–17, 1970), Akademia Kiado, Budapest, 1971; Fiz. Tekh. Poluprov. **5**, 1415 (1971) [Sov. Phys.-Semicond. **5**, 1241 (1972)].

[10] É. I. Adirovich, in: Mikroélektronika [Microelectronics], No. 1, Soviet Radio, 1967, p. 75; Izv. Vuzov, Radioélektronika **11**, 679 (1968).

V. P. Shcheglov. Prospects for the Development of Astronomy in Uzbekistan.

The contemporary scientific profile of the Astronomical Institute—the only agency of the Uzbek Academy of Sciences concerned with problems of astronomy—is determined by two trends:

1) Research in astrometry.

2) Study of the physics of the sun and nonstationary stars.

To determine the prospects for development of these trends, it is necessary to begin first of all with their importance for natural science and their usefulness to the national economy. A second criterion mandatory for the prospects of development of astronomical research must be recognized in the aggregate of natural conditions under which these problems can be elaborated with special success.

We shall examine the scientific trends at our institute from precisely these two standpoints.

Astrometry as a science dates from at least two thousand years ago. Despite its great age, it has not exhausted its subject matter. Moreover, each epoch confronts it with new problems whose solutions often have enormous natural-scientific repercussions.

Astrometry cannot be defined, as it is in many dignified tomes, as the science of determining the exact positions of celestial bodies, geographic coordinates, and time. This confining definition does not do justice to the scientific importance of astrometry, which should instead be regarded as the science of measuring time and cosmic space. This definition includes all measurements made with the object of understanding the cosmos, ranging from the determination of coordinates to the curvature of light beams in gravitational fields, detection of time changes under the conditions of high velocities, and measurement of the quantities characterizing the drift of the continents, which are at the limit of accuracy of measuring instruments. All of these are astrometric problems. It is characteristic of most astrometric problems that they are elaborated by many scientific agencies cooperating under governmental or international auspices.

The basic astrometric programs in which the Astronomical Institute of the Uzbek Academy of Sciences has been a participant for many years have as their objective the creation of an inertial space-time coordinate frame and study of the earth's rotation about its axis. Such a system is absolutely necessary for study of the positions and motions of both natural and artificial space objects. It must make it possible to solve the above problems with an accuracy that increases with each year, as is particularly necessary for the spatial localization of artificial space probes.

To fix the directions of the axes of this system in cosmic space, catalogues of the positions and proper motions of a large number of stars are being compiled and astronomical constants that permit reduction of the system to any desired epoch are being determined. The proper motions of the stars are determined by tying them to objects whose tangential motion in space cannot be detected by modern measuring facilities—objects millions of light years from us.

The second astrometric problem being elaborated at the Astronomical Institute involves study of the nonuniformity of the earth's rotation.

It would hardly be an exaggeration to say that against the background of the general development of astrome-