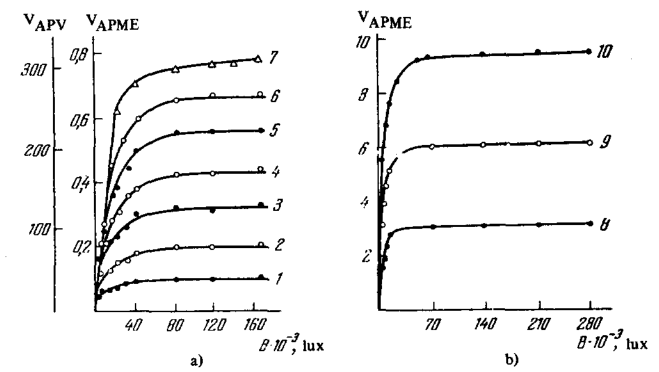

FIG. 2

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.

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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 astrometry, this project has achieved outstanding results, both theoretical and observational, over the last few decades. The nonuniformity of the earth's rotation that was hypothesized long ago by theoreticians has become a tangible fact before our eyes. This fundamental discovery has broadened our conceptual material in the field of time measurement and led to the establishment of new values of the time units. The notion of Ephemeris Time has emerged. Thanks to it, the empirical terms that had perplexed investigators for centuries were banished from the theory of the motion of the moon and planets. Ephemeris Time has become an argument in various equations whose numerical values form the content of the astronomical yearbooks.

In recent years, the development of quartz and molecular standards has raised the accuracy of time measurements by at least three orders—an exceptional fact in the history of astronomy.

The seasonal nonuniformity of the earth's rotation and sudden changes in its velocity are being studied systematically with the performance of these standards as a background.

Our Astronomical Institute participates in All-union and international joint efforts toward the definition of appropriate time standards.

The nonuniformity of the earth's rotation is manifested in variation of the velocity and of the direction of the latter in space. The Department of Time at Tashkent is concerned with study of the former effect and the Ulugbek Kitab International Latitude Station, located 400 km from Tashkent, with the latter. This is the only such station in the USSR and one of five strung around the globe on the geographical parallel of 39°08′. Taken together, they form the International Earth's Pole Service. Regular determinations of latitude made at these stations in accordance with the same program yield the data from which the polhode, which represents the path of the pole's motion on the surface of the earth, is derived. Our station has at its disposal an unbroken forty-year series of latitude observations, a phenomenon seldom encountered in world science. Such series are of particular value for establishment of slow natural phenomena. Among other things, the secular motion of the earth's pole that was observed only a few years ago is based on the steady work of the latitude stations over a seventy-year period. It amounts to about one decimeter per year, but who can deny the unquestionable fact that through this small quantity we are approaching the solution of such grandiose problems as the changes in the climate of our planet, the periodic glaciation of its surface, and the discovery of "the bones of mammoths and fossilized India grasses in habitats unfriendly to them," to use the words of Lomonosov in his classical work "On the Layers of the Earth."

All astrometric problems under development at our Institute have a direct bearing on practice. The determination of time enters as one of the components into the All-union and International time standard. It is used by geodetic agencies as a base for cartographic projects and by all investigators who require an exact time reference. Catalogues of star positions are also used by geodesists, hydrographers, geographers, and representatives of other professions who are interested in geographic-coordinate determinations.

The motion of the earth's poles has attracted the attention of geophysicists concerned with the internal structure of our planet and that of geodesists because the orientation of coordinate systems on the earth's surface changes with changes in the position of the pole.

We have thus reviewed the astrometric projects under development at our institute from the premises of the first criterion stated at the beginning of our paper—scientific urgency and usefulness for practice. Our second criterion—the presence of natural conditions for successful performance of these tasks—bears a natural relation to the physicogeographic and climatological characteristics of Uzbekistan.

Among all of the astrometric agencies of the Soviet Union, our institute and its affiliate have the southernmost locations. Their geographic latitudes are 41°19′ and 39°08′, respectively. Astrometric instruments at such geographic positions have observational access to Southern Hemisphere objects down to −30° in declination, something that is impossible at latitudes farther north. As concerns climatological characteristics and primarily the number of nights suitable for observations, it is around 226 according to averaged statistical data. No other astrometric observatory of the Soviet Union enjoys such an abundance of clear sky.

Summarizing the above, we conclude that the astrometric problems being worked up at the Astronomical Institute of the Uzbek Academy of Sciences meet the conditions that justify their further development.

And we do propose to develop them in the future. However, it should be remarked that our instrumentation leaves something to be desired for solution of these problems at the present-day level. In this respect, we are in much the same boat as many other astrometric observatories of the Soviet Union. But this is a subjective matter. With a will, the difficulty can, as it must, be overcome.

It should be noted here that most of the astrometric instruments with which our observatories are equipped are a century old. I shall have the pleasure of demonstrating one of them to the participants of this session. Over the past half-century, our industry has built only one meridian circle, that at Moscow University. Having completely given up the hope of acquiring modern instruments, some of the astronomers have taken to consoling themselves with the idea that, like Stradivarious violins, aged meridian circles not only do not lose their qualities, but even improve in the course of time. Although there is a certain analogy between astrometric observations and the arts, we do not share this point of view when it comes to instrumentation. Going further, we submit that modern astrometric instruments should reflect all of our epoch's attainments in metrological technique.

If we take a historical view of astronomical instrumentation, we note at once that the most refined technical attainments are concentrated in it with one object: that of attaining high accuracy in observations. Two giants may be cited as examples: one of the oldest meridian instruments at the Fifteenth Century observatory at Samarkand, which our guests can inspect on visiting this ancient city, and the six-meter reflector at Zelenchuk. Thus, the accuracy of astronomical observations may serve as a kind of indicator of the technical attainments of our epoch.

Astrometric instrumentation must be recognized as a problem that the government cannot put aside, the more so since it requires an outlay at least an order of magnitude smaller than that required for astrophysical instruments.

In expectation of these measures, we are making every effort to build up our arsenal of observational facilities. Thus, in 1973, we hope to take delivery of a Zeiss double astrometric astrograph for study of the proper motions of stars and star clusters—problems that I mention only in passing, but which are also traditionally within our field of research. We propose to install this instrument at our affiliate in Kitab, out of range of the interference created by the proximity of a large city. By agreement with the Main (Pulkovo) Observatory of the USSR Academy of Sciences, we shall also install a photographic zenith telescope at Kitab with the object of implementing the international program for study of continental drift that was originally developed at our institute in 1964. The basics of this program were approved, and their implementation recommended, by the Thirteenth Assembly of the International Astronomical Union at Prague in 1967. We hope that our efforts will move us closer to solution of this subtle problem, which is so important for many of the sciences that study our planet.

Let us turn to the prospects for development of astrophysical research. Solar physics has been a traditional problem in this trend for our institute. We need hardly speak here of the importance of studying this nearest star, the violent processes on whose surface and in whose atmosphere have a direct relation to many terrestrial phenomena. I shall therefore note only that research on the sun has been in progress at our institute since 1933. Like the other projects, it is developed on the basis of regular observations. It is known that the cycle of solar activity encompasses 11 years. Our institute has a continuous series of high-density-sunspot observations covering three-and-a-half cycles. A number of investigations that are highly regarded by our colleagues engaged in similar work at other observatories have been carried out on the basis of these observations and observations of various other processes unfolding on the surface of the sun and in its atmosphere. In connection with research under the IGY program, the equipment of the Solar Physics Department was supplemented with a chromospheric-photospheric telescope; this enabled us to film fast processes taking place in the solar atmosphere.

In 1966, a horizontal solar telescope and diffraction spectrograph with a mean dispersion of 1 Å/mm was placed at the disposal of the Solar Physics Department. Three years later, this unit was supplemented by two narrow-band monochromatic filters that make it possible to observe the solar atmosphere in the hydrogen and calcium lines. The spectrophotometric observations made possible by this equipment have expanded considerably the range of subject matter covered in the solar research. The proposed acquisition of a magnetograph will make it possible to begin study of the sun's magnetic fields. In its work, the Department maintains close contacts with other agencies studying the sun, both within the USSR and abroad. There is every basis for further development of the problem, especially when the possibility of observing the sun on as many as 300 days per year is considered.

The Variable Star Department is occupied with investigation of nonstationary stars of the T Tauri, RW Aurigae, UV Ceti, and other types. The object of these studies is to develop a concrete notion of the initial stage in stellar evolution (between the formation of protostars and the start of the Main Sequence) and to deliver the related description of nonstationary phenomena in the atmosphere of T Tauri stars and a morphology of extremely young star groupings.

The most noteworthy aspect of the work of this Department is the fact that it is done without even medium-sized optics, not to mention large ones. Observations are made at other observatories and "imported" by the Institute. By the way, I should like to express my profound gratitude to the Crimean Astrophysical Observatory, the Shternberg State Astronomical Institute, and the Éngel'gardt Astronomical Observatory for making large-instrument observing-time available to our staff in accordance with prearranged schedules. In recent years, work has been done jointly with the Crimean Observatory in the infrared spectroscopy of faint objects.

Naturally, this approach to the work involves major difficulties of an organizational nature. For several years now, we have therefore been bending our efforts toward the acquisition of our own astrophysical instruments—if not excessively large ones, then at least in modest dimensions. In anticipation of the success of these efforts, we have instructed the Variable Star Department to make an astroclimate study—a task that has no direct relation to its subject matter but is very important for the development of major astrophysical work. Although the concept of the astroclimate has not yet crystallized in canonical form, we presume to define it as the aggregate of the physicogeographical, climatological, and atmospheric conditions of a given locality that characterize its suitability for the erection of large astronomical instruments.

We have pursued this topic with greater or lesser intensity over the past ten years. During this time, 19 sites in Central Asia and Kazakhstan have been surveyed, including five at which expeditionary studies have been conducted by other astronomical organizations. We shall leave the highly interesting scientific results of these studies for a special report and scientific discussion. Here we confine ourselves to the statement that in 1969, in the Karshi Oblast' of the Uzbek SSR, one hundred kilometers from our Kitab affiliate, we found a location on Mt. Maĭdanak with astroclimatic indicators superior to those of any other site that we surveyed. Since 1970, a permanent high-mountain expedition has been at work on Mt. Maĭdanak with the mission of refining the astroclimatic parameters of the site. All of the data collected by our staff has convinced us that this site has some of the best astroclimatic characteristics in the Soviet Union and is comparable with few points on our planet. Not to place one of the large astrophysical instruments here would be as inexcusible as to find a nugget of pure gold and pass it carelessly by. How and when this site will be used for major astrophysics, I find it difficult to say. This question is outside of my competence and requires a concensus of my colleagues. This much is certain: sooner or later, a major astrophysical observatory will be functioning on it. In the interest of our science, it must be hoped that this occurs as soon as possible.

In defense of the right of the Central Asian Republics and Kazakhstan to a major astrophysical instrument, I beg to draw your attention to the following facts. This is not the time or place to speak of causes, but a situation has arisen in which all major reflectors built for Soviet astrophysics in recent decades have been located in a narrow strip of longitudes, for the most part in the Crimea and Caucasus. I have figured out the total area of the reflector mirrors, Schmidt cameras, and Maksutov telescopes 50 cm and more in diameter in operation in the European Soviet Union. It came out to 18.0 m^2. It will triple in the present five-year plan, reaching 51.6 m^2. The increase will result from commissioning of the Zelenchuk giant, which has a mirror 27 m^2 in area, and the Byurakan 260-centimeter telescope with a mirror area of 5.07 m^2. At the same time, reflectors with a total mirror area of only 1.11 m^2, i.e., only 2% of the total mirror area of the European instruments, are in operation on the territory of the Asiatic Soviet Union from the Urals to the Bering Sea.

In light of these data, and recognizing the high astroclimatic parameters of various sites in the Central Asian Republics and Kazakhstan, our claim to a major modern astrophysical instrument does not appear excessive or immodest.

M. S. Saidov. Joint Impurity Distributions in Semiconductors.

The paper shows, with supporting arguments, that the hypothesis of generalized moments $\bar{u} = \bar{\varphi} m$ ($\bar{u}$ is the average value of the potential energy of interaction of the atom or ion, $\bar{\varphi}$ is a quantity that characterizes the intensity of the phase molecular field, and $m = ez/r$ is the generalized moment, where e is the electronic charge, z is the valence of the ion, and r is the crystallographic radius) and further development of V. K. Semenchenko's molecular-statistical theory of surface effects in solutions[1] make it possible to explain and codify existing experimental data on the behavior of impurities in semiconductors and contribute to solution of the problem of simple and complex doping of semiconductors and metals.

Formulas are proposed for the solubilities, distribution coefficients, and diffusion and adsorption coefficients in multicomponent solid solutions based on elemental substances and compounds. It is shown that the formulas obtained are in most cases in qualitative agreement with available experimental data. For evaluation of impurity distributions in Cottrell clouds, the dislocation is regarded as a statistical analog of phase and the notion of linear sorption is introduced. Formulas are proposed for the linear sorption in multicomponent solid solutions based on elemental substances and compounds[2-5,7].

The paper points out the possibility of using the current-voltage characteristics of tunnel diodes to estimate the change in the solubilities of doping elements in semiconductors and for estimation of low solubilities in certain liquid metallic solutions. The influence of various impurities on the solubility of indium in solid germanium and on the solubilities of aluminum and boron in solid silicon is determined. The results obtained here confirm the proposed solubility formula in all cases[6].

Experimental data obtained by the author's coworkers on the influence of aluminum, gallium, indium, germanium, lead, gold, silver, and copper on the solubility of silicon in liquid tin at 800°C and in a broad range of concentrations are reported. These results are also explained qualitatively on the basis of the generalized moment and indicate the possibility that surface effects may influence the solution process at low concentrations of the third component.

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P. V. Shcheglov. Astroclimatic Conditions in Central Asia and Kazakhstan.

Progress in many rapidly developing branches of contemporary astronomy is closely related to the observation of extremely faint celestial objects in the optical band of the spectrum. Detailed study of extragalactic peculiar objects, observations of variable stars and of novae and supernovae in the nearest galaxies, investigation of extremely faint stars in open and globular clusters, which is necessary for refinement of theories of stellar evolution, and, finally, cosmological research—all of this falls far short of a complete listing of the most interesting problems whose solution might be approached by increasing the reach of optical telescopes.

Astronomy deals with very weak luminous fluxes. Objects can now be photographed with a radiant flux of $\sim (1-2) \times 10^{-3}$ quantum/cm^{2}sec ($\Delta\lambda = 10^3$ Å) at the surface of the earth and spectrographed with a flux of $10^{-4}-5 \times 10^{-5}$ quantum/cm^{2}sec ($\Delta\lambda = 10$ Å). We note that astronomical radiation and image receivers are sensitive enough to register even fainter objects.

Let us consider the signal/noise ratio in the photography of point objects. Let D and f be the diameter and focal length of the telescope, β the diameter of the star image on the photographic plate, p the linear resolution of the emulsion, p/f the angular resolution of the system, n (photon/cm^{2}sec) the radiant flux from the object, S (photon/cm^{2}sec-sr) the radiant flux from the sky background, and m the number of photons per square centi-