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.

[1] V. K. Semenchenko, Poverkhnostnye yavleniya v metallakh i splavakh [Surface Effects in Metals and Alloys], Gostekhizdat, 1957.
[2] M. S. Saidov, Fiz. Met. Metalloved. **17**, 795 (1964).
[3] M. S. Saidov, Zh. Fiz. Khim. **38**, 2681 (1964).
[4] M. S. Saidov and Kh. A. Shamuratov, in: Rost kristallov [The Growth of Crystals], Vol. 8, Nauka, 1968, p. 57.
[5] M. S. Saidov, in: Protsessy rosta kristallov i plenok poluprovodnikov [The Processes of Crystal Growth and Semiconductor Films], Novosibirsk, 1970, p. 578.
[6] M. S. Saidov and M. K. Yusupova, Fiz. Tekh. Poluprov. **4**, 252 (1970) [Sov. Phys.-Semicond. **4**, 203 (1970)].
[7] M. S. Saidov, Investigation of the Interaction and Distribution of Impurities in Certain Semiconductor and Metallic Systems, Doctoral Dissertation, Physicotechnical Institute of the Uzbek Academy of Sciences, Tashkent, 1970.

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/cm²sec ($\Delta\lambda = 10^3$ Å) at the surface of the earth and spectrographed with a flux of $10^{-4}-5 \times 10^{-5}$ quantum/cm²sec ($\Delta\lambda = 10$ 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/cm²sec) the radiant flux from the object, S (photon/cm²sec-sr) the radiant flux from the sky background, and m the number of photons per square centimeter necessary to produce the optimum density on the negative.

Then if $\beta > p/f$ (the tremor disk produced by atmospheric disturbances is resolved) and $mf^2 = \pi D^2 t_0 S/4$ (the exposure is terminated short of the sky background), the ability of the telescope to detect a faint ($n < \beta^2 S$) object is $1/n \sim BDt^{1/2}/\beta S^{1/2} = Bm^{1/2}f/\beta S$, where

$$B = [(n+\beta^2 S)\, D^2 t]^{1/2}/nD^2 t.$$

We see that the diameter of the telescope and the unsteadiness of the atmosphere appear in the first power in the expression for the limiting stellar magnitude. Doubling the quality of the astroclimate is equivalent to doubling telescope diameter.

If the tremor disk is not resolved, $\beta < p/f$, $1/n \sim Bm^{1/2}f^2/pS$ when $t_0 = 4mf^2/\pi D^2 S$ penetrating power increases in proportion to the square of the telescope's diameter. We see that there are no fundamental limitations on the penetrating power of telescopes situated on the surface of the earth. Analogous relationships can be derived for the cases of low-dispersion electrophotometry and spectroscopy (with the sky background registered)[1]. Figure 1 shows the limiting magnitude for a telescope having D = 2.6 m as a function of f for various β. The points on the curve for $\beta = 1.25''$ were entered according to[1]; since the cost of a telescope $R \sim D^3$, we have $1/n \sim R^{1/3}/\beta$. At focal lengths greater than ~ 20 m and with D = 260 cm, the sky background can be registered with exposures of a few tens of minutes only with the aid of an image intensifier. Magnitudes of 22 to 23 are now the limit for photography.

Thus, lowering β is an extremely effective way to increase the penetrating power of a telescope. As concerns the optical systems themselves, the quality of those found in good telescopes has long been close to the diffraction limit[2].

The basic objective of astroclimatic research is to find sites with small β for location of large telescopes. Astronomical observational practice has shown that β may vary substantially at different stations and at different points in time. Temperature inhomogeneities of the air represent the basic factor distorting the wave front. It is expedient to locate telescopes on mountain tops, where the ground inversion layer may be only a few meters in thickness. Here it is necessary that the wind speed be moderate. In Fig. 2, the atmospheric-distortion pattern of a star wave front is shown schematically

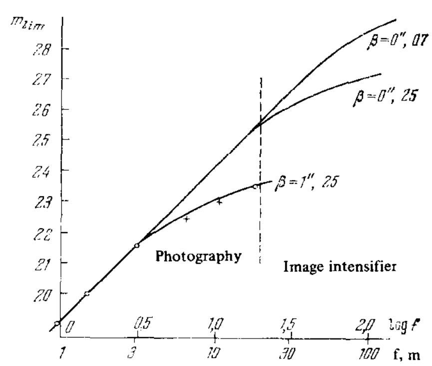

FIG. 1. Stellar-magnitude limit of a telescope with D = 2.6 m as a function of focal length for exposure to the sky background for various β.

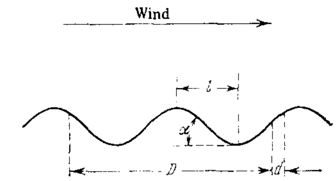

FIG. 2. Schematic pattern of atmosphere-distorted wave front from a star.

in motion relative to the telescope at the speed of the wind in the perturbing layer. Observations made with telescopes of various sizes indicate that atmospheric wave-front distortions usually range from ~ 50–100 cm in size. In large telescopes ($D > l$), the image is blurred, but does not tremble, while in small ones ($d < l$), it trembles without being misshapen. It is obvious that in siting surveys for a telescope of diameter D using an astroclimatic instrument of diameter d, the image tremor α observed in the latter should be measured (see[3]). This was well understood by the early students of astroclimate[4], but then t, the deviation of segment d of the wave front from the plane[5], was long considered the basic astroclimatic criterion. This procedure was not calibrated against large telescopes. The quantity α was measured as an auxiliary parameter, but it was later found that the method of measuring α was subject to substantial accidental and systematic errors. A new astroclimatic procedure was calibrated against large telescopes[6,7]. Figure 3 shows the relation between the α measured by the new (visual) and old (photographic) methods, t, and β for a telescope of D = 125 cm[7]. The old method was nonlinear and only about one-third as sensitive as the new one on its linear segment. Use of a two-beam visual instrument that is much less sensitive to wind vibration than single telescopes was an important practical improvement in conversion to the new method[8]. The latter includes mandatory localization of the perturbing layer by microthermometric measurements in a ground layer 15–30 m in height[9,10]; these measurements make it possible to determine the height of the telescope tower. In a number of cases (in valleys), the perturbing layer may be situated at a very great height[11].

Astroclimatic research has been underway since the early 1930's in the Central Asian Republics of the USSR. During this time, approximately 1.5×10^5 estimates of t have been obtained by the old method and about 3×10^3 estimates of α with the double-beam instrument. The sites that were found to be best were recommended for

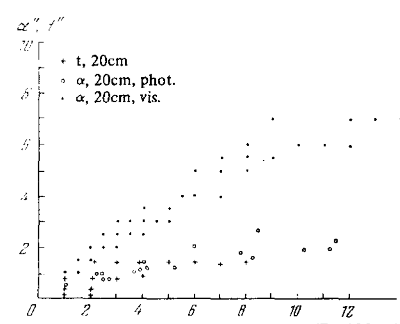

FIG. 3. Relation between α (d = 20 cm, photographic method), α (d = 20 cm, visual method), t (20 cm), and β (D = 125 cm) (after [7]).

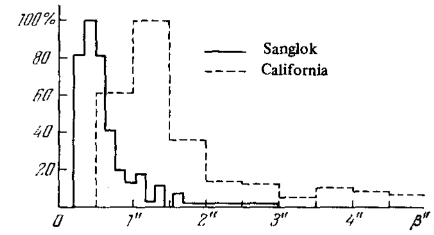

FIG. 4. Histograms of β for Mt. Sanglok [14] and Junipero Serra Peak Station, California [15].

astroclimatic study by climatologists as nearly equivalent in regard to conditions and free atmosphere. Study of Mt. Sanglok in Tadzhikistan, which had been chosen on the basis of these considerations, was begun in the early '60's. Astroclimatic studies using the old[12] and new[13-14] methods indicated exceptionally small values of β for this site. Unfortunately, Mt. Singlok is in the region of the rapidly developing Nurek industrial center. Histograms of β for Mt. Sanglok and one of the sites in California with good images[15] are given in Fig. 4. In the autumn of 1967, O. A. Semenova of the Central Asian Scientific Research Hydrometeorological Institute drew my attention to the area of the Minchukur Weather Station in southern Uzbekistan as a highly interesting one from the standpoint of astronomical requirements. A detailed analysis of the weather data[16,17] indicated that in the amount of clear-sky time and the temperature and wind characteristics this region surpasses the astronomically promising regions of Chile[18]. In the fall of 1969, the Tashkent Astronomical Institute made the first astroclimatic observations in the Minchukur area, which yielded extremely encouraging results[19]. The results of a year's observations[20] using the double-beam instrument on the dominant peak in the region—Mt. Maĭdanak—appear in Fig. 5. For comparison, the same figure gives the results of measurements of β by an objective method for Morado Peak[21]. The good quality of images obtained on the mountaintops of Central Asia is explained by the low wind speed in this region, which is remote from the oceans and thoroughly insulated on the south and east by high mountains.

However, rather much still remains to be done for utilization of all of the opportunities afforded by the atmosphere at the sites investigated. Study of the aero- and thermodynamics of the telescope towers and the preparation of high-quality optics and high-information image receivers are the basic problems without solution of which it would, of course, be impossible to create a highly efficient astronomical telescope. There is no doubt that installation of such instruments at the sites that have been found is a task of prime urgency for our astronomical establishment.

[1] I. S. Bowen, Astron. J. 69 (10), 816 (1964).
[2] G. W. Ritchey, L'Astronomie 42, 179 (1928).
[3] S. B. Novikov, A. A. Ovchinnikov, and P. V. Shcheglov, Astron. Tsirk. No. 554 (1970).
[4] J. A. Anderson, J. RAS Canada 36 (5), 177 (1942).
[5] A. Danjon and A. Couder, Lunettes et telescopes, Paris, 1935.
[6] V. V. Rodionov and S. P. Yatsenko, Astron. Tsirk. No. 482 (1968).

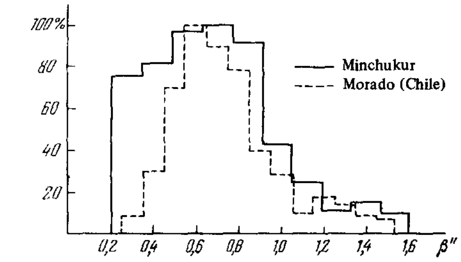

FIG. 5. Histograms of β for Mt. Maĭdanak (Minchukur) [20] and Morado Peak, Chile [21].

[7] V. É. Slutskiĭ and A. G. Printsev, ibid. No. 593 (1970).
[8] S. B. Novikov, in: Atmosfernaya optika [Atmospheric Optics], Nauka, 1970.
[9] H. Siedentopf and F. Unz, ESO Publ., March, 1964.
[10] A. V. Bagrov and A. A. Ovchinnikov, Astron. Tsirk. No. 558 (1970).
[11] V. V. Rodionov, ibid. No. 554 (1970).
[12] O. P. Vasil'yanovskaya, Byull. Inst-ta Astrofiz., Dushanbe, No. 39–40 (1965).
[13] S. B. Novikov and P. V. Shcheglov, Astron. Tsirk. No. 491 (1968).
[14] A. V. Bagrov, Yu. F. Nikitin, G. V. Novikova, S. B. Novikov, and P. V. Shcheglov, ibid. No. 574 (1970).
[15] M. F. Walker, Publ. Astr. Soc. Pac. 82 (No. 487), 672 (1970).
[16] G. V. Novikova, Astron. Tsirk. No. 482 (1968).
[17] G. V. Novikova, in: Atmosfernaya optika [Atmospheric Optics], Nauka, 1970, p. 10.
[18] ESO Annual Report, 1969.
[19] V. É. Slutskiĭ and V. G. Khetselius, Astron. Tsirk. No. 573 (1970).
[20] S. P. Yatsenko, ibid. No. 637 (1971).
[21] I. B. Irvin, ESO Bull., No. 3 (1968).

G. Ya. Umarov. Development of Research on the Utilization of Solar Energy within the System of the Uzbek Academy of Sciences.

Although the efficient utilization of solar energy has always been an intriguing problem to many scientists, the very low density of the solar radiation has been an obstacle to effective use of energy in this form. Little attention was given the subject, and the amounts of money and manpower devoted to it were small.

Extensive scientific and experimental studies have indicated the possibility of efficient utilization of solar energy with the aid of modern technical facilities. In recent years, the amount of research being done in this direction has increased substantially both in the Soviet Union and abroad. Examples:

A solar furnace that concentrates the solar flux to a power of 1000 kW and a temperature of 3500°K at a focus 30 cm in diameter has been built in France. Work is being done on the large-scale preparation of pure and ultrapure materials and alloys with desired physicotechnical properties.

Solar energy is used extensively in the USA, Japan, and Israel for domestic and communal purposes.

In the USA, such firms as General Electric, Thompson-Ramo-Wooldridge, Ryan, Goodyear, and