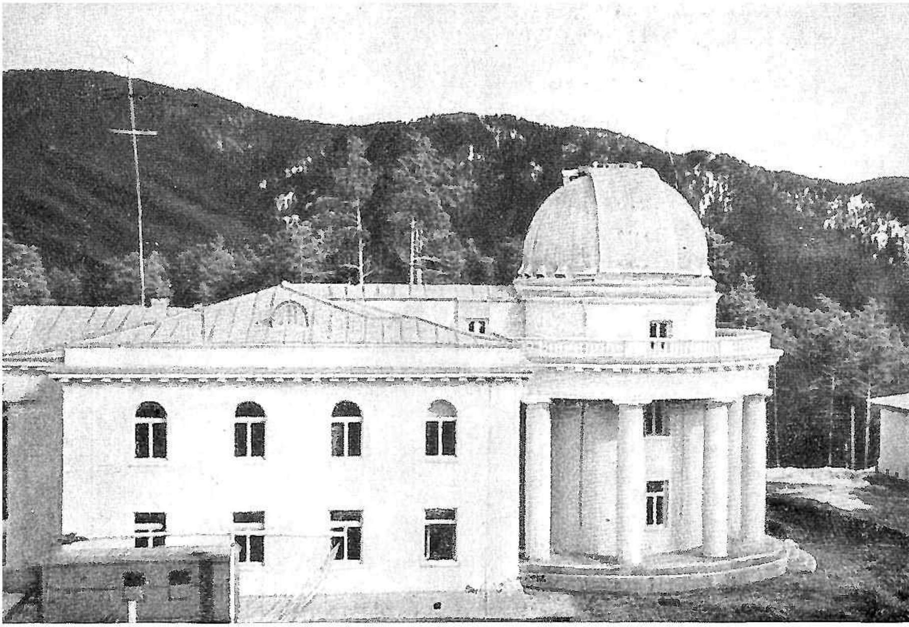

E. K. KHARADZE

THE ABASTUMANI ASTROPHYSICAL OBSERVATORY

1958

ACADEMY OF SCIENCES OF THE USSR
ACADEMY OF SCIENCES OF THE GEORGIAN SSR

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ON THE OCCASION OF THE X GENERAL ASSEMBLY OF THE INTERNATIONAL ASTRONOMICAL UNION, MOSCOW

12—20 August 1958

Edited [by]

P. G. KULIKOVSKY

The well-known mountain health resort of Abastumani is situated 200 km west of Tbilisi, the capital of the Georgian SSR, on the forest-covered southern slopes of the Adzharo-Imeretin range, along the banks of the Otskhe, small mountain river.

The road from Tbilisi to Abastumani passes through the ancient city of Mtskheti located on the Georgian Military Highway at the confluence of the rivers Aragva and Kura. It runs then through Gori and Khashuri, the lovely spa of Borzhomi, and through the ancient town of Akhaltsikhe, which lies 30 km from Abastumani and is connected by railroad with Tbilisi. In the past Akhaltsikhe was for a long time the political, cultural and economic centre of the south-western area of Georgia, Meskheti, the granary of the land and its ancient cultural seat. There are still numerous cultural monuments in its vicinity: fortresses, monasteries ornamented with rich frescoes by old Georgian masters,

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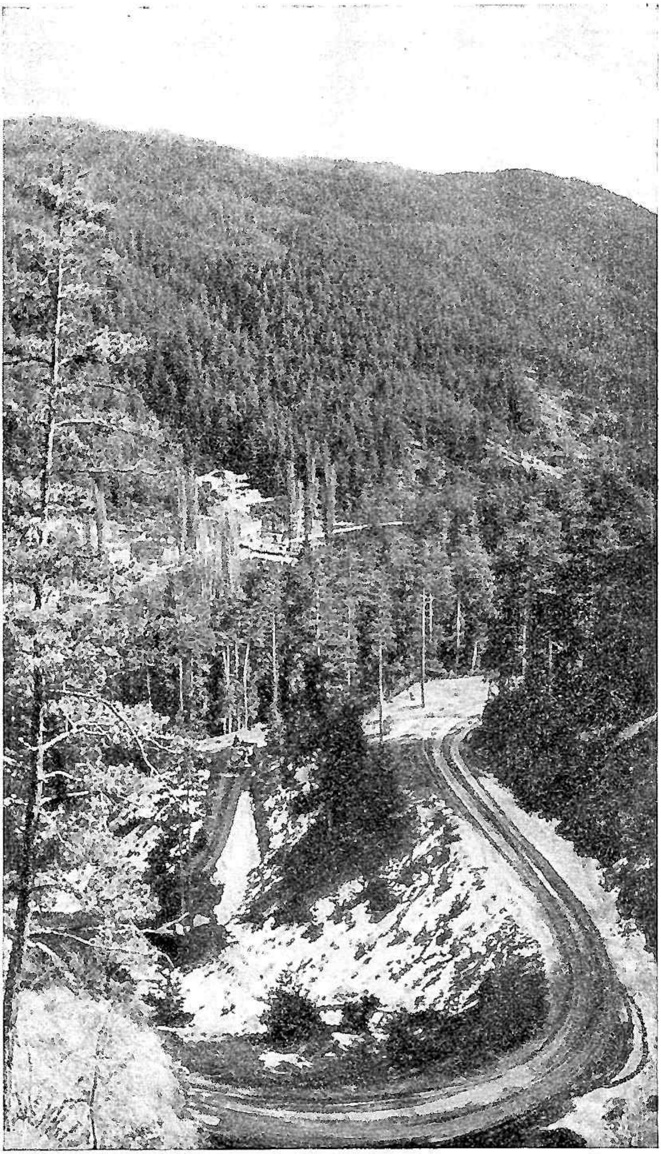
temples with engraved stone cupolas erected in the VII—XIIth centuries, ruins of palaces, a great multitiered cave city hewn in sheer rock in the XIIth century, complicated aqueducts and other relics of Georgian ancient art and architecture.

Travelling north along the Otskhe river to the outskirts of the resort town and then up the steep mountain highway, a magnificent view opens before you: great mountains covered with dense primeval pine forests form a kind of giant hollow, and deep down at the bottom, the villas and rest homes glimpse through the rich verdure. The southern side, where the mountains end, reveals a section of the Akhaltsikhe plain with a mountain chain in the far distance. The high mountains in the north, towering over the forests, are covered with alpine meadows vividly green under the blue of the sky from summer till autumn and gleaming with snow throughout the winter till late in the spring.

Soon the highway becomes steeper and steeper, enters a dense forest and emerges at the summit of a mountain spur stretching from west to south. Here the forest is a little thinner and several white buildings with built-in towers culminating in spherical domes come into view. By driving along the spur to the east and west, however, one has a glimpse of other buildings scattered amidst the trees. There are over 20 buildings on this 10 hectare territory, including astronomical towers and pavilions, dwelling-houses, a small house of elementary school, the power station, a garage and other auxiliary structures.

Here, in this little settlement amidst the age-old forests and mountains, far from any town or village, people live and work the year round. Special instruments have been mounted, laboratories equipped, libraries supplied with thousands of books and magazines, workshops opened,



Mount Kanobili road. Summer houses of the Abastumani resort are seen in the canyon and so on. Students of many universities and pedagogical institutes come here for practical training. The Observatory is frequently visited by excursion groups.

On this mountain, for many ages called Kanobili, at an altitude of 1700 m above sea level, stands the Abastumani Astrophysical Observatory of the Academy of Sciences of the Georgian SSR. For over twenty years the staff of the Observatory has been carrying on planned observations of stars, planets, the Sun, and the Moon, as well as research in different fields of modern astrophysics, stellar astronomy, solar and planetary physics.

The question arises: what was the reason of setting up an observatory here, so far from any city, amidst mountains and forests, in severe natural conditions?

To answer this question we must refer back to the end of the last century, when the well-known Russian astronomer Professor S. P. Glasenap spent two winters in Abastumani. He had only a small refractor at his disposal, but the results of his measurements of close double stars were more than satisfactory. The extreme transparency and stability of the air, and hence the excellent images of the stars, enabled him to measure close double stars which under ordinary conditions would be unresolved.

The results of Glasenap's observations attracted the attention of astronomers. The well-known American astronomer Burnham wrote in 1893: «... His observations show conclusively, not only from the amount of work done, but the character of the stars measured with a small equatorial, that the site of Tiflis (i. e. Abastumani — E. Kh.) was remarkably favourable for astronomical work. If one may judge by results, and certainly there is no better way, no Observatory in Europe has so favourable location, and it would be difficult to name one elsewhere, aside from that Mt. Hamilton, where the atmospheric conditions are equally favourable. ...Professor Glasenap, with optical means vastly inferior to anything used by his illustrious predecessors, has undertaken to place his country again pre-eminent in this field.... doubtless the Russian government will place him in a position to carry on with more powerful instruments the work inaugurated at Abastumani» *.

Progressive Russian scientists had more than once insisted on the necessity of setting up an astronomicaln observatory in the vicinity of Abastumani. Collection of funds for the establishment of an observatory was commenced. In the «Bulletin of the Caucasian Department of the Imperial Russian Geographical Society» for 1900 one may read: «The Russian Astronomical Society is now discussing the question of re-establishing the mountain observatory in Abastumani **, which excels all European observatories in air transparency. The observatory is to be equipped with the most up-to-date instruments» ***.

A year later, the following appeared in the same Bulletin: «According to the «St. Petersburg News», the collection of funds in the Russian Astronomical Society for the mountain observatory in Abastumani is proceeding successfully, and it will soon be opened. It is to be equipped with the most powerful refractors» ****.

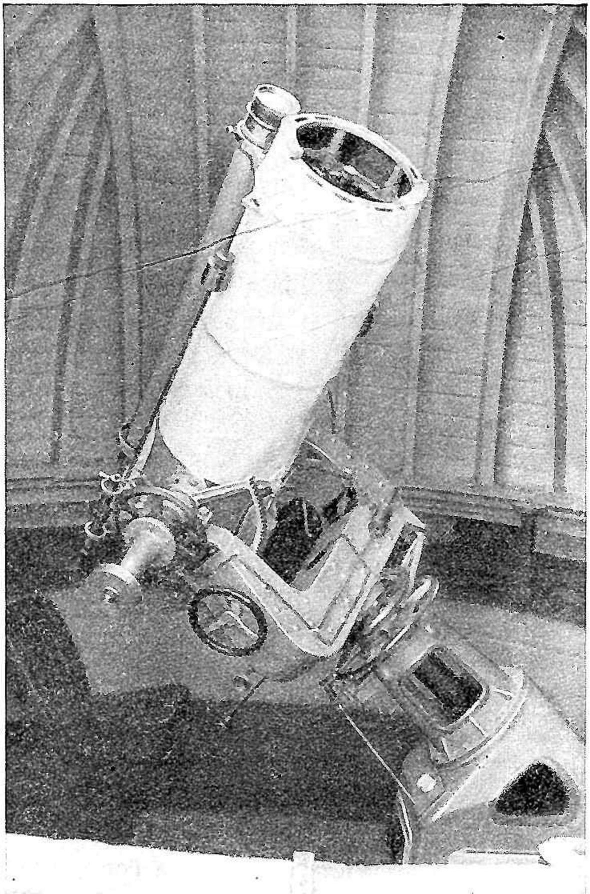
However, under the tsarist regime the idea of creating a large scientific institution in an outlying location far from the centre of the Russian Empire could not be re-

* S. W. Burnham. Astronomy in Russia. Astronomy and Astrophysics, vol. XII. No. 117, 1893, pp. 595—596.

** This referred to the small (4-meter) dome set up just above the resort, containing S. P. Glasenap's 22-cm refractor. This tower is still there now.

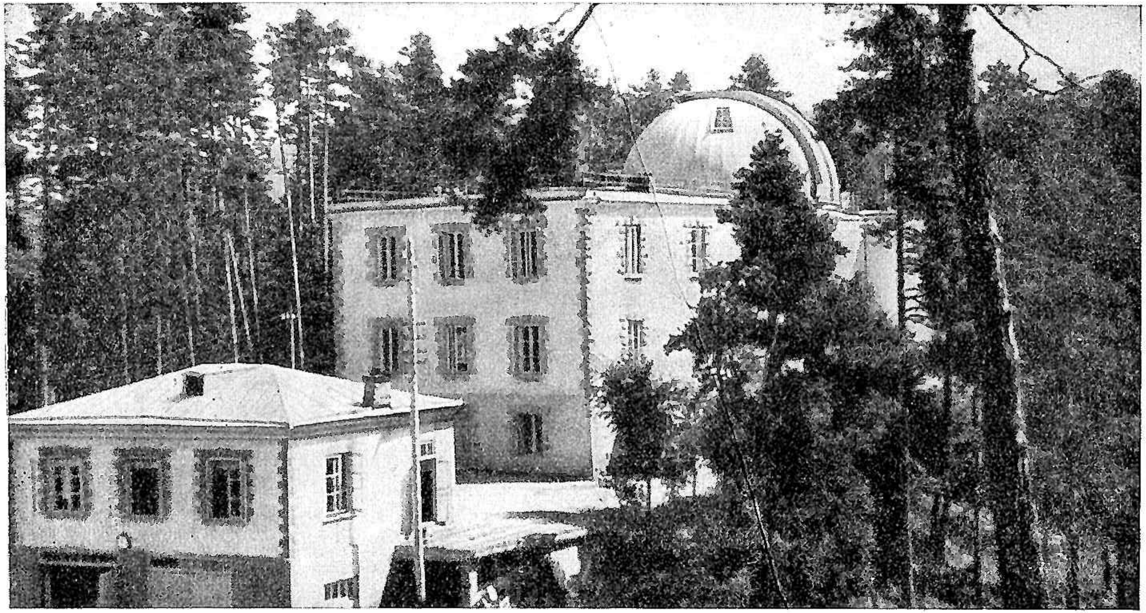
*** Bulletin of the Caucasian Department of the Imperial Russian Geographical Society, vol. XIII, 1900, p. 193.

**** Bulletin of the Caucasian Department of the imperial Russian Geographical Society, vol. XIV, 1901, p. 34.



The first Soviet telescope — a 33 cm reflector mounted in the Glasenap's tower

alized. Private contributions proved inadequate and no support was granted by the tsarist government. The establishment of an observatory in Georgia became possible only under Soviet rule when new creative forces were brought



Main building with a tower housing the 40 cm refractor (south-west view). The dining room and the garage are seen to the left to life and numerous new scientific and cultural measures began to be implemented according to plan and with the collaboration of the Soviet Republics.

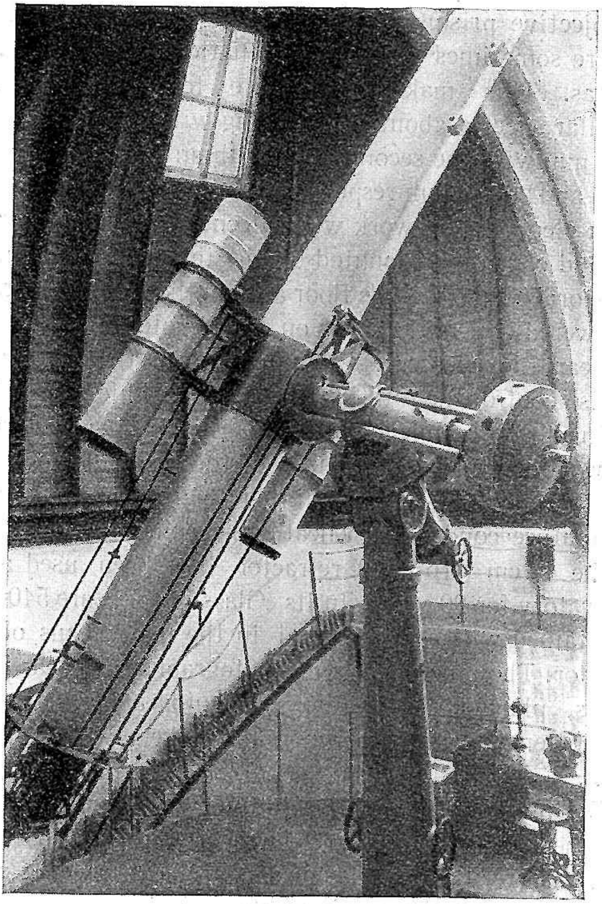
In 1930 and 1931 special expeditions of the Leningrad Astronomical Institute, the Geophysical Observatory in Tbilisi and other institutions proceeded to choose suitable sites for new observatories in the southern part of the USSR.

The environs of Abastumani attracted their attention owing to the mentioned above exceptional transparency and stability of the air, and in 1932 the first mountain astrophysical observatory in the Soviet Union was established here. A 33 cm reflector was installed in the tower that was formerly Glasenap's, and from 1932 to 1936-photographic and photoelectric observations of variable stars were carried on here.

In 1937 the first buildings were completed and equipped on Mt. Kanobili. The 35 cm reflector was transferred to the new observatory and other telescopes were installed. That autumn the first scheduled observations were commenced, which were systematically extended in line with the further development and equipment of the observatory continued to this day.

The white two-storey building consisting of a large tower with symmetrical quadrangular extensions at its east and west sides is the oldest one on Mt. Kanobili; it was built in 1937 for the large Zeiss refractor.

This refractor is set up under spherical dome in a tower 9.5 m in diameter. The length of the tube is about 7 m, the diameter of the objective lens is 40 cm, and the focal length — 680 cm. By introducing a special correcting plate celestial objects may be photographed on 9 × 12 cm plates, covering a field of about 20′ in diameter. The so-called lunar-solar camera may be adjusted to the refractor, giving an enlargement of 3 and 14 times. However, the



Zeiss 40-cm refractor with two 20-cm cameras

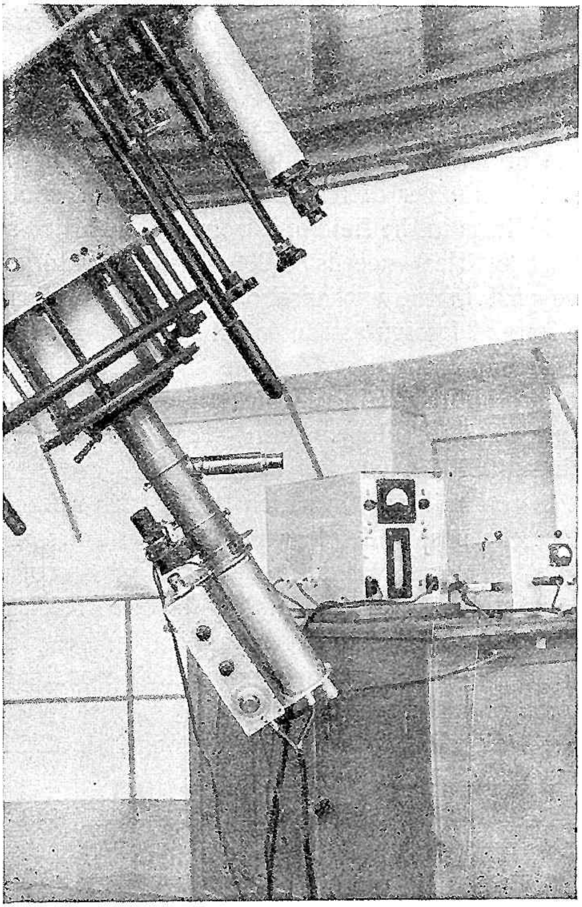
main work of sky photography is carried out with two cameras mounted parallel to the main tube. The four-lens objectives of the cameras have D = 20 cm, F = 100 cm, and produce a field of 10 × 13° on 18 × 24 cm plates.

Objective prisms with refracting angles of 15.°5 and 5.°5 are sometimes used in combination with one of these cameras. This makes it possible to obtain photograhs of stellar spectra about 13 mm long with the first prism, and 6 mm with the second, i. e. with an average dispersion of 140 and 290 Å/mm respectively.

An electric clockwork with a centrifugal regulator and a second control is mounted on the telescope pier and fed by a storage battery. The floor around the pier can be raised or lowered by switching on the motor with a button near the eyepiece. From his place the astronomer can also control the rotation of the dome, which has widely opening shutters convenient for long-exposure photographs. The wood casing on the inside of the metal dome and its outside ruberoid surface painted white ensure constant temperature conditions beneath the dome.

The 40 cm (16-inch) refractor has been used at the observatory for 20 years. In its «Glass library» are 5400 plates obtained with cameras and in the main focus of this refractor. They include direct photographs of stellar fields, comets, planets, minor planets, photographs made with light filters, spectral photographs taken with objective prism.

The photographic and colorimetric material obtained with the cameras of the sixteen-inch refractor has served as the basis for the compilation of a large catalogue of colour indices of many thousands of stars, and for the study of interstellar matter in the Galaxy. Spectral photographs have been used for the determination of absolute magnitudes of faint stars, and for the investigation of the spectral transparency of the Earth's atmosphere. With the aid of this telescope there have been discovered several minor planets (by M. A. Vashakidze and others), comets (by G. A. Tezadze, in 1942 independently and simultaneously with



The electropolarimeter mounted in the main focus
of the 40 cm refractor

Whipple and Fedtke), a nova (by R. A. Bartaya, 1948) and other objects.

A specially designed lunar electropolarimeter placed in the main focus has been used recently.

The premises east and west of the 16-inch refractor dome contain the observatory's library, clock room, photolaboratory, planet laboratory, lecture and conference halls, workshops, administration offices, etc.

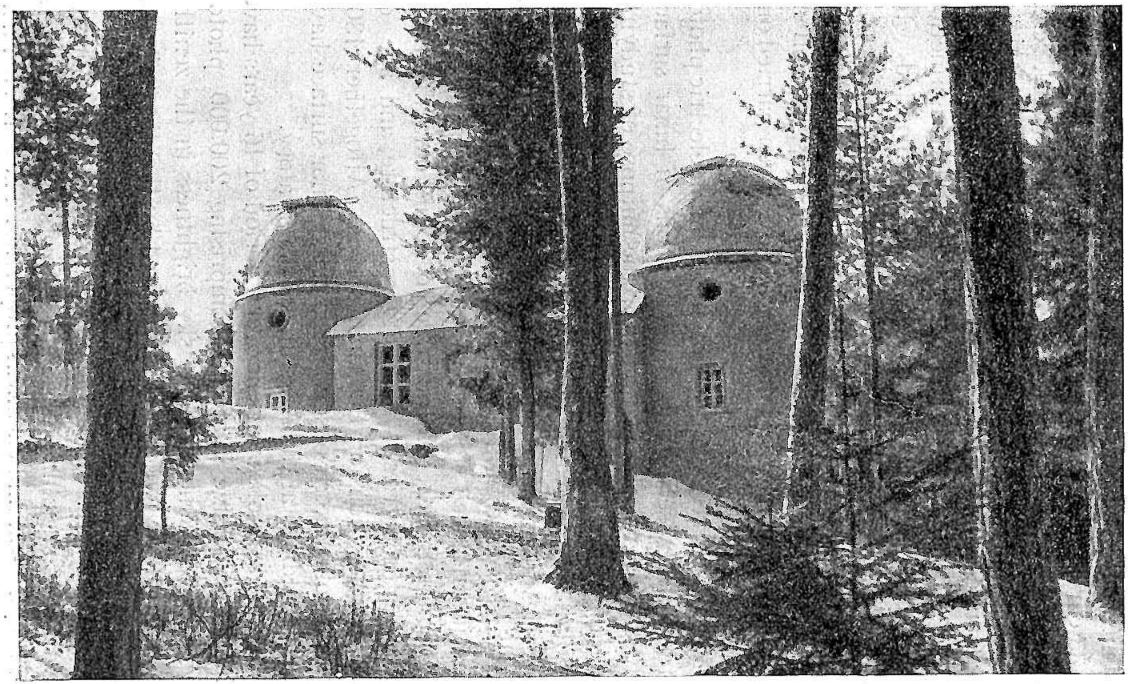
At the present time the library contains over 17.000 volumes. The number of magazines, observatory publications, periodicals in the field of astronomy and allied sciences (about 800 titles) exceeds 33.000. The observatory takes an active part in the exchange of scientific publications with Soviet and foreign astronomical institutions. Results of the most important investigations completed at the observatory are published in the Bulletin of the Abastumani Astrophysical Observatory. Twenty-three volumes were issued since 1937.

Next to the building in which the 16-inch refractor is housed, are the post and telegraph office, and a small tower with a 4-m dome, mainly used for testing new or experimental instruments and models. A plastered brick pillar near the tower contains the «geographical address» of the Abastumani Observatory. The geographical coordinates of the Observatory have been determined by means of a transit. They are: latitude 41°45′18″ north, longitude $2^{h}51\ 18^{s}$ east of Greenwich.

An asphalted pathway leads through a shady pine park to the two towers connected by a small passage.

In the eastern tower under a 4-m dome is a 33 cm reflector, which is the first astronomical instrument built in the Soviet Union with fork type mounting and weight clockwork.

The reflector can work either in the Newton or Nasmyth focus. In the first case its light ratio is 1 : 5 and it can be used for direct photography. In the second case the ratio is 1 : 15 and it is used in combination with an electric photometer when two observers work simultaneously.



The two-tower building housing the 33 cm reflector and the 44 cm Schmidt camera

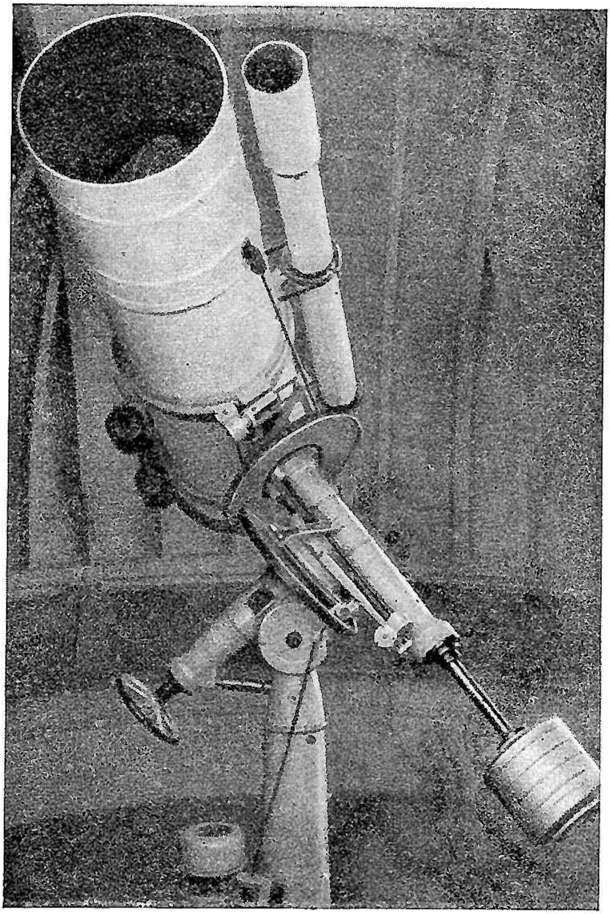
Since 1937, when V. B. Nikonov and P. G. Kulikovsky designed the first Soviet stellar photoelectric photometer, the 33 cm refractor has been working exclusively in combination with it. It made possible the extensive work connected with the compilation of the fundamental catalogue of colour equivalents for stars of selected spectral classes. A precise method of correction for atmospheric extinction at photoelectric observations was elaborated by V. B. Nikonov.

Systematic photometric and colorimetric observations of eclipsing variables and spectral binaries, as well as of selected intrinsic variable stars, have heen carried out during recent years.

Moreover, the 33 cm telescope with photoelectric photometer is likewise used for investigations of lunar surface and twilight sky observations, for the purpose of studying the composition of the Earth's atmosphere.

Solar light reflected from the lunar surface changes its properties depending on the peculiarities of the lunar surface. By investigating the moonlight by means of the polaroid attached to the photoelectric photometer of the 33 cm reflector, it is possible to obtain data about the physical properties — friability, structure, and age of various formations on the lunar surface. Altogether 1300 series of polarimetric observations of the lunar surface have been carried out at the Abastumani observatory.

Twilight sky observations over a period of 16 years have yielded extensive material comprising 200.000 photoelectric measurements of the sky brightness in the zenith. Intensity of the twilight sky is caused by the dispersion of the light from the Sun submerged beneath the horizon by the air molecules of the Earth's atmosphere. It is connected with the structure of the upper layers of the atmosphere and its physical and chemical properties. The collected ma-



The 44 cm Schmidt camera

terial enables us to draw important conclusions concerning the upper air structure.

Beside the 33 cm reflector, a coma free Schmidt telescope with a ratio of 1 : 1.75 is mounted under the western dome. The telescope camera has a spherical mirror 444 mm in diameter and a Schmidt correcting lens 360 mm in diameter.

Since the focal surface in cameras of this type is not flat, a special plate-holder arrangement gives the film the required curvature. The camera yields excellent images of stars on a field 4° in diameter.

The telescope, mounted in the usual parallactic fashion, is operated by a weight clockwork and has Zeiss lenses and tube. Observations with this telescope were taken as a basis for compiling catalogues of colour indices of extragalactic nebulae and long- and short-period cepheids.

The residences, sport grounds and gardens are not far from the twin-towered building at the extreme east of the Observatory's territory. The astronomers are lodged in a two-storeyed building. One of the small houses contains the elementary school and a kindergarten for the personnel's children. The other is a hostel for postgraduates.

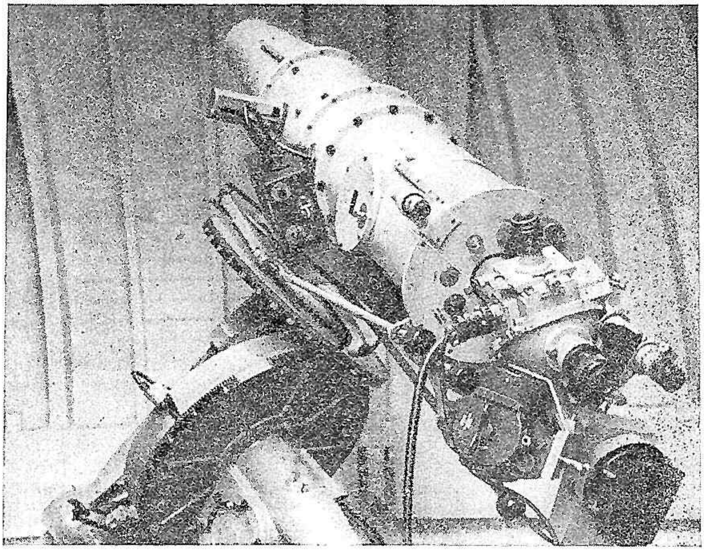
Other scientific premises are located in the western part of the territory, where, on a high flat-topped spur of Mt. Kanobili stands a white stone building with a high domed tower surrounded by a veranda which is supported by columns.

A smaller tower and two pavilions are located on a slope, south of this building. They house the instruments for solar observations, which occupy a conspicuous place in the work carried on at the Abastumani Observatory. A spectrohelioscope — an instrument for the observation of the Sun in monochromatic light — has been installed here since 1938.

A two-mirror coelostat with a clockwork mounted on a special pier outside the building directs the reflected solar rays horizontally into the pavilion. Having passed through the objective lens the rays give an image of the Sun 52 mm in diameter. The grating and a special moving photographic device in combination with slits makes possible to take photographs of the entire solar image in monochromatic light, usually an intense red line of hydrogen.

Nearly two decades of work with the spectrohelioscope have yielded about 55000 visual observations, measurements and records of chromospheric formations: protuberances, filaments and flocculi. Visual observations have been supplemented since 1956 by photographic ones (spectroheliographic) in the calcium line; in addition, photography of the solar photosphere with a meniscus photoheliograph is carried on daily.

A new solar instrument — the chromosphere-photosphere telescope—was recently mounted in a newly-built tower south of the spectrohelioscope pavilion. This instrument consists of a double camera placed on the same parallactic mounting with a weight clockwork. The first camera — a chromospheric telescope — has an effective aperture of 6 cm, and two equivalent focal lengths: 543 cm and 214 cm, and is used for photographic and visual observations of the Sun in monochromatic light by means of an interference polarisation filter. For visual observations magnifications of 133, 90, 53 and 36 times can be achieved. The time of exposure can vary from 0.02 to 4 sec. The valid field of observation equals 34′. The image of the solar disc will be 50 and 20 mm depending on the focal length used. Of prime importance for the efficient performance of the chromospheric telescope is a new tipe of light filter manufactured by the Vavilov State Optical Institute. The construction of the filter is essentially based on the interference of polarized rays, which makes possible the isolation of a spectral band of 0.5 Å, and the taking of photographs of flares, protuberances and other phenomena originating with particular frequen-



The chromosphere-photosphere telescope

cy in the periods of maximum solar activity. The filter works at hydrogen line of 6552.8 Å under strict temperature conditions, maintained by means of a special thermostat, limiting the temperature variation to 0°. 2.

The second camera is used as a photoheliograph with a 13 cm aperture and equivalent focal length of 908 cm. The Sun may be observed in the focus with magnifications of 454, 325 and 277 times and photographed with exposures within 0.01—0.1 sec. The image of the Sun on the plates is 7.7 cm in diameter.

In another pavilion is the horizontal laboratory instrument for the investigation of the infra-red region of the solar spectrum. Here, just as in the spectrohelioscope, the solar rays are intercepted by coelostat mirrors and directed into the pavilion, a monochromator with a grating being mounted in it. The rays are received by a photoresistance sensitive to infra-red radiation. Special amplifiers and a recorder register on a paper tape the energy distribution and the intensity of the lines. This instrument was designed at the Abastumani Observatory. It is mounted in a flat-roofed pavilion. On the roof there is a station for visual observations of artificial Earth satellites. About 20 or 30 observers watch their passage by means of special telescopes.

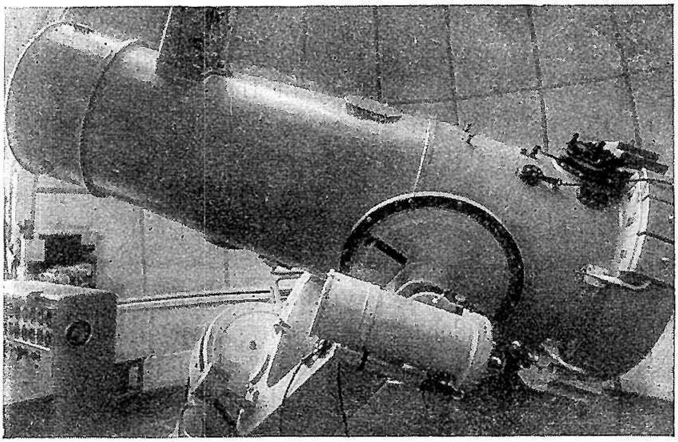
To the west from the pavilion stands a 14 meter tower with a platform under a rolling roof. On the platform stand three spectrographs for visual, ultra-violet and infra-red night-sky glow observations, electrophotometers for measuring the intensity of the crepuscular and night glow and also a photoelectric ozone meter for the study of the intensity variations of the ozone layer of the Earth's atmosphere. These observations, carried out according to the programme of the International Geophysical Year, are intended for investigations of the physical and chemical features of the upper atmosphere.

A white stone building with a 7.5 m dome just above the terrace, houses a 70 cm meniscus telescope (fig. 9) mounted on a 12 m high concrete base.

The Maksutov meniscus telescope of the Abastumani Observatory in combination with its objective prism, is the largest and the most powerful of its type.

This telescope was designed by B. K. Ioannissiani, Lenin Prize winner in 1957, and built by the State Optical Institute in 1955.

The meniscus, which is 70 cm in diameter is made of UV-glass transparent for the near ultra-violet light. The weight of the main telescope mirror is 220 kg, its diameter 975 mm. The plate-holder is inserted between the meniscus lens at one end and the spherical mirror at the other end of a thin-walled welded metal tube. An additio-



The 70-cm meniscus telescope. Control desk is seen to the left

nal low-reflection-coated objective in front of the focus corrects the curvature of the focal field.

In this system the light ratio of the telescope is 1 : 3 (its focal length 210 cm). Excellent images are obtained on plates 18×18 cm in a circular field of 4°50′ (scale — 98″per mm). Thirty-minute exposures permit us to photograph stars as faint as 19^{m} on astronomical plates of medium sensitivity.

An objective prism 725 mm in diameter with refracting angle of 8° and weighing 180 kg is mounted in front of the meniscus. In combination with this prism, spectra of field stars are obtained on plates with a dispersion of nearly 160 Å/mm and a length of 16—17 mm. The ultraviolet end of the obtained spectrum reaches 3500 Å. The objective prism, which is the second largest in the world used in astronomy, makes the telescope especially valuable, facilitating mass photography of spectra of comparatively faint stars (up to $12^m.5$—13^m at fourty minute expo-sures with very sensitive plates of high).

The telescope permits another optical combination, that is when a hyperbolic mirror is placed in front of the main mirror and the diagonal flat mirror directs the convergent beam of light into the second, the so-called Nasmyth, focus on the side of the outer surface of the tube. In this combination the equivalent focal length of the telescope is 1030 cm at a speed of 1 : 15; the diameter of the field is 40′ at a scale of 20″ per mm. This system can either be used for direct photography or works with a slit spectrograph. The diffraction spectrograph is also of the meniscus type and is therefore very compact. The two changeable diffraction gratings give a dispersion of 83 and 22 Å mm respectively. The guides on either side of the tube are also of meniscus type.

The somewhat conical telescope tube is mounted on a massive forked polar axis. Handles, grips, steering wheels, divided circles, etc., usual for ordinary telescopes, are absent. The instrument is electrically operated from a desk in the southeastern section of the tower whose instrument-board is equipped with adjusting and control dials, divided into degrees and parts of degrees, hours, minutes and seconds, also with coloured lamps, various switches, etc. The astronomer operates the telescope from this desk. The adjustment of the telescope to a given point of the sky, the broadening of the spectrum by using the objective prism, the manipulation of the shutter and numerous other operations are carried out automatically. All this was introduced by B. K. Ioannissiani and will greatly facilitate the work. Of course it involves complications in the design of the instrument: the telescope and desk consist of over 2500 parts; a number of relays, fourteen motors in the telescope body and in the desk are running during its operation. Four other motors rotate the dome, open the shutters, lower the windguard and drive the winch crane suspended under the dome and used for removing or adjusting the large objective prism.

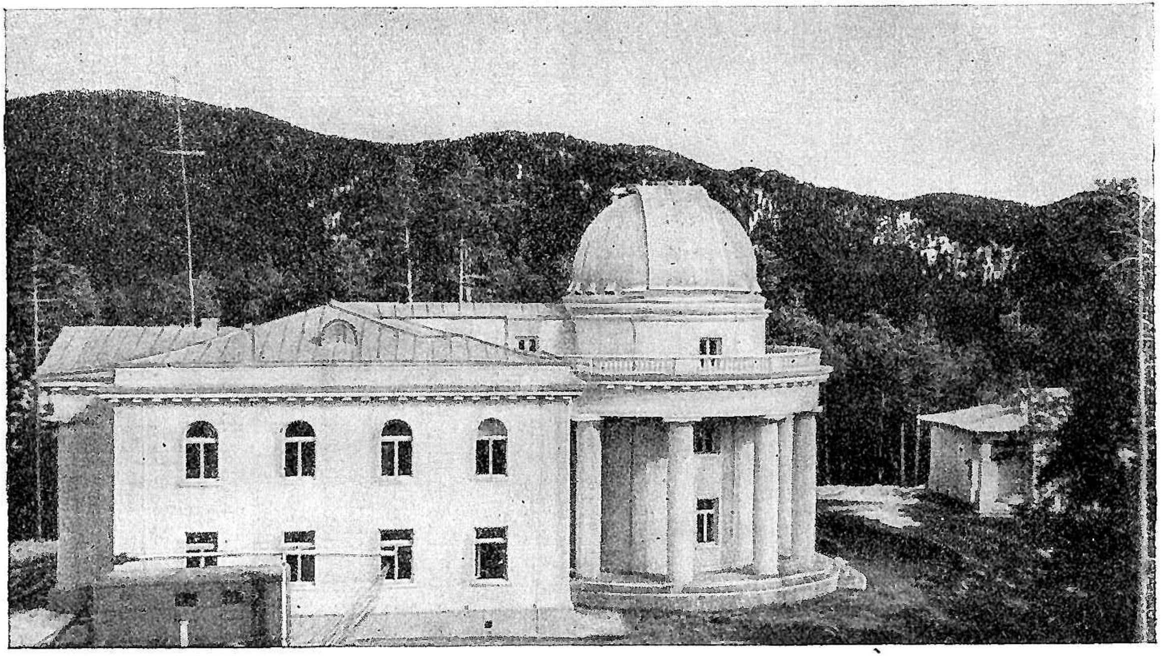
The dome has a lining for thermal insulation and a system of air-channels which provide temperature regulation.

Up-to-date methods of astronomical research require that the investigation of observed phenomena take place not at the telescope but in laboratories equipped with instruments for the handling and analysis of plates and records.

The laboratories are housed in a two-storeyed extension of the meniscus telescope tower. The sixteen rooms of this building include photolaboratories, the so-called «Glass library» where plates are stored, a room for catalogues, stellar atlases and maps, calculation rooms and work rooms, as well as spectral, photometric and other laboratories.

The spectral laboratory has a slit spectrograph for the calibration of astronomical spectrograms, a self-recording microphotometer for the study and automatic recording of energy distribution in the spectrum of celestial bodies, a sensitometer and other auxiliary instruments. The photometrical laboratory is equipped with different microphotometers for the measurement of the image density on plates, a stereo-comparator permitting us to compare two photographs of the same stellar field taken at different times and to discover the changes in the position and brightness of celestial bodies. The laboratory of photographic astrometry contains instruments for precise measurements and calculations of the positions of stars and planets in the celestial sphere.

Manifold and wide application of new physical methods of research in practical astrophysics is steadily growing.



New laboratory building

The laboratory of physical research is used for the assembly of amplifiers, the testing of photomultipliers, experiments with light transformers and so on.

A quite young and rapidly developing branch of science is radioastronomy, which studies the celestial bodies by obserwing and recording their radio emission. A radio-astronomical laboratory is now being equipped at the Abastumani Observatory. It includes receiving equipment, oscillographs, self-recorders, etc.

In the dense forest of the western section of the territory dividing the scientific laboratories from the auxiliary administrative units there is a large threes-toreyed house with a spacious cinema-hall. This is the new residence for astronomers. Nearer to the meniscus telescope building the grounds for the installation of a two-camera astrograph are being prepared.

The problems studied at the Abastumani Astrophysical Observatory include investigations of the interstellar matter, eclipsing and intrinsic variable stars, the Sun, the Moon, the upper air, as well as motions of stellar groups.

One of the main problems of modern astronomy is that of the structure of our stellar system, the Galaxy. Only a quarter of a century ago it was established that matter in the Universe is not only concentrated in the form of such compact bodies as stars, planets, etc., but is likewise abundantly scattered between them. This scattered matter forms in the interstellar space «clouds» or «nebulae» of dust of the smallest solid particles, or of gas, free atoms and electrons. The mass of this scattered interstellar matter is comparable to that of the stars and cannot consequently be neglected in investigating the structure and evolution of the Galaxy, or studying the origin and evolutions of stars.

Since its foundation the Abastumani Observatory has been studying interstellar matter. Dispersion of stellar light by the dust particles of interstellar matter causes reddening of the stars and changes their colour index. An analysis of colour indices of a large number of stars yields data on the distribution, thickness and physical properties of the interstellar dust medium.

Catalogues of colour indices of a large number of stars have been compiled at the observatory. The study of these catalogues has shown a non-uniform distribution of interstellar dust in the Galaxy. The peculiar features of the structure and spatial distribution of the dust have been revealed, i. e. the tendency of small separate clouds to form groups, their asymmetrical distribution in relation to the equatorial plane of the Galaxy. An analysis of the catalogue of dark galactic nebulae established that the plane of symmetry of this system of nebulae is inclined towards the galactic plane.

Some of the investigations of diffuse matter were devoted to the study of the light polarisation of a number of galactic nebulae. Polarisation of the emission of the Crab nebula, a remnant of the Supernova of 1054, was discovered by M. A. Vashakidze. Several photoelectric studies were made of galactic diffuse and planetary nebulae, as well as calculations of the mass of nebulae and determinations of the degree of concentration of electrons, protons, oxygen ions, etc., in them*.

* For these and several other studies of the problem see Bulletin of the Abastumani Astrophysical Observatory, No. 2, 1938; No. 11, 1950; No. 12, 1952; No. 13, 1953; No. 14, 1953; No. 18, 1955; No. 20, 1956; No. 23, 1958; Astronomical Journal (USSR), No. No. 1 and 5, 1956; No. 2, 1957 etc. (Papers by J. F. Alanya, V. A. Ambartsumian, S. G. Gordeladze, M. A. Vashakidze, T. A. Kotchlashvili, V. B. Nikonov, N. A. Razmadze, A. F. Torondjadze, Y. S. Khavtasi, E. K. Kharadze.)

One of the most important problems of astrophysics and stellar astronomy is the study of variable stars. It affords ample data for the study of the physical properties of stars and the structure of the Universe. Studies of Novae, novalike and other stars of high luminosity also belong to the investigations conducted at the Abastumani Observatory. Its investigations of novae were more of a theoretical character and dealt with the evaluation of the mass ejected by novae during outbursts. A method was worked out for the approximate estimation of the temperature of novae and the density of their gaseous envelopes at the moment of appearance of the forbidden lines in the spectrum. Besides the investigations mentioned above a detailed spectrophotometric study of the nova discovered at Abastumani in Serpents, studies of a number of non-stable stars and WR type stars, of special interest from the point of view of stellar evolution, were carried out at this observatory. This resulted in the discovery of changes in the spectrophotometric gradient of the star P Cygni, a representative of an extremely interesting stellar type. Irregular variations of brightness and changes of the colour of this star were discovered.

Many scores of eclipsing and intrinsic variable stars are included in the electrophotometric and electrocolorimetric investigations of the Abastumani Observatory programme. The orbits of eclipsing stars have been calculated and the properties of light variability established. Some have been found to possess ellipsoidal components. Observations of several intrinsic variable stars constituted a part of the international cooperative investigations. One of these stars (ν Eridani) has been studied in greater detail. Besides the known short period of light variation, a second, longer period was discovered. The colour and temperature changes, light variation amplitude etc., known previously or discovered at Abastumani, were explained *.

Stellar astronomy is also represented at Abastumani by investigations of the properties of motion of stars belonging to the early spectral classes. These properties have found a new explanation in the light of the theory of stellar associations put forward by V. A. Ambartsumian. Several regularities in the motion of stars in solar surroundings in the so-called Local System have been studied. The motion of stars perpendicular to the galactic plane was analysed. On the basis of the expression of the gravity potential deduced by P. P. Parenago, a theoretical study was made of the galactocentric stellar orbits and conclusions drawn as to the boundaries of possible motions of stars belonging to different components of the Galaxy **.

Several other studies in astrophysics and stellar astronomy were carried out at the Observatory; in particular a method for the determination of spectral parallaxes of faint stars from low dispersion spectra has been elaborated ***.

The statistical method proposed by M. A. Vashakidze for the determination of spatial stellar densities in the

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* Bulletin of the Abastumani Astrophysical. Observatory. No 1, 1937; No. 2, 1938; No. 4, 1940; No. 10, 1949; No. 11, 1950; No. 15, 1953; No. 20, 1956; No. 22, 1958; No. 23, 1958. (Papers by R. A. Bartaya, M. A. Vashakidze, S. G. Gordeladze, M. V. Dolidze, P. G. Kulikovsky, Y. J. Kumsishvili, N. L. Magalashvili, V. B. Nikonov and E. S. Brodskaya, N. A. Razmadze, E. K. Kharadze).

** Bulletin of the Abastumani Astrophysical Observatory, No. 15, 1953; No. 18, 1955; No. 20, 1956 (Papers by R. M. Dzigvashvili, A. F. Torondjadze.)

*** Bulletin of the Abastumani Astrophysical Observatory, No. 10, 1949; No. 15, 1953; No. 18, 1955; No. 22, 1958. (Papers by R. A. Bartaya and N. B. Kalandadze.)

Galaxy has been extensively applied *. This method was proposed independently and simultaneously with the Dutch astronomer Prof. J. J. Oort and is known in literature as the Vashakidze — Oort method.

Of special interest is the study of the Sun. The study of the Sun, our nearest star, is indispensable for the solution of the most important problems of stellar evolution and the origin of planets. Observation and investigation of the physical processes occurring at various depths of the solar atmosphere are of great significance for the physics of atomic and nuclear processes, of electromagnetic and gas-dynamical phenomena. Of particular importance is the study of the relationship of solar and terrestrial phenomena, and especially, the physical state of the ionosphere and the propagation of radio waves, etc.

Basic data for the study of solar physics are obtained by systematic observations according to the standard Solar Service programme. Besides participating in this Service, the Abastumani Observatory has carried out a number of other investigations. For example, observations of chromospheric flares and their connection with other solar phenomena have been conducted for several years; certain regularities in the distribution of flares according to time and on the solar hemispheres have been discovered and their relation to sunspots and the magnetic field intensity of a group of spots was studied.

Total solar eclipses offer astronomers an unusual opportunity to extend and elaborate investigations of the physical state of the Sun. Scientific expeditions to the Republics of Central Asia, the Transcaucasus, the Karelian ASSR and to Brazil, participated in by the

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* Bulletin of the Abastumani Astrophysical Observatory, No. 1, 1937; No. 2, 1938; No. 13, 1953.

Abastumani Observatory, for the observation of solar eclipses in 1936, 1941, 1945, 1947, 1952 and 1954 yielded important material which made it possible to clarify some properties of the solar corona. For instance, it was discovered that the degree of polarisation of coronal radiation and distance from the area of maximum polarisation to the solar photosphere depend on the solar activity *.

The investigation of the physical properties of the planets and their satellites is closely linked with the cosmogony of the solar system. A correct theory of planetary origin must take into account data on the physical properties of the surfaces of the planets and their satellites. Such data are indispensable for the problem of interplanetary communication which has arisen in our epoch. Of special interest are studies of the structure of the lunar surface, the Moon being closest to the Earth.

Research carried out at Abastumani has shown that various parts of the lunar surface polarize light differently. The mean maximum of polarisation of lunar «seas» was found to be greater than that of the continents. This may be interpreted as a result of lesser pulverization of the sea surfaces and consequently their comparatively later origin. On the whole, observations made at Abastumani corroborate the hypothesis of the volcanic origin of the lunar relief **.

As is known the night sky has its own luminescence, so faint that it may be measured only by extremely sensi-

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* Bulletin of the Abastumani Astrophysical Observatory No. 3, 1938; No. 7, 1943; No. 8, 1945; No. 11, 1950; No. 16, 1954; No. 17, 1954; No. 20, 1956, No. 22, 1958. (Papers by M. A. Vashakidze, K. G. Zakharin, M. S. Zeltser, Y. I. Kumsishvili, V. B. Nikonov, T. S. Razmadze.)

** Bulletin of the Abastumani Astrophysical Observatory No. 21, 1957. (Paper by V. P. Djapiashvili.)

tive instruments. This is caused by the atoms and molecules of nitrogen, oxygen and other gases present in the Earth's atmosphere. The height of luminous layers from the surface of the Earth is several hundred kilometers. Along with simultaneous investigations of the intensity, colour and polarisation of the twilight sky and measurements of the ozone content in the atmosphere, studies of the night sky glow are of great value for the elucidation of the upper atmosphere and of the phenomena going on in it and their connection with solar activity.

Sensitive electrophotometric, electropolarimetric, colorimetric, spectral and other methods and means are employed at Abastumani for an all-round study of this problem. The seasonal curve of the glow intensity, with the still unexplained maximum in November of each year has been revealed. Four main types of nightglow variation have been revealed and the connection between the intensity of infra-red lines of the glow and solar activity established. Investigations of temperature distribution and atmospheric density at a height of 80—120 km from the Earth's surface have been made. An intense twilight glow of thin atmospheric layers at a height of 35—40 and 95—100 km has been discovered*.

As indicated by this brief and far from complete review, a number of important problems of modern astronomy are being actively studied at the Abastumani Observatory. By the end of 1957 the total number of papers, text-books and popular-science monographs and books published by the associates of the Observatory approximated 450.

* Bulletin of the Abastumani Astrophysical Observatory No. 9, 1948; No. 19, 1955; No. 22, 1958. (Papers by T. G. Megrelishvili, L. M. Fishkova, Sh. M. Chkhaidze.)

The Chair of astronomy of the Tbilisi State University, is closely connected with the Abastumani Observatory in its research and pedagogical activity. The staff of the Chair is engaged primarily in research work in celestial mechanics, the structure and kinematics of the Galaxy *.

The Chair of astronomy possesses a planetarium, an astronomical tower with a small equatorial and a photometric and measuring laboratory. The Abastumani Observatory and the Chair of astronomy are responsible for the general astronomical education and astronomical instruction throughout the Republic. In connection with this the staff of the Observatory and the Chair devote much time to writing popular-science literature and textbooks on astronomy in Georgian, as well as to improving Georgian astronomical terminology.

The rich collections of manuscripts dating back to the IX century and earlier in the care of the State Museum in Tbilisi show that astronomical data and the then up-to-date theories were already widely known in Georgia**. In the literary heritage belonging to the X and later centuries we find a fairly-rich Georgian astronomical terminology. Secular literature of the time is full of artistic expressions and metaphors of an astronomical origin.

Finally, we deem worthy of mention the two following remarkable facts. Firstly, that in the XIII century ther existed in Tbilisi an astronomical observatory, some of

* Bulletin of the Abastumani Astrophysical Observatory, No. 11, 1950; No. 20, 1956, No. 22, 1958. (Papers by M. G. Kolkhidashvili, N. G. Magnaradze.)

** According to Brosset, «...already in 1233 the Georgians knew a good half of the inaccuracies of the old calendar system which compelled the Pope Gregory XIII to reform it in 1582» (Brosset. Etudes de chronologie technique, St. Petersbourg, 1868).

whose associates were so skilled as to have received invitations from outstanding Observatories of other countries (for example, the Nasireddin observatory in the city of Meraga) *. Secondly, that in the same century a very accurate, for that period, determination of the geographical latitude of Tbilisi was made, a task which required goniometrical instruments and advanced knowledge of astronomy and practical experience.

Nevertheless, all these successes have been forgotten for a long time. Only in 1932 began the new history of astronomy in Georgia, told in this short description.

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* Transactions of the Conference on the History of Natural Sciences. December 24—26, 1946, Moscow 1948.

Подписано к печати 1/VIII 1958 г. Формат 84×108 1/32. Печ. л. 2,25=1,84 усл. печ. л. Уч.-изд. л. 1,6. Тираж 2600 экз. Тип. зак. 616.

Цена 1 р. 10 к.

Издательство Академии наук СССР. Москва, Б-64, Подсосенский пер., 21

2-я типография Издательства. Москва, Г-99, Шубинский пер., 10.

1 р. 10 к.