ODESSA TELEVISION METEOR PATROL

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ABSTRACT. The historical information on the photographic meteor studies in Odessa is given. A modern observational complex – television meteor patrol for recording the meteor events occurred in the Earth's atmosphere is presented. The meteor patrol instruments available and the observation methods are specified. The meteor database structure is analyzed; the statistics of meteor observations conducted from June, 2003, to December, 2010, is reported. The total number of meteor events recorded by television method using various instruments is 4276. The software package is developed including 12 programs that enable to carry out the whole cycle of processing the observation data: from preprocessing to obtaining of the orbital elements of the recorded meteor particles. The programs on the basic and non-basic observations made in Odessa and at the observation stations in Kryzhanovka village and on Snake Island are presented. We also discuss the principal tendencies in the meteor studies conducted at Odessa astronomical observatory on the basis of observation results obtained by the meteor patrol using the television method.

Key words: meteor, meteor shower, television observations, the meteoroid monitoring.

1. Introduction

The first photographic meteor patrol was assembled at Odessa astronomical observatory by E.N. Kramer and engineer N.I. Timchenko in 1953. It consisted of four surveying cameras with F-24 lenses (with the focal length of 200 mm; the lens speed of 1:2.9; the angle of view of 48 degrees). A rotary disc shutter rotated in from of the lenses with the angular velocity of 24 tps. It is then that the first pictures of meteor events were made. Odessa observatory participated in the International Geophysical Year (IGY) program. The workgroup of the Committee on comets and meteors under the Astronomical council of the Academy of Science of the USSR approved Odessa astronomical observatory as the leading institution on the "Meteor studies" issue (section "Ionosphere"). The meteor patrol has been conducted in Odessa for over 40 years, from 1953 to 1993. More than 600 pictures of basic meteors and several thousands of those of non-basic meteors have been recorded. The data received by Odessa meteor patrols underlay several hundreds of scientific publications.

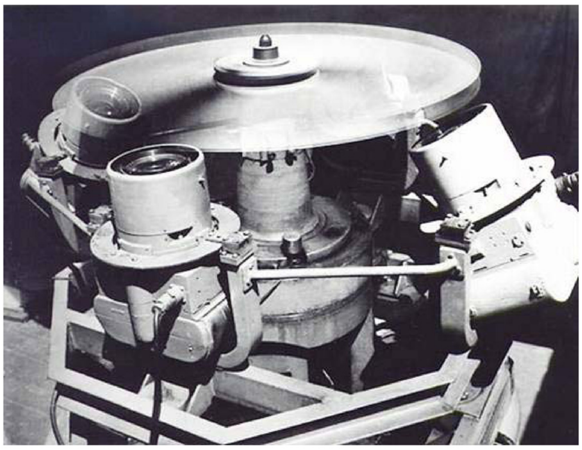

Figure 1. The photographic meteor patrol at Odessa astronomical observatory

The photographic meteor patrol consisting of four cameras HAFA-3C/25 and the rotary disc shutter system to determine the time marks is shown in Fig.1. Unfortunately, the outdated meteor patrol instruments became obsolete and required cardinal modernization. Thus, as per [1], a new ideology and new technical means were indispensable to continue carrying out the effective meteor patrol.

As the range of speeds, masses of meteor dust particles and conditions of their meeting the Earth's atmosphere is rather wide, there can be no all-purpose method of meteor astronomy.

The comparative scheme for peculiarities of different observational methods in meteor astronomy is shown in Fig. 2. None of those methods, except the telescopic one, can cover the full meteor event brightness range; besides, the time, position and photometric accuracies differ by a factor of a hundred. However, in the previous century, the telescopic method, on being visual, suffered from a number of shortcomings, such as, in particular, a narrow field of view when patrolling and impossibility to reliably record a meteor event. That is why the telescopic method was used just to solve purely specific problems concerned with the weakest meteors.

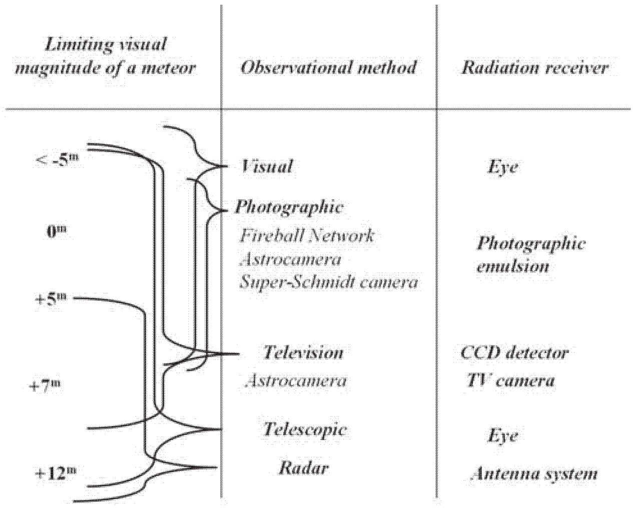

Figure 2. Facilities of the observational methods in meteor astronomy

The main problem, which arose when passing from the photographic methods of recording the meteor events to the recording by solid-state photoelectric detectors, was that of small sizes of the recording effective areas of those detectors. There is no photoelectric analog of the photographic emulsion for such cameras as HAFA-3C/25 (the field of view of tens of degrees with a spatial resolution of seconds) yet. That is why there were two alternatives for the panoramic patrol systems to pass to new detectors without loss of spatial resolution. The first option was to enlarge the sizes of the solid-state photoelectric detectors; the second – to narrow the effective fields of view of the meteor patrol. The reduction of the fields of view for the meteor patrolling leads to a decrease in the number of records of the meteor events. When the new highly sensitive solid-state photoelectric detectors had been applied, it became possible to combine the telescopic method with the television equipment for recording the meteor events. A new chance to reject complex and barely reliable rotary disc shutter systems to receive the temporal resolution appeared. The television method copes with that task: the meteor event image is recorded in separated frames.

2. The television meteor patrol and the methods of observations

Through objective and subjective reasons, it managed to renew the outdated meteor patrol at Odessa astronomical observatory only by June, 2003. When combining telescopic and television methods, the Schmidt telescope (see Fig. 3) was chosen certainly owing to its lens speed and comparatively wider field of view as the linear dimension of the recording surface of the detector – WATEC LCL902 camera – is just of ½ inches.

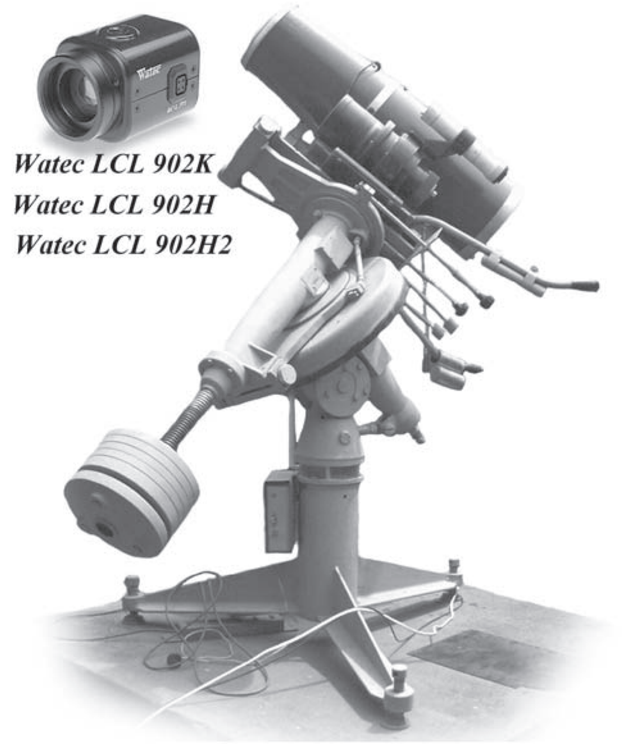

Figure 3. The meteor patrol on the base of the Schmidt telescope and the detector – WATEC camera

The details of the initial stage of the television telescopic method implementation in the meteor patrolling practice are given in [2].

There was just one telescope at that time; at present, the meteor patrol complex contains a set of various instruments; however, the choice of the detector model has not changed: WATEC LCL902K, WATEC LCL902H and WATEC LCL902H2 cameras proved to be the best among all tested ones. The implementation of new optical schemes in the meteor patrolling practice was caused, firstly, by new tasks on the meteor studying area and, secondly, by the shortcomings of the pair 'the Schmidt telescope – WATEC camera'. One peculiarity of the new television patrol should be noted. The old photographic patrol with wide-angle cameras allowed of using fixed mounts. The increase of the focal length up to 50 cm caused the necessity of using guiding mounts as a shift of the images of stars and meteors can be observed in the television frame even with exposure of 20 ms. That is why, we install the instruments on parallactic mounts and carry out the meteor patrol near the radiant points of the meteor showers.

At the initial stages of research, the observations were conducted only at one station and using the only instrument – the Schmidt telescope.

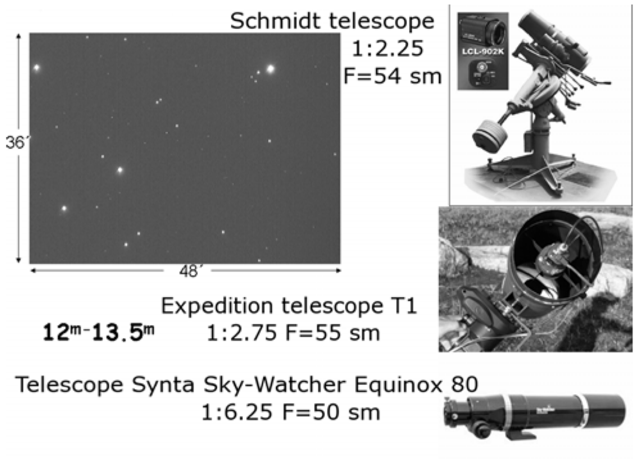

Figure 4. The telescopic systems of the meteor patrol

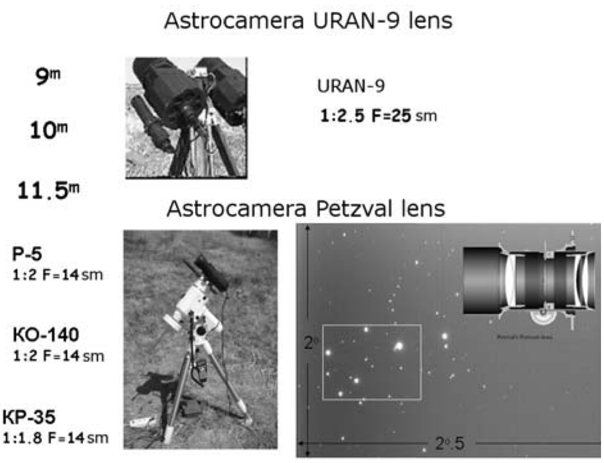

Figure 5. The astronomical cameras of the meteor patrol

Except the main observation station in Kryzhanovka village, located near Odessa, the basic observation stations in Odessa (at Odessa astronomical observatory in the T.G. Shevchenko Park), the observation station in Mayaki village and the expeditionary observation station on Snake Island were operated. The basic distances and the execution periods of the observational programs are presented in Fig. 7.

Except the main Schmidt telescope, modified in 2008 (a new corrector plate was installed), the telescopic systems that had been tested during expeditions to Snake Island were applied. Those were small telescopes (see Fig. 4) that allowed of reliably recording of faint meteors on even being inferior to the main telescope.

At the subsequent stages of modernization, in order to expand possibilities of the meteor patrol, the astronomical cameras with different performance characteristics, but with detectors of the same type were operated. The astronomical cameras with Uran-9 lenses from old cameras HAFA-3C/25 were created and used for observations; however, they had to refuse using them due to the narrow field of view (of about 1 arc degree) and low penetration power (9^m).

The cameras with the Petzval lenses P5, KO-140, KP-35 with fields of view of 2 by 2.5 arc degrees (see Fig. 5) showed themselves to considerable advantage. Although those astronomical cameras yielded to the Schmidt telescope in the resolution (3-5 arc seconds to 1 arc second for the Schmidt telescope) and in the penetration power (11.5^m to 13.5^m for the telescope), they performed a number of associated patrolling tasks due to their wider field of view. Except the Petzval lenses, other lenses have also been used, such as Sigma AF 70-200 f/2.8 EX F=13.5 cm.

That lens enabled to change the focal length of the astronomical camera from 7 cm to 20 cm and accordingly to select the field of view depending on the observational task. The astronomical cameras with Nikon lens 85 mm f/1.8D AF Nikkor F=8.5 cm allow of the meteor patrolling with the field of view of 4 by 4.5 arc degrees and the penetration power of 11.5^m.

The astronomical cameras with Samsung and Sony lenses with the focal length of just 8 mm and the field of view of 36 by 49 arc degrees have been used for the meteor patrol of the fireballs.

The penetration power of such systems reaches the value of 7^m.

The so-called synchronous observations – observations using three-four polytypic instruments, installed on the same parallactic mount, proved themselves to be especially efficient. The application of the synchronous method permits to take advantage of different optical systems in full measure. Depending on the observation task, there is a possibility to widen the field of view or to record the meteor event with a high resolution using different systems.

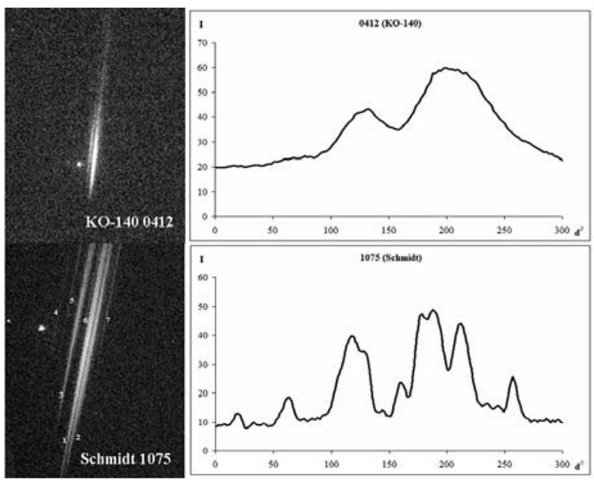

Figure 6. The comparison of the meteor TV images recorded with the Schmidt telescope and astronomical camera KO-140

Figure 6 presents the results of such synchronous observations when the meteor event is recorded by different instruments, namely using astronomical camera with the Petzval lens KO-140 (meteor 0412 in the database) and the Schmidt telescope (meteor 1075). The indicated figure shows the meteor event frames (with the time resolution of 20 ms) as well as the cross-scans of the meteor path images in relative intensity units (in arc seconds). It is easy to see in the image recorded with the astronomical camera that only two fragments of the broken meteoroid can be identified. At the same time, the image recorded with the Schmidt telescope shows that there are at least seven such fragments. Therefore, the astronomical camera enabled to record the meteor path almost entirely, and the telescopic system resolved the event details. That is why in the meteor patrolling practice we keep using the method of synchronous observations. The methods of selection of the celestial sphere regions for the meteor patrol consist in the preliminary analyzing of the ephemerides of the meteor showers for the current observation night. The area of the meteor patrolling should be close to the radiant point of the meteor shower at some distance; then, the probability of entirely recording the meteor path rather than in fragments is getting higher. The angular distance from the radiant point (elongation) depends on the altitude and also on the linear velocity of the meteor. Sometimes, an observer selects the region of the patrolling empirically; especially if it is not possible to preliminary identify the recorded meteors as components of some meteor shower. There is a practice of analyzing the observation data of the past years and nights to detect the areas of activity of different meteor showers and to conduct the patrol in those areas. The time reference is carried out with Trimble's module ACE III GPS.

3. The meteor patrol database and statistics

According to the generally accepted definitions, the created meteor database (MDB) can be characterized as a distributed database – a set of logically interconnected databases, distributed in the computer network [5]. The MDB consists of a set of individual databases. An individual database is created for each new instrument or new observation point. Besides, with large information content, it is possible to stop the receiving new observation material to the current database and to continue the receipt to a new one. The structure of all databases is absolutely analogous, that is why there is a possibility to connect a new database to the network of the available ones. To connect a new database, it is enough to make necessary records to the configuration (profile) files, and then to copy new observation material. The creation of individual profile files allows of working with both the whole of databases network and the selected databases. The observation materials – the recorded meteors – are objects for individual and complex investigation from the viewpoint of studying of their belonging to the same meteor shower. That is why such structure of database makes it possible not only to conduct measurements and computations for each meteor event individually, but also to analyze spatial and temporal characteristics of the meteor showers in whole.

Table 1: Television meteor patrol statistic data

Database name	Observation point	Focal length	Field of view	Observation period	Quantity of meteors
Schmidt	Kryzhanovka village	540 mm	36 x 48 arc minutes	28.06.03-15.06.09	1173
Uran-9	Kryzhanovka village	250 mm	1 x 1.5 arc degrees	05.11.05-10.03.06	18
Uran-9 Island2005	Snake Island	250 mm	1 x 1.5 arc degrees	08.12.05-27.08.05	29
P-5	Kryzhanovka village	140 mm	2 x 2.5 arc degrees	18.07.06-10.10.07	125
P-5 Island2006	Snake Island	140 mm	2 x 2.5 arc degrees	05.08.06-24.08.06	84
T-1 Island2006	Snake Island	550 mm	32 x 45 arc minutes	05.08.06-24.08.06	20
KO-140	Kryzhanovka village	140 mm	2 x 2.5 arc degrees	05.12.06-17.06.09	604
KO-140 Island2006	Snake Island	140 mm	2 x 2.5 arc degrees	08.07.07-01.08.07	119
T-1 Island2007	Snake Island	550 mm	32 x 45 arc minutes	08.07.07-01.08.07	45
KO-140 Island2008	Snake Island	140 mm	2 x 2.5 arc degrees	16.06.08-03.07.08	14
EQ Island2009	Snake Island	500 mm	52 x 60 arc minutes	21.07.09-03.08.09	4
NK Island2009	Snake Island	85 mm	4 x 4.5 arc degrees	21.07.09-03.08.09	100
SG Island2009	Snake Island	85 mm	4 x 4.5 arc degrees	21.07.09-03.08.09	20
SM Island2009	Snake Island	8 mm	36 x 49 arc degrees	21.07.09-03.08.09	46
SM Odessa	Odessa	8 mm	36 x 49 arc degrees	18.11.09-18.11.09	19
SchmidtII	Kryzhanovka village	540 mm	36 x 48 arc minutes	21.06.10-31.12.10	279
KO-140IIa	Kryzhanovka village	140 mm	2 x 2.5 arc degrees	21.06.10-31.12.10	549
KP-35	Kryzhanovka village	140 mm	2 x 2.5 arc degrees	22.06.10-31.12.10	814
KO-140 Island2010	Snake Island	140 mm	2 x 2.5 arc degrees	08.08.10-24.08.10	73
NK Island2010	Snake Island	85 mm	4 x 4.5 arc degrees	08.08.10-24.08.10	100
Kryzhanovka NKb	Kryzhanovka village	85 mm	4 x 4.5 arc degrees	25.11.10-07.01.11	41
Total: 4276					

Moreover, the work with the MDB allows of remote placing of users. The astronomical observatory and observation stations or different observatories are located far from each other, but the MDB structure makes possible both to ensure the receipt of new observation data and to simultaneously process the interconnected databases.

The main work unit of the MDB is an AVI-film with the recorded meteor event. Each film is rigidly assigned with an identifier – the number of the meteor in the database, the observation date and time, information on the instrument used, the guiding star, the timing of the television frame with the meteor image. When it is necessary, it is possible to revert to the initial material any moment, and then, on having the preprocessing repeated, to rectify any errors, which could arise on different stages of measurements and computations. The total content of AVI-films has been enlarging with the lapse of time, and that hampers the work with the MDB; that is why the following approach is used: the inquiry of the lists of the films' names, but not the films themselves is made, that permits to store the films in archives on separate carriers. The structural object DATA exists to store the data of the preprocessing of the television image of each meteor event. Physically, there is a separate corresponding folder in the database for each meteor. It is filled in with information as the observation data are received, and the measurements and computations are made. Besides, separate television frames of the meteor event, the combined pictures of the meteor path, the aggregate pictures for positioning with the reference stars images, the files with the data of the preprocessing of the picture background, etc. are stored in that folder. As the further processing is made, the files with parameters of the meteor event are added. For instance, COMBO objects are the combined pictures of meteors; PRO are the files with the longitudinal scanning data of the meteor picture. Such independent structure enables to connect new processing modules as the new software is developed and also to add new object types for the results of processing or any other information without any additional structural changes.

There is a possibility to store the parameters of profiles, procedures of measurements and computations for each database in object Common Meteor Files. If the profile is global in respect of all databases, object Common Meteor Files.MDB is used. The mentioned objects allow to take into account peculiarities of each working database separately and all databases in whole. The FTP (File Transfer Protocol) is supported that permit to save the measurements to a remote server.

Some features of the object-oriented database (OODB) are used in the MDB, namely control of parallelism (a property of systems to make computations simultaneously or concurrently), restoration of data and the associated queries.

The statistics of the meteor patrolling at Odessa astronomical observatory is shown in Table 1 in chronological order. The names of individual databases and the corresponding observation points, the focal lengths of optical systems of instruments, the working fields of view, the time periods of the meteor patrolling and the quantity of the recorded meteors are indicated. Totally, 4276 meteor events have been recorded from June, 2003 to December, 2010. To process the observation material, it became necessary to devise methods and to develop a series of programs, combined to the program package.

4. Software

The Program package *Odessa Meteor* is intended for processing the results of the television meteor patrolling and was created by the workers of the Department of Small Solar System bodies department at Odessa astronomical observatory using the license version of programming language Visual Basic 6.0, which is a part of Microsoft Visual Studio 6.0. The working out of methods of processing the meteor observations and the development of the programming code were made as the observation material had been received and the observational equipment and the methods of the meteor patrolling had been improved. For some programs the algorithm was corrected on the testing stage as the computation errors had been revealed.

Some methods of processing are similar to those used when the photographic observations had been carried out; but in most cases, the computation algorithms had to be adapted to the television method of observation.

Here below, we give the list of software (SW) that is used at present.

1. *AVICutter* program is intended to carry out the preprocessing of the initial AVI-films with duration of 4 seconds. During the processing, the working folders of the numbered meteors are created, and the procedures of creation of separate and combined frames of the meteor event, and the file of the background values are conducted. The demand for such program is caused by the large content of the observation material and the necessity to promptly fill the MDB. Thanks to *AVICutter*, the preprocessing takes an observer just up to one minute. Besides, the archiving of the primary AVI-film and its conversion to the 8-bit format is made at the same stage.

2. *AVIStar* program is intended to carry out the preprocessing of the observation material to determine the parameters of scintillation of the star images. Due to the atmospheric conditions, not all the nights were favourable to conduct observations. That is caused mainly by the meteorological factors and the condition of the upper layers of the atmosphere. With the strong turbulence there are random non-uniformities in the atmosphere that refract the light rays, arousing the scintillation of stars. When observing, they become apparent in variations of brightness, scintillation of the star images and unsharpness of the meteor trails. *AVIStar* makes possible to estimate the sky quality for each observation using the initial AVI-film. The data obtained permit to classify the conditions of the meteor recording and to take into account the selectivity of observations caused by the condition of the Earth's atmosphere at those points at the coelosphere where the meteor patrolling is carried out.

3. *DubleCutter* is a graphics editor to work with the digitized data of the meteor image that enables to form the image of components of the trajectories of double and multiple meteors and to create the longitudinal and cross-section profiles of the meteor trajectories at the specified point with the predetermined step. The necessity of devel-

opment of such editor program was dictated by the research of the processes of fragmentation of the meteor particles during its flight.

4. *Meteor Manager* is a program to conduct the further integration of the observation material into the meteor database with the possibility of timing. It enables to work with both a separate database and all databases simultaneously. It consists of a number of files and editors that permit to work with AVI-films, to adjust the positioning and timing of separate frames of the film, to structure the list of the guiding stars, and, using the FTP protocol, to compile the results of measurements and computations, made by different users on the remote computers. It permits to create the total tables on the results of observations and to select samples for different databases by basic and synchronous observations. The demand for such program has arisen with the enlargement of the observation material content and appearance of the synchronous and basic methods of observation.

5. *Combo* is special software that enables to create a combined image of the meteor path using separate frames of the meteor event. With the television method of observation the image of the meteor trajectory is recorded frame-by-frame with exposure of 20 ms. The set of frames is enough to see the process dynamics; however, to measure the whole meteor path, it is necessary to combine all separate frames of the meteor event into the single image. To carry out such procedure correctly, the mentioned program was developed. The software allows of combining pictures both in manual and semiautomatic modes.

6. *PicScan* allows of conducting the high-accuracy measurements of the meteor path image in the rectangular coordinate system of the picture. The program is adjusted to work with both poor and diffuse, and bright overexposed images of meteors. When processing, the meteor image signal is selected and the meteor path pixel array is formed. There are several methods of scanning of the meteor path image used that enables to select the most appropriate one for each specific meteor. The methods of measurements using SW *PicScan* are stated in detail in study [3]. A user can analyze the results of the measurements by deviations of coordinates of the points of the meteor path. In the end of measurements made, a separate file of processing data is formed for each measuring instrument; the analysis of such files enables to eliminate distinct errors.

7. *PSF* is software to promptly identify and automatically measure the rectangular coordinate system of the picture, and to reduce the rectangular coordinates by the equatorial ones by Turner's method. The measurement of star images on the picture is carried out, and the coordinating of six or twelve constants is determined by Turner's method. The methods of measurements are based on the principles of the aperture CCD-photometry. To identify stars, one of the compilation star catalogues, created on the base of SAO, Tycho2, USNO-A2, etc., with a restriction by magnitude in V-filter up to 13.5^m, is used.

8. *MeFoMer* is software that enables to conduct the photometric measurements of the meteor image, using the results of processing with *PSF* and *PicScan* SW and the meteor image itself, based on the principles of the aperture photometry.

There are two such methods of photometric measurements: for the stars images and for the meteor trails. The transition to the magnitude scale is made by the calibrating dependencies derived by the photometric measurements of the star images. That is why when carrying out the photometric measurements of the long-duration meteor trails, the circumference-type aperture is used, the same way as for the stars. The star and meteor profiles are presented in the Gaussian fixed model function.

9. *Meteor Control Data* enables to analyze the measurements of the rectangular coordinates, obtained with various measuring instruments, using SW *PicScan*. It permits to analyze the photometric measurements of the star images, made with SW *MeFoMer*, and to derive the characteristic dependencies, and then to study them. It analyzes the results of processing the scintillation of the star images, made using SW *AVIStar*.

10. *Meteor Pole* is a program to compute the equatorial coordinates of the polar point of the wide circle of the meteor path, taking into account the flight direction. It takes into account the interlace television effect correction for the meteor path image. It enables to analyze the pole coordinates and to identify the recorded meteor's belonging to the known meteor showers.

11. *Meteor Explorer* is software to arrange and conduct the basic television observations. It is intended for the telescopic meteor patrol observations, as well as for the observations with the astronomical cameras with narrow field of view. On the grounds of coordinates of two observation points and the known guiding star at the first patrol station, the program allows of compute the area of the meteor patrolling for the second station, orientating by the meteor zone in 80-100 km of the Earth's atmosphere. The application of that SW for the base "Snake Island – Kryzhanovka village observation station" (150 km of distance) enabled to record basic meteors when the basic television patrolling was carried out.

12. *Meteor Card File* is an electronic file of the recorded meteor events. Such file permits to store information on all meteor events, recorded by the meteor patrolling, on the measurements and computations, made with the program package *Odessa Meteor*. In particular, that is the archive name of the film with the recorded meteor event, the time of recording, the name of the observer, the observation data and time, the equatorial and horizontal coordinates of the meteor, the arc length and the angular velocity of the meteor. There is a possibility to view the combined and single pictures of the meteor event. Using that SW, it is possible to search the synchronous and basic meteors in different databases, to make computations by the Stanyukovich method. SW *Meteor Card File* has been constantly improving and makes possible to connect new modules to determine the kinematic and physical characteristics of the meteor particles. A separate module permits to work with the compilation catalogue of the coordinates of the radiants of the meteor showers and also those of individual meteors, recorded by the meteor patrolling.

5. Basic and non-basic observation programs

According to the practice of the meteor patrol, when the basic observations are carried out, the percentage of non-basic meteors is very high. There are several explanations of such situation:

1) The probability of favourable weather conditions at two and more stations simultaneously depends on many factors, especially if those stations are located at tens of kilometers away from each other.

2) Some technical problems, which can be caused by the equipment work, reduce the time of simultaneous work of basic stations.

3) The limited field of view of the astronomical cameras and telescopes, as well as spatial position of the meteor event trajectory, can cause the meteor is out of the field of view of one of the basic stations.

4) The essential difference in distances to the meteor from the basic stations can cause the meteor becoming not available for recording for one of the stations due to the absorption of the meteor radiation by the atmosphere.

5) If two basic stations and the recorded meteor are on the base line, then the angle of approach does not matters a lot that causes very poor accuracy in determination of kinematic characteristics of the meteor, and sometimes, it is absolutely impossible to process the observation material.

The indicated problems cause a great number of non-basic meteors that do not give full information on the meteor events as opposed to the basic ones.

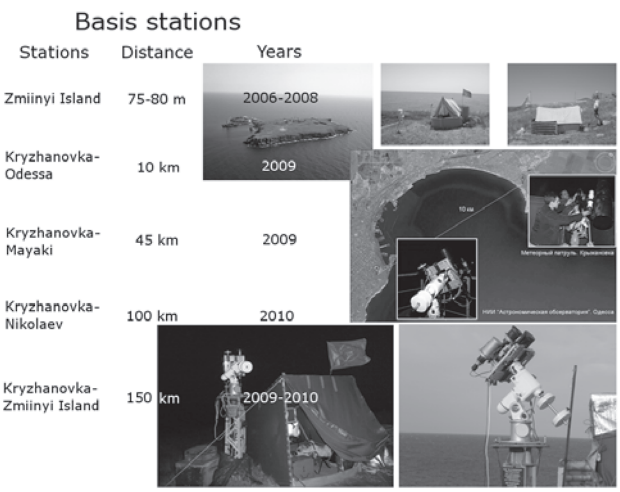

Figure 7. The basic stations of the meteor patrolling

When the methods of processing of our meteor observations were created, we addressed to those methods that had not been developed earlier due to the poor technical base. One of such methods was developed by Stanyukovich. In study [3], we present the results of application of the Stanyukovich method to the modern television methods of the meteor observations. To adjust the methods of processing of the non-basic meteors, it is necessary to conduct independent control of the results obtained. Independent usage of the non-basic methods of computation of the meteor parameters and classical basic methods of processing allows of receipt of reliable criteria of accuracy of the processing methods. That is why the basic meteor observations become more and more customary in the practice of our patrolling stations.

The information on the basic observations is presented in Fig. 7. Except the stationary mounts that conduct regular patrolling at the observation station in Kryzhanovka village, there is an expeditionary meteor patrol (EMP). As a rule, EMP is used on Snake Island during the activity of the Perseid meteor shower in August. In 2005, the first EMP, consisting of one station and non-guiding mount, was tested on Snake Island. In 2006, to conduct the basic meteor patrolling two observation stations started working on the island. Each station was equipped with a tent for the receivers (computer, TV-tuner, camera Watec-LCL-902K operating in the television mode). The distance between two observation stations was 75 meters. One of the stations used a telescope with the focus length of 55 cm and the field of view of 45 by 32 arc minutes (the maximum magnitude up to 11.5^m); an astronomical camera with the focal length of 14 cm and the field of view of 2 by 2.5 arc degrees and the penetration power up to 10^m was installed at another station. Both stations were equipped with the parallactic guiding mounts with the remote control. To synchronize the timing of the patrols the computer network was set, and one of the stations was equipped with a GPS-receiver. To synchronize the work of the observers the intercoms were used. The basic stations demonstrated high performance facilities of the observation complex.

Figure 8. The coordination of work of the basic patrol stations for the meteor observation

In 2007, similar observations were conducted on Snake Island using the modernized facility to study the July meteor showers.

Each year since 2005, when the next meteor expedition to Snake Island was prepared, the EMP is modernized on having taken into account its exploitation during the previous expeditions and in accordance with the given observational tasks. The observations with a large base demanded to develop specific software *Meteor Explorer* to arrange and conduct the basic television observations, as well as to provide the continuous tracking the area of patrolling at the one of the stations. The synchronization of the work of two basic stations demanded to set an Internet connection and to provide a reliable work of the mobile communication in the expeditionary conditions on the island. The brief list of the basic observations is presented below:

From 2006 to 2008, the basic observations (3 expeditions) were conducted on Snake Island using two stations located at the distance of 75-80 meters from each other. The similar observations are presented in study [6], where the basic distance was 105.2 m and even 27.5 m. The precondition of such basic observations is the usage of the long-focus instruments.

The observations of the Leonid meteor shower were carried out on the base of 10 km Odessa-Kryzhanovka village in 2009.

In the same year, the basic observations at the observation stations in Mayaki and Kryzhanovka villages, the distance between which is 45 km, were conducted.

In July-August of 2009 and 2010, the basic observations (2 expeditions) were carried out on Snake Island and at the observation station in Kryzhanovka village, the distance between them was 150 km.

At present, the testing of observations at the observation stations in Kryzhanovka village and Mykolaiv is con-

As a result, about 50 basic meteors were obtained during the television meteor patrolling with the super short basic distances (75-80 m) and super long distances (150 km).

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