

International Conference "Space Protection of the Earth 2000"

In the range of September 11–15, 2000 in Evpatoriya (Ukraine) International conference "Space protection of the Earth 2000" was held. It was dedicated to investigations and development of methods and facilities preventing regional and global catastrophes caused by approach and collision of asteroids, comets and meteorites with the Earth. The basic organizers of the Conference were Russian Federal nuclear center of technical physics — VNIИ of technical physics, Scientific and technical foundation "Space shield" (Snezhinsk, Chelyabinsk area), S.A.Lavochkin Scientific and Production Association, Crimean astronomical observatory (CrAO), National center of control and test of space facilities (NCCTSF) NSAU (Evpatoriya). About 130 participants took part in the conference including specialists from France, Germany, Austria, Italy who presented more than 80 reports. The work of the conference was organized in three basic sections: Asteroid-comet danger, Counteracting asteroid-comet danger, Investigation of small heavenly bodies.

At the plenary meeting the report of vice-president of Foundation "Space shield" V.A. Simonenko "Large-scale collisions; some important geological consequences" pointed out that the problem of asteroid-comet danger for the Earth emerged in "near-Earth space environment" ("near space") whose borders spread from the orbits of the nearest orbits of artificial satellites of the Earth to minimal distance to the nearest to us planet Venus (100 distances to the Moon) that is $\sim 0.3 AU = 45$ mln.km. In "near space" apart from the Moon and many artificial satellites there are also objects of natural origin, they are asteroids, comets, meteoroids and objects of space litter of man-made origin. Asteroids and comets approaching the Earth (AAE and CAE correspondingly) are the objects approaching the Earth at the distance less than $1.3 AU = 195$ mln.km in perihelion. At present more than 1000 AAE are discovered and catalogued, among them there are approximately 400 large ones with characteristic diameter exceeding 1 km. Speed of their discovery in the recent five years grows almost exponentially exceeding 100 units per year. Potentially dangerous asteroids (PDA) are ones approaching the Earth at the distance less than $0.05 AU = 7.5$ mln.km., with characteristic diameter more than 150 m. The ways of integrated solution of the problem of the Earth space protection at the international level were outlined.

The chairman of the International Foundation "Space guard" A. Caruzi (Italy) characterized the coordination activity of this organization, corresponding international committees, structures of European Council and UNO in the field of space protection of the Earth.

The report of A.A. Boyarchuk, A.V. Bagrov, A.M. Mikish, L.V. Rykhlova, M.A. Smirnov "Astronomical aspect of the problem of space protection of the Earth" (Institute of astronomy RAS, IARAS) and two more section reports of the specialists concerned dealt with the results of analysis of availability of large bodies in star and bolide showers by optical observations made in IARAS since 1995 with telescope in small town Simeiz (Crimea). 20 new meteoroids with characteristic diameter more than 10 m are discovered and eight basic star showers are determined, their various activity in different months of the year is established, their orbits are predicted by short observations using the original methods developed in IARAS.

The report of the chief designer of S.A. Lavochkin SPA S.D. Kulikov considered the possibilities of applying SPA's developments for making segments of searching and intercepting in the system of space protection based on the known prototypes of space vehicles (SV) "Astron", "Granat", "Oko", "Vega", "Fobos", "Mars".

A.V. Zaytsev's (S.A.Lavochkin SPA) report was dedicated to conceptual project of the system of planetary protection "Tsitadel", in particular to principles of realization of its part by Russia involving Ukrainian carrier rockets "Zenit" (orbits explorer SV at the stage of discovery) and "Dnepr" (SS-18 ("Satana")) (orbits intercept SV). It was pointed out that intercept SV was to annihilate a dangerous celestial body at the distance 150 000–200 000 km. from the Earth with the help of nuclear charge.

Conception of design of rocket space complex on the basis of Ukrainian carrier rockets as the element of the system of the Earth protection from dangerous asteroids was considered in the section report of S.N. Konyukhov, N.N. Slyunyaev, V.V. Shkarupin (State design office "Yuzhnoye").

In the field of astronomic aspects of asteroid danger analytical report of prof. V.G. Kruchinenko, A.M. Kazantsev and academician NAN of Ukraine Ya.S. Yatskiv "Inflow of celestial bodies to the Earth and asteroid danger" aroused a great interest. The general integral dependence of motion to the Earth of celestial bodies in a wide range of their characteristic diameters is obtained: from some millimeters to more than 100 km. Space distribution of orbits of 600 AAE is investigated and numerical calculations of their orbits are made.

In the section of investigation of small celestial bodies attention was attracted by the report of N.S. Chernyh, V.V. Rumyantsev "First results of Crimean program on observation of AAE" (CrAO). Analysis is made of an experience of optical observations of AAE, performed by constantly acting state programs in USA, where 95% of world discoveries of AAE are made. According to preliminary estimates in frames of Crimean program by using reconstructed 64 cm telescope supplied with purchased in the frame of Grant of American planetary society CCD-matrices with sufficiently high resolution, Ukraine will have a possibility to discover about 3500 asteroids during a year in the main zone between Mars and Jupiter and about two asteroids approaching the Earth.

The subsection of radio-astronomic observation listened to the analytical report of A.L. Zaytsev "Radar investigations of near space from the Earth" (Institute of radio-engineering and electronics (IRE RAS)). On the basis of analysis of the world experience of radio-location of objects of near space the main advantages of radar observations as compared with optical ones are described (under corresponding constraints, economic in particular). They are: possibility of making observations in any weather, at any time of day and night with physical-mineralogical composition of objects being determined; by radio observation determining the trajectory of motion of the mass center of an object rather than photocenter determined under optical observations; providing the highest resolution of objects at the distances of tens millions kilometers from the Earth exceeding resolution of the best optical telescopes by hundreds times; possibility of determining concentration and distribution of particles of a cosmic litter of several millimeters.

The Ukrainian-Russian system as the most sensitive one in the Eastern hemisphere was suggested to be used with purpose of carrying out complex investigations of "near space". This system involved 70-meter antenna and transmitter with 6 centimeter range and power 150 kilowatt of unique planetary locator RT-70 (Evpatoriya, Ukraine) and two receiving 64-meter antennas in a small towns Medvezhyi ozera and Kalyazin (Podmoskovye, Russia). It was reported that asteroid 1998 WT24 would approach the Earth at the minimal distance $0.012 AU = 1.8 \text{ mln.km.}$ on December 16, 2001. Thus, unique conditions will be provided for possible application of planetary locator RT-70 in the international project on observing this asteroid by using 22-meter receiving antenna (small town Simeiz, Cr.AO).

The joint poster paper of the specialists of NCCTSF NSAU, Radio-astronomical Institute (RI) NASU (Kharkov), NIRFI (Nizhniy Novgorod), Institute of applied astronomy (IAA) RAS (St. Petersburg) was devoted to the results of test observations when use was made of radar long-wheelbase interferometry for precise determining parameters of asteroids. Ukrainian-Russian group of scientists has world priority in realization of this method, A.A. Konovalenko from RI NASU occupying the leading position.

Three reports of the specialists from the Center of reception of scientific information NCCTSF NSAU Yu.G. Tomilin, A.F. Sorokin, A.M. Tsyuh, B.P. Vlasenko aroused considerable interest with regard to application. They covered the following problems. The original methods were proposed in narrowing equivalent antenna directional pattern aimed at increasing its resolution. At that decrease of noise contribution and inconclusive effect of side lobes of antenna directivity pattern were ensured. In case of monoantennas (for example RT-70) this was ensured by fixing special Fresnel-zone plates into the arms of antenna focusing and in the case of multi-antenna complexes by the right phasing on individual elements of antenna. Highly accurate measurements of the parameters of trajectory of space object motion in one appearance is provided by realization of radar method on the basis of pulse-code modulation and multichannel registration of reflected radiation by some phase-lock receiving antennas whose overlapping directivity patterns are spaced in the picture plane of the object. Reflector characteristics of natural and artificial space objects under irradiation by radio-waves on the terrestrial stand NCCTSF NSAU are investigated. Comparison of reflection indices of models of space objects obtained on the stand with those

obtained from real space bodies by using similarity factor “relation of a reflected power to square of an object remoteness (model)” confirmed efficiency of the methods suggested. The methods and algorithms described are being implemented at all antenna complexes of the Center of receiving scientific information NCCTSF NSAU.

In the course of discussion between the representative of the Institute of space research NASU-NSAU and the specialists of NCCTSF and IRE RAS the idea was suggested about advisability of their participation as well as other international organizations in the joint project on watching asteroids approaching the Earth. At that it is supposed to use means of radio watch of NCCTSF NSAU in particular, planetary locator RT-70 whose registration units, control computational facilities and systems of data processing need modification.

The meeting was held at high scientific-organizational level and clearly demonstrated the recent state of problem about space protection of the Earth in the international range, worked out proposals for its effective solution, facilitated establishing contacts between the specialists concerned, attracted public attention. Conference decision pointed out the necessity of making observations of potentially dangerous space bodies and creating planetary system of space protection of the Earth in the frame of special intergovernmental programs.

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