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ANALYSIS OF PROJECT "INTERNATIONAL LUNAR OBSERVATORY"

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ABSTRACT. Some results in analysis of a Project "International Lunar Observatory" are presented in the Paper.

Scientific and technical problems of the lunar telescope - its scientific objectives, the wavelengths, and its main characteristics - are discussed in the first part.

The spacecraft design, the launcher choice, the space flight scheme are considered then.

Possible taking part in the Project for some Russian companies in frame of the international cooperation is suggested and analyzed in the final part of the Paper.

Key words: International Lunar Observatory (ILO), Lunar Telescope, Earth-to-Moon Flight.

CONTENTS

1. INTRODUCTION

The idea to create and send to the Moon the International Lunar Observatory (ILO) given by the Lunar Enterprise Corporation/Space Age Publishing Company (Steve M. Durst and Colleagues, [1]) seems to be very interesting and useful for both Science (Monitoring of Asteroid-Comet Hazard for the Earth, Astronomy, Astrophysics, e.g.) and Space Technology. The general public may be interested in this Project, too.

The Paper gives some results in analysis of a Project for the International Lunar Observatory. They are: the problems of the Lunar telescope, its scientific objectives and main characteristics; the spacecraft design, the choice of a rocket and a scheme of the flight; international cooperation.

2. LUNAR TELESCOPE

2.1. Scientific objectives of the ILO

A **regular survey of the sky to search new celestial objects in our Solar System** (**asteroids and comets approaching the Earth**, in particular [2]) could be interesting and very important goal (may be, the main one) for the lunar robotic observatory. **New astrophysical objects** outside the Solar System (Gamma-ray bursts, Supernovae, in particular) can be detected by this survey, too. The telescope has to operate completely automatically. To realize these objectives fully, the ILO project can include landing two telescopes on the Moon, near both the South Pole (probably, on Malapert Mountain [3]) and the North one. After detection and observation of any new celestial object by the lunar survey telescope, this information would be sent to the Earth for large telescopes to determine better its characteristics.

Optical (visible light) wavelengths (may be with UV and near IR) are desirable for the telescope taking into consideration the objectives shown.

The Lunar station with the telescope has to be also supplied by **solar panels** as the **source of** the **energy** for the spacecraft and the **thermal defense** from direct solar heating depending on a landing place at the Moon. A good **information system** with an onboard **computer** supplied by the special **software** should be realized at the station, too, to perform the real-time processing and analysis of the observations and to correct the observation program in case of necessity. The station has to be supplied by **a radio system** to support the connection with the Earth and transmit there the scientific information, in particular. The Lunar station has also to include the **pointing devices** for the telescope and for the solar panels.

2.2. Characteristics of the Telescope

Two different telescope systems for this survey are shown here.

a) "**Master" - M**obile **A**stronomical **S**ystem of **Te**lescopes-**R**obots - is designed by the Sternberg State Astronomical Institute of the Lomonosov Moscow State University, and by the Moscow Union "Optica", Russia (V.M. Lipunov, S.M. Bodrov, G.V. Borisov, V.G. Kornilov, A.V. Krylov, et al. [4-8]). This system is operating in optical range, completely automatically, has a wide field of view (6-20 square degrees) and can register the sky objects up to 20^m in the sky area of 1,500 square degrees per hour, with the estimation accuracy of 0.1 arcsec. Special software for the real-time processing and analysis of observations is developed and being used in the system. For a main telescope of the system: diameter is of 35.5 cm, mass is about 20 kg; CCD-camera has 4098x4098 pix. Fig. 1 gives its optical scheme (modified Richter-Slevogt one, designed by Dr. Terebizh V.Yu. [9-11]). The system is operating from January 2004 near Moscow and has made several surveys of the accessible sky. There are found already some new celestial objects, Supernova SN2005bv – first in Russia, in particular. Fig. 2 [6-8] gives the picture of the advanced system MASTER-IV that is in designing now. These systems can be developed for the space observations, from the Moon, in particular.

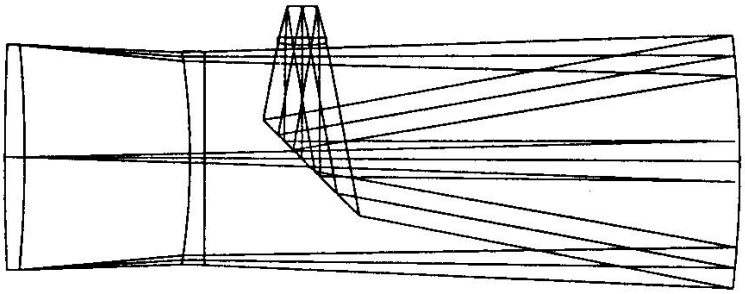

Fig. 1. Optical scheme for a main telescope in the system MASTER.

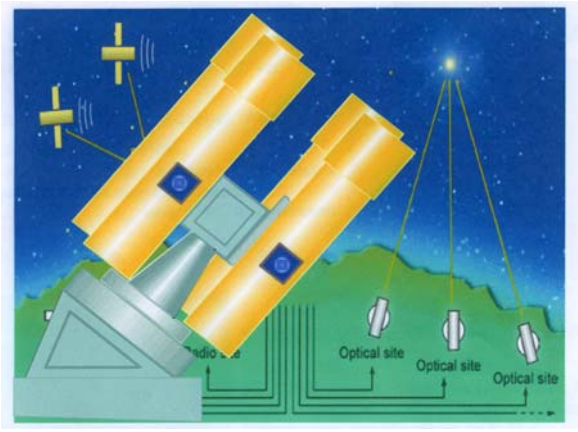

Fig. 2.Wide-field telescopes-robots system MASTER-IV.

b) Another wide-field optical system was made in Russia by Institute of Astronomy, Russian Academy of Sciences (Dr. Bagrov A.V. and colleagues) and “Kosmoten” company [12].

It may be developed for the space survey of the sky. For this case, an analysis performed by Dr. Bagrov A.V. has given the following parameters of the telescope [13]. It is operating in optical range, has a wide field of view (about 9 linear degrees) and can register the sky objects up to 17^m per 1/25 sec, with pixel size of 90 arcsec. Telescope’s mass is about 20 kg; its diameter is about 40 cm. It can detect the asteroids with diameter of 100 m at a distance of about 10 million km.

3. SPACECRAFT DESIGN

Russian specialists have well known good experience in Lunar studies. In the Russian Federal Space Program now there is the Project “Luna-Glob” for wide studies of the Moon, with landing a scientific station near the Lunar Pole, in particular. Lavochkin Association (Russian Space Agency, http: //www.laspace.ru) performs designing of this spacecraft. Figures 3, 4 give a picture and a scheme of the flight for this spacecraft [14, 15].

Fig. 3. The Picture of the Spacecraft “Luna-Glob”.

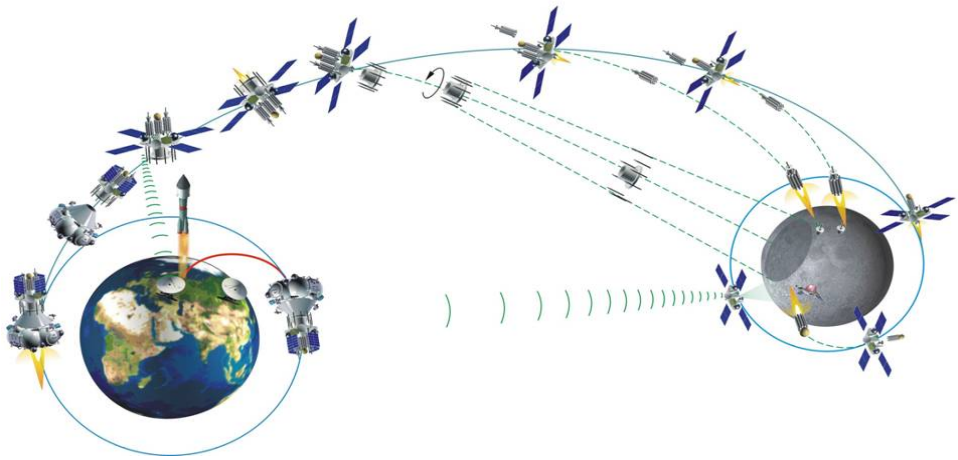

Fig. 4. The Scheme of the Flight for the Project “Luna-Glob”.

These results can be used to design the spacecraft for the **International Lunar Observatory (ILO).** In particular, flights to the Moon using rockets **"Dnepr"** and **"Soyuz"** can be analyzed.

Preliminary analysis showed that using the rocket "Dnepr" with the spacecraft mass of about 3700 kg on the LEO and the usual direct scheme of the Earth-to-Moon flight with the flight time of about 4.5 days gave a small enough final mass and it was not easy problem to place there the landing and control systems as well as the lunar observatory with its sub-systems. So, using the rocket "Dnepr" is not easy for the Project "International Lunar Observatory". The additional studies have to be performed to get final conclusions.

In particular, **scheme of the flight** can be optimized, too. For example, approximate analysis performed for the soft landing of the Luna-9 station [16] showed that using the **long-time detour trajectories** with the capture by the Moon (like the Hiten flight, Fig. 5 [17]) resulted in increasing the final mass from 100 kg to 129 kg. This can improve the situation in the ILO Project.

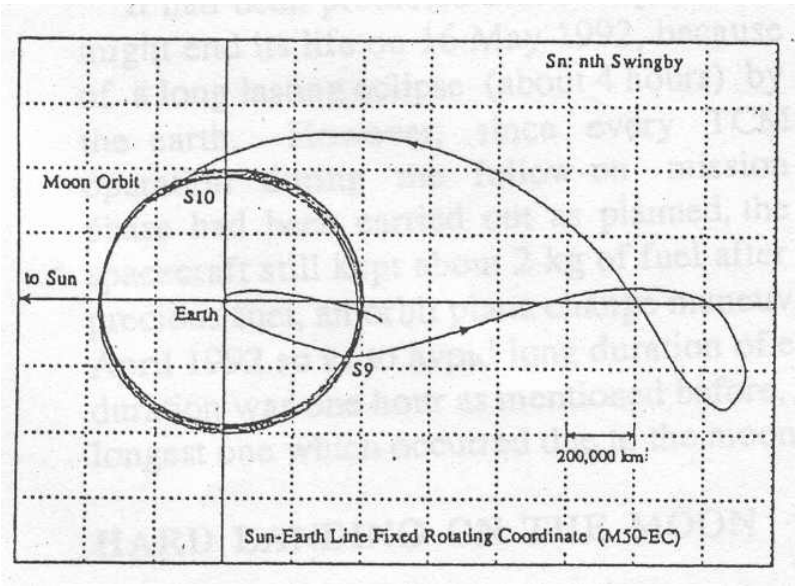

Fig. 5. Flight scheme for Hiten.

Using the Launcher "Soyuz-Fregat" can definitely solve the problem of the spacecraft ILO.

4. PROBLEM OF INTERNATIONAL COOPERATION

Some Russian organizations and institutes could be involved in this Project ILO, in particular:

Institute of Astronomy, Russian Academy of Sciences (INASAN RAS) – to design the telescope, to analyze the results of lunar observations;

Keldysh Institute of Applied Mathematics (KIAM RAS) – to perform the ballistic analysis of the Project, to analyze the spacecraft trajectory, to perform the mission control in the real time of the flight, to analyze the results of lunar observations;

Lavochkin Association (Russian Space Agency) – to perform analysis of the Project, to choose the rockets, to design the spacecraft and its landing system, to take part in the mission control;

Mission Control Center (TsUP, Russian Space Agency) – to perform the mission control in the real time of the flight: to determine (from the measurement data) the real orbit and the control data for the maneuvers of corrections, decelerations, landing, etc.;

Sternberg State Astronomical Institute of the Lomonosov Moscow State University (GAISh MGU) – to design the telescope, to analyze the results of lunar observations.

5. CONCLUSION

The Project of the International Lunar Observatory gives very good prospects for Science and Technology as well as for the general public. It gives some problems in Technology, of course. But this Project can be realized quickly enough if the modern achievements and international cooperation are used. Russian specialists can take part in this Project.

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