USS-T

National Aeronautics and Space Administration
Goddard Space Flight Center
Contract No.NAS-5-12487

ST-PR-LPS-10840

# " R A D I O R A Y "

## INVESTIGATIONS CONTRIBUTE TO THE TREASURE OF HUMAN KNOWLEDGE

*-*-*

Newspaper Column

by

Prof. V. Troitskiy

(USSR)





28 MAY 1969

ST-PR-LPS-10840

# " R A D I O R A Y "

## INVESTIGATIONS CONTRIBUTE TO THE TREASURE OF HUMAN KNOWLEDGE

HIGHLIGHTS of the Column in
Newspaper "PRAVDA", No. 139
Moscow, 19 May 1969

by Dr. V. Troitskiy
Professor of
Physics-Mathematics Sciences
Radiophysical Institue of
Scientific Research (NIFRI)
Gor'kiy, USSR

SUMMARY

This article is especially devoted to the discussion of the respective roles of ground, optical and radar astronomy observations of nearby planets. The discussion centers mainly on the Moon and planet Mars with the view of comparing the physical conditions of both, while evaluating the extent to which the methods applied to the study of the former would apply to the latter.

The author examines in some detail the knowledge acquired to date on physical conditions of Mars. While giving full credit to "ground" investigations as the basis of further studies, he still stresses the fact that so far, optical and radar investigations did not take advantage of their full potentialities; for example, submicrowave and longwave infrared bands are far from being mastered. The complete success of planet study can only be assured through complex, coordinated research by all methods available to science. This is precisely what is now being done in USSR.

* * *

The remarkable flights of our stations to Venus once again demonstrated the high skill and the depth of imagination of Soviet space investigators. The manned orbital flights, the journeys of unmanned probes to the Moon and planets, the constant duty of artificial satellites in the near-earth space, the diversified observations of celestial bodies from the Earth, constitute a wide complex of methods of study of the Universe reciprocally supplementing each other. In their coordination and interpenetration lay the pledge of new successes in the mastery of the cosmos.

Spectral analysis is one of the most powerful means of investigation in the field of optics. For instance, the star light spectrum and its density bespeaks of stars' temperature and of the chemical composition of their gaseous shell. The spectral optical methods are well developed and applied with great success in the investigations of the infrared radiation of planetary atmospheres. For example, its concentration in the atmosphere of Venus and Mars was determined by means of the absorption lines of carbon dioxide. Naturally, the question arose as to how could its physical properties and chemical nature be determined by the radioemission of a solid body. With this in view methods of analysis of planets' proper radioemission and of electromagnetic wave reflection were worked out during the last ten-twelve years. Great results were achieved in the investigation of the Moon, which was conducted by complex radioastronomy, radar and infrared astronomy methods. The broad investigations of Moon's proper radioemission, the development of the theory and of methods of analysis, for the most part accomplished at the Gor'kiy (NIRFI), permitted to obtain sufficiently full data on physical properties, microstructure and temperature conditions of a layer of matter about 10 meter thick. Thus were determined the Moon's matter density, heat conduction, porosity and chemical nature. Finer properties of matter were also found, such as the degree of heat conduction's dependence on temperature. The microstructure of Moon's matter was deciphered. It was found that the upper porous layer is constituted of loosely bound silicate-type particles with dimensions of tens of microns, while the average thickness of the hard porous mantle, lying on a dense substratum constitutes about 4-6 meters. Heat flow of intensity close to that on Earth was revealed as having its origin in the Moon's interior and the total radioactivity of the Moon's whole matter was estimated. The temperature conditions of the upper layer were determined. Finally, only quite recently could the chemical composition of the Moon's upper mantle be determined by means of radioastronomy; it was found to agree with the determination of the chemical composition by an American automatic station. Now it is possible to practically speak in terms of complete agreement of the results of Moon investigation by radiophysical and optical methods, with those of direct investigations conducted by Soviet and American automatic stations operating in the near-lunar space or directly on the surface of the Moon. This points to the objectivity of the developed ground methods of investigation and analysis. At the same time, this confirms convincingly the great importance of direct investigations of celestial bodies by means of automatic probes, namely the remarkable flights of "luniks", whose creative pioneers, Soviet scientists, gave us the final assurance of the accuracy of "ground" conclusions.

Thus, the Moon served as the experimental polygon in the development and application of the new methods of planet investigation. Greatest success in the application of optical and particularly of radiophysical methods could now be obtained in the study of Mars. Due to its rarefied atmosphere, the methods of analysis developed for the Moon, could be used for this purpose almost without any variants.

The study of properties of the upper mantle of Mars is based on the investigation of the character of propagation in depth of its surface daily temperature fluctuations. However, by comparison with the Moon, the investigation of Mars is beset with great experimental difficulties due to great distances. The radiowaves emitted by Mars from various depths and carrying information on the temperature under the surface layer, are ten thousand times weaker than the radiowaves from the Moon even in the period of the closest rapprochement between Mars and Earth.

As in the case of Moon investigations, the main requirement in the achievement of success is the high precision of measurements. For the Moon it was attained by application of radiation standards in the form of absolutely black bodies placed at sufficient height and distance from the radiotelescope. The standard radiation served for comparing with it the measured radiation of our satellite. The standard which we used was called "artificial Moon', as it was manufactured in the shape of a disk of several meters in diameter with identical angular dimensions to those of the real Moon, provided one observed it through a radiotelescope. However, this method being hard to apply technically for the investigation of Mars, the quest for other precise measurement possibilities is necessary. Finally, for the investigation of the Moon one could do away with parabolic antennas of one to twelve meters in diameter. For the observation of Mars and owing to weak radiation, antennas of no less than 30-70 meters in diameter are required, as they could operate in the wavelengths from 3-4 to one hundred millimeters.

For the last ten years certain data on the radioemission of Mars were obtained abroad, although insufficiently correct in a series of cases. Despite this, they allow us to draw interesting conclusions provided we make use of the locational and infrared measurements developed by us. Obviously, these conclusions bear only a preliminary character.

Let us recall, first of all the general data on physical conditions on Mars. As is known, the martian days are approximately one half hour longer than the terrestrial. About three quarters of Mars' surface is occupied by light reddish formations (continents) and one quarter by dark ones (maria). Certain dark parts frequently appeared to the observers in the form of geometrically regular shapes, thus forming the so called "canals" or "basins". However, no water in liquid phase was found on Mars' surface, while the water vapor content in its atmosphere is approximately 1.000 times less than the terrestrial. Change of seasons is observed.

The Mars' proper infrared radiation indicates that in equatorial zone the surface temperature is equal to +15°C at noon, and at night it drops to —100°. The atmosphere of Mars is quite rarefied, its pressure is close to one hundredth part of the terrestrial pressure. Apparently, basically it consists of carbon dioxide. From time to time, cloudiness is observed, of which the motion indicates the presence of winds. The compact reddish cloudiness is considered to be dust storms. According to the photographs of Mars, taken in 1965 by the American probe "Mariner-4", the surface of the planet is covered by craters and cirques, similar to lunar ones; no formations suggesting the presence of canals were found. Unexpectedly the world of Mars was found to be similar to the world of the Moon.

What does the analysis of radioastronomical, radar and infrared investigations of Mars yield? As for the Moon, it was possible to determine the thermal, electrical and mechanical properties of the upper layer and its thermal conditions. It turned out that the above indicated daily temperature fluctuations in the equatorial zone, decrease by a factor of 2.7 as early as at depths of 4-6 cm and are practically absent at depths of 15-20 cm under the surface, where the constant temperature of minus 40°C prevails, implying the existence of perpetual frozen state, which also takes hold of equatorial regions. The continents' matter density is approximately equal to that of water, while that of "maria" is apparently, one and a half to two times higher. The heat conduction of the matter of continents is rather low, approximately by a factor of 20-30 lower than that of dense terrestrial rocks, but by the same factor higher than the lunar heat conduction. By its structure the reddish matter of continental regions of Mars is highly porous and is most probably found in loose state with small particle dimensions.

The Mars' proper radioemission allows us to estimate the electrical properties of the matter. The micro and centimeter radiowaves penetrate the martian matter to a depth of 3-4 wavelengths, at which their energy decreases by 2.7 times. At the same time for the matter of the Moon the analogous depth constitutes 15-20 wavelengths. The increased wave damping in the Mars matter could be induced by a notable moisture of porous material. However, this contradicts the data on low moisture concentration in the atmosphere and consequently is most likely linked with the peculiarity of the chemical composition of the rocks. As was ascertained by special investigations conducted in our Institute, it is possible to estimate reliably enough their chemical composition by the content of radiowave damping in silicates. However, only approximate conclusions on the fact that the upper layer of martian continents is formed most likely of basic rocks, are available at present.

The above examples, illustrate sufficiently well the scientific effectiveness of planet ground investigations. As the direct ones, they allow us to obtain valuable information about the physical conditions on the planets. These methods mutually supplement one another. More than that, in order to set up the problems of direct investigations, it is necessary to base oneself on the "ground" results. The up to date optical and radar investigations did not take advantage of all their potentialities. For example, such important wave bands as the submicrowave and the longwave infrared are far from being mastered. A genuine success of planet study may be assured only through complex investigations by all the methods and means available to science. Such a complex method is precisely applied in our country.

* * * * THE END * * * *

CONTRACT NO. NAS-5-12487

Volt Information Sciences, Inc.,
1145 19th Street, N.W.
Washington, D.C. 20036
Telephone: [202] 223-6700 X 36,37

Translated by
Ludmilla D. Fedine
26 May 1969
Revised by
Dr. Andre L. Brichant
27 May 1969