OPTICAL PARAMETERS OF MARTIAN DUST AND ITS INFLUENCE ON THE EXPLORATION OF MARS.
A. V. Morozhenko[1] and A. P. Vidmachenko[1,2], [1]Main astronomical observatory of NAS of Ukraine, Str. Ak. Zabolotnoho, 27, Kyiv, 03680. [2]National University of Life and Environmental Sciences of Ukraine. vida@mao.kiev.ua.

Introduction: There is a well-founded assumption that dust can interfere with the colonization of Mars. Quite often, there are global dust storms on Mars. At this time, more than a billion tons of small particles enter the atmosphere [17]. This is several orders of magnitude greater than in the largest dust storms on Earth. The dust is so shallow that it penetrates through any obstacles. In conditions of a limited amount of oxygen and small solar radiation, astronauts can only live in special rooms and go to the surface of Mars - only in special spacesuits with special protection. Therefore, they will not directly inhale toxic dust.

But the Martian wind, the bombardment of micrometeorites and charged particles, scatter this very small dust over the entire surface of the planet [1-3, 18]. Constantly circulating in the atmosphere, the dust particles probably acquired a static charge. Therefore, they will fit snugly against the surface of the spacesuit and penetrate inside. In this case, even with careful processing, the dust will get into the dwelling; There it will fall into the lungs of the settlers of Mars. And this will happen, even if the astronauts go into the protected blocks through a special vestibule. Dust will clog up air filters, water purifiers and other vital items in living quarters. Dust will spread like smoke, and can penetrate into all moving parts of spacesuits and mechanisms, and lead to their mechanical wear.

Studies have shown that Mars dust contains a large number of toxic compounds such as perchlorates (salts of perchloric acid). They were first discovered by the Phoenix Mission of Mars in 2008 near the North Pole [6]. Apparatus “Curiosity” also found huge reserves of minerals like gypsum. Its particles when inhaled will cause dangerous diseases. Thus, small particles of gypsum can lead to serious lung diseases, cause irritation of the eyes, skin and respiratory system. Comparison of remote observation data with laboratory studies has shown that the dust that covers almost the entire surface of Mars also consists of a fine-grained silicic acid salt (silicates). When ingested in human lungs, this salt reacts with compounds in human tissues, resulting in the formation of dangerous chemical compounds. Martian dust contains, among other things, many chromium compounds.

Features of Martian aerosols: Atmospheric aerosols play an important role in the formation of the climate of Mars [7]. Using the results of our photometric and polarimetric [10] observations of Mars, we determined some optical characteristics and basic parameters of aerosol particles, such as their size r_0, the real and imaginary parts of the refractive index n_r and n_i for various conditions of development of the Global dust storm [4, 5, 7, 8, 16]. The influence of the shape of dust aerosol particles in the Martian atmosphere on the value of the imaginary part of the refractive index n_i, obtained from photometric observations during the period of the greatest activity of the dust storm, was also studied. In the calculations, spherical particles and flattened spheroids of different sizes were used in the lognormal distribution of particles in size.

A similar analysis was carried out for the average particle radii r_0 and the optical thicknesses τ_0 of the dust layer, estimated from polarization observations during periods of high atmospheric transparency. As a result of the performed analysis it was shown that the obtained values of these optical parameters depend on the adopted aerosol form. Thus, the values of ni, r_0 and τ_0 found for spheroidal particles turned out to be twice as large as for spheres [5]. A similar analysis for periods of high transparency was carried out with respect to estimates of the average particle radius r_0 and the optical thickness of the dust layer τ_0, which were obtained from the polarimetric measurements [10]. It was found that the aerosol form adopted influences these optical parameters. Namely, the values of n_i, r_0 and τ_0 obtained for spheroidal particles turned out to be approximately 2 times larger than for the spheres. For the greatest activity of a dust storm in 1971, it was found that with an optical thickness of a dust cloud of $\tau_0 \geq 15$, the particle size would be in the range $4.5 \leq r_0 \leq 7.5$ μm. It turned out that the real part of the refractive index n_r of dust particles was practically the same for both the transparent atmosphere and during the maximum development of the dust storm and equal to $1.54 \leq n_r \leq 1.62$.

We believed that the measurements of the reflection coefficient of the Martian disk [4, 8] obtained during the dust storm peak in 1971 (at a phase angle $\alpha = 42^0$) were most suitable for determining the imaginary part of the refractive index n_i. In this case, the Martian atmosphere can be accepted as semi-infinite. Under such conditions, the contribution to the reflection of light by the underlying surface can be neglected. Assuming that the dust layer consists of spherical particles with n_r = 1.57 for the lognormal particle size distribution, the value n_i = 0.0001-0.0025. As a result, the best agreement was obtained between the observed and calculated values of the reflection coefficient of the Martian disk at r_o = 4.5 µm. Such a value of r_o corresponds fairly well to data obtained from our polarimetric observations (r_o> 5.7µm). These values of n_i are an order of magnitude smaller than the data, obtained for the highly transparent atmosphere of Mars. The obtained values of n_i correspond quite well to the dust analogues obtained in the laboratory, such as basalt and basalt glass. Note that the results of laboratory measurements and calculations carried out for spherical and randomly oriented nonspherical particles of the same effective radius have shown that the influence of the shape of the particles is not significant in the analysis of photometric data [8, 16]. More careful calculations showed that in the early stage of a dust storm in the clouds there are particles with a size of 1 to 20 µm; during the period of the greatest activity of the dust storm, the mean particle radius was ~8-10 µm, and in the final stages ~1 µm. The value of the real part of the complex refractive index of particles turns out to be equal to n_r = 1.59 ± 0.01 and is in good agreement with the hypothesis of their silicate nature.

On the surface of Mars, three regions are distinguished in the middle and low latitudes: Tharsis, Arabia and Elysium, where the night temperatures allow almost all seasons [9, 11-13, 19] to convert carbon dioxide from the atmosphere to frost on the surface. All three areas are covered with dust. Therefore, the temperature in these places varies much faster than in areas not covered with dust. These regions are cold at night, and the warmest - in the daytime. Therefore, these smal dust particles very quickly heat up during the day, and are cooled at night. Formed by frost hoar - separates motes. In the morning the frost evaporates, and the dust on the surface becomes very fluffy. That is, frost constantly prevents the joining of grains of dust into one whole. And such a cycle “carbon dioxide – frost” leads to a change in the soil and can cause erosion processes [15].

Flights to Mars: Both states and private companies are regularly spoken about the flights to Mars. Some of them recruit future Martian colonists. For example, in early 2015, the “Mars-1” project conducted the third round of recruitment of future Martians, having already selected 100 candidates. However, the time has not even come to test the Martian ships. It is clear that a Martian ship must be very large and heavy for the delivery of astronauts, a lot of food, water, fuel, air, scientific tools, spare parts, etc. Of course, technology does not stand still. And the initial mass of a potential Martian ship can significantly decrease. But still the Martian ship should be assembled in orbit around the Earth in several stages. And only after assembling the ship will go to Mars. This circumstance complicates and increases the cost of the project.

The flight to Mars can last from six to nine months. People on Earth and in its orbit are protected by the magnetic field of the Earth. But having gone to Mars, the astronauts are deprived of this protection. For 15 months of flight to Mars and back the astronaut will receive about 1 sievert of radiation. This dose is set as the maximum permissible for astronauts in their entire career. But 15 months is a long time, and during this time a powerful flash can occur on the Sun. In this case, the dose can be increased by an order of magnitude and the crew can easily be killed. Experiments show that a dose of 3-5 sievert leads to death from radiation sickness within 30-60 days with a probability of 50%. Therefore, a serious problem on Mars is a weak magnetic field [14, 20, 21]. Together with the rarefied atmosphere, this increases the amount of ionizing radiation that reaches the surface.

Conclusions: Therefore, it is believed that the flight to Mars is a huge risk, and the exploration of Mars can be delayed. The main reason for the delay is the presence of a large amount of toxic dust on the Red Planet. If such dust gets into the body, the earthly inhabitant can get sick, the work of vital organs can be broken or even stopped. In addition, because of the rarefied atmosphere on Mars, there is a much more likely meteorite threat [1-3, 18]. These factors make us seriously think about the very possibility of organizing a Martian expedition even in the distant future. But it is possible that given the technical, physiological and psychological aspects, the flight to Mars will soon become quite real.

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