V. I. Moroz, L. V. Ksanfomaliti, and A. E. Nadzhip. "Mars-3": Astrophysical Studies of the Lower Atmosphere and the Surface of the Planet. In the period of opposition in 1971, three artificial satellites were put into orbits near Mars: the Soviet satellites "Mars-2" and "Mars-3" and the American "Mariner-9." The studies performed with these space instruments substantially expanded our knowledge of our neighboring planet. We shall treat here the results obtained with "Mars-3" in four experiments: 1) measurement of the infrared brightness temperature of the surface in the range 8–40 mμ, 2) determination of altitudes on the surface from the intensity of the CO_2 absorption band at $\lambda = 2$ mμ, 3) measurement of the H_2O content in the atmosphere from the intensity of the absorption band at $\lambda = 1.38$ mμ and photometry in the continuous spectrum near this band, 4) photometry of the planet in five narrow intervals in the range 3700–7000 Å.

The problems that the listed devices solve are the classical problems of astrophysical studies of Mars that have been posed for many years in Earth-based observations. Use of artificial satellites of Mars for such studies makes it possible to increase sharply the spatial resolution (e.g., in the H_2O photometer, to 5 km on the surface of the planet, instead of several thousand km in Earth-based observations), to eliminate difficulties caused by absorption by H_2O and CO_2 in the Earth's atmosphere, and to perform measurements at angles of incidence and reflection unattainable from the Earth, and in particular, to study the night side of the planet.

"Mars-3" has a period of about 12 days, and the distance at the pericenter of the orbit was from 1000 to 1500 km. The measurements were conducted during seven passages of the pericenter. A narrow band on the surface of the planet that crossed it from south to north over a range from 50–60° South lattitude to 40–70° North latitude was scanned at each passage (by using the motion of the satellite).

The measurements began in December and were completed in March. There was a dust storm during the initial period of observations of Mars, which abated in January. Comparison of the December and February observations made it possible for the first time to study certain properties of the clouds, which envelop the planet in an almost continuous blanket during dust storms.

The nature of the daily temperature trend of the surface reveals its low thermal conductivity. The thermal inertia constant $(k\rho c)^{1/2} \approx 0.006$ cal·cm^{-2}sec$^{-1/2}$ degree^{-1} is characteristic of dry dust at low pressure. The dark regions are 10—15° warmer than the light regions. Temperatures were measured in the region of the North polar cap that were close to the condensation temperature of CO_2, the main constituent of the atmosphere of Mars. It turned out that a dust storm substantially affects the heat regime of the planet. During a dust storm, the surface is colder than in "clear" weather with a transparent atmosphere. Apparently, the temporary cloud layer that arises during a dust storm creates a sort of anti-greenhouse effect. The dust clouds transmit the shortwave solar radiation more poorly than they do the longwave planetary radiation. Consequently the surface is chilled and the atmosphere is heated.[1-3]

As a rule, the altitudes measured from the CO_2 bands agree satisfactorily with the results of Earth-based radar wherever such a comparison can be made. Along the routes of measurements, the altitudes vary from −2 to +5 km. A certain correlation was noted between the altitudes and the albedo: if a dark and a light region lie alongside one another, then in most cases the dark part proves to be higher.[1,4] The height of the clouds during the storm was of the order of 10 km, but the upper boundary was apparently very diffuse.

The content of water vapor was very small, even for Mars: several micrometers of precipitated water in the vertical column from December to February, while it apparently rose in March to 20 μm. The H_2O content over the North polar cap was less than 0.5 μm. At past oppositions, Earth-based measurements of the H_2O content (mean for the entire planet) showed more moisture at the same season (up to 60 μm). The decrease in the amount of H_2O in the lower atmosphere was accompanied by a decline in the concentration of hydrogen in the upper atmosphere.[5]

Comparison of the photometric profiles of Mars in the 0.7 and 1.4-μm regions shows a considerable increase in contrast upon going to longer wavelengths during the storm. This fits with particles of approximately a micrometer in dimensions. Brilliant ultraviolet clouds were observed during the dust storm, and they apparently involved even smaller particles. The total amount of dust in the atmosphere during the dust storm was estimated to be about 10^9 T. Condensation clouds having particles of submicrometer dimensions were observed in the region of the North polar cap.

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[1]V. I. Moroz and L. V. Ksanfomaliti, Vestn. Akad. Nauk SSSR, No. 9, 10 (1972); V. I. Moroz and L. V. Ksanfomality, Icarus 17, 408 (1972).

[2]V. I. Moroz, L. V. Ksanfomaliti, A. M. Kasatkin, G. N. Krasovskiĭ, N. A. Parfent'ev, V. D. Davydov, and G. F. Filippov, Dokl. Akad. Nauk SSSR 208, 299 (1973); V. I. Moroz, L. V. Ksanfomaliti, A. M. Kasatkin, B. S. Kunashev, and K. A. Tsoĭ, ibid., p. 1048.

[3]V. I. Moroz, L. V. Ksanfomaliti, A. M. Kasatkin, and A. É. Nadzhip, Kosm. Issl. 10, 925 (1972).

[4]V. I. Moroz, A. É. Nadzhip, A. B. Gil'varg, F. A. Korolev, and V. S. Zheguler, Dokl. Akad. Nauk SSSR 208, 797 (1973).

[5]N. N. Dementyeva, V. G. Kurt, A. S. Smirnov, L. G. Titarchuk, and S. D. Chuvahin, Icarus 17, 475 (1972).