VASSILI IVANOVICH MOROZ -- AN APPRECIATION. D. P. Cruikshank. Astrophysics Branch, NASA Ames Research Center, MS 245-6, Moffett Field, CA 94035. e-mail Dale.P.Cruikshank@nasa.gov

Introduction: The 2005 LPSC special session, OMEGA At Mars, is dedicated to the work and memory of V. I. Moroz, in recognition of his pioneering studies in the characterization of planetary bodies with remotely sensed data, and his special interest in, and contributions to, the study of Mars.

Life and Career: Moroz was born in Moscow in 1931, and finished Moscow State University in 1954. His first job was in Alma-Ata at the Astrophysical Institute of the Academy of Sciences of the Kazakh Soviet Republic, where he built instruments and made his first observations of Mars at the favorable opposition of 1956. He returned to Moscow in late 1956 and joined I. S. Shklovsky's group at the Sternberg Astronomical Institute of Moscow State University. As one of a group of young scientists studying many aspects of astronomy and astrophysics under the stimulation of Shklovsky, Moroz began to develop instruments in the then-new field of infrared astronomy.

By 1959, Moroz had built an IR spectrometer and made his first IR observations of planets with the telescopes in the Crimea. His initial results included a tentative identification of bound water in Martian surface minerals, and the derivation of a new (lower) atmospheric pressure estimate than was generally accepted, stimulating a life-long interest in the properties of the surface and atmosphere of Mars. He discovered the phase dependence of CO_2 bands in the spectrum of Venus, from which he derived the extinction coefficient of the clouds, later largely confirmed by spacecraft experiments. In 1965, Moroz published the first near-IR spectra of the Galilean satellites, identifying the surface ices of Europa and Ganymede.

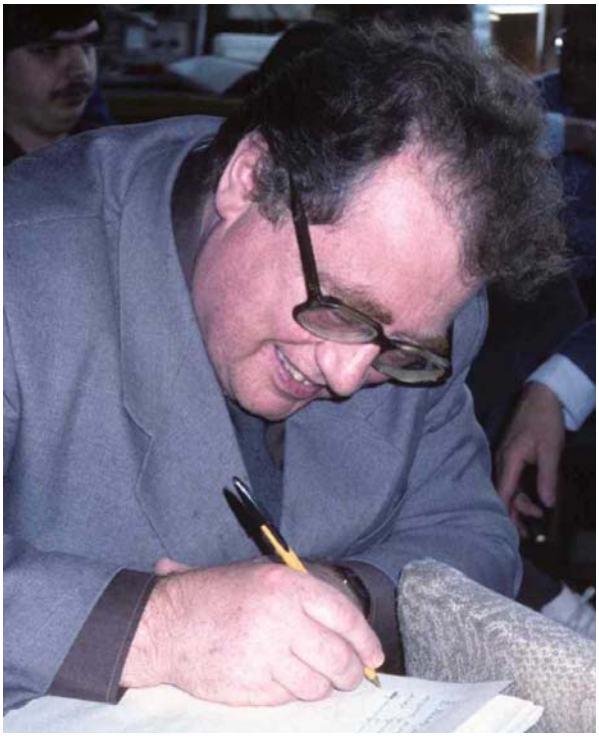
In 1967, Moroz published his monograph, *Physics of the Planets*, the first comprehensive physical treatment of planetary atmospheres, surfaces, and interiors in any language. A later monograph**,** *Physics of the Planet Mars* [2], was published in 1978, and he contributed to an important university-level text book that has been published in many editions.

As a graduate student I learned about Moroz' work through his earliest publications in the mid-1960s, and took special interest because he was working on planetary problems using PbS infrared detectors, just as we were in Kuiper's Lunar and Planetary Lab. When I finished my Ph.D. in 1968, I had the opportunity to spend a year in the USSR under the mutual exchange agreement between the national academies of science of the US and Soviet Union, and Moroz agreed to be my host at the Sternberg Astronomical Institute. At that time, the Space Research Institute (IKI), which was founded in 1965, was entirely closed to foreigners. I arrived in Moscow on Sept. 1, 1968, from Prague, where I had been when the Soviet Army invaded Czechoslovakia less than two weeks before. World tension was high, and my Soviet hosts were clearly uneasy and uncertain about how to deal with an American and his family. Moroz rose to the challenge, and despite his natural reticence, introduced me into his group of students and associates. He later wrote, "Dale Cruikshank, a former graduate student of Kuiper, visited Prague just during these events and told me later what it had been like. Dale spent many months at the Sternberg Institute as a visiting scientist starting in September 1968. It was something new in our scientific life. Soon, we became good friends. Only thanks to everyday contacts with Dale I passed a 'critical barrier' and started to speak English faster, without stopping to search for every other word. Dale had the same sort of problem with Russian that I had with English, but within some time he also began to speak fluent Russian." [3]

To appreciate fully the situation in the 1960s in the USSR vis-à-vis foreigners, we need to recall that contact between Soviet scientists and their counterparts in other countries were both uncommon and filled with tension over concerns about espionage and the transfer of classified information. This was the height of the cold war and the war in Viet Nam. Still in the shadow of suspicion cast by Stalin, few Soviet astronomers had been allowed to travel outside the Soviet Bloc, and contacts with foreigners were closely monitored. Moroz was, in retrospect, rather courageous in his willingness to host an American visitor at that time, and later, when he was allowed to travel more freely, he displayed further courage in fostering international relations and cooperation in space missions.

Known as the "Professor with the soldering iron" for his hands-on work in the laboratory, Moroz continued at the Sternberg Institute but took a joint appointment at IKI where he calculated reference models of the atmospheres of Venus and Mars (a responsibility he continued for many years and later expanded to an international scope) and established science definition plans for missions to those two planets. As the head of the infrared astronomy lab at IKI he developed spacecraft instrumentation for the early Mars missions, and by 1971 was getting data from an initially successful Mars 3. He built a dynamic group of scientists and instrument developers at IKI, and when R. Sagdeev became Director in 1973, he accepted the job as head of a new Department of Physics of the Planets, later

expanded to include small bodies of the Solar System. His department eventually consisted of seven individual laboratories and a staff of about 70 people.



Moroz took a leading role in establishing international cooperation in planetary exploration by his involvement first with eastern bloc countries, then France, and then the U.S. When cooperative ties with the U.S. were established in the 1980s, Moroz was frequently the Soviet (later Russian) representative in annual meetings with NASA officials.

Through his own scientific work and spacecraft instrument development at IKI, contacts with Soviet industrial instrument builders, and foreign space scientists and space agencies, Moroz became the most influential and productive organizer in his country's program of planetary exploration.

As a key scientist in planetary exploration, Vassili Moroz acquired a vast range of experience over the years. He was Principal Investigator on instruments on the Soviet Mars 3 and 5 spacecraft. Moroz was the Project Scientist for Venera 9 and 10 and PI for a NIR spectrometer on the orbiter and a filter photometer on the descent probe. He was an instrument PI for Veneras 11, 12, 13, and 14, and Co-PI for instruments on Venera 15, the Vega cometary probe and Venus descent probe. He was Co-I on the infrared spectrometer and filter photometer on the Phobos mission and Orbiter Science Coordinator and Co-PI on some missions that later failed. He was the Russian coordinator and Co-I of the OMEGA instrument on Mars Express, contributing greatly to its implementation and success. In an autobiographical article [3], Moroz gave interesting and important insights into his country's program of planetary exploration and cooperation with foreign scientists and space agencies.

Moroz received many honors for his scientific work, including the Soviet Red Banner order (1976), the USSR State Prize (1985) and additional distinctions. He was awarded the COSPAR Space Science Award posthumously in 2004, shortly after his death.

The legacy of Vassili Moroz is found in his pioneering contributions to infrared astronomy, the physics of planetary atmospheres and surfaces, his devotion to Russian science, his pivotal contributions to his country's space missions, and the students who were introduced to planetary studies in his lectures and drawn to his department of Physics of Planets and Small Bodies of the Solar System, at the Space Research Institute.

References: [1] Moroz, V. I. (1967) *Physics of the Planets* (in Russian), Nauka, Moscow, 496 pp. [2] Moroz, V., I. (1978) *Physics of the Planet Mar*s (in Russian), Nauka, Moscow, 351 pp. [3] Moroz, V. I. (2001) *Plan. Space Sci. 49*, 173-190.