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# An unforgettable personality

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**Abstract.** This paper contains anecdotes concerning Konstantin Iosifovich Gringauz, his life, character, and scientific results. His transmitter-antenna system on Sputnik 1 announced the opening of the space era, and his scientific results, obtained during a period of 35 years, made a significant contribution to space physics.

## 1. In the Beginning

Konstantin Iosifivich Gringauz was born on July 5, 1918, not long after the Great October Revolution in Russia. He grew up together with the development of the Soviet system in the country, and his biography was crossed by one of the most romantic achievements of national history. Although he was the son of a pharmacist, Gringauz was captivated by the technical revolution from the very beginning. As a boy he became a radio amateur, and later he chose radio physics as his profession. He graduated from the Electro-physical Faculty of the Leningrad Electrotechnical Institute in the spring of 1941, specializing in frequency modulation. Consequently, during the Great Patriotic War (World War II) his talents were much in demand. He worked in Siberia on the production of transmitters and receivers for tanks and later carried out studies of the effectiveness of radio communications under battlefield conditions in Poland.

In 1944 Gringauz passed the entry examinations required for postgraduate studies and in the following year obtained a position in a classified radio institute where he became involved in studies of radio wave propagation in the ionosphere. His destiny took a fortunate turn in 1947, when the first rocket development organization in the country was established. Gringauz began to collaborate with Sergei Korolev, father of the Soviet space rocket program, and in the same year he entered a laboratory for radio wave propagation in Korolev's Bureau for Rocket Development. From 1948 to 1958 he participated in series of experiments, first using modified V2 rockets and later using Soviet rockets, in which he carried a radio sounder to study the electron density distribution in the Earth's ionosphere. Finally, with rockets capable of reaching 480 km altitude, the $F$ layer of the ionosphere was probed on three occasions in 1958. It was demonstrated that in contrast to then-current ideas, the electron density did not decrease rapidly above the $F$ layer maximum.

In 1949 he was awarded his Ph.D. and put in charge of a laboratory for radio technology. In 1956 he began designing instruments to measure ions in the Earth's atmosphere from a satellite which became Sputnik 3, and was assigned responsibility for the design of the transmitter-antenna system for what became Sputnik 1. His idea that this satellite should use a decametric transmitter was exhaustively debated, but Gringauz was confident that his system would work, and Korolev finally decided in favor of Gringauz's position.

## 2. The First Space Missions

In 1964, when I met Gringauz for the first time, he was already a distingushed scientist and had had many "firsts." His radio transmitter's signals, "beep, beep...", on the Sputnik 1 opened the era of scientific space studies. He was the last person to touch Sputnik 1 on checking his transmitter before the launch and he was very proud of that all his life.

The experiments on Lunik I, II, and III and on Venera 1 in the period 1959-1961 were remarkable in space science and in Gringauz's biography:

> When the vehicles were sufficiently far from earth the solar wind was detected during periods of communication with ground stations, as a directed stream of protons having fluxes of $10^8 - 10^9 \mathrm{cm}^{-2}\mathrm{sec}^{-1}$. There appeared to be no stationary component of the plasma, and the observations were wholly consistent with a supersonic solar wind as predicted theoretically. The flux was found to be related to geomagnetic activity, and in one case an enhancement of the flux was followed by a sudden commencement geomagnetic storm. In addition to providing the first observations of the solar wind, these experiments also gave profiles of the topside ionosphere, showed the existence of the plasmapause for the first time, proved that previous estimates of the flux of energetic electrons in the outer radiation belt were incorrect, and discovered the regions containing soft-electron fluxes which are now described as the "cusp"( i.e. the plasma sheet) and the "transition zone"(i.e. the plasma sheath)

by Ian Axford in an article published in *Space Science Rev.* in 1968, which made him Gringauz's friend for life.



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The discovery of the plasmapause by Gringauz had not been noticed in the United States. Don Carpenter discovered the plasmapause in 1960 independently using the whistler technique and identified it with the inner boundary of magnetospheric convection where the flow divides and passes around the Earth, corresponding to the inner boundary of the ring current plasma and of auroral plasma penetration. Unfortunately, he was not able to publish this idea, which was in principle correct, although it was also necessary for reconnecion (according to Dungey's classic paper in 1961) to open magnetic field lines allowing the possibility for plasma to escape from the outer magnetosphere and produce a sharp change in plasma density. Ian Axford pointed out Gringauz's paper on the plasmapause to Don Carpenter. He and Gringauz were happy to acknowledge each other's contributions, and very soon the plasmapause was generaly accepted by the scientific community. All of this was not bad for a man about 45 years old.

From the very beginning few scientific spacecraft were launched into space without instruments developed by Gringauz's team. "This advantage hath enabled them to extend their discoveries much futher than our astronomers in Europe," Jonathan Swift would have said in describing Gringauz's achievements. The instruments used by Gringauz were very simple by present-day standards. Various kinds of ion traps, based on the retarding potential method, permitted Gringuaz to meausure the density of charged particles in the whole space accessible to Soviet spacecraft. Later, when more sophisticated instruments were developed, the robustness and simplicity of Gringauz's instruments still guaranted good results. "For although their largest telescopes," continues Swift in his *Gulliver's Travels*, do not exceed three feet, they magnify much more than those of an hundred among us, and show the stars with greater clearness. They have likewise discovered two lesser stars or satellites, which revolve about Mars...."

## 3. In Khrushchev's Time

My meeting with Konstantin Iosifovich was a lucky break in my life. During all of my last 3 years at school I dreamed of Mars. Unfortunately, however, I graduated from the physical faculty of the Moscow State University during Nikita Khrushchev's time. The boom of Soviet space achievements then was overshadowed by the political shock following the dethroning of the Stalin Cult and later by a revision of economic politics in a country. Nikita Khruschev had started his social and agricultural experiments. His adopted daughter, Rada, graduated with me from the same faculty of the Moscow State University and had invited him to participate in the traditional graduation ceremony. The ceremony immediately lost its attraction for us: all alcoholic drinks were removed from the University buffets, and the central halls and corridors were filled with suspicious strangers, the bodyguards of the Government. There was a presidium at the scene of the biggest University hall. Such distinguished scientists as the Nobel Prize laureate Lev Landau, Lev Artsimovich, Michael Leontovich, and others were seated at the presidium table. Khrushchev made a speech. As usual he started calmly, but as the speech progressed his excitment increased and his voice rose. Finally, he said to the people in the presidium: "Do you think that you are responsible for the success of the Soviet science? The worker who cleans the ice from a slippery road is doing much more than any of you. If he did not do his job, you would break your neck on the street and Soviet science would be nothing!"

Following such a strong implied criticism of pure science, all graduates were sent by the faculty administration to industrial and military companies to make a "real" input into the national economy. Obviously, it was not as straightforward for my generation as it was for Gringauz's to transform our hobby into a profession. I escaped somehow the military authorities and entered the Government publishing company NAUKA ("science") as an editor of physical literature. This was not too bad for women, but after 3 years there I still dreamed of Mars, and my husband, a plasma theoretician from the Radiotechnical Institute (RTI), once asked me: "Why don't you apply to Konstantin Gringauz in my Institute? He is doing space research in the Earth's environment, but perhaps he will turn to Mars some day."

## 4. RTI

Our meeting with Konstantin Iosifovich took place in late spring of 1964 at a street near the Institute, which was carefully protected by special guards keeping government secrets from the enemies of the state. Only after very long investigations of an applicant's loyalty was it possible to enter and work there. In fact this Institute had more freedom than the classified organization from whence Gringauz and his team were taken in 1959 by academician Alexander Mints, Director of RTI. Before he moved to RTI, Gringauz was not even given permission to publish his scientific results in normal scientific journals.

I was pleasantly surprised by Konstantin's appearance. He was very elegantly dressed, which was unusual in our scientific community, and very self-confident. A small gold medal with Lenin's silhouette shone on the lapel of his grey coat. At that time he had already been awarded the Lenin Prize and had become a Doctor of Science. I recognized soon that Gringauz, except on some important formal occasions, usually carried this medal on the back side of his lapel. According to the rules, Lenin Prize winners, in addition to receiving the medal, were granted significant privileges in the Soviet society. For example, they could avoid long queues usually associated with the acquisition of all current needs in times of chronic shortages, including very simple ones such as cinema and theater tickets, entry to exhibitions and restaurants. This privilege could be very helpful in such conditions, and Gringauz used it successfully, showing the back side of his lapel to the responsible persons wherever needed.

After some questioning and investigations he accepted me, and in 2 months I became his coworker in further studies, and very soon I was presented with the possibility of investigating Mars!

The Radiotechnical Institute, to which the Gringauz's team belonged, was not an ordinary one. Academician Mints began his scientific career as a head of the radio division of the First Cavalry Army of Semyon Budyonny, who was the hero of the Great October Revolution and Civil War. As a consequence of his revolutionary activity, Mints was imprisoned during the Stalin Cult time in a special concentration camp for scientists, "Sharashka." One such place has been described by Alexander Solzenitsin in his novel *The First Circle*. Sergei Korolev's career, as is well known, was also crossed by Sharashka. The intelligentsia and others were detained there to redeem their faults and prove their devotion to the socialist system. Alexander Mints had proved his devotion to the system for a second time in his career (after the revolution) during the Great Patriotic War. He was liberated after the War and given permission to organize a new Institute and to invite anyone whom he wanted.

The Space Research Department which Gringauz headed in RTI included about 60 people. There were many high-quality engineers, such as L. Musatov, V. Kaptsov, I. Knorin, and others, who designed our plasma probes and analyzers and their electronic systems and tested them in vacuum chambers and under artificial XUV radiation. At the beginning V. Rudakov, V. Bezrukikh, G. Gdalevich, and Nina Shutte were coinvestigators of Gringauz in ionospheric radio, Langmuir, and other probe experiments carried on geophysical rockets and on the Kosmos and Prognoz satellites. Later a new generation appeared, namely, A. Remizov, V. Afonin, M. Verigin, and myself, who participated in ionospheric, magnetospheric, and plasma environment studies near the Moon, Venus, and Mars using the Lunik, Prognoz, Venera, and Mars series of satellites. Gringauz and members of his laboratory were given the "green light" in Mints' Institute and in the Academy.

Our Institute was doubly dependent (from both the Academy and the Ministry of the Radioindustry) and doubly supported with financial resources. I remember when Nina Shutte, one of the principal members of the Gringauz scientific team, needed an X ray source to test the sensitivity of plasma probes to short-wavelength radiation. There was a shortage in Russia of such sources, as in most essentials. However, Mints ordered for Nina some very complicated and expensive medical X ray equipment. The source was removed, and the equipment itself was sent to a local hospital for medical purposes.

We participated in international conferences and workshops from the very beginning. For example, I participated in a meeting in Belgrade on Solar-Terrestrial Physics for the first time in my life in 1967, not even being a Ph.D. at that time. We had just obtained our first results from one of the Venera spacecraft and had detected the distant tail of the Earth's magnetosphere near the Lunar orbit. I was very pleased to meet American space scientists such as Norman Ness and Siegfried Bauer, who had known of me for a long time although only from the scientific literature. They were suprisingly young and nice people and very respectful to Gringauz. Gringauz and I spent a lot of time with our foreign colleagues, having lunches and dinners together and very much enjoyed our discussions. Unfortunately, this was too much for the Soviet rules regulating international relations at that time. We got into a lot of trouble from the representatives of the Institute security service department, who recommended that we participate in such meetings with foreign colleagues only in the presence of three Soviet persons. Mints helped us to overcome concequences of this intrigue and prevented it from coming to the attention of the highest security authorities.

Life in the RTI was comfortable for Konstantin Iosifovich also because of the quality of the scientific community there. After his experience with the socialist system, Mints was not afraid to collect very bright and distinguished people in his Institute. One such person was Michael Levin, the head of the theoretical plasma physics department. Unfortunately, however, a group of very young intellectuals, including Levin and writers who became well known later, Yu. Dunsky and V. Fried, and the mathematician Nina Ermakova, who is now married to academician Vitaly Ginzburg, were charged with plotting to kill Stalin on his way through the old Arbat Street, where Nina's flat was located. They were all removed to places distant from Moscow, despite the fact that the windows of Nina's apartment from where they supposedly planned to shoot Stalin were directed toward the yard and not to the street. Returning to Moscow after deportation and invited to work at the Radiotechnical Institute by Mints, Levin maintained his contacts with refugees and dissidents. He was a friend of Andrei Sakharov from university days and visited him a few times in his Gorky exile.

Gringauz was usually advised by Levin on the plasma theory required for the interpretation and understanding of his data. It should be remembered that Konstantin Iosifivich developed as a plasma physicist only with time. I suppose that at first he did not conisder the charged particles, which he investigated using different types of probes, a belonging to a space plasma. There were no plasma physics courses even in the University at that time, and Gringauz, like most members of his

Department, had had an engineering education. It was necessary to be skillful, sensitive, and clear-sighted, as he was, to avoid making errors in the interpretation of data never obtained before and not even expected. He felt it necessary to study many important subjects in plasma physics and astrophysics, but as he was very busy with experiments, he also wanted to attract people with high qualifications in such fields. He pressed Levin and his theoreticians to join his studies with his characteristic style, familiar to everybody who knew him. Space plasma physics was not as popular as thermonuclear fusion among the plasma physicists at that time, and Levin, having a very sharp tongue, after being strongly attacked by Gringauz, once joked: "Konstantin Iosifovich, you remind me of a musician who played the triangle in an orchestra for his whole career. Upon retiring he attended a concert and afterwards remarked to friend with astonishment: 'Do you know that together with my special piece on the triangle in the opera "Carmen" there is a very nice melody: "Toreador"...'." Gringauz was not at all subdued by this comment. Very soon he became a very qualified person professionally and received a professorship in radio physics in 1970.

Gringauz was never involved in any opposition to the system, although he had close contacts with people like Mints and Levin, who had suffered under it. He was a Communist Party member, and everybody who knew him well will remember that he discussed the social questions of his country in a very positive way. The most important thing was that Gringauz was always honest in his patriotism and was proud of the success of Soviet science, to which he had contributed significantly. Such attitudes were not so uncommon in our lives at that time. Probably for Gringauz, as for the many Soviet people not suffering personally from the "regime," patriotism was followed by an acceptance of membership in the Communist Party, which claimed its responsibility for our success. Gringauz, like others successful in their job and carefully following all the rules of the socialist system, lived quite comfortably. Moreover, Mints and Korolev always supported him strongly with their authority in the Academy of Sciences and in the Government.

## 5. IKI

In 1960 our space program turned to other planets of the Solar System, namely, Venus and Mars. In 1967 Gringauz's team received the first results from Venera 4 and detected the bow shock near Venus just 1 day before Mariner 5. Venera 6 approached Venus in 1969 and later, in 1971, Mars 2 and 3 became orbiters around Mars. The series of Martian satellites, including Mars 5 in 1974, led to the discovery of the Martian magnetosphere with its plasma sheet, a characteristic phenomena similar to the Earth's magnetosphere, and to the possibility of estimating the magnetic moment of the intrinsic magnetic field of Mars. For me it was a very exciting time. I had participated in realizing my dream and gained my Ph.D in 1973. However these Martian discoveries were already made in the Space Research Institute (IKI) of the Academy of Sciences: in 1971 Gringauz and his team had been ordered to move to this newly organized Institute.

The Government issued a decree creating IKI in 1965. The Institute began to function in 1967-1968, when the space age was already at its peak. Before its creation, experiments in space had been carried out by individual groups of specialists from academic and departmental institutes and firms such as Gringauz's former institute, RTI. However, at this time, when industry had begun the mass production of specialized scientific spacecraft, there arose a necessity for long-term planning of scientific programs and the competitive selection of the experiments that were to be carried out and for specialized scientific instrument building, since the latter's unique and complex nature was becoming more and more obvious. There was also a need for high-quality engineers who were specially qualified to install instruments, to test their functioning in conjunction with other instruments under simulated space conditions, and to act as an interface with the space industry which was developing instruments for scientific purposes. Last of all there was a need for a modern computing center which would provide for the processing of space data. All these tasks were entrusted to IKI.

IKI carried out a multitude of functions which were not traditional for a typical academic institute. Apart from a staff of 250 scientists, it also employed about 800 engineers and technicians, programmers and computer operators, as well as maintenance and service staff, a total of about 1400 people. The spacecraft launches were conditioned by set deadlines, and therefore the Institute was almost constantly working under pressure. It was responsible for keeping other Soviet and international organizations taking part in the experiments to their timetables: failures threatened the country with loss of prestige. From the very beginning of IKI's existence the Institute was involved in four main areas of fundamental science: astrophysics, planetary physics, gasdynamics, and plasma physics. Research in these areas was carried out by outstanding theorists and experimentalists.

In 1973 R. Z. Sagdeev became Director of the Institute. He was at that time the youngest academician at the USSR Academy of Sciences. Three members of the Academy of Sciences besides Sagdeev coexisted under IKI's roof. There were academicians G. Petrov, I. Shklovsky, and Ya. Zel'dovich, together with their "schools" of disciples, many of whom were already world-famous and had their own pupils. Sagdeev's task was difficult: he had to find a loyal and, at the same time, firm strategy for dealing with his outstanding wards. Of course, passions raged at the Institute not only because of science but also because of the complex relations between the various staff members.

Experiments on spacecraft are limited by weight, energy power, and telemetry considerations. There were not enough spacecraft to satisfy everyone. Because of this, competition in scientific space research always was, and still is, very stiff. Clear priorities and objectiveness are necessary in the choice of experiments for the creation of balanced scientific programs. Such methods were well-established in the United States, but in the USSR there was the incredible poverty and lack of rights of the Academy in the face of the military industry. In fact it was the Military-Industrial Commission (VPK) which laid down priorities for scientific space research. Only the fact that M. Keldysh, who was talented and had a great interest in this subject, was the President of the Academy of Sciences and a member of the Central Committee of the Communist Party, enabled him to deal with the situation. The next President, Aleksandrov, was not interested in space research. He had his own field, thermonuclear physics. Accordingly, Sagdeev began his battle with the VPK for the perestroika of the ideology and organization of Soviet space research with no real support from the Academy.

The space plasma community in IKI expected to gain much from the leadership of such a person as Sagdeev. He was famous for his work on collisionless shocks, which the Institute's scientists had discovered in space. The Space Plasma Department in the Institute expected to have interesting and helpful advice and data interpretation from Sagdeev's theoreticians, A. Galeev, V. Shapiro, V. Shevchenko, S. Moiseev, and G. Zaslavskii, who soon appeared in the Institute. However, it was necessary before that to build relationships between the members of the Plasma Department and the newcomers.

When they first appeared in IKI, there was a considerable gulf between the plasma theoreticians and space experimenters in terms of the level of qualification and the degree of abstraction. The former had been "brought up" on fundamental problems of thermonuclear physics and regarded the space experiments as if having to accept the "plat du jour" rather than selecting from a more extensive and exotic menu. As A. D. Sakharov used to say to astrophysicists, the classical plasma physicists still needed to feel "the poetry of the facts" discovered through experiments in space. Indeed, the first plasma experiments in space mainly involved in the discovery of purely morphological peculiarities of the interplanetary and near-planetary environment and probably could not satisfy the appetites of Sagdeev's gourmands who had been accustomed to the refined kitchen of laboratory plasma. In fact, apart from the discovery of collisionless shock waves and the Earth's radiation belts, the first experiments in space did not fire the imagination of the theorists with any unsolved riddles. In order to change the level of the experiments the least that was needed were scientific instruments of another level. These only became accessible later through international cooperation. Furthermore, the preparation of experiments needed a different approach based on carefully thought-out tasks, optimized in accordance with the specific possibilities allowed by the spacecraft. So, from the beginning most of the theorists in IKI absorbed themselves once again in their traditional problems, consulting only rarely with the experimenters at the Institute. The latter, including Gringauz, for understandable reasons, never voiced any particular dissatisfaction, for they had nothing to discuss seriously with the theorists in any case.

Although it may sound very strange, an objective reason for the "nonmerging" of Sagdeev's theorists and space plasma experimentalists in IKI (other than A. Galeev, who was charged to be Director of IKI when Sagdeev moved to the U.S.), was the introduction of perestroika to the country. It was perestroika that made it possible for those theorists who had come to Moscow and IKI, not only to enter orbits of international cooperation but to rotate in these orbits with such cosmic speed that as a consequence of centrifugal forces, they soon broke away altogether. The long-awaited possibility of contacts with foreign professional colleagues naturally distracted them from the establishment of close contacts within the country. Perestroika dispersed IKI's main theoretical potential of both plasma and astrophysics throughout other countries. What a pity! Who knows what would have happened if they had stayed together for just a little longer and had gone in search of scientific partners in their own country!

Gringauz and Sagdeev enjoyed a respectful relationship from the very beginning until the end of Sagdeev's leadership, covering 15 years during which there were many reorganizations and upheavals in the life of the Intsitute. Sagdeev supported Gringauz in the very strong competition with other space plasma groups and gave him comfort in the Institute, although he sometimes did not accept Gringauz's combative style of advancing his point of view. There were long discussions and disagreements concerning the role of a weak intrinsic magnetic field of Mars in its interaction with the solar wind. Gringauz, based on his results, claimed that an intrinsic field existed and that therefore there could be an Earth-like magnetosphere around Mars. Other scientists, including probably Sagdeev, did not find sufficiently strong arguments to reach such a definite conclusion. Gringauz objected so strongly that Sagdeev would sometimes ask, "Konstantin Iosifovich, you usually take your partners in discussion by the collar, beat them on the wall and repeat many times, 'There is an intrinsic magnetic field at Mars.' This is not the way to prove it. People have a right to have doubts!" Gringauz was right in the main in this connection, as was shown by Phobos 2, and as was argued by Bill Hanson following the Viking 1 and 2 missions. It was really very complicated to discuss with him some scientific subjects due to his active, even aggressive, style. However it was a pleasure to know that he always accepted arguments of his collaborators when they were correct, even if these partners did not have the same status in science.

## 6. Perestroika of IKI

With the beginning of the wide international cooperation following Sagdeev's perestroika of the Space Research Institute, IKI became responsible for the realization of international programs. In fact, for many years, IKI carried out a function similar to that of the U.S. National Aeronautics and Space Administration (NASA) and of the European Space Agency (ESA). The only difference was that in the USSR a large proportion of the scientific experiments were conducted directly by the Institute itself.

Gringauz now used the possibility to attract an international community to contribute hardware to his experiments. Many of his instruments were developed from that time jointly with the Hungarian Central Research Institute for Physics (K. Szego and his colleagues) and the Space Physics Research Laboratory of the University of Michigan (A. Nagy). A number of scientists from the Max-Plank-Institut für Aeronomie in Germany (W. I. Axford, H. Rosenbauer, A. Richter, E. Keppler, and others) have had long and successful collaborations with Gringauz, participating in Vega, Phobos, and Mars-94/96 missions and were also strongly supportive of Gringauz's team.

Gringauz spread his contacts through such an extraordinarily wide international community that many of its constituents began to communicate with each other for the first time through and due to his needs and influence. It is very obvious from papers describing results of the Phobos 2 mission, where such names as W. Riedler and K. Schwingenshuh (Austria) are linked together with J. G. Luhmann, C. T. Russell, J. Slavin (United States); S. McKenna-Lawlor (Ireland); and E. Marsch, R. Schwenn, A. Richter, H. Grunwald, S. Livi, and M. Witte (Germany). At that time Gringauz was also writing a book on the physics of plasmasphere together with J. Lemaire (Belgium).

A much-changed approach to international collaboration in the world space scientific community developed at that time in comparison with the earlier period. I remember the Bilateral US/USSR Seminar at IKI in 1975, where the results from the series of Martian satellites were intensively discussed. We then expected the Americans, N. Ness, H. Bridge, J. Spreiter, and others, to behave as a kind of Supreme Court, judging our discussions and internal disagreements on the problem of the intrinsic magnetic field of Mars. During perestroika, however, Gringauz's confidence grew due to the dependence of his international colleagues on his personal activity. He "colonized" much of Europe except for France, which was involved in collaboration with other groups in IKI.

## 7. Venus and Mars

The Phobos 2 mission, from which Gringauz again received very interesting results, revealed that during solar maximum the neutral atmosphere of Mars is strongly involved in the solar wind interaction with the planet, while during solar minimum (the Mars 2, 3, and 5 missions) it is involved only under conditions of high solar wind dynamic pressure. The data allowed Ian Axford to argue that only a combination of three factors, the weak intrinsic magnetic field, the ionosphere, and the neutral atmosphere, depending on solar wind dynamic pressure and UV intensity, can explain the features of experimental data obtained over whole solar cycle. Konstantin Iosifovich did not entirely accept these explanations, although Ian had always been a person of a great authority for him and a very good friend. He held strongly to his preliminary ideas on the intrinsic magnetosphere of Mars. Perhaps his flexibility of thinking decreased a little with age and with the growing problems of the Soviet Union.

Returning to and recalling the 1970s and the period immediately afterwards, it should be mentioned that there were many interesting and successful space projects. Our scientists had hardly enough time to deal with the results of one project before receiving data from the next. In 1975 we obtained results from the first near-Venus orbiters, Venera 9 and 10, during minimum solar activity. Tamas Gombosi, now a professor at the University of Michigan, came to Moscow to join Gringauz's team in processing and interpreting data from these missions. It was the time when Sagdeev had just started his perestroika in space research and Gombosi was practically the first foreign visitor-scientist in history of the Institute. The charming young scientist from Hungary did not entirely care for the strong rules pervading our Institute. According to these rules, foreigners were obliged to be accompanied by a member of the Institute staff to any place they wanted to visit. I was responsible for accompaning Tamas to begin with but got into a lot of trouble because of his independent behavior. He very often appeared alone at another floor of the Institute, where the Computer Center was located, escaping somehow from my vigilant eyes. As a result Micsha Virigin was ordered to take on this duty and Gombosi's care was in more suitable hands.

We published several papers as a result of Tamas' successful computations and proposed a hypothesis concerning the origin of the mysterious nighttime ionosphere of Venus. Gringauz was very proud of these Venera 9 and 10 results. The highly variable and sharp upper peak of the electron density in the Venusian nightside ionosphere was suggested as originating from solar wind electrons precipitating into the atmosphere from the nightside-induced magnetosphere of Venus. It appeared to be necessary to decrease the neutral atmospheric density by an order of magnitude in comparison with the existing models and to reduce the neutral temperature by about 1.5 at the altitude of the electron density peak to obtain the peak number density corresponding to that measured by the radio occultation method from the same satellites. It was of course courageous to make such predictions before the Pioneer Venus mission.

Sagdeev submitted our paper to *Doklady Academii Nauk*, the most important journal of the Soviet Academy of Sciences, which published new and advanced results. Very few people believed our hypothesis, and long discussions took place when the first results from the Pioneer Venus appeared. These discussions continued for about 11 years, until the next solar cycle minimum. Only Gringauz, with undying confidence in his own results, could stand his ground for so long. The Pioneer Venus measurements of the neutral atmosphere density and temperature nicely confirmed Gringauz's estimates. Finally, W. C. Knudsen and his colleagues published papers in *Journal of Geophysical Research* confirming the suggestion that the sharp peak of the electron density in the nightside Venus ionosphere during solar minimum is a result of electron impact ionization. The ion fluxes, which they measured at the Venus terminator, could be the main source of the wide peak of the electron density at the nightside of Venus mainly during the solar activity maximum. It was good victory for our international team and a good start for Tamas Gombosi.

## 8. Halley's Comet

An important point in Gringauz's career occurred during the encounter of the twin spacecraft Vega 1 and 2 with Halley's comet when his plasma analyzer "Plasmag" provided high-resolution measurements of the solar wind and the cometary plasma environment. The most impressive result from these measurements, which included the cometary bow shock, the distribution of the neutral gas, and the heavy ion envelope of the comet, was the discovery of a new and unexpected boundary in the cometary environment: "the cometopause." It was not a pressure balance boundary for the solar wind; the solar wind electron fluxes and the interplanetary magnetic field were found to penetrate this boundary right up to the magnetic field cavity near the cometary nucleus. It was, rather, a chemical boundary in the ion composition near the comet where the solar wind proton fluxes terminated. Gringauz was awarded the State Prize of the USSR in 1986 for his discoveries. I discussed with him the similarities of the mass-loading effects near Halley's comet and near the nonmagnetic or weakly magnetized planets Venus and Mars, in both cases connected with an interaction of the neutral atmospheres with the solar wind. Indeed, the cometary and planetary neutrals should remove the protons from the inflowing solar wind due to the extremely strong charge-exchange processes on the scale length of the interaction. Gringauz however prefer to think of his cometopause as different and unique. He was always faithful to his own ideas!

## 9. Beyond Science

The creative activity of K. Gringauz is very well known to the scientific community. For a long time he was a Charman of the Solar Wind and Interplanetary Magnetic Field Section of IAGA, a Vice-Charman of the Interdisciplinary Space Plasma Scientific Comission of COSPAR, and an initiator and Chairman of the Solar Wind and Interplanetary Magnetic Field Section of the Russian Geophysical Committee. He was recipient of the COSPAR award at the COSPAR meeting in Helsinki in 1988.

People who visited Gringauz's apartment in Moscow were usually surprised to discover book shelves from the floor to the ceiling overfilled with a wide variety books, covering practically all subjects, from physics to art and philosophy. He loved music very much: there was a big collection of tapes, records, and CDs in his apartment. Films were his greatest hobby: I remember that we always visited the cinema in foreign countries, especially during the time when it was possible to see some well-known masterpieces only abroad. He was always generous in inviting his coworkers and friends to join him to take pleasure in such films, despite the very limited financial means of Russian delegates at international conferences.

Gringauz was often organizer of local and international conferences in Russia. His wife Irina and daughter Tatiana usually had a very busy task receiving guests, who often arrived from the meeting by the busload, at their home. It was always a very great pleasure to have a good meal, to meet nice people, and to have interesting and open discussions at such parties. During discussions on social topics Gringauz was invariably very strong in his point of view, as much on the style of art, for example, as on scientific and political problems.

I would like to recall a final, typical story of Konstantin Iosifovich, which occurred in 1989-1991. There existed a special Govermental Committee on Inventions and Discoveries (GCID) which had the task of registering inventions and discoveries and of awarding the applicants a certificate and quite a considerable amount of money. This, the only such organization in the world, it would seem, was set up in our highly bureaucratic country. Gringauz certainly had registered most of his discoveries. However, during Gorbachev's perestroika academician Vitaly Ginzburg was put in charge of the "Anti-Bureaucracy Commission" of the Academy of Sciences. Ginzburg fought in the press and in the Academy of Sciences against the idea of issuing certificates for discoveries. He rightly considered, as did many members of Gorbachev's Commission on

Science and Technology, that priority would become clear naturally by means of references to one's publications, that is, through the recognition of one's colleagues. Gringauz at that time was in the process of registering his discovery of the source of the ionization of the nightside ionosphere of Venus. Unfortunately, it appeared to be just as difficult to complete the registration as to make the discovery itself, because of the long queue of applicants and the extremely bureaucratic procedure. GCID's members considered our application for years. They required us to formulate it in such a way that on the one hand, experienced bureaucrats would not consider the novelty of the results to be insufficiently substantiated and, on the other hand, that no novelty would be lost by substantiating the results to too great an extent. Gringauz fought for his discovery in his usual energetic way, and very soon even the Committee Chairman tried to avoid meeting him. Ironically, the Chairman of GCID participated, together with Gringauz, in a special discussion of the expediency of discovery certification at Gorbachev's Committee on Science and Technology, initiated by Ginzburg. The ensuing discussion did not reach the desired goal as a consequence of Gringauz's penetrating speech at that meeting, where he compared the salaries of the members of Committee with the amount of money awarded. CGID still survives and works in Russia. Unfortunately, the consequences of that discussion led to a long break in the work of the Discoveries Committee, and Gringauz did not make further progress on the registration of our discovery. He died on June 10, 1993, of a heart attack. Micsha Verigin and I are not sufficiently tough to continue the process of registration, and Tamas Gombosi is very far away, in the United States.

K. I. Gringauz was a happy person in his scientific career and in his friendship with many people. He left many disciples and pupils around the world and made a highly visible contribution to space science. He was indeed an unforgettable personality.

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