Vitaliĭ Lazarevich Ginzburg (on his sixtieth birthday)

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Ten years ago, this journal published a brief article on the occasion of V. L. Ginzburg's 50th birthday. It ended with the words: "There is every reason to expect that this storm of activity, which has been going on for over a quarter of a century, will continue unabated for many more years, in keeping with the hopes and warm best wishes of his numerous friends." As will be evident from what follows, these expectations were fully justified. More than that, there are no noticeable signs of slackening of his great creativity and productivity, of his unsatiable interest in science, of his passionate effort to understand and clarify the incomprehensible and mysterious and to explain them to others, to organize new groups of investigators in widely diverse fields of physics and lead them. If anything, he has gained in organizational experience, which enables him to accomplish even more. He has become more interested in broad general-scientific, scientific-historical, and methodological problems, and in his case such interest has always produced an effusion of new and highly interesting publications. Therefore the concluding words of the earlier anniversary article could be reprinted here with the same confidence.

Ginzburg's scientific career began in the last years before the war.[1)] By the time he was forty years old, he had published about three hundred scientific works, including eight monographs and numerous articles, pamphlets, and books oriented to a broad readership. Ginzburg founded several scientific schools (in space physics and solid-state physics in Moscow, in radiophysics at Gor'kiĭ), and the dozens of Doctors of Sciences among his students would make up only the top of the rollcall.

No matter how impressive the above recitation may be, it characterizes only the quantitative aspect of the matter. The brilliance of his talent defies verbal description, but Ginzburg as a scientist possesses attributes that strike the eye of even a student who is hearing Ginzburg lecture or deliver a paper for the first time.

Ginzburg is a theoretical physicist with the stress on the second word. This may mean little to the nonphysicist, but both the theoreticians themselves and experimenters know full well that the mathematical and methodological progress made in theoretical physics during the 1950s and 1960s, while greatly broadening its opportunities, had at the same time undesirable consequences of no small importance. Theoretical physics became strongly formalized, and many theoreticians began to lose direct insight into the essence of the physical phenomenon, into its characteristic causal relationships and its analogies to other phenomena, the insight that is the hallmark of the good physicist in the true sense of the word.

It is this quality that shines so brilliantly in Ginzburg's work and especially in personal association with him, distinguishes him from the many other theoreti-

[1)]Ginzburg was born in Moscow, completed grade school there, and worked for two years as an x-ray laboratory assistant; he then entered Moscow University directly as a second-year physics student. On completing these courses, he became a graduate fellow in experimental optics under G. S. Landsberg, but, being attracted to theoretical physics, transferred a year later, with the blessing of his supervisor, to the "tutelage" of I. E. Tamm; completing his Candidate's Dissertation early, he became a "Doctorant" (a title then applied to physicists in advanced training) in the P. N. Lebedev Physics Institute of the USSR Academy of Sciences (FIAN), again under I. E. Tamm. His entire later life has been inseparably associated with the FIAN, where he now heads the Department of Theoretical Physics. Ginzburg defended his doctoral thesis in 1942. He was elected a Corresponding Member of the USSR Academy of Sciences in 1953 and a full member in 1966.

cians, and is most highly prized by his younger colleagues. A man of good native intelligence might conceivably be able to master the apparatus of theoretical physics by himself, to teach himself to apply it, and to become a first-rate specialist. But it would hardly be possible for him to become a good self-taught physicist; for this he requires a school. For Ginzburg himself, this school was the atmosphere of the old FIAN, the scientific style of L. I. Mandel'shtam and Ginzburg's own teacher—Igor' Evgen'evich Tamm, whom he succeeded as head of the FIAN's Theoretical Division in 1971. As a scientist, Ginzburg was also influenced in no small way by his friendship with L. D. Landau.

We are struck by the uncommon breadth of Ginzburg's scientific interests. Now, in the last quarter of the Twentieth Century, science is developing at such a rapid pace that narrow specialization of the scientist, for all of its obvious undesirable consequences, has become almost inevitable. Even most of Ginzburg's students, who worked in several areas in their youth, are gradually beginning to localize their activity. Ginzburg himself, however, continues with the same dedication and soundness of purpose to work on such diverse problems as, for example, the astrophysics of the late stages in stellar evolution and the search for the mechanism of high-temperature superconductivity. It is not easy to say how he manages to do this. He is probably driven by the "thirst" of the genuine scientist, who cannot remain a detached witness to scientific progress, by a high degree of internal organization, and, finally, by a powerful physical intuition that is capable of penetrating the facade of apparently remotely related phenomena and discerning their common physical nature. Ginzburg himself sometimes remarks that he is rescued by his capacity for collateral association. This is certainly more than a joke, and we must assume that it is Ginzburg's special "associative" turn of mind that has redeemed many of his scientific achievements.

Quite arbitrarily, we may classify Ginzburg's activities as dealing with the following main areas: 1. Quantum electrodynamics and elementary-particle theory. 2. The theory of radiation and optics of condensed media. 3. The theory of condensed media (solid state, superconductivity, superfluidity). 4. The theory of plasma and the propagation of electromagnetic waves in plasmas and in the ionosphere. 5. The theory of the origin of cosmic rays. 6. Astrophysics and general relativity theory.

This list does not include Ginzburg's research in acoustics, spectroscopy, or thermonuclear fusion, to which he has made major contributions, and other fields. However, we shall not concern ourselves with the latter. We present here a brief review of the basic results that he has obtained in the areas numbered above.[2)]

[2)]As a rule, co-authors will not be named in referring below to Ginzburg's published works. An exception has been made for monographs, major reviews, and the most significant papers.

1. *Quantum electrodynamics and elementary particle theory*. It is difficult to include these problems among the main trends of Ginzburg's scientific career. However, they were the ones that attracted him as a youth to the degree that he became a theoretician. Both of his dissertations belong here, as does the problem of internal degrees of freedom of elementary particles, on which Ginzburg worked back in the early nineteen-forties and to which he has reverted more than once; it was also the subject of a review that he recently authored (with V. I. Man'ko).

Ginzburg clarified several subtle problems of radiation theory in his work on quantum electrodynamics. Here he resolved the paradox of radiation by a uniformly moving charge, which arises in perturbation-theory calculations, and others. All of these results were summarized in his Candidate's dissertation (1940). This was followed by development of the quantum theory and other aspects of the Vavilov-Čerenkov effect.

Ginzburg's early work in elementary-particle theory was summarized in his Doctoral thesis (1942, published in part in 1946). It dealt with a problem that had become highly acute at that time (and remains important even today): that of the equations for particles with higher spins. Analyzing several important problems dealing with a spin-3/2 particle (and, in particular, its interaction with an external field), Ginzburg considered the effects of inertia and damping of the mechanical moment of the spin particle and constructed the first relativistic quantum model of a particle capable of being in states with different spin values.

An important new step in the same direction was the paper that Ginzburg wrote jointly with Tamm in 1943–1944 (publication date 1947), which was the first to propose relativistic equations for a particle with internal degrees of freedom (the "relativistic top" model). Here, even before the mathematical construction of Lorentz-group representations had been completed, we have in fact finite-dimensional representations of this group that correspond to states of higher spins. The theory of these representations was later to become a center of increased attention in quantum field theory. However, interest in the problem of internal degrees of freedom of elementary particles became especially strong during the past decade, after the discovery of a large number of new particles resulted in the appearance of a classification of these particles based on higher symmetry groups. This was echoed in a 1965 paper in which a natural realization of the group properties of unitary multiplets was given for the case of an oscillator model. When the theory of strongly interacting particles gave rise to the concept of the parton, a special structural component of these particles, this fact was reflected in the aforementioned review (1976) of the present state of the theory of the relativistic equations for particles with internal degrees of freedom.

2. *The theory of radiation and optics of condensed media*. Development of the theory of radiation and propagation of light in condensed media has been a significant part of Ginzburg's scientific activity. Here we

include first of all his papers on the electrodynamics of faster-than-light radiation sources. Ginzburg's interest in this problem was, of course, no accident—it was at the Physics Institute of the USSR Academy of Sciences, where he began these studies, that the Vavilov-Čerenkov effect had been discovered not long previously and its nature explained (by Tamm and I. M. Frank). In 1940, Ginzburg developed the aforementioned quantum theory of the Vavilov-Čerenkov effect and the classical theory of this effect in anisotropic media. Papers on Vavilov-Čerenkov radiation in inhomogeneous media were appearing by 1947: radiation of a particle moving in a vacuum along the axis of a narrow channel in a medium (with Frank), radiation during motion along an interface between two media, radiation during motion of a particle in a periodic electric or magnetic field. Ginzburg proposed that the last two effects be used to generate millimeter and submillimeter radio waves. A device in which a periodic field is used for this purpose was later built by experimenters and came to be known as the "undulator." Papers published in 1947, 1952, 1958, and 1959, in which the radiation of a faster-than-light source with an electric or magnetic dipole moment was investigated, belong in the same area. In 1972, Ginzburg stated and developed the elegant idea of a radiation source whose velocity exceeds the velocity of light in vacuum. The Presidium of the USSR Academy of Sciences awarded Ginzburg the 1962 Lomonosov Prize for his work on the theory of the Vavilov-Čerenkov effect.

In 1945, with Frank, Ginzburg predicted the possibility of a new form of radiation, transition radiation, which appears when a charge (even a uniformly moving charge) crosses the interface between two media, and gave a theory of this phenomenon, which was observed experimentally 10 years later. Dozens of papers were devoted to theoretical and experimental study of the transition radiation, and it is now used to investigate the optical properties of surfaces and to register and measure the energies of fast particles under conditions such that Čerenkov and ionization counters become ineffective. In 1973, Ginzburg discussed a new type of radiation similar in a number of respects to transition radiation—namely, the radiation emitted by a uniformly moving particle in an optically homogeneous medium whose properties vary with time.

Among Ginzburg's numerous studies of the optics of condensed media, we might single out a major series begun in 1958 on crystal optics, which culminated in the monograph "Spatial Dispersion in Crystal Optics and the Theory of Excitons" (with V. M. Agranovich) in 1965. Here a wide range of effects (for example, gyrotropy in the resonance range, supplementary waves, anisotropy of cubic crystals) that are closely related to the existence of excitons in the medium are treated in unified fashion within the framework of phenomenological electrodynamics with spatial dispersion. Ginzburg developed this subject matter even further (gyrotropic media in 1972, surface excitons in 1974, and so forth).

3. *The theory of condensed media (solid state, superconductivity, superfluidity).* The theory of the solid state and quantum fluids is one of Ginzburg's principal scientific interests and owes him numerous results, many of them of fundamental importance. First of all, we should mention the development of a theory of ferroelectric phenomena (1945). His interest in this subject was stimulated by the discovery (at the FIAN) of the unusual properties of barium titanate and by the increasing technical importance of compounds of this class. Ginzburg interpreted these properties as ferroelectric. His 1945 and 1949 papers resulted in replacement of the previous model conceptions of ferroelectricity by a unified phenomenological theory, which, being quite general, was later used successfully to interpret numerous experimental data. Several other predictions have been confirmed directly in experiments. It must be noted that the 1949 paper contained the important conclusion that one of the lattice vibration frequencies vanishes at the phase-transition point. The study of features of the phonon spectrum near the structural-transition point ("soft" vibrational modes) that grew out of this was eventually developed by many other investigators. In 1947, the Presidium of the USSR Academy of Sciences awarded Ginzburg the Mandel'shtam Prize for his work in the field of ferroelectricity.

An important result, and one justly regarded as classical, was obtained by Ginzburg in one of the pivotal problems of phase-transition theory—that of the range of validity of Landau's theory of 2nd-order phase transitions, which does not take account of fluctuations of the physical quantities near the critical point and is therefore an "average-field" theory. In 1960, Ginzburg derived for the validity of the average-field theory a simple and physically lucid criterion that is often known as the Ginzburg criterion (references to the "Ginzburg number" are also found).[3] Using this criterion, its author indicated, among other things, why average-field theory is applicable almost everywhere in a superconductor, whereas it fails in a much broader temperature range in superfluid liquids. The recently developed theory of 2nd-order phase transitions, intended to describe fluctuations near the critical point, interpreted the meaning of the Ginzburg criterion in the language of the parameters that characterize the "effective mass" of the fluctuations and their interaction.

The theory of superconductivity occupies a special position in Ginzburg's work in solid-state physics. His coverage of problems in this area has been astonishingly broad, ranging from thermoelectric phenomena in superconductors and the aforementioned criterion for applicability of average-field theory to manifestations of superconductivity in the Universe. Ginzburg published a monograph on this problem back in 1946, and in the decades since he has authored a number of major reviews that include many of his own results. However, his crowning achievement in the field of superconductivity has undoubtedly been the phenomenological theory of superconductivity that he created with Landau in 1950 (the Ginzburg-Landau or GL theory). Created

[3] A criterion of this kind is encountered in a more formal and implicit form in a paper written by Ginzburg as a graduate student (with A. P. Levanyuk).

nearly ten years before the appearance of the Bardeen-Cooper-Schrieffer microscopic theory, it anticipated several important elements of the latter. In turn, the microscopic theory revealed the exact sense of the quantities in the GL theory and established the limits of its validity. The GL theory has been used very widely: as a basis for the description of superconductors placed in a strong magnetic field, of thin superconductive films, of superconducting alloys, hard superconductors, and many others. It is one of Soviet physics' most monumental contributions to world science and has been used in one form or another in hundreds of studies without losing its significance even a quarter of a century after its creation. In recent years, the main nonlinear equation of this theory has also proved to be a convenient base for study of one of the most urgent problems of quantum field theory—the theory of spontaneously broken field symmetry. The term "GL-type Lagrangian" has already figured in tens of papers in field theory. With its general physical roots, the GL theory and the theory of broken symmetry agree in many of their consequences, and this has made it possible to extend many deductions of the physics of the superconducting state to the physics of elementary particles. A Lenin Prize was awarded in 1966 for the series of papers in which Ginzburg, with A. A. Abrikosov and L. P. Gor'kov, worked on the theory of superconductivity in strong magnetic fields and the theory of superconducting alloys, including papers on the conception, development, and use of the GL theory.

In speaking of Ginzburg's contribution to the physics of the superconducting state, we must not fail to mention his role as perhaps the world's most active enthusiast in the search for "high-temperature superconductivity," i.e., ways to obtain a radical increase in the critical temperature of the superconducting transition. Ginzburg himself is correct in regarding this as one of the most important scientific-technical problems of the present day. He has advanced here one of the most important ideas and spares no effort on behalf of scientific and organizational activity in this field. It is not possible, of course, to guarantee the success of these studies, or even indicate the one true path to be taken. For this reason, the special team formed at the FIAN under Ginzburg's supervision has engaged in research in practically every direction that promises even a small chance of success. At the moment, Ginzburg is working on and editing a collective monograph to be entitled "Problems of High-Temperature Superconductivity."

Coverage of a broad spectrum of problems is again characteristic of Ginzburg's work in the field of superfluidity theory: papers on the scattering of light in a superfluid liquid (1943), on the critical-velocity problem (1949, 1955), on the superfluidity of the nucleon fluid in neutron stars (1964), on the quantum thermal-circulation effect in liquid helium (1972–1974), and on the superfluidity that liquid molecular hydrogen may acquire in the supercooled phase (1972). The phenomenological theory of superfluidity (Ginzburg-Pitaevskiĭ theory, 1958) has won particularly wide recognition. This theory, which has the same significance for superfluidity as the GL theory for superconductivity, laid the foundations for understanding of the behavior of superfluid liquids near walls, in thin films, and in capillaries, of the structure of the vortex filament, etc.

The limited scope of this paper precludes lengthy discussion of Ginzburg's other results in the theory of condensed media. They include: a theory of the scattering of light near 2nd-order phase transition points (1955, 1958, 1974), a theory of the structure of the domain wall in ferromagnets and ferroelectrics (1963), ideas concerning ferromagnetic and superconducting ordering on the surfaces of crystals (1964), on the paramagnetism of linear structures (1960), on the influence of interelectron interactions on the properties of metals (1955, 1965), and others.

4. *Electromagnetic waves in plasma*. Ginzburg's research in plasma theory has had a very strong influence on the development of the contemporary theory of electromagnetic-wave propagation in plasmas, in the earth's ionosphere, and in the corona of the sun. These studies began with the 1942 prediction (subsequently vindicated) of the interesting tripling of radio signals reflected from the ionosphere, with investigations of radio-wave absorption and refraction, etc. In 1943, when microwave spectroscopy and quantum electronics were still unknown, Ginzburg showed that radio waves with certain frequencies are not absorbed in the atmosphere solely because of compensating induced emission of the same waves by air molecules. His numerous results in this area were summarized in a pioneering monograph that has seen several later editions—each fully revised and considerably expanded. In the latest editions (1960 and 1967 in the Soviet Union and 1961 and 1969 abroad), its title is "Propagation of Electromagnetic Waves in Plasma." A related monograph "Waves in Magnetically Active Plasma," 1970 and 1975, was written jointly with A. A. Rukhadze.

In speaking of Ginzburg's contribution to this field of physics, one must take special note of his important paper (with A. V. Gurevich, 1960) on nonlinear phenomena in plasmas. This widely recognized contribution formed the basis for further intensive development of the theory of thermal nonlinear effects and had a decisive influence on studies of the ionospheric propagation of high-power radio waves. For example, it drew attention for the first time to the possibility of artificial modification of the F-layer of the ionosphere by radio waves. The theory of this idea was later developed in detail, and its experimental realization was of great scientific and practical importance. Several other nonlinear effects mentioned in this paper have also been brought about in experiment. They include generation of difference combination frequencies, which is the basis of the ionospheric detecting effect observed in 1973.

Ginzburg's name is also closely associated with the first studies of the sun's radio emission and in radio astronomy in general. Among other things, he proposed a number of important radio-astronomical observing methods that were subsequently put to extensive use. These studies were developed in collaboration with representatives of the radiophysics school that he had founded at Gor'kiĭ. As early as 1946, however, he had advanced the hypothesis that the outer regions of the sun's corona produce powerful radio emission, a notion that was confirmed experimentally last year. In the same year, he suggested a bremsstrahlung mechanism of the quiet sun's radio emission, which was subsequently confirmed in experiment. In 1952, he proposed that the increased radio emission from sources situated over sunspots is of synchrotron-radiation origin—a hypothesis that has proven highly productive in explaining the nature of the various components of the solar radio emission.

A 1958 paper written with V. V. Zheleznyakov investigated in detail the propagation and escape of electromagnetic waves from the plasma of the solar corona and the associated problem of polarization of the solar radio emission. A theory of the sun's sporadic radio emission was formulated at the same time. The study of the coalescence (Raman scattering) of plasma waves that was given in this paper was one of the first in a broad series of subsequent studies devoted to decay interactions of electromagnetic waves in plasmas.

In 1956–1958 (jointly with V. V. Pisareva), Ginzburg proposed an important method for study of the inhomogeneous structure of the circumsolar plasma by observaing the "flicker" of compact radio sources that is caused by diffraction of the radio waves on the inhomogeneities. In the same area, we have the interesting method proposed in 1960 for study of outer space by observing the polarization-lane rotation and depolarization of the emission from radio sources. The idea of observing the diffraction of discrete radio-source emission at the limb of the Moon was of particular value for study of the structure of those sources. The method has record-high resolution and is widely used in practical work.

5. *The theory of the origin of cosmic rays*. Ginzburg's long series of papers on the astrophysics of cosmic rays or, more narrowly, on the theory of their origin is directly related to his radio-astronomical studies. They began in 1951 with establishment of a relation between the characteristics of the cosmic ray electron component and the intensity of the synchrotron radiation that they produce in the galactic magnetic fields. This made it possible to use radio-astronomical data as a basis for inferences as to relativistic electrons and, with additional assumptions, as to cosmic-ray protons and nuclei in remote regions of the Universe. These studies were of tremendous importance for creation of the radio-astronomical theory of the origin of cosmic rays. They relate to Ginzburg's studies of particle motion in interstellar space.

He also made the first studies of the role of plasma effects in the motion of particles in cosmic space, namely of excitation and buildup of waves in the cosmic plasma and the reaction of these waves on the cosmic-ray fluxes.

Ginzburg was among the first to recognize the vital importance of research in gamma- and x-ray astronomy and put a great deal of work into their development. Among other things, his studies showed that gamma astronomy is capable of producing unique information on the proton-nucleus component of the cosmic radiation, just as radio astronomy is a source of data on their electron component. The basic results in this area were summarized in the 1963 monograph "The Origin of Cosmic Rays," which was written jointly with S. I. Syrovatskiĭ (and published in expanded form in England in 1964). It has served as the basic reference in this field for many years. Several review articles, papers, and pamphlets published in the USSR and abroad have been devoted to later results.

6. *Astrophysics and general relativity theory*. Ginzburg's research in the theory of the origin of cosmic rays grew into an interest in astrophysics in the broad sense, including problems of general relativity theory, cosmology, and extragalactic astronomy.

His papers on analysis of the possibilities for experimental verification of the general theory of relativity were followed by an attack on the problem of gravitational collapse, which is now arousing universal interest. In 1964, he drew attention to the tremendous increase in the magnetic field of a star when it becomes a neutron star as a result of contraction (this prediction was brilliantly confirmed with the discovery of pulsars). He then established (jointly with L. M. Ozernoĭ) that the magnetic field first increases rapidly on collapse of the star and then vanishes as the surface of the star approaches the Schwarzschild sphere. The general nature of this conclusion became clear later: not only the magnetic field, but also other characteristics of the collapsing body (except for its mass, angular momentum, and charge) vanish. These results were eventually used in elaboration of problems of the nature of quasars, the relation of general relativity theory to the theory of elementary particles, etc.

Ginzburg's attention then turned to the physical state of the intergalactic medium. He concluded in 1965 that despite the expansion of the Universe, the intergalactic gas may at the present time have a very high temperature and degree of ionization as a result of heating by active galaxies via shock waves, cosmic rays, and other intermediaries. This conclusion was to be confirmed by direct observations. In 1971, Ginzburg pointed out the importance of quantum fluctuations of the gravitational field in the general theory of relativity and cosmology. Very recently, he drew attention to the relation of the fundamental-length problem to the question of evaporation of "black holes," thus building a new bridge between microscopic and macroscopic cosmic physics.

The discovery of the pulsars in 1968 gave rise to yet another direction in Ginzburg's astrophysical subject matter. Here we refer principally to the work done by Ginzburg and his students on the theory of pulsar radio emission (1969–1971, 1975), the problem of their atmospheres (1972), the already mentioned research on the superfluidity of pulsar matter, etc.

Along with his purely scientific work, Ginzburg devotes much time and effort to scientific-organization activity. In 1971, after the death of his teacher Tamm, Ginzburg became his successor in the post of chief of the Division of Theoretical Physics of the P. N. Lebedev Physics Institute. Simultaneously, he directs the Moscow Physico-technical Institute's Department of Physical and Astrophysical Problems, which he organized about 10 years ago. He is also an active member of the board of the Division of General Physics and Astronomy of the USSR Academy of Sciences and a member of several of the scientific problem councils. He is on the editorial staff of the journal "Uspekhi Fizicheskikh Nauk" and those of a number of other Soviet and foreign scientific journals, and responsible editor of the journal "Izvestiya Vuzov (Radiofizika)."

The seminars that Ginzburg supervises are inseparable from his scientific activity. The weekly all-Moscow "Ginzburg Seminar" at the FIAN has existed for 20 years and invariably attracts about two hundred participants from the many Moscow and suburban Moscow scientific agencies. It is necessary to be present at this seminar to sense the scientific-holiday atmosphere that prevails there. In general, Ginzburg has a remarkable gift for captivating an audience. The absorbing scientific discussion, efficiently organized and proceeding at a crisp pace, is a real school of physics for its participants. Then, too, there is a weekly FIAN seminar on astrophysics, which brings several laboratories together, a more narrowly specialized seminar on superconductivity, and, once a month, the scientific session of the Division of General Physics and Astronomy of the USSR Academy of Sciences. Ginzburg has now headed these sessions for many years at the request of the Board of Directors of the Division.

How one man manages to do all of this may seem something of a mystery. Nevertheless, Ginzburg arrives at each of his appearances prepared and with notes, participates actively and in businesslike fashion in the work of the editorial staff of each journal, replies promptly to every letter, call, or request for criticism, and never signs his name to a single jointly written paper unless he himself has done the lion's share of the work. One way of answering might be to refer to the American saying: if you need help, go to a very busy businessman—an idle one never finds time. Or, even more simply: genius knows no rules.

As for the value of Ginzburg's accomplishments to science, there is his favorite proverb: "The proof of the pudding is in the eating." His works, and the trends that they establish, are being picked up and developed in many dozens, if not hundreds, of papers by a multitude of theoreticians and experimenters. This is probably the highest source of satisfaction for a scientist. But Ginzburg's career has also been recognized with more than a few official honors. His outstanding scientific achievements have won him Lenin and First Degree State Prizes, and, as we have already noted, the Lomonosov and Mandel'shtam Prizes; he holds the Orders of Lenin and of the Red Banner of Labor and the Badge of Honor, along with other medals; he has been elected to the USSR Academy of Sciences and to various foreign academies and scientific societies.

Ginzburg has every reason to rejoice at having reached the age of sixty. His many friends, colleagues, and students share this joy with him.

Translated by R. W. Bowers