L. I. Dorman, Cosmic Rays and the Solar Wind. About a quarter of a century ago, long before direct studies in space began, it was possible to acquire important information on the plasma streams from the sun and on the magnetic fields frozen into them from cosmic-ray observations. Two types of streams were detected. It was then possible to establish with the aid of the cosmic rays that the magnetic field strength is a few gammas ($1\ \gamma = 10^{-5}$ G) in type I streams (which later came to be known as the quiet solar wind after a suggestion of E. Parker), and an order higher in the type II streams (the disturbed solar wind, which causes magnetic storms on the earth). Direct measurement of the magnetic fields made in interplanetary space many years later confirmed these results. We should note that the first cosmic-ray solar-wind information was obtained by the use of the coupling-coefficient method, which was applied to data from continuous ground observations of the mesonic (from 1935) and neutron (since 1952) cosmic-radiation components [1].

Solar-wind cosmic-ray sounding techniques were subsequently improved both by the use of a powerfully developed experimental base (ground observations of cosmic rays at more than a hundred stations equipped with neutron and meson supermonitors; observations in the stratosphere and at various depths underground; indirect methods using meteorite and ionospheric data; cosmic-ray experiments on satellites and unmanned interplanetary spaceprobes) and by the development of methods for extraction of space-physical information from cosmic-ray observations (allowance for meteorological and geomagnetic effects; satellites, variational coefficients, the ring of stations, reception vectors; determination of the total cosmic ray distribution function in interplanetary space from measurements at the worldwide station network; study of cosmic-ray fluctuations) [2-9]. The reliability and accuracy of information obtained from cosmic rays on processes in interplanetary space also depend in large part on the correctness and completeness of our conceptions as to the manner in which cosmic rays (CR) propagate and their interaction with the solar wind (theory of isotropic and anisotropic diffusion of CR with consideration of convective transfer and adiabatic cooling, calculations for unsymmetrical models with consideration of the real distribution of solar activity over the sun's disk and its variations with the 11-year cycle; the kinetic theory of cosmic-ray propagation and modulation and of the formation of anisotropy and fluctuations of the CR, the interaction of cosmic rays with interplanetary shock waves) [10-19]. A nonlinear theory of the modulation of cosmic rays in interplanetary space with consideration of the reciprocal effects of the CR on the solar wind has also been developed on the basis of a system of self-consistent equations [20].

The problem of the cosmic ray-solar wind interaction is exceptionally complex and many-sided. In recent years, it has been possible to obtain significant results in the following areas: a) action of the solar wind and distortion of the spectra of various nuclei and electrons of the galactic cosmic rays in the energy range 0.1 MeV-2×10^2 GeV, reconstruction of the interstellar spectrum and the problem of subcosmic rays; b) action of the solar wind on the external anisotropy of cosmic rays of galactic origin (which is especially significant at low energies); c) establishment of a relation between the modulation parameters of cosmic rays in interplanetary space and the solar-activity indices (with consideration of the delay of electromagnetic conditions at various distances from the sun relative to the processes in the solar atmosphere); d) investigation and interpretation of the 11-year, annual, and 27-day variations, of the solar anisotropy, and of the radial and transverse cosmic-ray gradients in interplanetary space; e) investigation of the properties of the solar wind at great distances from the sun and from the plane of the ecliptic (where we do not yet have direct measurements of the plasma and magnetic fields from space vehicles) through the cosmic-ray modulation effects, prediction of the presence of a transitional layer between the solar wind and the interstellar medium and estimation of conditions in it; f) use of cosmic rays to investigate the sector and jet structure of the solar wind and features of the regular component of the interplanetary magnetic field (cosmic-ray current systems, rotation of anisotropy vector on crossing between sectors, analysis of the second cosmic ray spherical harmonic, propagation behavior of solar cosmic rays along the boundaries between sectors with opposite field directions); g) study of the shape, structure, and velocity of interplanetary shock waves from chromospheric flares and compressed magnetic field regions propagating away from the sun through the increases of cosmic ray intensity before the onset of magnetic storms; h) study of the properties and spectrum of magnetic inhomogeneities in the solar wind using data on the nature of the transport path for cosmic-particle scattering as a function of the distance to the sun and of the hardness of the CR, and also data on the fluctuations (flicker) of cosmic-ray intensity and its distribution function [21-24].

[1] L. I. Dorman, Variatsii kosmicheskikh lucheĭ (Cosmic Ray Variations), Gostekhizdat, 1957.
[2] L. I. Dorman, Variatsii kosmicheskikh lucheĭ i issledovaniye kosmosa (Cosmic Ray Variations and Investigation of Outer Space), AN SSSR, 1963.
[3] A. I. Kuz'min, Variatsii kosmicheskikh lucheĭ vysshykh énergiĭ (Variations of High-Energy Cosmic Rays), Nauka, 1964.
[4] A. I. Kuz'min, Variatsii kosmicheskikh lucheĭ i solnechnaya aktivnost' (Cosmic Ray Variations and Solar Activity), Nauka, 1968.
[5] L. I. Dorman, Meteorologicheskie éffekty kosmicheskikh lucheĭ (Meteorological Effects of Cosmic Rays), Nauka, 1972.
[6] L. I. Dorman, V. S. Smirnov, and M. I. Tyasto, Kosmicheskie lucheĭ v magnitnom pole zemli (Cosmic Rays in the Earth's Magnetic Field), Nauka, 1971.
[7] L. I. Dorman, R. T. Gushchina, M. A. Sheĭ, and D. F. Smart, Éffektivnye zhestkosti obrezaniya kosmicheskikh lucheĭ (Effective Cosmic Ray Cutoff Rigidities), Nauka, 1972.
[8] P. Velinov, G. Nestorov, and L. Dorman, Vozdeĭstvie kosmicheskikh lucheĭ na ionosferu i rasprostranenie radiovoln (Effects of Cosmic Rays on the Ionosphere and Radio Propagation), Bulgarian Academy of Sciences Press, 1974.
[9] L. I. Dorman, Cosmic Rays: Variations and Space Explorations, Amsterdam, North-Holland, 1974.
[10] E. Parker, Interplanetary Dynamic Processes, Wiley, 1963.
[11] E. N. Parker, Planet. and Space Sci. 13, 9 (1965); W. I. Axford, ibid., p. 115; L. I. Dorman, in: Proc. of 9th Intern. Conference on Cosmic Rays, Vol. 1, London, 1965, p. 292.
[12] L. I. Dorman, Comm. Astrophys. and Space Phys. 5, No. 3 (1973); ibid., No. 4.
[13] L. I. Dorman, in: Cosmic Rays, No. 8, Nauka, 1967, p. 305; ibid., No. 13, 1973, p. 5.
[14] G. F. Krymskiĭ, Modulyatsiya kosmicheskikh lucheĭ v mezhplanetarnom prostvanstve (Modulation of Cosmic Rays in Interplanetary Space), Nauka, 1969.
[15] A. Z. Dolginov and I. N. Toptygin, Izv. Akad. Nauk SSSR, Ser. Fiz. 30, 1780 (1966); 31, 1269 (1967); 32, 1821 (1968).
[16] L. I. Dorman and M. E. Kats, ibid. 36, 2271 (1972); 38, 1961 (1974).
[17] L. I. Dorman and Z. Kobilinski, ibid. 32, 1928 (1968); 34, 2408, 2415 (1970); 36, 2332, 2346 (1972).
[18] L. I. Dorman, N. S. Kaminer, and A. E. Kuz'micheva, ibid., p. 2391; 37, 1241 (1973).
[19] A. V. Belov, L. I. Dorman, and B. A. Shakhov, Geomagn. i Aéronom. 13, 399 (1973); Izv. Akad. Nauk SSSR, Ser. Fiz. 38, 1884 (1974); L. I. Dorman and V. Kh. Shogenov, ibid., p. 1888.
[20] I. V. Dorman and L. I. Dorman, ibid. 32, 1838 (1968); 33, 1908 (1969); Geomagn. i Aéronom. 8, 817, 1008 (1968).
[21] Cosmic Rays, Nos. 8–14, Nauka, 1967–1974.
[22] Proceedings of Leningrad International Seminars on Cosmic Rays and Related Problems, Vols. I–V, Leningrad, 1969–1973.
[23] Izv. Akad. Nauk SSSR, Ser. Fiz. 34 (11) (1970); 35 (12) (1971); 36 (11) (1972); 37 (6) (1973); 38 (9) (1974).
[24] Proc. of 13th Intern. Conference on Cosmic Rays, Vols. 1 and 2, Denver, 1973.

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