where the units of measurement of the characteristic scales of the field and electron density are $[l_B]\approx 10^{10}$ cm and $[N]\approx 10^8$ cm^{-3}. As measured with this formula, the magnetic fields at heights of $(50-100)\cdot 10^3$ km are in the tens of oersteds, in general agreement with the conception of the potential nature of the field in the corona.

Special interest attaches to the results of coordinated studies of active regions in which radioastronomical magnetic-field measurements made by all three of the above methods were combined with observations of the same region in other wavelength bands. Several coordinated observations of this kind have been within the framework of the international Solar Maximum Year program. An interesting example was the study of the arches of a behind-limb coronal condensation that was observed on November 19, 1980 jointly with the Mountain Astronomical Station at Kislovodsk. Among other things, it was shown that the magnetic fields within the coronal arch and outside of it at the same altitude were of the same order of magnitude (about 20 G at a height of 75 000 km).

L. I. Dorman. *The Sun and galactic cosmic rays.* The sun is not only a generator of powerful electromagnetic radiation and high-energy particles (solar cosmic rays, SCR), but also strongly influences the intensity, anisotropy, and spectrum of the high-energy particles arriving from the galaxy (galactic cosmic rays, GCR). This modulation gives rise to local effects that are shaped in a comparatively small volume with dimensions of, say, a few astronomical units (the Forbush decrease of the GCR, the solar anisotropy, the false "stellar" anisotropy, the 27-day variations, effects in which GCR are intensified before strong interplanetary shock waves arrive at the earth, GCR scintillations), and global effects, which are shaped throughout the entire solar-wind region with dimensions running to many tens of astronomical units (the 11-year and 22-year GCR variations).[1-6]

The modulation effects are classed as extraterrestrial CR variations. In the variations that can be observed with ground-based instruments for continuous CR registration (neutron monitors and supermonitors, muon telescopes, etc.),[5] we have the sum of all three classes: those of atmospheric,[7] magnetospheric,[8] and extraterrestrial origin. They are separated, and the extraterrestrial CR variations isolated, by spectrographic analysis of the results of simultaneous measurements of several components with different sensitivities to the primary CR (with different coupling coefficients; see Chap. VIII of Ref. 9). For this purpose, two mountain CR spectrographs were built in the Sayan Mountains and on Mt. El'brus in the Soviet Union between 1968 and 1975; they are still the only installations of their kind in the world. They can be used to separate the variations of magnetospheric origin, apply the appropriate corrections to observational data from the worldwide station network, and find the planetary distribution of the manifestations in the secondary components of variations in the extraterrestrial primary CR. Then the coupling coefficients and computed particle paths in the real geomagnetic field are used to make the corresponding conversion beyond the limits of the earth's magnetosphere for each station. The planetary CR distribution found for each instant of time is subjected to spherical analysis to find the temporal variations of CR density (of the isotropic intensity component) and the parameters of the spherical harmonics (see Refs. 4, 6, and 10 and Chap. IX in Ref. 9). In this procedure, therefore, the world station network (with its approximately 100 stations) is used as a unified multidirectional planetary instrument. The results obtained in this way are exceptionally accurate and reliable. They form the basis for acquisition of detailed information on both local and global CR modulation effects.

Using this approach, it has been possible in recent years to make a thorough study of the interaction of the flare plasma and the high-velocity solar wind fluxes with the GCR and to obtain a rather complete picture of the formation of the diurnal and semidiurnal components of the anisotropy vector, the radial and transverse gradients, and the 27-day variation of the GCR.

Study of the global modulation—the 11- and 22-year variations of GCR intensity and anisotropy—is considerably more difficult. This is because these variations are governed by processes that are related to the cyclic activity of the sun and unfold in interplanetary space at such great distances from the earth (both in the radial direction and in the direction transverse to the sun's equatorial plane) that practically no direct information on them is available or can even be expected within the next few years. However, it is possible to obtain some indirect information on these processes by comparing the theoretically expected effects with the observed global modulation.

First of all, it was possible to establish back in 1967 that the relation between the long-term variation of the GCR and solar activity is not linear, but has a complex hysteretic nature because of the large size of the region of global GCR modulation (50–100 a.u.).[11] This relationship has been found to differ significantly for GCR particles of low hardness (~1 GV, observations on space vehicles and in the stratosphere), medium hardness (~10 GV, neutron-monitor observations), and high hardness (~100 GV, ground and underground observations using muon telescopes). To explain these features, it was proposed that the dimensions of the solar wind are quite large (50–100 a.u.), so that the variations of electromagnetic conditions in interplanetary space (which determine the global GCR modulation) occur with a considerable lag behind the processes on the sun. Since the intensity of the interplanetary magnetic field decreases with distance from the sun, the effective dimensions of the modulation region decrease with increasing particle hardness. In accordance with these conceptions, computer calculations were made to determine the expected global modulation[13] within the framework of the theory of anisotropic GCR diffusion in interplanetary space.[12] It was believed at that time that the magnetic field has a sector structure in interplanetary space, and that the directions of the force lines reverse at the transitions between sectors. Therefore the off-diagonal components of the anisotropic-diffusion tensor would also change sign, and could be neglected on averaging over times longer than the period of rotation of the sun on its axis. Although the theory explains the basic patterns of the global modulation correctly in first approximation, a certain disagreement of theory with observational data was noted, and became significant after the polarity reversal of the sun's general magnetic field in 1969–1970, when the intensity of GCR increased much more rapidly with time than had been expected[14] (see also the review in Ref. 15).

It was clearly necessary to consider the influence of the sun's general field and its polarity reversals on the global modulation of the GCR. Actually, owing to the solar wind, the general field of the rotating sun is drawn out into interplanetary space in the form of Archimedean spirals, in such a way that if the force lines leave the sun north of the equatorial region (where the field has sector structure owing to the influence of the active regions), they enter the sun south of that region. The general field reverses approximately every 11 years, so that the total cycle comes to about 22 years. Thus, the off-diagonal components of the anisotropic diffusion tensor are nonzero above and below the equatorial region and drift fluxes arise owing to the presence of the transverse and radial GCR density gradients. As a result, the global modulation would be weaker for GCR protons and nuclei in 1947–1957 and 1971–1981 (owing to the drift fluxes toward the equatorial region), and the anisotropy vector would shift to later hours; in 1958–1970 and 1982–1993, the modulation would become stronger, and the anisotropy vector would shift to earlier hours.[16,17] It is important to stress that in Ahluwalia's alternative model[18] of reconnection of the force lines of the heliomagnetosphere and the galactic magnetic field, the effect should not depend on the sign of the charge on the particles and the phase of the anisotropy vector should not change. The reconnection model can produce only a certain incremental effect to the above principal mechanism of global modulation by drift fluxes within the framework of anisotropic-diffusion theory.

Since the dimensions of the modulation region are large (50–100 a.u.; this follows from ground observations of the hysteresis effects and from direct determinations of the radial GCR gradient from synchronous measurements made on different spacecraft), it is necessary to consider the nonlinear interaction of the solar wind and cosmic rays (radial deceleration of the solar wind and transverse constriction of the high-velocity cosmic-ray fluxes are predicted).[20]

[1]L. I. Dorman, Variatsii kosmicheskikh lucheĭ (The Variations of the Cosmic Rays). Gostekhizdat, Moscow, 1957.

[2]L. I. Dorman, Variatsii kosmicheskikh lucheĭ i issledovanie kosmosa (The Variations of the Cosmic Rays and Space Research). Nauka, Moscow, 1963.

[3]E. N. Parker, Interplanetary Dynamic Processes. Wiley, 1963 [Russ. Transl. Mir, Moscow, 1965].

[4]G. F. Krymskiĭ, Modulyatsiya kosmicheskikh lucheĭ v mezhplanetnom prostranstve (Modulation of Cosmic Rays in Interplanetary Space), Nauka, Moscow, 1969.

[5]L. I. Dorman, Éksperimental'nye i teoreticheskie osnovy astrofiziki kosmicheskikh lucheĭ (Experimental and Theoretical Foundations of Cosmic-Ray Astrophysics), Nauka, Moscow, 1975.

[6]L. I. Dorman, Variatsii galakticheskikh kosmicheskikh lucheĭ (The Variations of the Galatic Cosmic Rays). Moscow State University Press, Moscow, 1975).

[7]L. I. Dorman, Meteorologicheskie éffekty kosmicheskikh lucheĭ (Meteorological Effects of Cosmic Rays). Nauka, Moscow, 1972.

[8]L. I. Dorman, V. S. Smirnov, and M. I. Tyasto, Kosmicheskie luchi v magnitnom pole Zemli (Cosmic Rays in the Magnetic Field of the Earth). Fizmatgiz, Moscow, 1971.

[9]L. I. Dorman, Principles of Cosmic Ray Astrophysics and Geophysics. Amsterdam: D. Reidel Publ. Co. (in press).

[10]L. I. Dorman, Cosmic Rays: Variations and Space Explorations. Amsterdam: North-Holland, 1974.

[11]J. V. Dorman and L. I. Dorman, Izv. Akad. Nauk SSSR, Ser. Fiz. **31**, 1273 (1967).

[12]L. I. Dorman, In: Proc. of 9th Intern. Cosmic Ray Conference, London **1**, 292 (1965).

[13]L. I. Dorman and N. P. Milovidova, In: Proc. of 13th Intern. Cosmic Ray Conference. Denver **2**, 713 (1973).

[14]A. I. Charakhch'yan, G. A. Bazilevskaya, A. K. Svirzhevskaya, Yu. I. Stozhkov, and T. N. Charakhch'yan, Izv. Akad. Nauk SSSR, Ser. Fiz. **37**, 1258 (1973).

[15]A. N. Charakhch'yan and T. N. Charakhch'yan, Izmenchivost' obshchego magnitnogo polya Solntsa kak istochnik modulyatsii kosmicheskich lucheĭ (The Variability of the Sun's General Magnetic Field as a Source of Cosmic Ray Modulation), FIAN SSSR Preprint, Moscow, 1981.

[16]M. V. Alaniya and L. I. Dorman, Izv. Akad. Nauk SSSR, Ser. Fiz. **43**, 4 (1979).

[17]M. V. Alania and L. I. Dorman, In: Proc. of 16th Intern. Cosmic Ray Conference. Kyoto, **3**, 57 (1979).

[18]H. S. Ahluwalia, *ibid*. **12**, 216.

[19]I. V. Dorman and L. I. Dorman, Geomagn. i Aeronom. **8**, 817–1008 (1968); Izv. Akad. Nauk SSSR, Ser. Fiz. **33**, 1908 (1969).

[20]V. Kh. Babayan and L. I. Dorman, In: Proc. of 15th Intern. Cosmic Ray Conference. Plovidiv, 1977. V. 3, p. 107; Proc. of 16th Intern. Cosmic Ray Conference. Kyoto, 1979. V. 3, p. 117, 123; Proc. of Intern. Cosmic Ray Conference. Paris, 1981. V. 3, p. 373.