ORBITAL SPECTRA OF GALACTIC COSMIC RADIATION FOR TWO MODELS OF LOCAL SPECTRA

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Estimation of the action of radiation on matter, calculation of the dosimetric characteristics, and the solution of a number of physical problems all demand knowledge of the spectra of penetrating particles, integrated over the time that the space apparatus was in orbit.

In particular, at small distances from the earth the essential value is that of the proton component of the galactic cosmic radiation (GCR). In connection with the necessity of calculating the local spectra at a large number of points in the orbit, there arises the question of whether there might be a simpler method of obtaining them. One frequently used for this the value of the vertical hardness of the cut-off, calculated, for example, according to the formula

$$P_{\text{vert}} = 14.8\,(1/L)^2, \text{ GV},$$

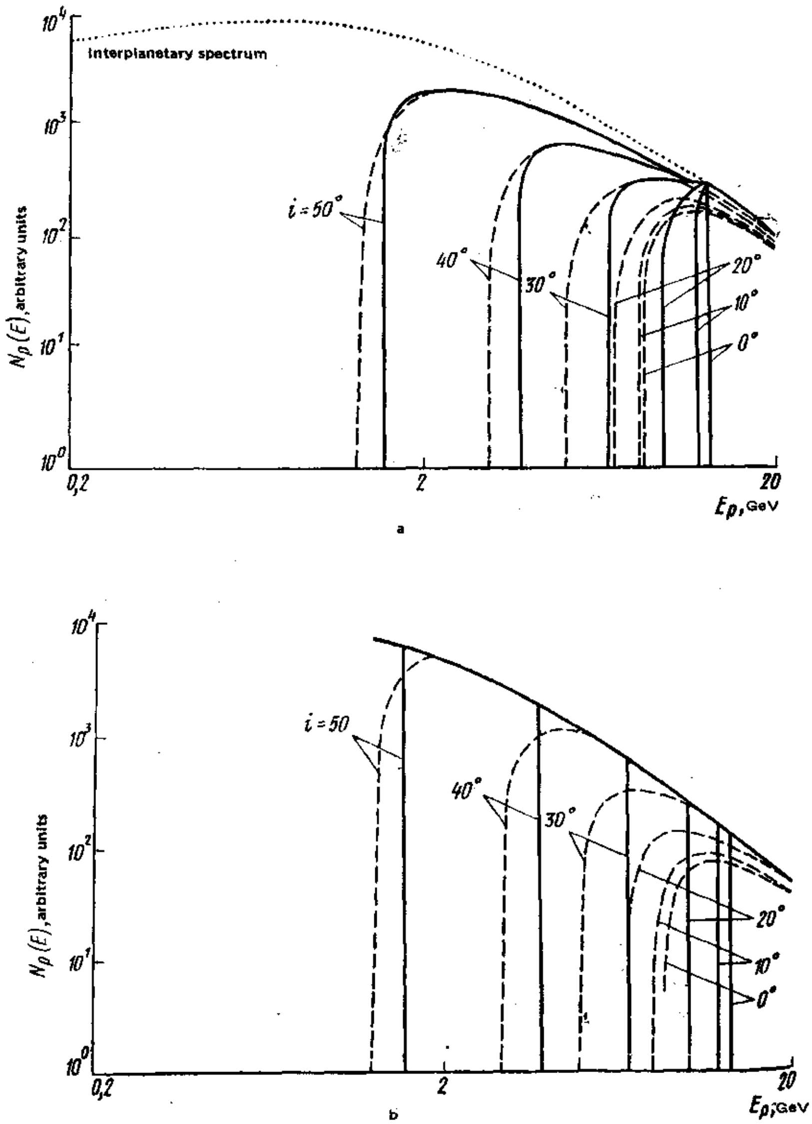
where L is the McIlwain parameter. The local spectrum in such a case is considered to be coincident with the interplanetary spectrum of GCR for hardnesses greater than the vertical hardness of the cut-off, and zero on the side of smaller values.

Another more exact but more complicated method of calculation is based on the evaluation of the solid angle of the volume Ω as a function of the hardness of the particles in the entire inverval $0<\Omega<2\pi$. Knowing the interplanetary spectrum and applying the Liouville theorem, it is easy to convert to the local spectrum. The theoretical groundwork of the calculation is set forth, for example, in [1]; a description of the practical aspects of the calculation is developed in [2].

To obtain a quantitative estimate of the difference between the spectra obtained by the two methods, a computer calculation was carried out. The figure (a) shows the spectra integrated over one revolution of a circular orbit of radius 6670 km for different angles of inclination. The figure (b) gives the local spectra calculated at points of the same orbit situated at maximum latitudes. For this calculation, the earth's magnetic field was assumed to be that of a central dipole, coaxial with the planetary rotation axis. The interplanetary spectrum was taken from [3] for minimum solar activity.

As can be seen from the figure, the difference of the lower boundaries of the spectrum, taken at a level of -10 dB from the point of intersection of the graphs (same currents), changes approximately from 50 down to 10% as the angle of inclination of the orbit increases from 0 to 50°. The character of this change is the same for both the single-revolution and local spectra. The difference between the spectra is observed mainly for hardnesses larger than or approximately equal to the vertical hardness of the cut-off (figure (b)), and for single-revolution spectra relates to the part of the orbit near the point of maximum latitude. But since this is so, the change of the difference between the spectra calculated by the two methods caused by conversion to a multipolar representation for the earth's magnetic field will be due to mainly the change of the point of maximum latitude of the orbit. And this reduces in practice to taking a pair of spectra (figure (a)) with some altered angles of orbital inclination.

From what we have said, it follows that the value we have just estimated is preserved upon conversion to a more exact model of the earth's magnetic field. And, in particular, the results obtained can be used to optimize the calculation procedure for the actual field. We note that a practical dosimetric calculation demands that account be taken of



Proton spectra evaluated according to the vertical severity of the cut-off (solid lines) and according to the cones of Stermer (dashed lines): *a* is integrated over one revolution; b is at the point of maximum latitude of the orbit.

such sources as albedic protons, fission products of particles in the material of the object, etc., which have not been examined in this paper.

REFERENCES

1. L. I. Dorman, V. S. Smirnov, and M. I. Tyasto, Cosmic Rays in the Magnetic Field of the Earth [in Russian], Moscow, 1971.

2. V. V. Suvorov and M. V. Tel'tsov, Vestnik Moskovskogo Universiteta. Fizika [Moscow University Physics Bulletin], vol. 30, no. 3, p. 41, 1977.

3. A. N. Charakhch'yan and T. N. Charakhch'yan, Geomagnetizm i Aeronomiya, vol. 2, p. 240, 1970.

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