Diurnal Variation of Cosmic Rays and Terrestrial Magnetism

Quite recently A. H. Compton[1] and Bennett, Stearns and Compton[2] have secured data showing that the intensity of the softer components of the penetrating radiation increase with magnetic latitude and with the altitude of the sun above the horizon. They suggest that the variation with latitude results from the ionic nature of the ionizing ray. Indeed, this is just what one would conclude from the expansion chamber experiments which show tracks corresponding to ionic energies of 10^9 electron volts and these would be greatly deflected by the earth's magnetic field. It is the purpose of this note to point out that the diurnal variation of the cosmic-ray intensity is a necessary consequence of the newly demonstrated deflectibility of the ionizing particles by the earth's magnetic field.

The observed variation of cosmic-ray intensity with latitude shows that the intensity is quite sensitive to the magnitude and the direction of the earth's magnetic field. Thus since the earth's magnetism is subject to a large diurnal variation we should expect a reflected variation in the cosmic-ray intensity.

We have shown that diamagnetism in the ionized regions of the high atmosphere distorts the earth's magnetic field in much the same way as the solar magnetic field is distorted, except the distortion is much less and is confined pretty much to the sunlit side of the earth. This diurnal distortion decreases the magnetic field above 200 km by 0.1 percent or more in noonday regions so that the cosmic rays (or perhaps, more precisely, the secondary rays) are less deflected and produce locally more intense ionization at low levels. Qualitatively the observed diurnal variation is about what we would infer from the way that the ionization changes with latitude.

Thus it does not seem necessary to suppose that the sun is a weak source of penetrating radiation or that space in the direction of the sun has special properties.

Perhaps, we should point out finally that the asymmetry of the earth's magnetic field will introduce variations of the cosmic-ray intensity with longitude and with the time of year.

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[1] A. H. Compton, Phys. Rev. **41**, 111 (1932).

[2] Bennett, Stearns and Compton, Phys. Rev. **41**, 119 (1932).

The Spin of the Neutron

From some of the recent information reported about neutrons it seems possible to find out whether the neutron has a spin and if so what its value is. In order to do this it is necessary to make several assumptions about the structures of light nuclei: (1) They are built as far as possible out of alpha-particles. (2) The nuclear spin is determined from the spin of its component spins alone. (3) From the evidence that neutrons may be obtained from Li, it is assumed that at least one of the isotopes contains a neutron in its nucleus. (4) The possibilities considered for the spins of the various particles in the nucleus are proton 0, $\frac{1}{2}$; neutron 0, $\frac{1}{2}$, 1; electron 0, $\frac{1}{2}$; alpha-particle 0. The first assumption is one commonly made and is supported by studies on the artificial disintegration of the light elements. The second assumption seems reasonable for the light elements in view of what is known about their nuclear moments. (If orbital moments quantized to integer values are assumed for the nucleus, deductions about whether the nuclear moment should be integer or half integer are not disturbed but those utilizing the actual value are.)

The spin of the free proton is determined from hydrogen to be $\frac{1}{2}$ and that of the extranuclear electron is well known to be also $\frac{1}{2}$ but the possibility of both of these losing their spin in a nucleus should not be overlooked. The various possibilities given above will be divided into two groups for which the proton spin is considered to be 0 and $\frac{1}{2}$ respectively.

As nuclei on which to try these various possibilities the two isotopes of Li, and N^{14} are considered. Curie and Joliot[1] have recently discovered that the highly penetrating radiation emitted from lithium when it is bombarded with alpha-particles from polonium consists of neutrons. They are similar to the particles emitted by Be and B recently dis-

[1] Curie and Joliot, Nature **130**, 57 (1932).