JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN Vol. 17, SUPPLEMENT A-II, 1962
INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part II

II-2-14. On the Theory of the Outer Van Allen Belt

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An outline of a theory of the outer radiation belt is given, implying three simple processes:

(A) The capture by the Earth's magnetic field of an interstellar plasma by means of a varying large-scale electric field $\boldsymbol{E}=\boldsymbol{v}\times\boldsymbol{H}_0$ in the environment of the earth. The field is produced by the motion of a plasma having the magnetization H_0 with the velocity $\vec{v}$. The variation of $\vec{E}$ is caused by changes in $\vec{v}$, or $\vec{H}$ or in the angle between them. By this variation plasma is pumped into the Earth's magnetic field. The density and the energy of the electrons will increase roughly proportional to H_1/H_0 where H_1 is the strength of the geomagnetic field in the considered point.

(B) Besides this pumping by means of a large-scale electric field, electric "microfields" may also be of importance. It is well known that if a number of electrons are injected with equal energy into a magnetic field, a small number of them will increase in energy at the expense of the other. The process is effected by means of an electrostatic field of "noise" character.

By means of (A) and (B) electrons will increase in energy and at the same time there will be a displacement of the density maximum inwards (Herlofson).[1]

(C) There may be many processes by which the electrons are removed from the radiation belts. One of the most important is probably due to magnetic scattering. As Herlofson has shown already a very small magnetic disturbance is able to dump the radiation into the ionosphere if the linear extension of the disturbing field is of the same order as the Larmor radius of the electrons.

References

1) N. Herlofson: Proc. ICRES II-2-10.

Discussion

Swann, W. F. G.: I presume that the electric field to which Prof. Alfvén refers is *not* the field occurring in his theory of magnetic storms. In that theory if the stream moves in the direction of the axis of X, and carries with it a magnetic field in the direction of Z, there will be no motion of a particle for an observer who travels with the storm. To a stationary observer there will be an electric field but also a magnetic field $\vec{H}$ such that $(\vec{E}+\vec{v}\times\vec{H})$ is zero, so that again there will be no motion of the particle in relation to the stream consistent with the above there will remain only the effect of the earth's magnetic field except for the motion of the stream perpendicular to itself as viewed from the earth.