core V19 29 where the observed value changed from 4.61 to 4.79 per mil. We suggest that this transition correlated with a depth of about 415 cm in the present core. Such a procedure is difficult to apply with absolute rigor since the two records to be correlated are both approximations to the actual time sequence of isotopic fluctuations. However, the use of this procedure enables us to pick confidently all the stage and substage boundaries except the boundary between stages 4 and 3, which is poorly developed in core Y72 11 1.

With few exceptions, 500 pollen grains were counted in each sample. Relative frequency and concentration data for the roughly 50 taxa recognized will be discussed elsewhere (L. E. Heusser and N. J. Shackleton, in preparation). The most significant pollen types (> 2 percent) are presented here as the percentages of the total arboreal and nonarboreal pollen. Pollen zones are those discussed in (*18*).

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Power-Line Harmonic Radiation: Can It Significantly Affect the Earth's Radiation Belts?

Abstract. *It has been suggested that harmonic radiation from the earth's 50- and 60-hertz power transmission lines might significantly influence the distribution of electrons in the radiation belts. On the basis of observations presented here, it seems advisable to accept such a hypothesis with caution. New evidence suggests that power-line radiation does not play any major role in the nonadiabatic dynamics of radiation belt electrons.*

Considerable attention has recently been paid to the possibility that man-made radio signals (in particular, harmonic radiation from the earth's 50- and 60-Hz power transmission lines) can significantly influence the distribution of energetic electrons in the radiation belts (*1*–*3*). Although power-line radiation (PLR) itself has yet to be directly reported deep in the magnetosphere, the premise is that such radiation can leak into the magnetosphere and there act as a source of embryonic emission which subsequently grows to measurable amplitudes as a result of resonant wave-particle interactions. The enhanced waves then strongly scatter electrons, causing electron precipitation loss to the atmosphere. The question that we raise here is the relative importance of scattering by such triggered waves as compared to that from naturally generated emissions.

There are three categories of magnetospheric waves that are known to exert a major effect on radiation belt electrons.

1) Close to the earth within the relatively high-density region termed the plasmasphere, there is an essentially continuous, broad-band, structureless, electromagnetic emission with frequencies between a few hundred hertz and a few kilohertz (*4*). It has been explicitly shown that this emission, called plasmaspheric hiss, can account for both the observed flux distribution and the gradual precipitation loss of electrons after their injection into the inner magnetosphere during geomagnetic disturbances (*5*).

2) Outside the plasmasphere, an intense electromagnetic emission, termed chorus, is detected during substorm electron injection events (*6*, *7*). In contrast to hiss, these waves have a discrete frequency-time structure and their growth is clearly nonlinear (*8*). When present, the waves are sufficiently intense to cause rapid precipitation of electrons in the outer radiation zone (*7*).

3) Electrostatic waves with frequencies above the electron gyrofrequency (Ω_-) are continuously present on auroral field lines (*9*) and are commonly found throughout the outer radiation zone, especially during substorms. These waves are thought to be the principal cause of diffuse auroral precipitation (*10*, *11*) (1 to 10 keV) and an important source of outer-zone electron scattering during disturbed times.

If PLR is to be considered as a significant means of modifying the earth's radiation belts, one must inquire whether any of these emissions are predominantly triggered rather than excited naturally.

In the case of plasmaspheric hiss, the waves exhibit no perceptible frequency structure which might indicate stimulation by power-line harmonics. As a further test for man-induced triggering, we have analyzed (*12*) the occurrence of extremely low-frequency emission in over 1800 samples of data taken during an 18-month period on the polar-orbiting satellite (Orbiting Geophysical Observatory) OGO-6. We found no tendency for the emissions to be enhanced during weekdays (as opposed to weekends when power-line currents are smaller). Furthermore, whereas waves stimulated by PLR should exhibit strong geographic control, the hiss activity (Fig. 1C) is essentially independent of geographic longitude; this result has recently been confirmed by an independent study of signals from 500 to 1000 Hz measured on Ariel 4 (*3*). We therefore conclude that plasmaspheric hiss originates naturally [an adequate source is the cyclotron resonant amplification of background thermal emissions (*13*)] and that the nonadiabatic dynamics of inner-zone and slot-region electrons are primarily controlled by natural processes (*14*). Powerful very-low-frequency transmitters might locally enhance the electron precipitation flux (*2*), but, because of the narrow-band nature of these waves, the scattering is confined to a limited number of resonant electrons in a restricted region of the magnetosphere. Such monochromatic waves, no matter how intense, are therefore unable to significantly affect the overall evolution of the radiation belts.

When considering man-induced effects on the outer radiation belt, one must inquire into the source of electromagnetic chorus and the intense electrostatic electron cyclotron waves. Ashour-Abdalla and Kennel (*11*) have recently shown that the electrostatic waves have very small group speed; consequently, these waves can readily grow from thermal levels to finite amplitude before propagating out of the generation region. The waves are also found in bands centered near odd half harmonics of the electron gyrofrequency, $(n + \frac{1}{2})\Omega_-$, with no indication of enhancement at the power-line harmonics. It is therefore unlikely that such waves are stimulated by PLR. In the case of electromagnetic chorus, one cannot immediately rule out the possibility of triggering. However, chorus is predominantly observed in the outer magnetosphere under highly disturbed conditions when rapid wave growth can be expected. In addition, the increased electron fluxes present during such conditions will lead to enhanced thermal noise (incoherent cyclotron or Cherenkov radiation); there is no a priori reason to discard this mecha-

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nism as an adequate source of natural embryonic emission for the subsequent coherent growth of chorus.

Luette *et al.* (*15*, p. 275) have presented evidence for an enhancement in the occurrence of magnetospheric chorus in regions "threaded by magnetic field lines that intersect industrialized areas." They attribute this enhancement to a stimulation by PLR. We have undertaken (*12*) an analogous study based on the use of 1 year of analog data obtained from the OGO-5 search coil magnetometer. The instrument design and method of data acquisition have been described elsewhere (*7, 16*). We eliminated from the data base emissions such as magnetosheath lion roars and plasmaspheric hiss (*7*) and digitized the remaining chorus data into 10-minute intervals. Our subsequent method of analysis (*12*) was essentially the same as that used in the OGO-3 study by Luette *et al.* (*15*). In each case chorus data acquired in the outer magnetosphere ($L \gtrsim 4$, where L is the maximum radial extent of a magnetic flux tube measured in earth radii) were used to compute the frequency of occurrence within 10° intervals of dipole longitude. A comparison of the two results is exhibited in Fig. 1, A and B. Although both distributions exhibit longitudinal variability, there is little correspondence between them.

This apparent discrepancy can be reconciled, however, if a statistical significance test is applied to the data. The 2σ (95 percent confidence, where σ is the standard deviation) levels (Fig. 1B) indicate that the OGO-5 distribution lies within the normal statistical fluctuation for a random distribution; none of the maxima are statistically significant. Since the number of independent satellite passes analyzed by Luette *et al.* (*15*) was essentially the same as the number in the OGO-5 study, we believe (*12*) that the four OGO-3 maxima shown in Fig. 1 can also be explained as random fluctuations. From statistical arguments alone one cannot rule out the possibility that certain chorus elements are indeed triggered, but on the basis of our analysis (*12*) we believe that it is safe to conclude that such triggering is not a dominant source mechanism for chorus.

Although it is tempting to speculate on the possible influence of PLR on the earth's radiation belts, there is thus far little substantive evidence to support this suggestion. Fascinating examples of triggered emissions have been reported, based on data obtained at the ground (*1*), but such waves are rarely observed in the wave-particle interaction region of the outer magnetosphere. This is probably due to the added requirement that the triggered waves detected at the ground be ducted. The most likely propagation path is therefore confined to a region just within the plasmapause, which is also a favored region for triggering. It requires a large jump in logic to conclude that chorus, which occurs predominantly outside the plasmapause, is also triggered by PLR. The totality of satellite evidence indicates instead that the majority of magnetospheric waves are generated naturally. There is no dispute on the existence of triggered waves, but, in view of their low overall power in the magnetosphere, it is difficult to imagine that they can play any major role in the dynamics of geomagnetically trapped electrons.

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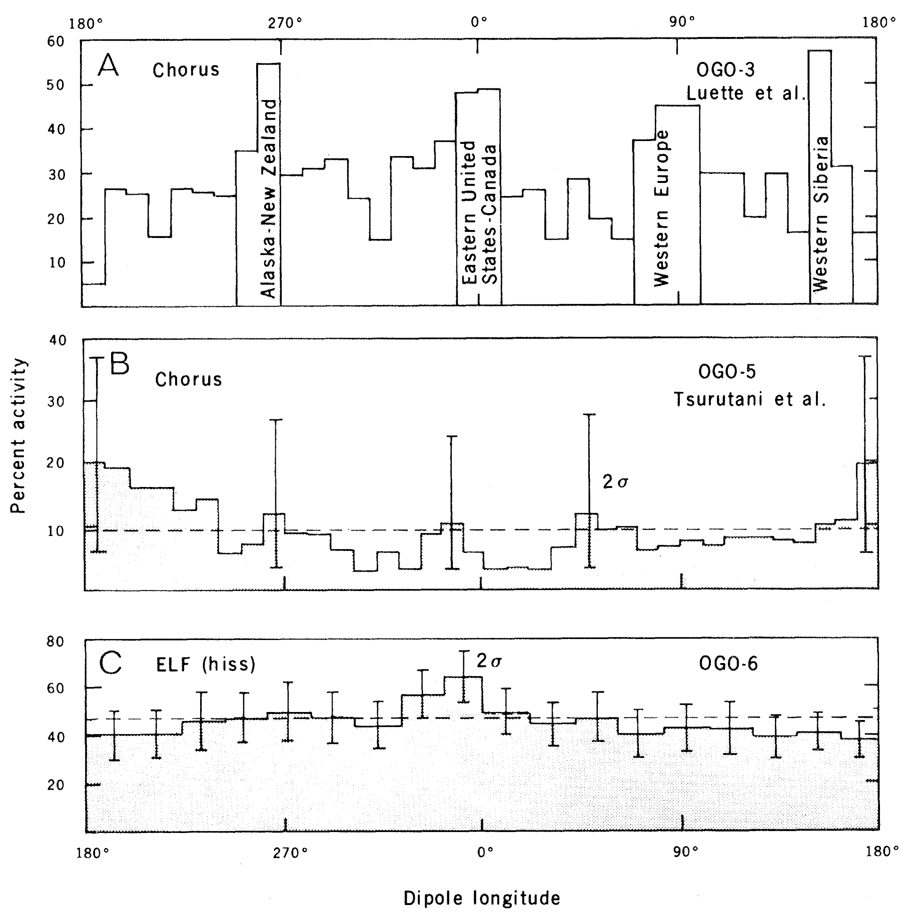

Fig. 1. A comparison of the occurrence of various magnetospheric emissions plotted against geographic dipole longitude. (A) A reproduction of the OGO-3 chorus occurrence reported by Luette *et al.* (*15*); they attribute the four regions of enhanced emission to triggering by PLR. (B) Corresponding results from our analogous study based on the use of OGO-5 data (*12*). There appears to be no correlation with the OGO-3 results, and none of the enhancements is statistically significant. (C) The occurrence of extremely low-frequency (ELF) emissions (which we attribute mainly to plasmaspheric hiss) (*12*) observed during geomagnetically inactive periods on the polar-orbiting satellite OGO-6. Although the region between 340° and 360° shows a modest ($>2\sigma$) enhancement above the mean, this result is still statistically consistent with a random distribution.

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25 January 1979

Isolation and Characterization of an Endogenous Type C Virus of Rhesus Monkeys

Abstract. *A type C retrovirus was isolated from a continuous cell line established from a spontaneous esophageal carcinoma of a rhesus monkey (*Macaca mulata*) by prolonged cocultivation with canine cells. A DNA transcript of the viral RNA hybridized to a high level and kinetic analysis indicated the presence of multiple copies of the viral genome in rhesus monkey DNA, showing that the virus is endogenous in this species. The rhesus monkey virus closely resembles, in several respects, an endogenous type C virus previously isolated from stumptailed macaques (*Macaca arctoides*), a species closely related to rhesus monkeys.*

We previously reported the establishment of an epithelial cell line, 816A, from a lymph node metastasis of a spontaneous, esophageal carcinoma of a rhesus monkey, *Macaca mulata*. At early passage levels, 816A cells showed both budding and extracellular type C virus by electron microscopy (*1*). In an effort to isolate this virus, 816A cells were cocultivated with cell lines of human (A204, HOS), mink (CCL64), bat (B88), and dog (Cf2Th, D-17) origins after treatment with 5-iodo-2′-deoxyuridine (30 μg/ml) and dexamethasone (0.1 μg/ml). Mixed cell cultures were passaged twice monthly, and clarified, 600-fold concentrated culture fluids were tested weekly for reverse transcriptase (RT) activity with the template poly(rA)·oligo dT_{12-18}, where rA is riboadenylate and dT is deoxythymidylate.

Reverse transcriptase assays for the first 5½ months after initiation of cocultivation were negative for all 816A cell combinations. In the sixth month, at post-cocultivation passage 15, the 816A/D-17 culture was positive for RT activity at a low level, 40 pmole per milliliter per hour above a background of 3.2 pmole per milliliter per hour. Similar weak RT activity was found over the next several passages. Electron microscopy of 816A/D-17 cultures at passages 16 and 17 revealed low concentrations of mature type C virus. At passage 17, 500-fold concentrated culture fluids from 816A/D-17 cultures were inoculated onto Polybrene-treated Cf2Th, CCL64, and A204 cells. At post-inoculation passage 13, 100-fold concentrated culture fluids of Cf2Th cells were positive for RT activity. Such activity increased in culture fluids over the next several passages to levels of 480 pmole per milliliter per hour above background. The RT activity showed preferences for the synthetic template poly(rA)·oligo dT_{12-18} compared to poly(dA)·oligo dT_{12-18} and for Mn^{2+} over Mg^{2+}, indicating type C virus activity. The inoculated A204 and CCL64 cells were negative for RT activity through passages 12 and 13, respectively. It was possible to develop positive RT activity in an additional 816A/D-17 cocultivation experiment over essentially the same time and passage levels after cocultivation. Prior to and during the entire period over which the virus was isolated from the 816A cells, no MAC-1 virus, the endogenous virus of stumptailed macaques (*Macaca arctoides*) (*2*), was present in our laboratory. We have designated the rhesus monkey cell isolate as MMC-1 (*Macaca mulata* type C, first isolate). For initial characterization MMC-1 was grown in Cf2Th cells.

In addition to having an RT characteristic of type C viruses, electron microscopic examination of MMC-1 revealed early, intermediate, and late budding stages and immature and mature extracellular virions typical of type C viruses. The mature, extracellular virus has a diameter of 110 nm and the nucleoid mea-

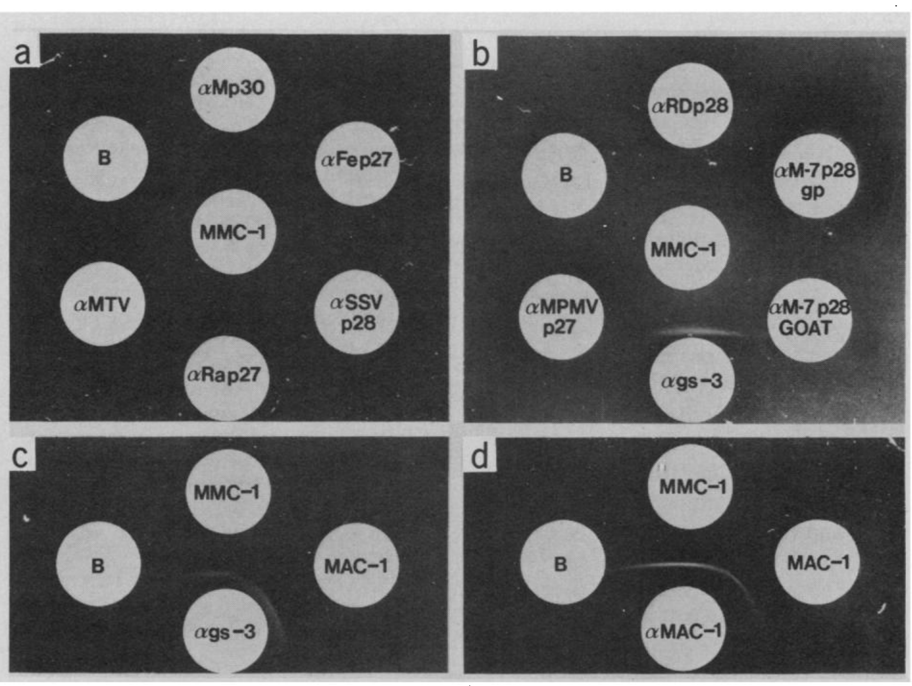

Fig. 1. Immunodiffusion patterns of MMC-1. (a and b) MMC-1 virus (1 mg/ml) disrupted with Triton X-100 in the center well. Antiserums in peripheral wells are described in a clockwise direction from the top well. (a) All antiserums of caprine origin. Antiserum to Rauscher murine leukemia virus p30 (*αMp30*), antiserum to feline leukemia virus p27 (*αFep27*), antiserum to simian sarcoma virus p28 (*αSSVp28*), antiserum to rat type C virus p27 (*αRap27*), antiserum to mouse mammary tumor virus (*αMTV*), buffer (B). (b) Caprine antiserum to RD-114 virus p28 (*αRDp28*), guinea pig antiserum to endogenous baboon virus p28 (*αM-7p28 gp*), caprine antiserum to M-7p28 (*αM-7p28 goat*), interspecies caprine antiserum to mammalian type C virus p30s (*αgs-3*), caprine antiserum to Mason-Pfizer monkey virus p27 (*αMPMVp27*), buffer (*B*). (c and d) MMC-1 virus and MAC-1 virus both at 1 mg/ml and both disrupted with Triton X-100. (d) In the lower well, caprine antiserum to purified MAC-1 virus [see (*4*)].

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