ence was not invited to attend. Well, who was to know in advance that the author would be mentioned repeatedly?

Nowhere does this well-known gatekeeper-editor, Horowitz, commend Holden for her brilliant article, which makes clear what is generally obscured by the social science jargon of our time.

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Power-Line Radiation

Thorne and Tsurutani (Reports, 25 May 1979, p. 839) address some important questions regarding power-line radiation (PLR) in the magnetosphere, a subject that has become a topic of intense research in recent years (*1-3*). Although Thorne and Tsurutani accept the existence of PLR in the magnetosphere, they conclude that it is unimportant in comparison to naturally occurring waves. We believe that their conclusion, based on analysis of a limited amount of data, is premature and that it is important to further investigate this man-made perturbation of the space environment out to a distance many times the radius of the earth.

It has been clearly demonstrated that PLR can trigger emissions that strongly interact with trapped energetic particles in the magnetosphere (*2*). However because of limitations in signal detection and processing techniques that have been employed to date, it is not *always* possible to determine conclusively whether a given emission is triggered or is generated spontaneously. For this reason, it is not possible at present to make a quantitative comparison between PLR effects and natural effects.

The main argument of Thorne and Tsurutani is based on the fact that their data on ELF (extremely low frequency) chorus collected by the Orbiting Geophysical Observatory (OGO) do not show significant variations at different longitudes that could be attributed to PLR. This is contrary to earlier results based on ELF and very low frequency data collected by OGO-3 (*3*). This discrepancy is not too surprising in view of the fact that the two relatively small data sets were acquired by different instruments covering different frequency ranges and were analyzed differently. Without getting into detailed technical arguments, we simply wish to make a fundamental point concerning their data—that the absence of evidence should not be used as evidence for absence.

There are undoubtedly waves of entirely natural origin that are important for magnetospheric dynamics. However, their importance cannot be used as evidence against the importance of PLR unless it is supported by a quantitative comparison. Such a comparison will require improved techniques for identifying PLR and PLR-triggered emissions. Fortunately progress can be and is being made in that direction. For example, since the report by Thorne and Tsurutani, direct evidence of PLR has been found in the deep magnetosphere in data from ISEE-1 and GEOS satellites (*4*). Theoretical and experimental studies of PLR sources are under way or are being planned by a number of research teams around the world (*5*).

It will be some time before we fully understand PLR effects and their importance, vis-à-vis natural phenomena, but there is certainly no basis at present to dismiss PLR as unimportant.

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5. The PLR intensities near power lines have been recently measured by R. Barr in New Zealand and T. Yoshino in Japan, both of whom used ground-based as well as balloon and rocket-borne instruments. Yoshino and his colleagues plan to make more measurements using balloons, rockets, and satellites. The University of Manitoba, Stanford University, and the Sandia Corporation plan to make balloon measurements in Manitoba, Canada, in collaboration with the Manitoba Hydro.

Park and Helliwell disagree with portions of our *Science* report, particularly our conclusion that the stimulated generation of magnetospheric chorus by PLR is unimportant in comparison to naturally occurring waves. We argue that our conclusion remains valid. There is no conclusive evidence of any dependence of outer zone chorus on geographical longitude. Claims of such evidence (*1*) are based on erroneous statistical arguments (*2*). Furthermore, such a dependence would not be expected because chorus occurs on magnetic field lines that intercept the polar regions of the earth, well away from high-density population centers. As we stated in our report, PLR would also be strongly damped as it propagates from the earth into the magnetosphere. Arguments concerning the dependence of chorus starting frequency on PLR frequency are contradictory (*2, 3*), and only further independent research will resolve the problem. Arguments concerning weekday dependence of chorus occurrence are also controversial. Ground-based evidence indicates a reduction of chorus occurrence on Sundays (*4*), but the validity of this work is currently being challenged (*5*). The only magnetospheric study done to date (*6*) shows no evidence of such an effect.

Previous discussions of PLR effects on chorus have generally ignored the wealth of published articles on energetic, outer zone electrons (*7*), magnetospheric substorms (*8*), and chorus, together indicating a natural generation of chorus. Space physicists have shown that intense fluxes of energetic (1 to 100 kiloelectron volts) electrons are injected into the near-midnight outer magnetosphere during the onset of substorms (*7, 9*). The electron fluxes are above the "stably trapped limit" (*10*) and generate chorus via the loss-cone instability, the "free energy" of the electrons going into wave (chorus) energy. The waves in turn interact with the electrons, scattering them such that they are lost into the upper ionosphere, giving rise to the polar x-ray aurora (*8, 11*). It has recently been confirmed that chorus is associated with substorm events and occurs at the same geomagnetic latitude and local time as the detected electron precipitation (*12*). Chorus has been shown to be localized close to the equatorial plane (*12*), where it is expected to be generated via a loss-cone instability. Examination of the energetic electron velocity versus magnetic field (pitch angle) distribution during chorus events shows that the electrons have the expected loss-cone distribution (*13*). Thus, the existing literature is adequate to explain the majority of chorus and its effect on the outer radiation belt electrons via natural causes.

Park and Helliwell (*14*) argue that PLR may act as an embryonic emission that stimulates the growth of chorus and subsequently induces the electron precipitation. However, they agree (*15*) that the electron flux must be high to provide the free energy for wave growth, thus a magnetospheric substorm must be in progress. The only consequential effect of PLR is to "force" the chorus growth and electron precipitation to occur over high-power consumption areas. However, even evidence for this is nonexistent; rather, within statistical uncertainty, chorus appears to occur at all geographic longitudes with equal probability (*1*, *2*).

We do not dispute the existance of PLR or PLR-triggered emissions especially in locations where there is adequate wave ducting (at latitudes less than 60°), allowing PLR field-aligned wave propagation to the equatorial region of the magnetosphere where unstable wave growth can occur. However, at magnetic latitudes above 60°, where chorus is principally detected (*16*), both the wave ducting and population centers are generally absent.

From the evidence and arguments presented in our report, we cannot rule out the possibility of minor PLR effects on chorus. We do show, however, that there is a general lack of evidence for significant PLR effects on outer-zone chorus. Until more positive evidence becomes available, we feel that it is best to remain with the well-established model for natural generation of outer-zone magnetospheric chorus.

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