Attenuation on an Earth-Space Path Measured in the Wavelength Range of 8 to 14 Micrometers

Abstract. *A telescope operating over the wavelength range of 8 to 14 micrometers has been added to the Crawford Hill sun tracker for the purpose of measuring attenuation in that atmospheric window. Over a 9-month period the attenuation (typically from clouds) exceeded 10, 20, and 30 decibels for 48, 43, and 34 percent of the time.*

The availability of high-power oscillators and molecular amplifiers at 10.6 μm has stirred interest in the use of this wavelength for space communications. The measurements reported here show that, in a climate such as New Jersey's, the attenuation of the lower atmosphere can be quite high in the 8- to 14-μm window for an appreciable fraction of the time.

Measurements were made with an 8- to 14-μm telescope, which was appended to the Crawford Hill sun tracker in Holmdel, New Jersey (*1*). The 8- to 14-μm telescope is mounted on the sun tracker in such a way that it tracks the sun in hour angle all day and moves through a 2.8° peak-peak sinusoid in declination at a 1-hz rate. The lower extremity of the sinusoid is at the declination of the sun.

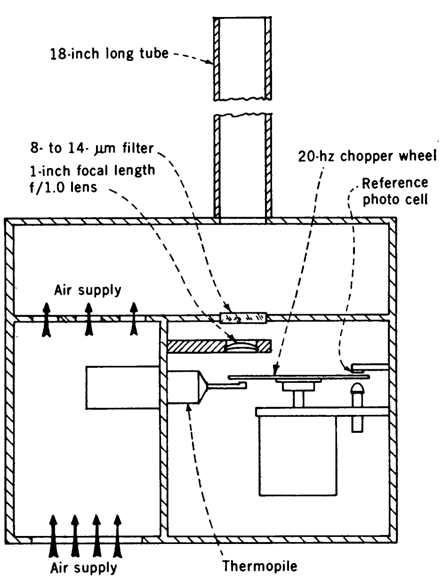


Fig. 1. Diagram of the telescope.

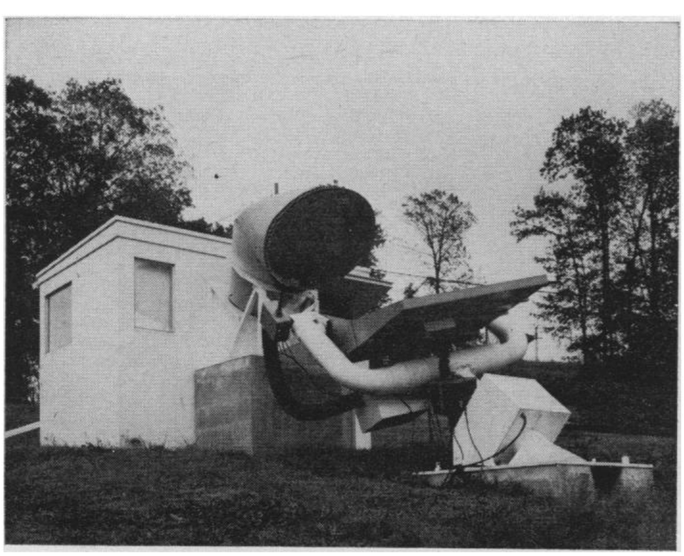
A diagram of the telescope is given in Fig. 1. The long tube that points to the sun is not a telescope tube per se but a device to exclude precipitation. It is supplied with air at a pressure of 3.8 or 5.7 mm-Hg. The resulting high-velocity flow of air out of the tube prevents precipitation from reaching the filter, which is the first component of the telescope. The 8- to 14-μm filter was bought from Spectrum Systems and is built on a Ge substrate. It effectively excludes radiation from the sun in the atmospheric windows of shorter wavelength and passes 70 percent of the radiation in the 8- to 14-μm window. The filter is followed by an Irtran IV lens 1 inch in diameter and 1 inch in focal length (1 inch = 2.54 cm). The detector is a Reeder thermopile placed at the focus of the lens. A 20-hz chopper interrupts the radiation just in front of the thermopile.

Figure 2 shows the telescope mounted on the end of the yoke that supports the declination axis of the microwave heliostat reflector. The long black tube carries air from the blower below the reflector to the 10-μm telescope. Three gears drive the declination axis of the 10-μm telescope from the declination axis of the microwave reflector.

The signal from the thermopile is amplified at 20 hz and is passed through two phase-sensitive detectors. The first operates at 20 hz and recovers a voltage proportional to the power entering the telescope. The second samples the output of the first at the time the sun is in the beam and then during the time the sun is away from the beam. The difference of these two is proportional to the brightness of the sun, with atmospheric radiation and detector offsets canceled out. The output passes through a logarithmic converter and is presented on a chart recorder at a scale of 10 db/inch. The effective time constant in the linear part of the system is 1.5 seconds. The measuring range is 35 db.

The first impression gained from the 10-μm measurements is that the attenuation at 10 μm varies in a way similar to the attenuation of visual light. There is no optical detector on the sun tracker, and thus the relationship is not quantitative; but, as a thin cloud covers the sun, 10 db of attenuation occurs at 10 μm, when one still sees diffuse shadows on the ground. The disk of the sun disappears at about 20 db. On a partly cloudy day the attenuation rapidly moves back and forth from 0 to 35 db or greater. When it is overcast, the whole day may pass with no sign of the sun at 10 μm, even though at 30 Ghz the attenuation is no more than a few tenths of a decibel.

Figure 3 presents a record of the attenuation at 10 μm and 30 Ghz for



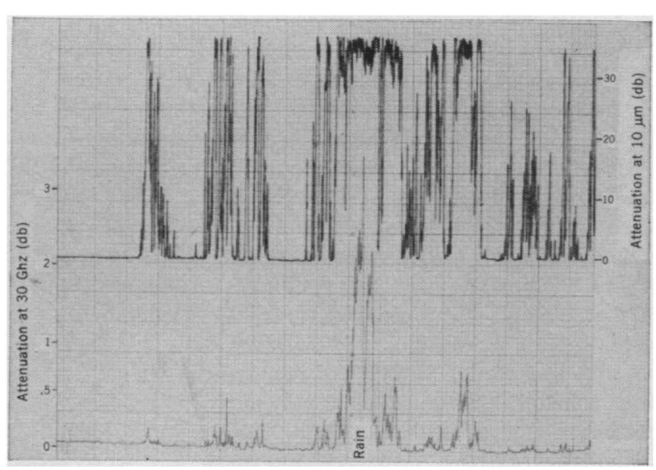


Fig. 2 (left). The mounted telescope.

Fig. 3 (above). Attenuation record on 22 October 1969.

a period of 4.5 hours. The 30-Ghz trace provides a useful indication of the amount of liquid water in the direction of the sun. Time proceeds from left to right at two major divisions per hour. Early in the period shown, the sky was clear. Soon broken, dark-bottomed cumulus clouds moved in, however, and in the middle of the picture a rain shower occurred.

The records from 28 October 1968 to 30 July 1969 were analyzed to determine the percentage of the time that the attenuation exceeded 10, 20, and 30 db. The results were 48, 43, and 34 percent. I conclude that, if the 10-μm atmospheric window is to be useful for earth-space communication, the earth station will have to be in a climate very different from the New Jersey climate; alternatively, the system will have to work through attenuations much greater than 30 db.

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Reference

1. R. W. Wilson, *Bell Syst. Tech. J.* **48**, 1383 (1969).

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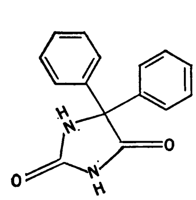
Diphenylhydantoin and Diazepam: Molecular Structure Similarities and Steric Basis of Anticonvulsant Activity

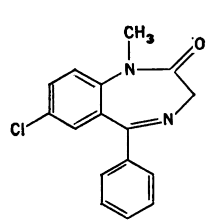
Abstract. *Diphenylhydantoin and diazepam are two useful antiepileptic drugs. Though not obviously related chemically, their molecular conformations exhibit marked similarities. These similarities indicate a steric basis for their anticonvulsant activity and lead to conclusions about the receptor sites for this type of pharmaceutical.*

Differently substituted barbiturates, hydantoins, and oxazolidinediones exhibit different hypnotic and anticonvulsant properties. Compounds with ethyl or other aliphatic groups substituted at C-5 are commonly used as sedatives, whereas C-5 phenyl substitution is necessary to obtain effective activity against grand mal epilepsy. These facts indicate to us a possible steric basis of behavior of this type of drug: that is, that conformational structure may be a primary factor in determining pharmacological properties. In order to test the validity of this hypothesis, we have determined the crystal and molecular structures of diphenylhydantoin (Dilantin) and diazepam (Valium), two clinically useful antiepileptic drugs which are not closely related chemically.



1

Diphenylhydantoin



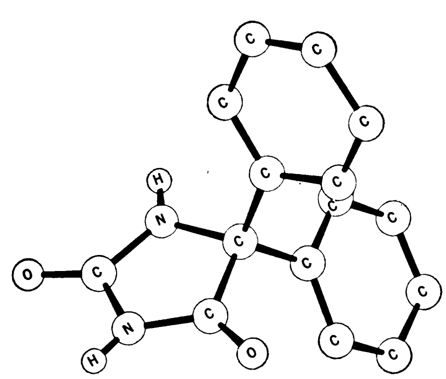
2

Diazepam

Since its introduction into medicine in 1938 (*1*), diphenylhydantoin (DPH) has been an extremely effective and widely used drug for the treatment of grand mal epilepsy. Diazepam (DAP) and other benzodiazepines, first introduced as tranquilizing agents, possess specific anticonvulsant action to varying degrees against grand mal, psychomotor, and petit mal epilepsies (*2*). Indeed, after extensive research and clinical investigation (*3*), DAP has been praised as the "drug of choice for the emergency treatment of all cases of status epilepticus" (*4*).

Diphenylhydantoin was obtained as the sodium salt and crystallized as the free acid from aqueous solution at *p*H 11. The crystals are orthorhombic with $a = 6.230$, $b = 13.581$, $c = 15.523$ Å; space group $Pn2_1a$ with $Z = 4$ molecules per unit cell. Intensities of 1210 reflections to $2\theta = 50°$ for MoKα were measured on a manual four-circle diffractometer. Preliminary statistics indicated a centrosymmetric space group and the 13 atoms comprising the hydantoin group and one phenyl ring were located by the symbolic addition procedure (*5*) applied to space group *Pmna*. This space group restricts the central hydantoin ring so that it lies in a mirror plane at $y = 1/4$ and the two phenyl groups so that they are related through the mirror. When this structure failed to refine, space group $Pn2_1a$ was chosen and the atoms of the second phenyl ring were located in a Fourier map calculated from the 13 atomic positions previously determined in space group *Pmna*. After refinement by least-squares methods, the discrepancy index *R* was shown to be 0.052.

Diazepam crystals were grown from



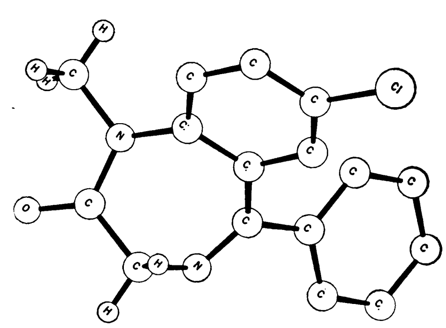


Fig. 1 (left). Perspective drawing of the diphenylhydantoin molecule. Fig. 2 (right). Perspective drawing of the diazepam molecule.

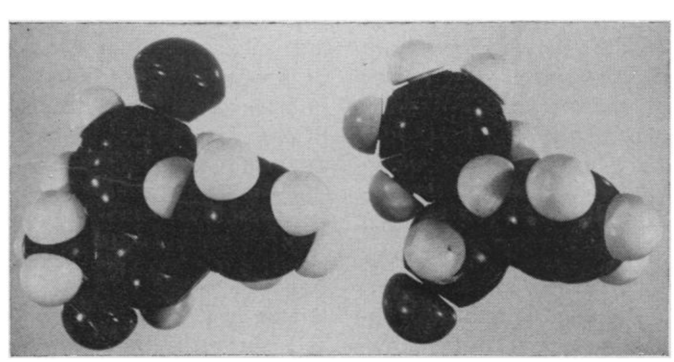


Fig. 3. Photograph of space-filling models of diazepam (left) diphenylhydantoin.