Technical Papers

Unusual Protective Action of a New Emulsifier for the Handling of Organic Phosphates

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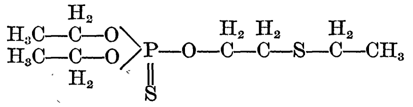
Hecht and Wirth (*1*) introduced a new type of emulsifier (No. 8139) with the claim that it would reduce the cutaneous toxicity of Parathion and its dimethyl derivative by half without influencing the insecticidal properties of these organic phosphates. Chemically the emulsifier can be described as a polyethylene oxyphenol of high molecular weight.

Because of the rather generalized interest in the so-called nerve poisons, this preliminary report is to call attention to an unusual protective action afforded by the American equivalent of this emulsifier[1] when mixed in roughly equal proportions with a new systemic organic phosphate insecticide that is being introduced by the Chemagro Corporation as Systox. Chemically this material is



For the study to be reported here the most toxic of several pilot plant preparations of Systox was employed. Various formulations of Systox were placed upon the abdominal skin of each of a group of albino rabbits, from which the hair had previously been removed by clipping. Exposures were limited to one period of 6 hr. After an exposure the Systox formulation was removed by thorough washing of the animal with soap and water under the tap. The animal was subsequently dried with a towel and kept under observation until it died, or for a period of 10 days.

The signs of intoxication observed were like those described for Parathion and related organic phosphates (*2, 3*). The approximate lethal dose (*4*) of undiluted Systox is less than 24 mg/kg (smaller doses could not be applied with accuracy), whereas the approximate lethal dose of Systox when applied as a mixture composed of equal parts of Systox and Emulsifier 42-1A was found to be equal to 620 mg/kg. The protective action of this emulsifier became gradually lost when the 50-50 mixture was diluted with increasing volumes of water. When diluted with approximately 200 volumes (such as are used for spraying), the approximate lethal cutaneous dose, in terms of Systox, was equal to 5 mg/kg. In other words, to induce a similar degree of intoxication in rabbits, more than 100 times as much Systox in Emulsifier 42-1A is required as when applied as undiluted or as highly diluted Systox.

[1] Manufactured by Chemagro Corporation, New York, and identified as "Emulsifier 42-1A."

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Manuscript received April 3, 1952.

Scatter-Sounding: A New Technique in Ionospheric Research[1]

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The existence of radio-reflecting regions in the ionosphere may be demonstrated, and their characteristics may be studied, by an indirect method of echo-sounding wherein an echo is received not from the layer itself, but rather from those portions of the earth's surface that are illuminated by reflection from the layer. Thus radiofrequencies may be used that are higher than the highest at which a vertical reflection can be obtained.

The signal making up the echo is a result of backscattering when energy from the transmitter, bent downward by the ionosphere, strikes the surface of the ground. Even at frequencies of the order of tens of megacycles, and paths involving highly oblique transmission, roughness of the earth's surface is sufficient to scatter back a readily detectable amount of energy. Furthermore, this roughness appears to a first approximation to be independent of geographical location. For example, there is no noticeable difference in the strength of echoes returned from the sea, as compared with those originating on land.

The transmission mechanism is such that the backscattered energy appears as a broad pip, or clump of echoes, on the timebase of a radar type "A" display. The leading edge of this composite echo is well defined. When a skip zone exists, it is possible to relate the time delay corresponding to this leading edge to the time required for wave travel along the ground from the transmitter to the edge of the skip zone and return. This may be done to a degree of accuracy which depends on the circumstances, but which is very good for reasonably long-distance transmission.

[1] This work was jointly supported by the Office of Naval Research, the Signal Corps, and the United States Air Force, under Project N6-onr-251 Task Order 7D.

In consequence, when a rotatable directional antenna is used, it is possible to obtain a range-azimuth or plan-position oscilloscopic display of those areas on the earth's surface to which high-frequency communication can be maintained at any given time and frequency.

The feasibility of this technique has not been fully appreciated in the past for various reasons. First, it was believed for many years that the observed scattering occurred in the E region of the ionosphere, rather than at the surface of the earth. Recent advances (*1, 2*) in the theoretical treatment of the subject have shown that the experimental observations on which the former belief was based are in point of fact consistent with scattering from the ground. Second, since most experimental ionospheric studies have been conducted with the aid of apparatus using pulse lengths short enough to permit resolution of thin layers directly overhead, few scatter echoes were seen and the belief was widely held that extremely high powers were needed for their excitation. It is now known that a large increase in echo amplitude, and hence reduction in the transmitter power required for a given signal-to-noise ratio, are brought about by selection of a pulse length about ten times that commonly used for vertical-incidence ionospheric work. Furthermore, for the long-distance radio propagation studies which this method makes possible, long pulses provide entirely satisfactory resolution and accuracy. Such pulses are essentially fast telegraph dots; they can therefore be generated by, and received on, existing communication equipment with only minor modification (*3*).

Under normal ionospheric conditions, when pulses of the order of milliseconds are used, along with a simple beam antenna, detectable indications can actually be obtained with peak transmitted powers of the order of 20–40 w. One kw is satisfactory for many practical applications. With this amount of power, and exceptionally good conditions, as many as seven multiple echoes have been obtained, representing energy scattered back to the transmitter after seven bounces between the earth and the ionosphere—a distance of nearly one quarter of the earth's circumference.

The simplicity of the technique suggests that its possibilities in ionospheric research are worthy of thorough exploration. It seems not unlikely that the method may supplement or even supplant the use of existing ionosphere sounders (*4*), which obtain an echo from reflecting regions directly over the station. With scatter-sounding, the effective point of contact between the transmitted ray and the layer can be moved out from the station to a distance which may be as far as 1250 miles away in the case of the F layer, or 600 miles in the case of the E layer, by proper choice of operating frequency. Thus a single ionosphere observing station, by observing the behavior of the most distant scatter echoes, can monitor some 5 million square miles of F layer, or 1 million square miles of E layer. In the case of the F layer, one centrally located observatory would suffice for the entire United States; to provide complete surveillance of the E layer over the same area, three stations would be needed.

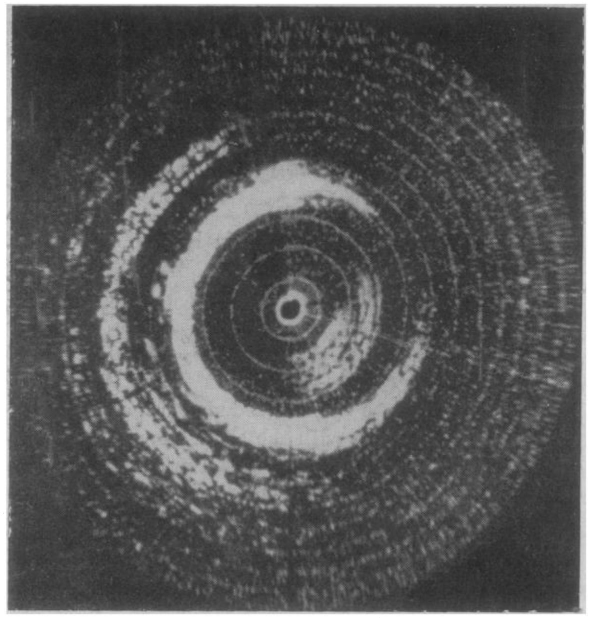

FIG. 1. Plan-position display of ground-scatter echoes propagated by both F and sporadic-E layers. Time: 1825.

Historically, echo-sounding in ionospheric research began with sounding at a single frequency. The extension to multifrequency recording represented an important advance. Rapid-scanning multifrequency recording brought further new knowledge to light. It seems reasonable, therefore, that the next step in the chain of development should be expansion of the physical area studied by a given ionosphere station, by means of the back-scatter technique.

The plan-position photograph of Fig. 1 represents a sample of the type of record obtainable by this technique. In this picture, north is at 12 o'clock, east at 3 o'clock, etc. The range circles are spaced 300 miles apart. The frequency is 14.2 mc, and the time shown is local. F-layer propagation to the east has failed, but is still possible to the north, west, and south. The crescent of echoes in these directions represents ground

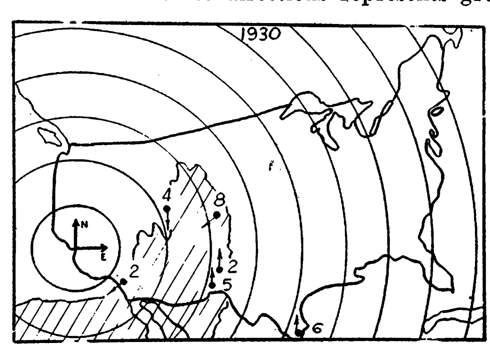

FIG. 2. Comparison of sporadic-E ground-scattering area, with amateur transmissions audible in a 15-min interval.

scatter propagated via the F-layer. Multiple echoes, representing more than one hop between earth and ionosphere, appear to the west and southwest. The patch of echoes lying at close range to the southeast, is from a cloud of sporadic E ionization.

To demonstrate that strong radio transmission is actually possible from regions returning scatter echoes such as these, advantage has been taken of the relatively large numbers and wide geographical distribution of amateur radiotelephone stations operating in the 14.25-mc band. Fig. 2 shows a comparison between a ground-scattering area (shown crosshatched) and those amateur stations which could be identified during an interval of 15 min centered about the time at which the scatter record was taken. The scatter area shown is due to the same sporadic E cloud delineated in Fig. 1, as it appeared approximately 1 hr later. Each amateur station is represented by a dot and a number giving its signal strength on a relative scale from 1 to 9. Arrows indicate the direction of transmission of each station. Figs. 1 and 2 are typical of a number of records that have been made (*3*).

When reflection is from a thick layer such as the F, the first energy to arrive back in the scatter echo will in general arise from scattering centers located on the ground at distances greater than the edge of the skip zone. Precise calculation of the skip distance accordingly requires not only knowledge of the height of the maximum ion density of the layer, but also knowledge of the form of distribution of this ionization (*5*). This information may be obtained from vertical-incidence multifrequency ionosphere records, which for best accuracy should be made at a location beneath the midpoint of the transmission path. In the absence of such information, assumed ion distributions and seasonal average layer heights may be used with surprisingly good accuracy when the skip distance is greater than 600 miles for F-layer transmission, or 300 miles for E-layer propagation. At shorter distances, ionospheric conditions are best studied by means of vertical-incidence measurements.

A brief enumeration of various possible applications of scatter-sounding follows:

1) *Instantaneous determinations of maximum usable frequency.* Variable-frequency scatter-sounding equipment may be used to determine the maximum usable frequency (MUF) for a given path, and to monitor variations in this frequency throughout the day. Conversely, for any given frequency at any given time, the distance to the edge of the skip zone may be determined.

2) *Communication via the scatter signal itself.* In situations where transmission is between points separated by less than 2500 miles, and a relatively small choice of operating wavelengths is available, it may be desirable to extend the number of hours a given frequency is useful during the day by taking advantage of scattering from the ground. After transmission by direct reflection from a layer has failed, ground-scattering will provide a relatively weak but nevertheless useful signal for an additional time, the length of which depends upon the circumstances. This signal may be maximized if sending and receiving stations employ directive antennas aimed at the general direction in which the ground-scattering occurs. This direction may be determined by scatter-sounding. For stations in the United States located along a north-south line, the best directions will, in general, be to the south-east in the morning, and to the south-west in the evening. By this technique, two stations can readily maintain communication at an operating frequency too high for transmission to take place between them by direct reflection from a layer at any time during the day.

3) *Study of geographical variations in F-layer transmission, under normal and abnormal conditions.* An interesting feature of the transmission mechanism by means of which a scatter echo is formed is the fact that the height of reflection of the energy making up the leading edge of echo is to a first approximation independent of the echo delay time provided only that the layer—no matter what its shape—is everywhere uniform. It follows from this that under the given conditions time delay to the leading edge of the echo is, very conveniently, a linear function of frequency (*1*). With the exception of certain unlikely special cases, any change in layer characteristics—such as might be caused by a transient disturbance—will appear in the echo delay time versus frequency plot as a departure from linearity. Thus variable-frequency scatter-sounding provides a simple and convenient means for determining the region about the station in which the F-layer characteristics can be regarded as substantially uniform. Departure from uniformity in any direction may be readily detected.

As an example of the possibilities of this method, unexpected apparent increases in F-layer ion density, occurring late at night, have been observed with the aid of scatter-sounding equipment at Stanford University. The increases in ion density have been found to be in motion from west to east.

4) *Study of ionospheric storms, and possible use in storm prediction.* Because of the two-way transmission, scatter-sounding may be expected to provide a sensitive indication of absorption changes, and of the onset of ionospheric storms. Since many ionosphere storms start at the auroral zone and spread southward, one or more strategically located stations monitoring this zone could conceivably provide improved warning of impending storminess.

5) *Comparison of antenna polar patterns.* It is possible to estimate the vertical angle of arrival of the energy in a scatter echo from a knowledge of the echo delay time and the measured or estimated characteristics of the ionosphere. The relationship between scatter echo delay time and vertical angle of takeoff, for an assumed parabolic electron distribution, is shown in Fig. 3. The parameter ρ is the ratio of operating to critical frequency. It will be seen that the minimum time delay portion of the echo (i.e., the leading edge) corresponds to energy leaving and returning at a definite vertical angle. Knowing

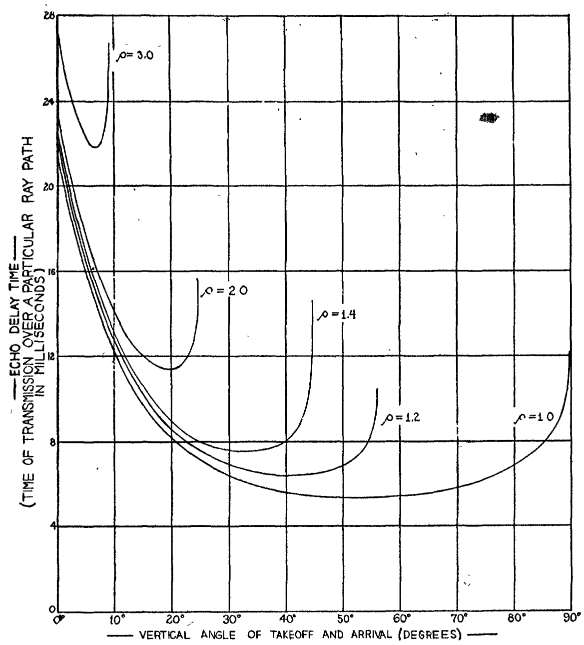

FIG. 3. Relationship between delay time of scatter echo component, and corresponding angle of takeoff.

this angle, it becomes possible to compare the vertical response characteristics of known and unknown antennas. The advantage of such a procedure is that the test is made under conditions closely approaching actual practice—i.e., taking into account local obstructions, ground conditions, and the like. The chief disadvantage is that if the operating frequency is fixed, the test can be made only at certain times of day.

6) *Tracking clouds of sporadic-E ionization.* From time to time there appear in the E region of the ionosphere thin, horizontal, reflecting clouds of ionization the cause of which is not understood. The size of these clouds, as well as their time and place of appearance, is unpredictable. Some clouds appear to move from one location to another; others remain fixed. It is not known whether the apparent motion is a consequence of true particle translation due to winds, or instead to some change in the position of the unknown agency producing the ionization. These clouds have in general a high reflection coefficient and may be tracked with ease by means of scatter-sounding (*6*). One such cloud is illustrated in Fig. 1, and the reflecting properties of the same cloud at a somewhat later time are evident in Fig. 2. Tracking the motion of such clouds—which is to say, the motion of the center of maximum ion density—is greatly facilitated by simultaneous scatter-sounding at two or more frequencies. The greater penetrating power of the higher frequency serves to outline those regions having the highest ion density.

This account would not be complete without mention of certain aspects of scatter-sounding in need of further study. At present it is not possible to specify the magnitude of the back-scattered echo as a function of frequency, time delay, and transmitted power. Further experimental and theoretical work on the back-scattering coefficient of the earth at the lower megacycle frequencies is needed. Explanation of the surprisingly great back-scattering power of the ocean should also be sought, along with a possible connection between this coefficient and ocean wave conditions.

At the present time, the scatter-sounding technique may be considered to be proved to a degree which highlights the desirability of further investigation of these points.

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Manuscript received May 26, 1952.

Resistance of *Solanum Ballsii* and *Solanum sucrense* to the Golden Nematode, *Heterodera rostochiensis*, Wollenweber

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Resistance to the golden nematode has not been found in any commercial potato variety. A search for a source of resistance among other tuber-forming species of the genus *Solanum* has produced somewhat more encouraging results. In preliminary experiments Ellenby (*1*) grew 40 wild species of Solanum in infested soil and found nematode cysts on the roots of all species except *S. pampasense*. In most cases the South American species appeared to be less susceptible than the English potato varieties. The results of later work, however, indicated that all the wild tuber-forming species tested were susceptible with the exception of *S. Ballsii*, which appeared to possess a high degree of resistance (*2*).

The testing of recently introduced varieties, potato seedlings, and wild tuber-forming species of Solanum for susceptibility to the golden nematode was started on Long Island in 1947. All varieties and seedlings tested were found to be highly susceptible. Fifty-five wild tuber-forming species,[1] including *S. pampasense*, were found to be highly susceptible, with the notable

[1] In addition to the species reported as susceptible by Ellenby (*1*, *2*), the following were heavily attacked by the golden nematode: *S. andigenum*, *S. Boergeri*, *S. chacoense*, *S. Cardenasii*, *S. immite*, *S. Jamesii*, *S. longipedicellatum*, *S. leptostigma*, *S. losseri*, *S. Lechnoviczii*, *S. malinchense*, *S. neoantiporiczii*, *S. polydenium*, *S. Soukupii*, and *S. subandigenum*.