A WAVE COMPONENT TO STARFISH PHASE B SIGNALS

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Following the Johnston Island Starfish test July 9, 1962, of a 1.4-megaton hydrogen bomb at 400 km altitude, detonated at 09:00:09.0238 UT,(1) observing stations around the world reported very large-amplitude signals, observed in a variety of ways, which were in most cases received with an elapsed time after detonation that was within the error in the fiducial calibration, and often also within the error of reading of their records. This came about because almost no one had anticipated disturbances, except for possible spherics of no great interest, which would propagate on a time scale below tens of minutes. Many observers noted an estimated instant of first detection for this signal, which they usually gave as two or three seconds, without intending that it should be taken as a measurement. Thus, for example, on an ordinary quick-run magnetogram the fiducial marks are 3 sec. wide, while the recording trace varies from 0.6 sec to 6 seconds width depending on the rate of change of the signal.

The recurrence of the value 2(±2) sec. as the reported arrival time of the signal at many stations around the world prompted Roquet *et al*. (2) to suggest that the whole phenomenon somehow took place at a world-wide instant. However, this idea is at variance with the total information available, some of which was considered in previous analyses such as that of Caner (3). (Caner termed this signal the Phase B signal, whereas Phase A was the electromagnetic wave.) Definite evidence exists showing that there was a progressive phenomenon buried in this welter of data. One fact is that Bowman and Mainstone (4) recorded a cutoff of reflection from the F_2 layer *overhead* at Brisbane, Australia at 9:00:12.8 ± 0.3 sec. Another is that Sheridan and Joisce (5) observed the disappearance of short wave reception at Sydney, Australia at different times for different stations around the world. The time from beginning to end of these dropouts was 3.0 ± 0.5 sec, as is measurable on their original records. The reflection paths for these stations could have been intercepted anywhere on the night side of the world from zero up to about 104 km distance.

The questions then arise (a) what was the nature of the presumed world-wide instant, (b) are there any more data confirming a progressive wave discernible among the many magnetic records, and (c) what was the nature of this presumed progressive phenomenon?

The answer to the first question can be found in Colgate's calculation (6) of the rate of expansion of the explosion sphere, which was in the nature of a plasma containing a charge separation (EMF) as has been shown by Latter *et al*. (7), and which advanced from the F_2 layer to the F_1 layer in precisely 2 seconds. At that instant the switching contact it made between these two conducting layers would have initiated currents detectable all around the world on the delicate magnetic detectors that were in operation. It was the timing of these initial upturns in magnetic field which were reported in the literature.

If then we are to obtain any data from the magnetic records which exhibit the postulated progressive phenomenon, it can be shown that it will occur near the maximum of each record, and will necessarily be convoluted with any oscillations in the driving EMF and any underdamped response characteristics of the detector. Even then, it will be only a measure of the point of closest approach to the detector by the conductive Idl or convective Qv element of charge flow, rather than an assured overhead motion. Most magnetic records, particularly the most sensitive and best-timed ones, went off scale, and the timing of maximum field is undeterminable. The timing of Guam Z, Wilkes H, and Huancaya low channel B can however be read from their records, and is given on Figure 1 (as if the passage had been overhead at the station), together with the previous results cited. It is seen that they also agree with the existence of a progressive phenomenon.

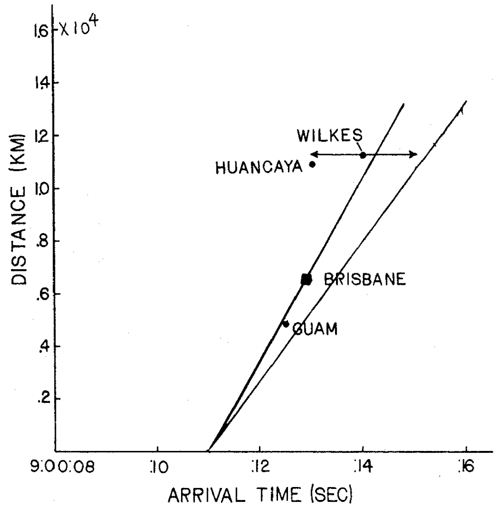

FIGURE 1. Evidence for a progressive wave component to Starfish Phase B signals. The two straight lines are the limits of velocity indicated by the observations of Sheridan and Joisce.

Finally, we consider the possible nature of any such progressive phenomenon. The potentials generated within the explosion may have ranged to 10^7 volts (7). When such a cloud potential was abruptly connected between two partial conductors such as the F_2 and F_1 layers of the ionosphere, a progressive breakdown of one or both layers would have ensued. We have been investigating such breakdowns in laboratory situations for some years (8). We would have expected the breakdown to occur in the much less conducting F_1 layer, as was observed. The breakdown would have taken the form of one or more auroral streamers moving outward from the source at speeds determined by the driving potential, the gas pressure, and the radius of the streamer. The speeds observed are quite compatible with those that would be predicted.

It is of importance to note that this breakdown wave is an electrostatic phenomenon, and is only weakly affected by the presence of magnetic fields, as has been both experimentally and theoretically shown. Thus the statement sometimes found in the literature that the progressive wave, if there was one, was a hydromagnetic phenomenon, do not apply, nor has this concept been successfully reduced to a model (9).

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