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A NOTE ON THE SOURCE OF INTERSTELLAR INTERFERENCE*

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Summary—*Further consideration of the data obtained during observations on interstellar interference has shown that these radiations are received any time the antenna system is directed towards some part of the Milky Way system, the greatest response being obtained when the antenna points towards the center of the system. This fact leads to the conclusion that the source of these radiations is located in the stars themselves or in the interstellar matter distributed throughout the Milky Way.*

Because of the similarity in the sound produced in the receiver headset, it is suggested that these radiations might be due to the thermal agitation of charged particles.

In former papers,[1,2] it was explained how interstellar interference was first observed with an automatic field strength recording system making use of a highly directional rotating antenna. It was pointed out that the directions of arrival were fixed in space and that there seemed to be only a single direction of arrival having a right ascension of eighteen hours and a declination of -20 degrees.

Some of the data did not check very accurately the theory of a single direction of arrival and it was suggested that a possible explanation of the discrepancies might be found in refraction of the waves during their passage through the ionized layers of the atmosphere.

Since the publication of the above papers further consideration of the data has led to some very interesting conclusions and speculations. The data obtained from the system are in the form of a continuous record of the output for all hours of the day and, since the antenna rotates continuously, for all directions as well. If we examine a typical day's record of the disturbance, for example that for September 16, 1932, given in Figs. 1 and 2, the following facts are evident. Besides varying gradually in height throughout the day the peaks obtained for each revolution of the antenna also change decidedly in shape. In Fig. 2 from 12:00 M to 3:00 P.M. the peaks are very broad, in fact one peak covers the time taken up by one complete revolution of the

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1 Karl G. Jansky, "Directional studies of atmospherics at high frequencies," Proc. I.R.E., vol. 20, p. 1920; December, (1932).

2 Karl G. Jansky, "Electrical disturbances apparently of extraterrestrial origin," Proc. I.R.E., vol. 21, p. 1387; October, (1933).

antenna. From 3:00 P.M. on, the peaks gradually get narrower and narrower until at 10:00 P.M. they are only one quarter the previous

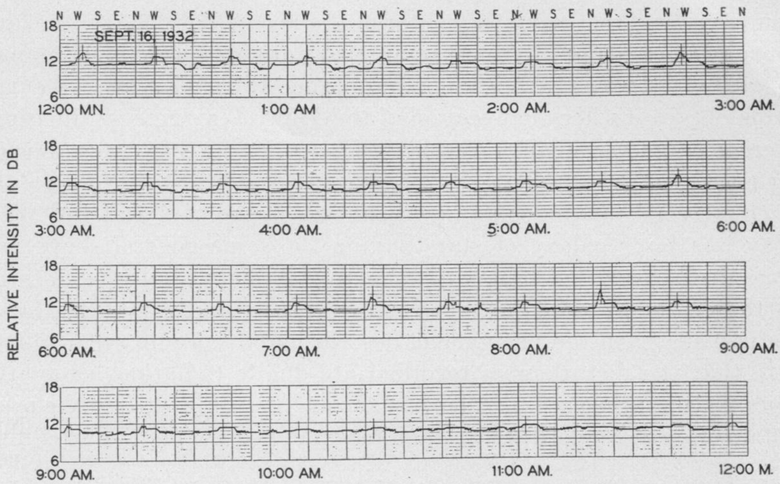

Fig. 1—Sample record of waves of interstellar origin. Record taken 12:00 midnight to 12:00 noon on September 16, 1932.

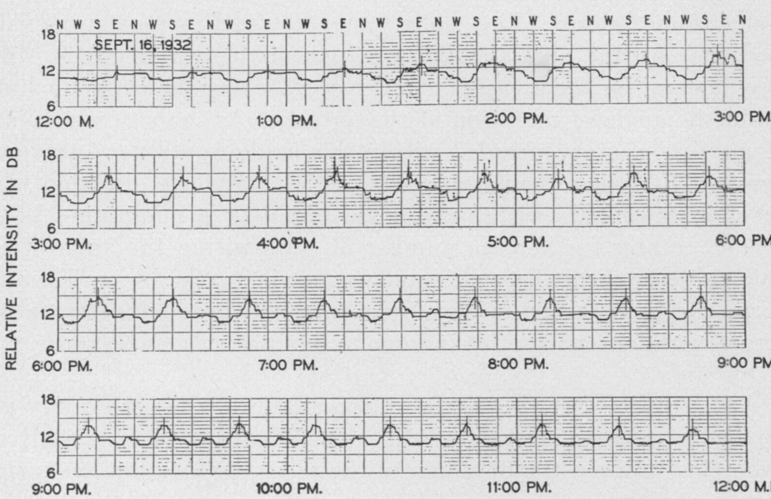

Fig. 2—Sample record of waves of interstellar origin. Record taken 12:00 noon to 12:00 midnight on September 16, 1932.

width. During the same time a much smaller and weaker peak begins to appear on the record. At 9:20 P.M. it is very clear.

Upon determining the direction towards which the antenna system points in space at these times, it is discovered that when the peaks are broad, the antenna is so located in space that it sweeps along the Milky Way and the maximum response is obtained when it points in the direction of the center of the Milky Way. When the large sharp peaks and the alternate small peaks are obtained the antenna is so located in space that it sweeps across the Milky Way, the large peak being obtained when that section of the Milky Way nearest the center is crossed and the small peak when that section farthest from the center is crossed.

If we consider the belief now held by astronomers that the Milky Way is a large galaxy of stars having the same general shape as a huge discus or grindstone with the solar system, and therefore the earth, located at some distance from the center and almost in the galactic plane, then the phenomena described above would seem to indicate that the disturbances recorded are due to radiations emanating from the stars themselves. The various heights and widths of the peaks obtained on the record would then be explained in the following manner.

If the axis of rotation of the antenna were perpendicular to the plane of the Milky Way the antenna would rotate so that it always pointed at some part of the Milky Way and therefore would always receive some energy. This energy should reach a maximum value when the antenna points in the direction of the center of the Milky Way System, for the greatest number of stars would then be included within the angle of reception of the antenna. As the antenna rotates the number of stars included within this angle would very gradually decrease until the antenna points in just the opposite direction when the number of stars within the angle would be a minimum. As the antenna rotates further the number of stars within the angle would again increase until the maximum was again reached, etc. Thus the energy received at such a time would show a gradual decrease and increase with one maximum and one minimum for a single rotation of the antenna.

Actually the axis of rotation of the antenna is never exactly perpendicular to the plane of the Milky Way, but approaches that condition closely when the meridian of the receiving location has a right ascension of twelve hours and forty minutes. Translated in terms of the time on the records this occurs about five hours and twenty minutes before the azimuth of the direction of arrival of the disturbances is south. For the record shown in the figures this time would be about 1:50 P.M. at which time the angular distance between the axis of rotation and the perpendicular to the plane of the Milky Way is twelve degrees and twenty minutes. However, due to the facts that the Milky Way has a very appreciable width, and the vertical directional characteristic of the antenna is very broad, the discussion given above is still applicable and explains the type of record that should be and is obtained at this time. Furthermore, at this time, the center of the Milky Way System as seen from the receiving location has an azimuth very slightly south of east which checks exactly the direction of the maximum disturbance as obtained from the curves.

Since the direction of the axis of rotation of the antenna changes as the earth rotates, the above condition exists for only a short time. Thus, after seven hours and forty-seven and one-third minutes (when the right ascension of the meridian of the receiving location is twenty-two hours and twenty-seven and one-third minutes) the axis of rotation will lie in the plane of the Milky Way instead of being perpendicular to it. In this position the antenna will sweep across the Milky Way twice for every revolution and we would expect two peaks on the record where previously we had only one, a large peak when the antenna sweeps across that part of the Milky Way nearest the center and a smaller one when it crosses that part farthest from the center. These peaks should be relatively sharp because the number of stars within the angle of reception of the antenna changes rapidly. The first case occurs when the antenna points in a southwesterly direction and the second when it points north-northeast.

Turning now to Fig. 2 we see that at 9:37$\frac{1}{3}$ P.M. (seven hours and forty-seven and one-third minutes after 1:50 P.M.) we have two definite peaks on the record for every revolution of the antenna, the larger of which is obtained when the antenna is pointing southwest and the smaller when it is pointing north-northeast, checking the predictions exactly.

After another eight hours and twenty-five and one-third minutes, or at 6:02$\frac{1}{3}$ A.M. on the record given, the axis of rotation of the antenna again lies in the Milky Way, but this time the two points where the antenna sweeps across the Milky Way are both some distance from the center so that neither peak should be very large. At this time the two points have directions of northwest by north and southeast by south, the former being the nearest to the center of the Milky Way. Turning again to the figures we find that at 6:02-$\frac{1}{3}$ A.M. the peaks are much weaker than at 9:37-$\frac{1}{3}$ P.M. and that they have the directions predicted.

A more detailed analysis of the data has shown that every time the antenna points towards some part of the Milky Way the record shows an increase in the energy received, and also every time the record shows an increase of energy received the antenna is found to be pointing towards some part of the Milky Way.

As said before, the most obvious explanation of these phenomena is one that assumes that the stars themselves are sending out these radiations and that the direction of arrival at the receiving location, instead of being confined to a single direction as was formerly intimated, include all directions, a greater indication being obtained for those directions confined to the Milky Way because of the greater star density there.

Another plausible explanation is one based on an hypothesis previously suggested,[2] that the waves which reach the antenna are secondary radiations caused by some form of bombardment of the atmosphere by high speed particles which are shot off by the stars.

Upon examining the characteristics of these radiations for further clues as to their source, one is immediately struck by the similarity between the sounds they produce in the receiver headset and that produced by the thermal agitation of electric charge.[3] In fact the similarity is so exact that it leads one to speculate as to whether or not the radiations might be caused by some sort of thermal agitation of charged particles. Such particles are found not only in the stars, but also in the very considerable amount of interstellar matter that is distributed throughout the Milky Way, which matter, according to Eddington[4] has an effective temperature of 15,000 degrees centigrade. If the radiations come from such particles one would expect the response obtained to depend upon the directional characteristic and gain of the antenna and the way it is pointed relative to the Milky Way, an expectation which agrees with the observed facts.

Attempting to explain the radiations in question on the basis of any of the above hypotheses immediately raises a serious question as to the effect of the sun. Since the sun is a star, although in comparison with some, a rather insignificant star, and since it is much closer to the earth than the stars of the Milky Way, so close in fact that the energy received from it in the form of light and heat is many times the combined energy received from all the stars and all the interstellar matter of the Milky Way, it would naturally be expected that radiations similar to those in question would be found coming from the sun with an intensity much greater than the intensity of those coming from the other sections of the Milky Way. So far no such solar radia-

[3] F. B. Llewellyn, "A study of noise in vacuum tubes and attached circuits," PROC. I.R.E., vol. 18, p. 243; February, (1930).

[4] Arthur Stanley Eddington, "Stars and Atoms," pp. 66–69, Yale University Press, 1927.

tions have been detected, and, although a possible explanation for their absence might be based on a supposition that the temperature of the sun is such that the ratio of the energy radiated by it on the wavelengths studied to that radiated in the form of light and heat is much less than for some other classes of heavenly bodies found in the Milky Way, the question will have to remain unanswered until more data have been taken.