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October 5, 1953

Grote Reber
Wailuku, Maui
Territory of Hawaii
U. S. A.

Dear Grote:

Thank you very much for your letter of September 21st with the five photos enclosed. It was a real pleasure to hear from you and it brought back nostalgic memories of our association at N.O.L. But why so formal a salutation? You haven't forgotten my first name have you ?

You may not realize it but your discourses after hours on your cosmic static researches had a profound affect on me and greatly stimulated my interest in doing work along this line. However, the war and getting several courses established here after the war prevented me from becoming active in radio astronomy work until about two years ago.

I don't know whether I ever mentioned it to you, but back in 1933 while working on my doctorate at Michigan Arthur Adel, who in later years was at the Lowell Observatory, engaged my help in setting up Cleeton and Williams' 1 cm receiver, using a 1 meter parabolic antenna, to see if we could detect 1 cm waves from the sun. Adel was of the opinion that sunspots might be strong sources of radio waves. Although he was correct in his supposition our receiver was far too insensitive and our results were completely negative. Then on July 3, 1935 I heard Jansky give his paper at the I.R.E. convention in Detroit (before an audience of hardly more than 15 persons) in which he concluded that the maximum signal he received came from the center of our galaxy. These were my only contacts with radio astronomy until you came to Washington in the fall of 1940.

In response to your request for photos I am enclosing three. One is of the O.S.U. radio telescope antenna, one of the receiver, and one showing a record taken at a declination of minus 38 degrees. Incidentally, the antenna is in the process of being doubled in size to 4 rows of 24 helices, or a total of 96 helices. Enclosed also is a reprint from "Sky and Telescope". I will also send you reprints of our recent articles in "Electronics" and "Nature" as soon as some are available.

In answer to your question about the angle of tilt of maximum radiation from a linear array with progressive phase shift, the case treated on page 83 of my book ANTENNAS is a general case. For the special case where the angle of tilt is almost perpendicular to the array (ϕ_1 nearly 90°) equation (4-57) can be expressed

$$\sin \delta_1 = -\frac{\delta}{d_r} = \delta_1$$

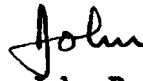
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where δ_1 is the complementary angle to ϕ_1 . Now if $d_r = 57.3^\circ$ we have $\delta_1 = -\delta$
or the angle of tilt is equal in absolute value ~~to~~ the phase shift.

I would gather that you are planning to give your talk in person at the A.A.A.S. meeting in Boston in December. This being the case I wish to extend to you an invitation to visit Columbus. I would like to have you give a talk to the radio and optical astronomers and students on some phase of your work, past or present, or on radio astronomy in general. Since our Christmas vacation is from December 18th to January 5th it would be desirable if your visit could be before December 18th or after January 5th but we would be happy to have you come anytime you can. Please let me know what date or dates would be convenient for you.

With best regards,

Sincerely yours,



John D. Kraus

P. S. Do you hear from Bill Conklin? We got a card last Christmas saying that they had returned to Bethesda, Maryland.

12-12-53

See my letter to Kraus of 9-21-53 and his reply of 10-5-53 plus Case 4 page 83 eqn (4-57).

ϕ_1 is angle between beam and line of array.

δ_1 is angle between beam and line perpendicular to array.

d_n is spacing between sources in radians

δ is phase difference between sources.

By (4-57)

$$0 = d_n \cos \phi_1 + \delta = d_n \sin \delta_1 + \delta$$

$$\text{or } \sin \delta_1 = -\frac{\delta}{d_n}$$

$$\text{if } d_n = 1 = 57.3^\circ$$

$$\sin \delta_1 = -\delta$$

When δ_1 is small, $\sin \delta_1 = \delta_1$ so

$$\delta_1 = -\delta$$

Which means the swing of beam from perpendicular is equal to phase angle when angle is small and the spacing of sources is one radian. This is perhaps true for a single line array. See Figure 5 of Foster paper. A spacing of $57.3^\circ = .159 \lambda$ which is closely $5/32 \lambda$ ($.156 \lambda$). When $T = 1/32$ period = 11° , shift is about 12° ; when $T = 1/16$ period = $22\frac{1}{2}^\circ$, shift is about 25° ; When $T = 3/32$ period = 38° , shift is about 37° ; When $T = 1/8$ period = 45° , shift is about 56° and beam breaks up badly. This relation does not hold for $d_n \neq 1$

as may readily be observed from Foster's diagrams. As the spacing increases the shift is progressively less for any given period. Apparently too much can not be deduced from these diagrams of a single line array as the situation is quite different for an array with reflector curtains. Actual calculations must be resorted to.
