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ISOLATION BETWEEN TWO STAGGERED PARALLEL HALF-WAVE DIPOLES

- J. Y. WONG AND MARGARET M. STEEN -

OTTAWA

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ABSTRACT

Calculated isolation curves are presented for two staggered parallel half-wave dipoles. The results are useful to the engineer in siting individual elements in a VHF/UHF antenna system to satisfy a given isolation requirement.

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FIGURES

ISOLATION BETWEEN TWO STAGGERED PARALLEL HALF-WAVE DIPOLES

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INTRODUCTION

In the design of a VHF/UHF communication system, the selection of the individual antenna locations is very often based on pattern considerations only - omnidirectional coverage being the usual requirement. This criterion alone is generally quite adequate in specifying the performance of a passive antenna system, but when the system contains both transmitting and receiving elements, the isolation factor must also be taken into account. Receiver desensitization and spurious intermodulation frequencies are just two sources of difficulty which can result from insufficient isolation between antennas.

COMPUTATION

To assist the antenna engineer in predicting the amount of isolation in a practical situation, the isolation between two staggered parallel half-wave dipoles is calculated for a range of antenna spacings. The method of computation involves first determining the mutual impedance between two dipoles and then employing the following relation [1] to obtain the isolation,

$$\frac{W_r}{W_t} = \frac{|Z_{21}|^2}{4R_{r_1} R_{r_2}} \qquad (1)$$

Equation 1 expresses the ratio of the received-to-transmitted power in terms of the magnitude of the mutual impedance Z_{21} and the input resistances R_{r_1} and R_{r_2} of the two antennas. The antennas are assumed to be matched.

The mutual impedance for different antenna geometries has been given by Carter [2], Brown [3], and Cox [4], and more recently the numerical results have been extended by King [5] and Baker and LaGrone [6]. In the latter paper, calculated values of mutual impedance are limited to antenna spacings of two wavelengths and we have extended the results to four wavelengths using the mutual impedance expression given by Carter [2].

RESULTS

The antenna geometry used in our calculations is shown in Fig. 1. The mutual impedance is plotted as a function of d/λ for ten different values

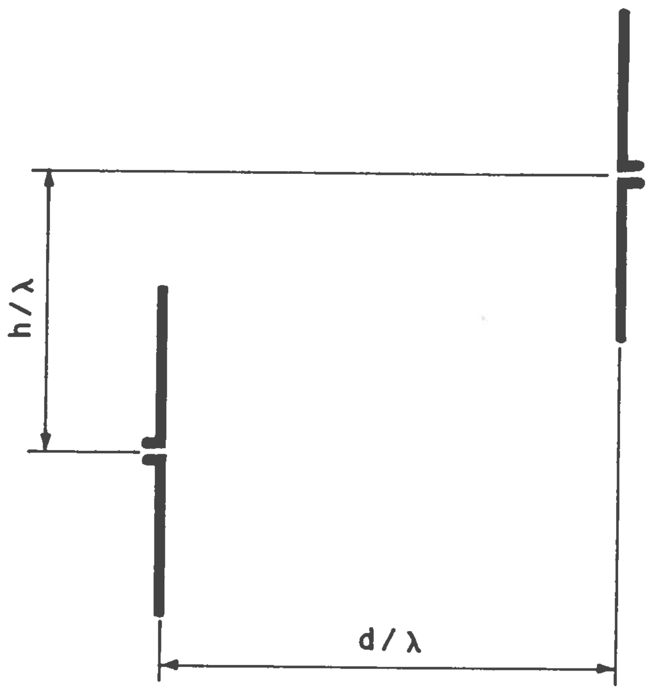

Fig. 1 Antenna geometry used in calculations.

of h/λ and the curves are given in Figs. 2-11. Employing equation 1 the isolation was obtained for the same range of antenna spacings and the results are given in Fig. 12. In a practical problem, it is often known what level of isolation can be tolerated. Figure 13 shows the isolation plotted as a series of contours enabling the antenna designer to select the proper combination of vertical and horizontal separations to meet a given isolation requirement.

As an addendum, a simplified approximate expression is given for the magnitude of the mutual impedance between two parallel half-wave dipoles. If one equates equation 1 and Friis transmission formula*, the following result is obtained,

$$Z_{21} = \frac{18.2}{d/\lambda} \qquad (2)$$

Equation 2 gives excellent results for antenna spacings greater than about one wavelength.

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* $\frac{W_r}{W_t} = \frac{g_r g_t \lambda^2}{(4\pi d)^2}$ where g_r and g_t are the antenna gains.

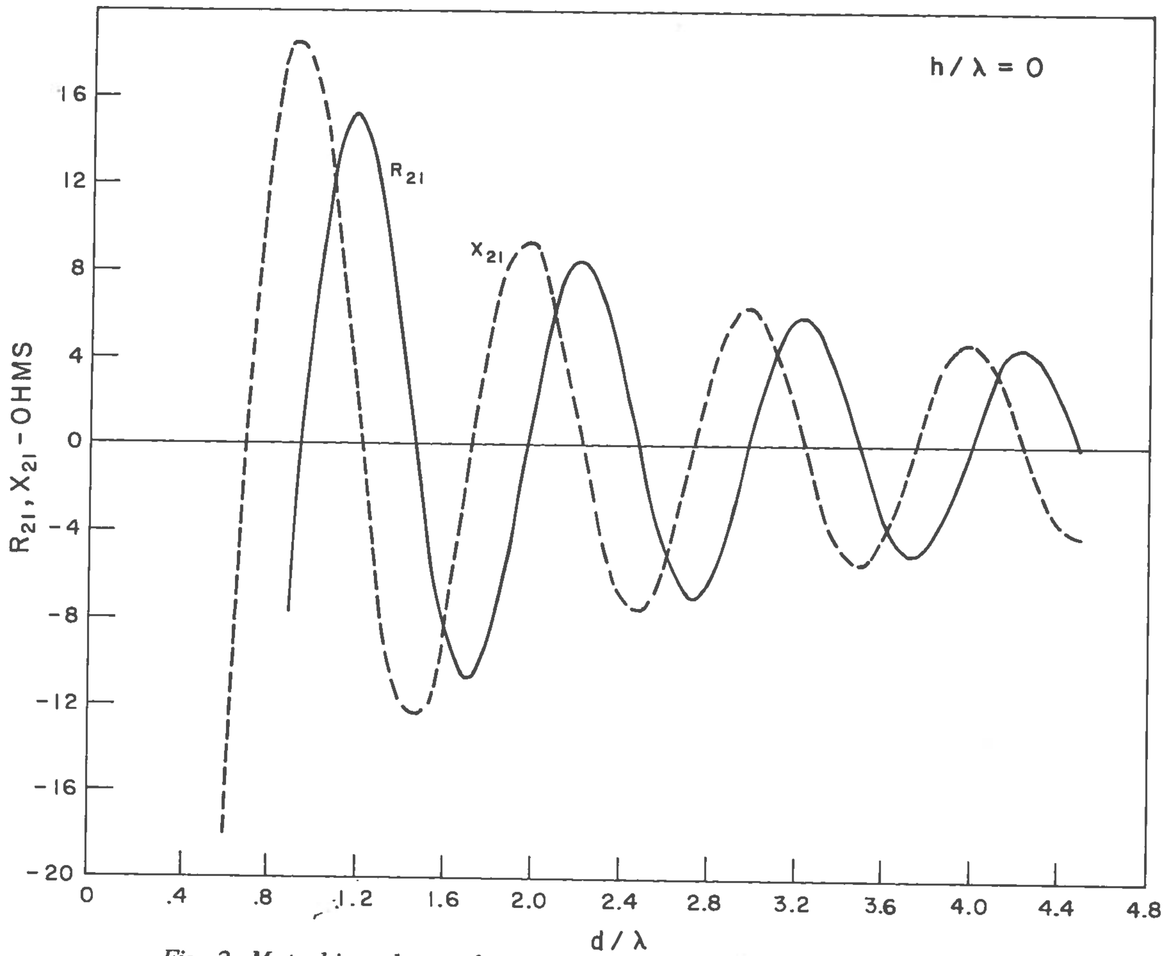

Fig. 2 Mutual impedance of two staggered parallel half-wave dipoles for $h/\lambda = 0$

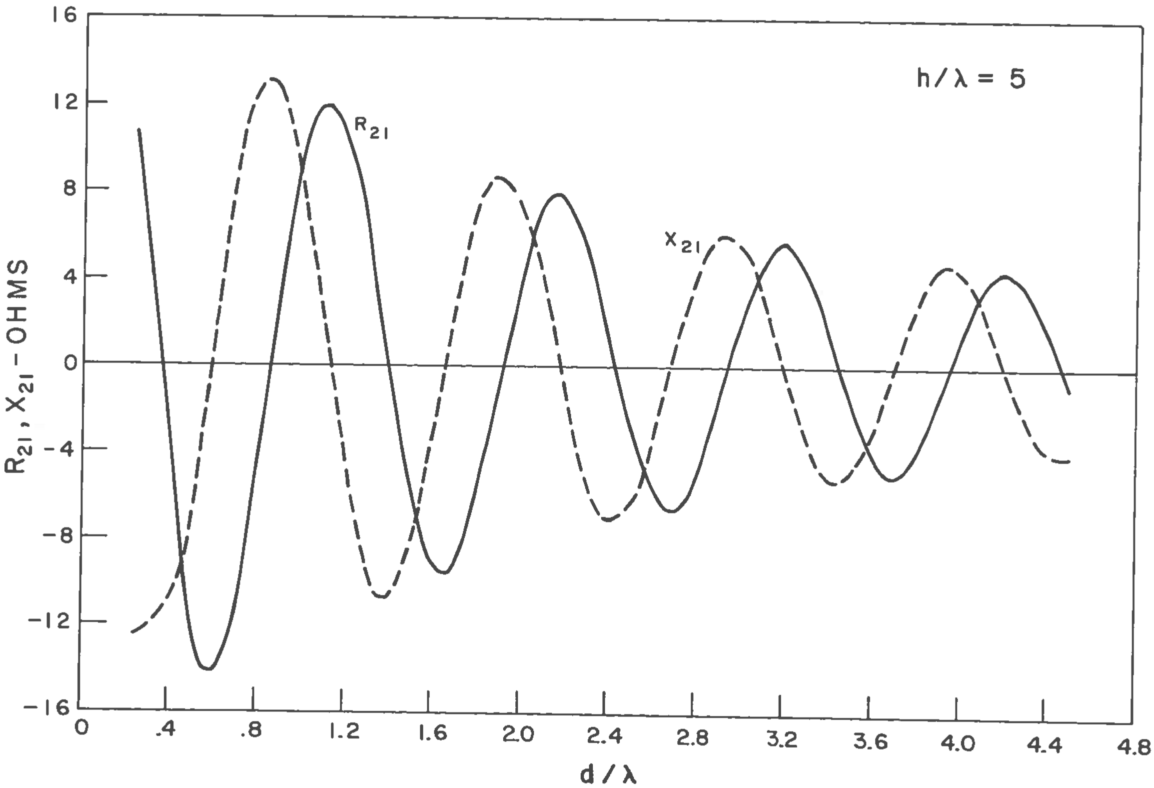

Fig. 3 Mutual impedance of two staggered parallel half-wave dipoles for $h/\lambda = 0.5$

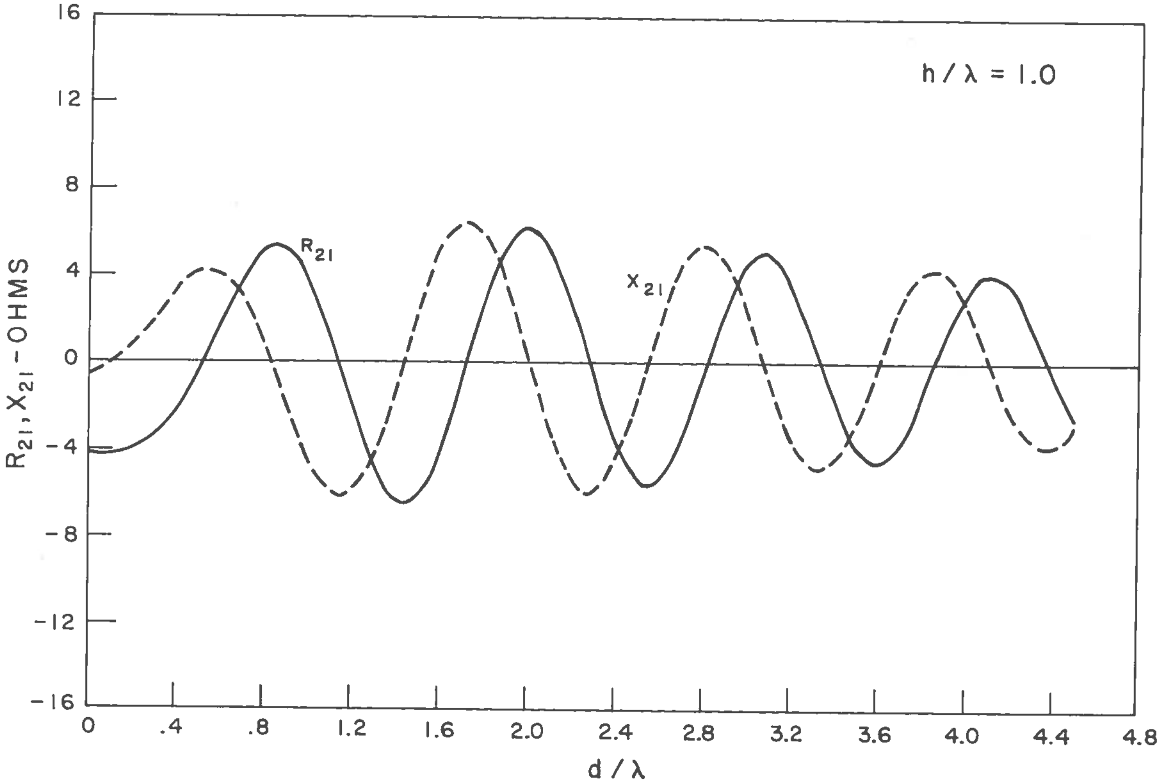

Fig. 4 Mutual impedance of two staggered parallel half-wave dipoles for h/λ = 1

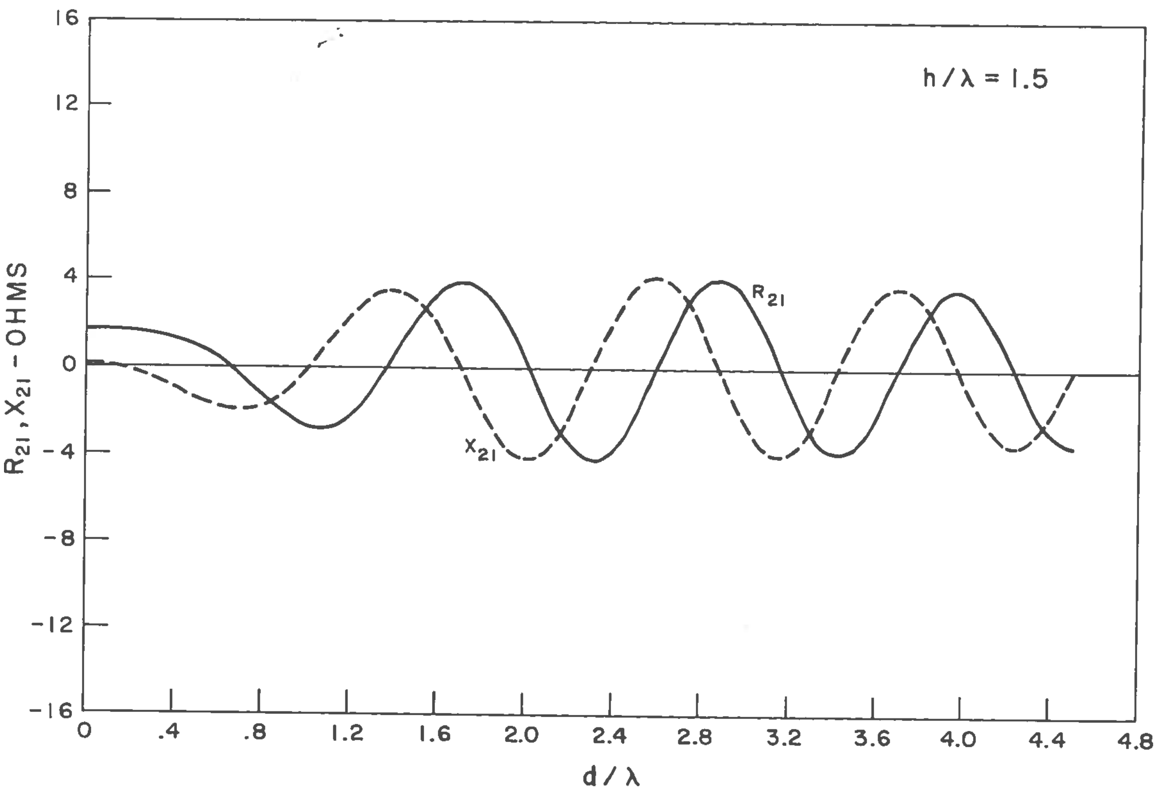

Fig. 5 Mutual impedance of two staggered parallel half-wave dipoles for h/λ = 1.5

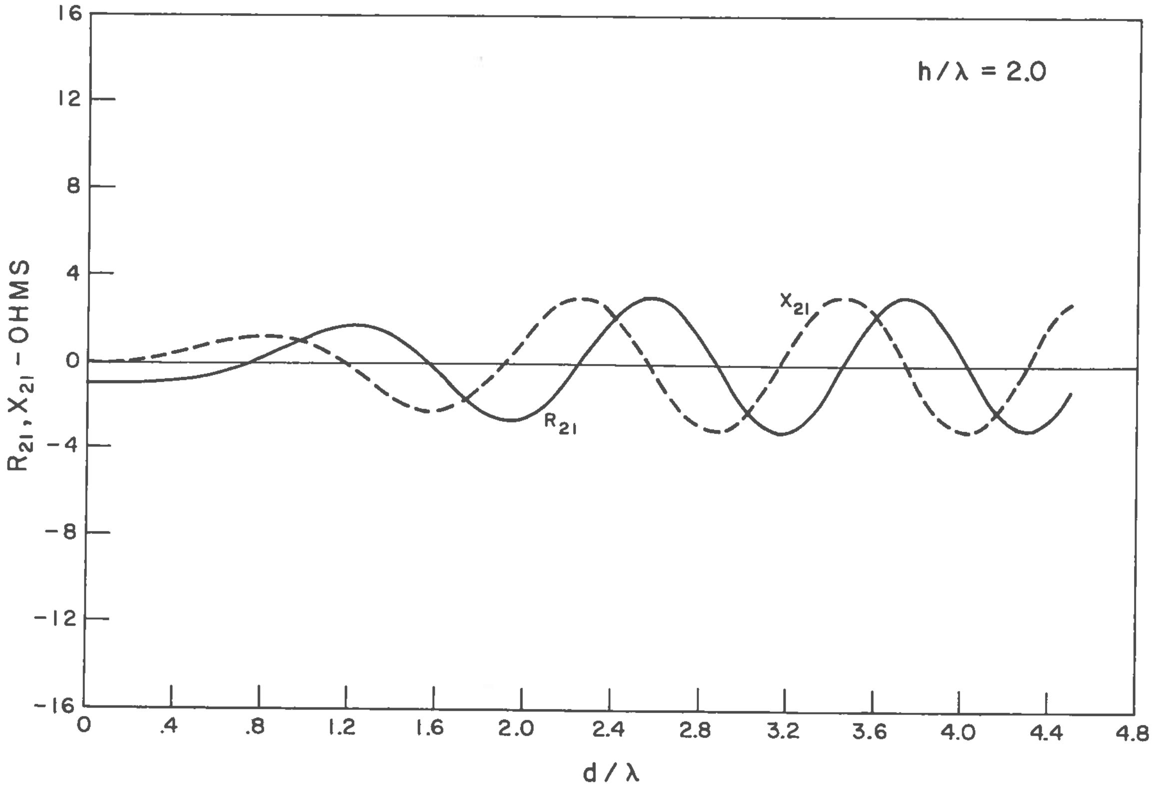

Fig. 6 Mutual impedance of two staggered parallel half-wave dipoles for $h/\lambda = 2$

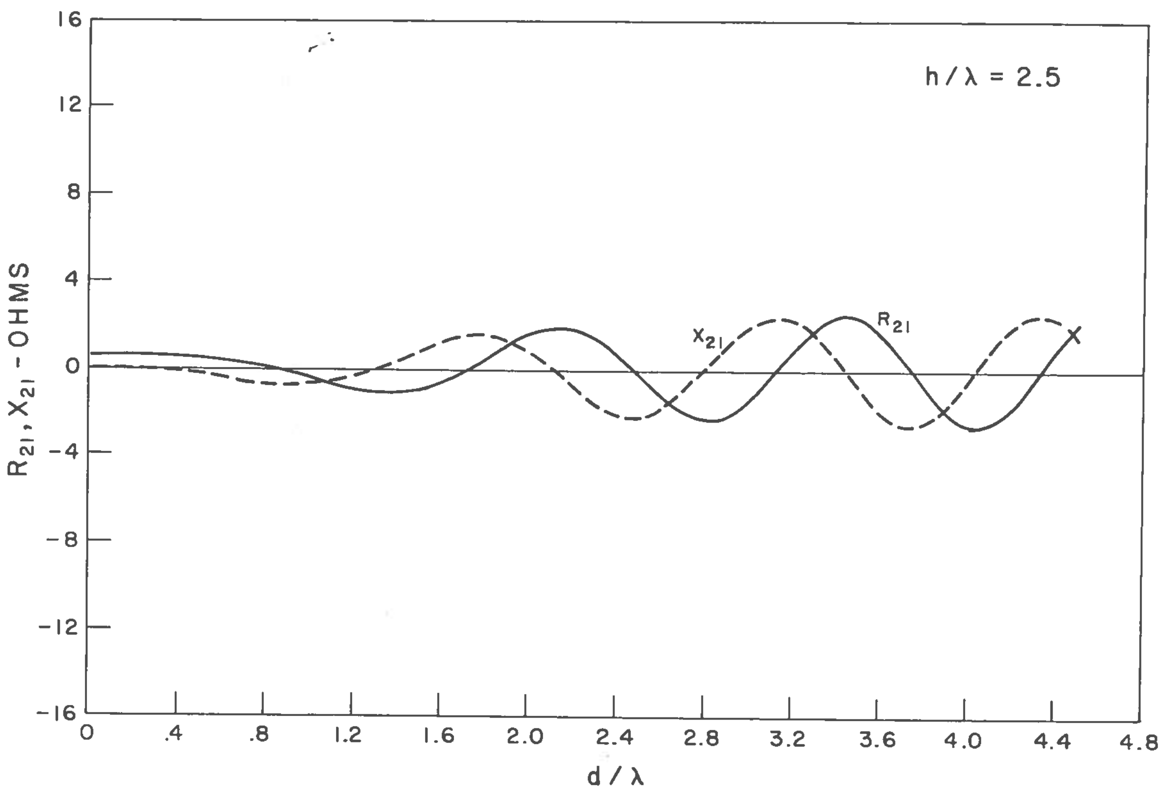

Fig. 7 Mutual impedance of two staggered parallel half-wave dipoles for $h/\lambda = 2.5$

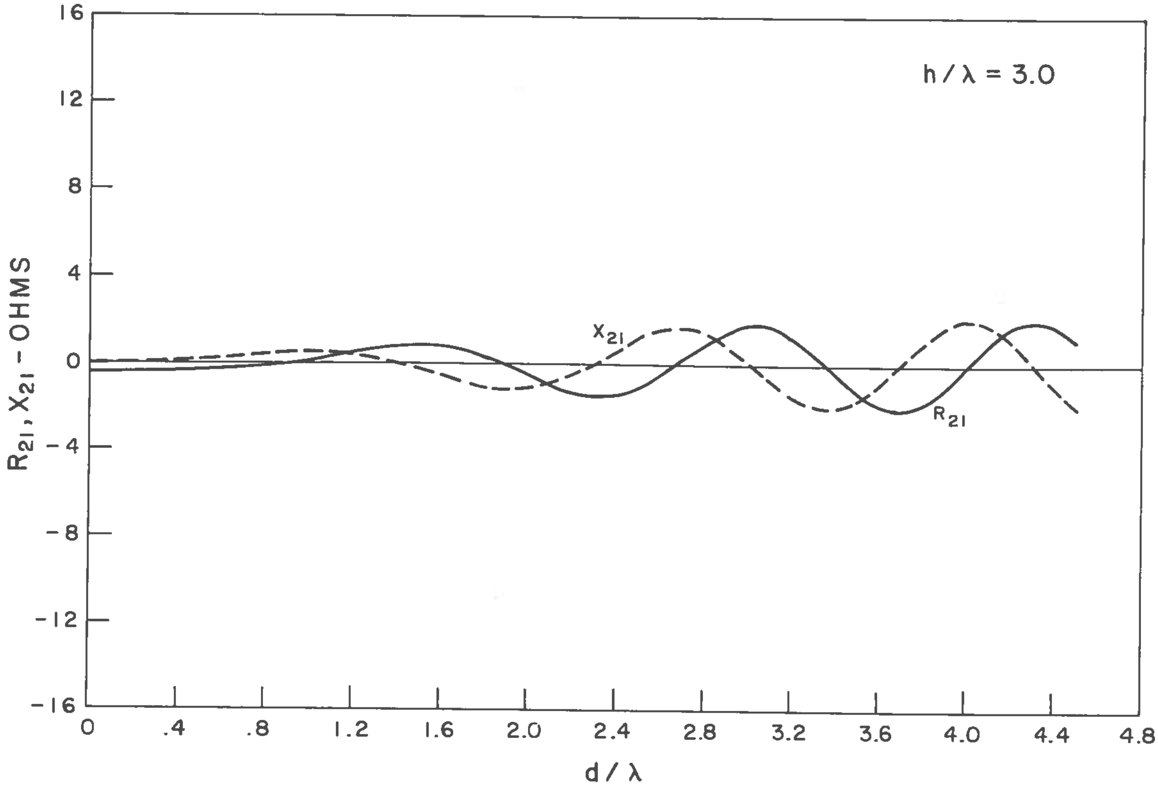

Fig. 8 Mutual impedance of two staggered parallel half-wave dipoles for h/λ = 3

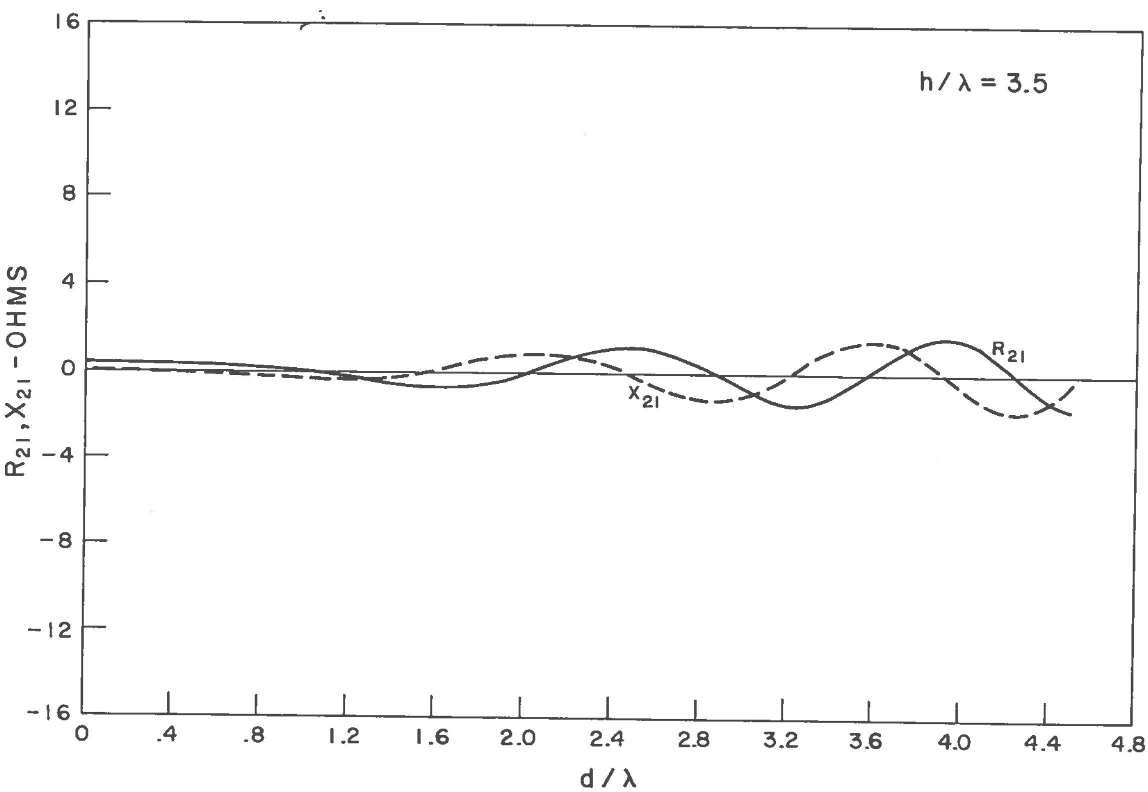

Fig. 9 Mutual impedance of two staggered parallel half-wave dipoles for h/λ = 3.5

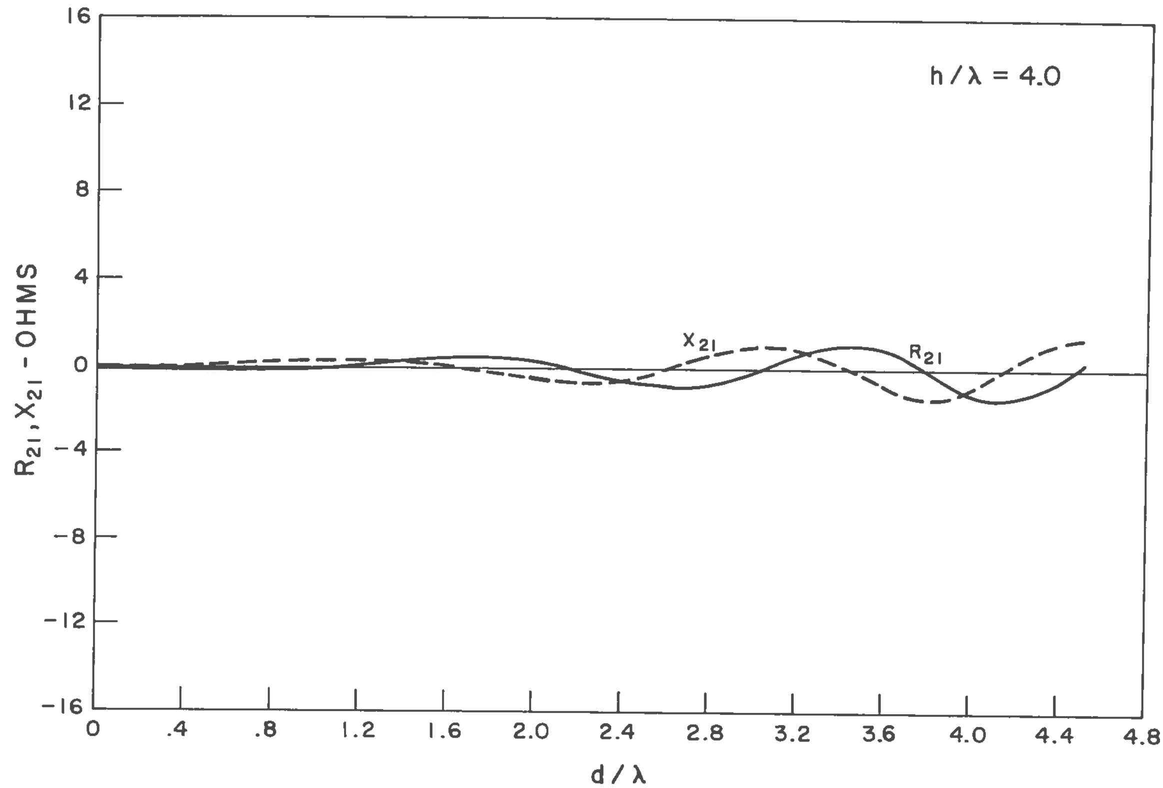

Fig. 10 Mutual impedance of two staggered parallel half-wave dipoles for h/λ = 4

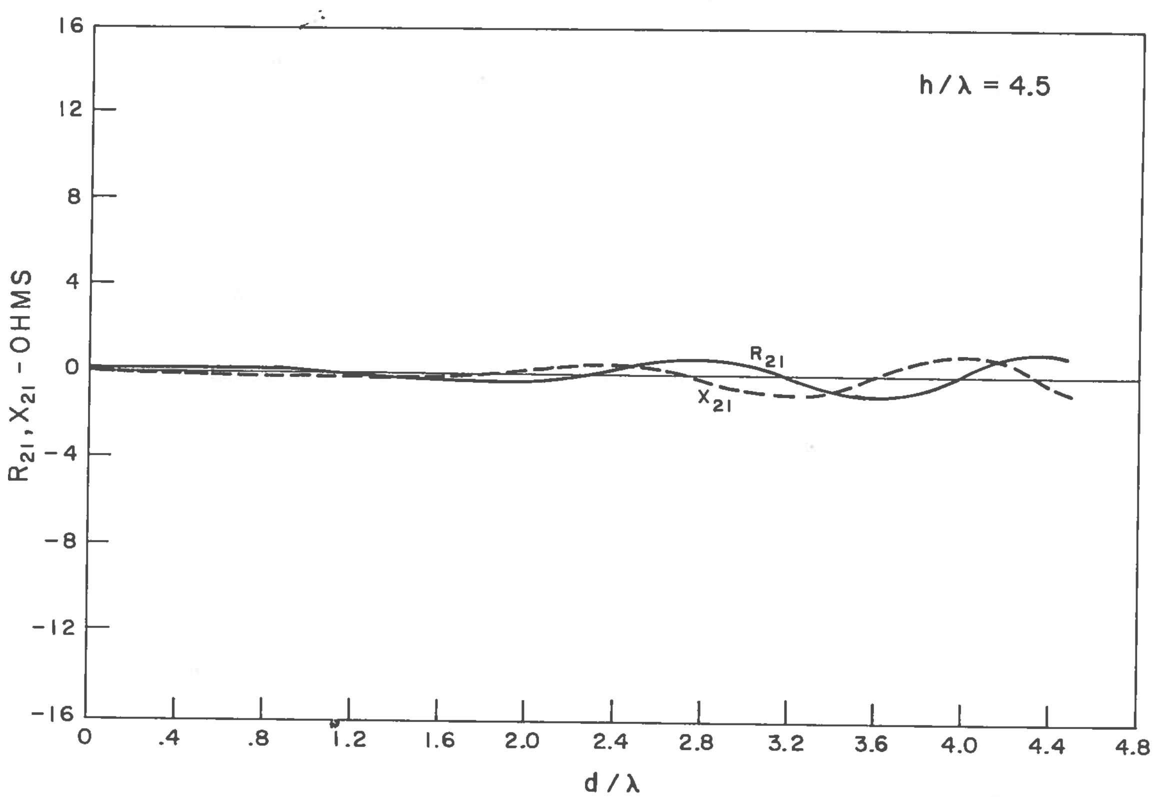

Fig. 11 Mutual impedance of two staggered parallel half-wave dipoles for h/λ = 4.5

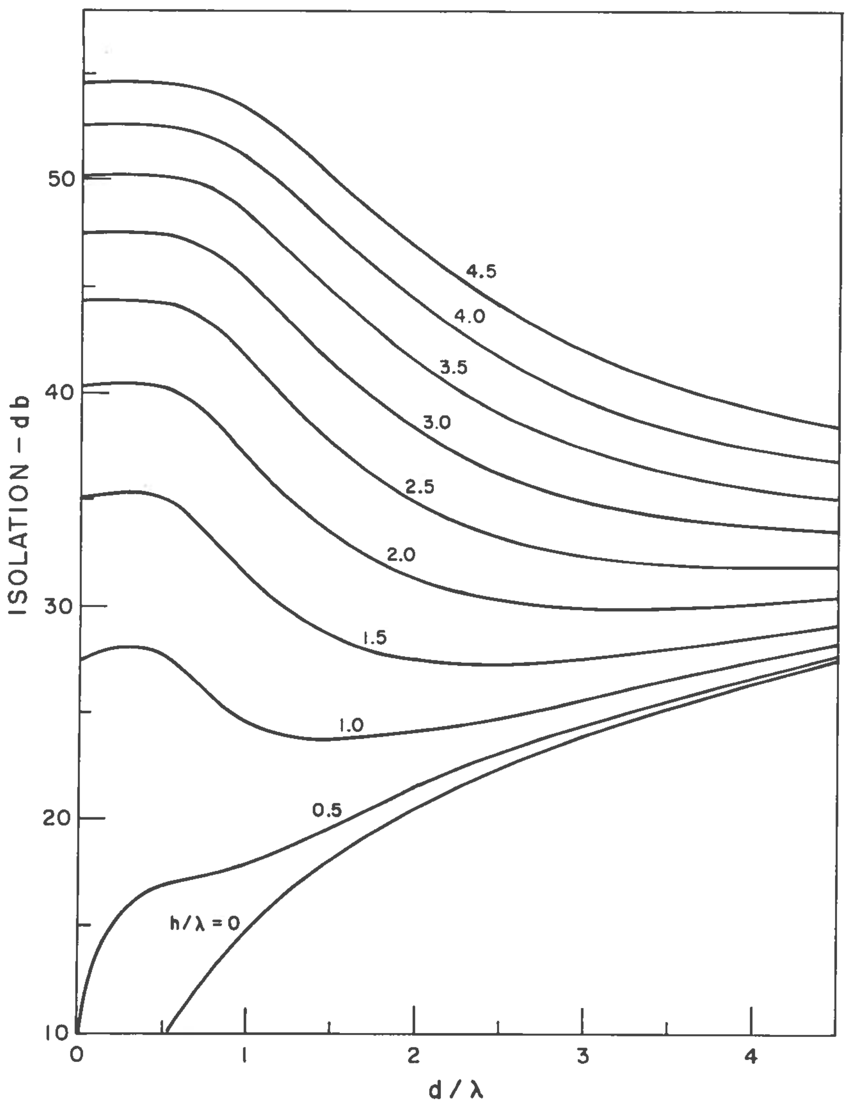

Fig. 12 Isolation of two staggered parallel half-wave dipoles as a function of antenna spacing

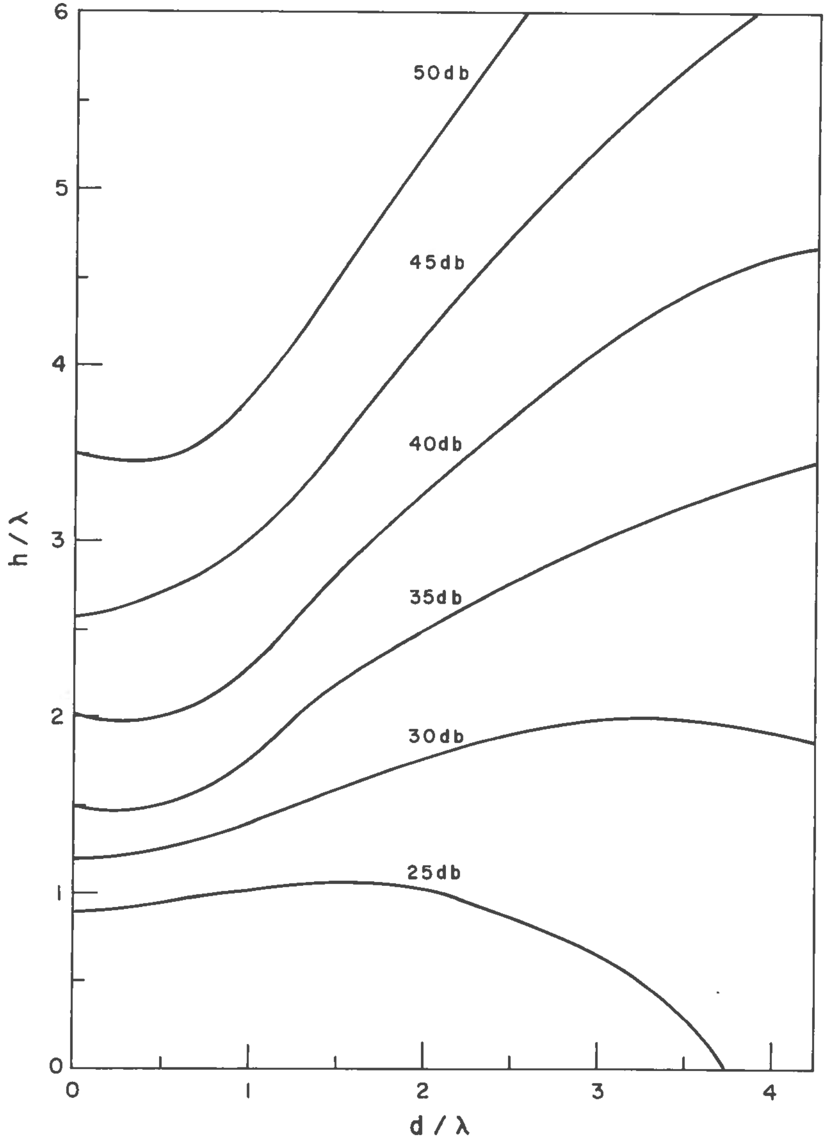

Fig. 13 Constant isolation contours for two staggered parallel half-wave dipoles

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