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THE INTERNATIONAL CONFERENCE ON ANTENNAS AND PROPAGATION (2ND) --ETC(U)
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OFFICE OF NAVAL RESEARCH

BRANCH OFFICE LONDON ENGLAND

2ND INTERNATIONAL CONFERENCE ON ANTENNAS AND PROPAGATION
T. C. Cheston
15 May 1981

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The Second International Conference on Antennas and Propagation took place in York, England in April 1981. This report reveiws some of the antenna papers.

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THE 2ND INTERNATIONAL CONFERENCE ON ANTENNAS AND PROPAGATION

The Second International Conference on Antennas and Propagation was held at the University of York, 13-16 April 1981. It was attended by over 480 people from 28 countries, and more than 150 papers were presented in 3 parallel sessions. A further 16 papers were available in poster sessions. Most of the participants stayed in rooms at the university and took their meals there. Dr. Alan W. Rudge, managing director of ERA Technology Ltd. in Leatherhead, England, and chairman of the organizing committee, said in his opening remarks that he hoped the proximity would lead to a fruitful interaction between people. This was actually the case and it was thought most commendable. Rudge thought that this conference would become a permanent, recurring event. This report reviews some of the antenna papers.

The first presentation was an invited review paper, "Circular Arrays: Their Properties and Potential Applications," by D.E.N. Davies (University College, London). He divided circular arrays into two groups, determined by their method of excitation. The first group, which he called beam cophasal excitation, uses elements from part of the circular aperture, added coherently with a phase corresponding to a plane wavefront. The patterns are characterized by high sidelobes, unless the aperture is restricted to less than 120° and the amplitude is tapered. The beam can be scanned by means of various complex switching schemes, or by using circular, beam-forming lenses (e.g., a Luneburg lens) and transferring the lens output to the circular array. Each beam is then associated with a specific input to the lens. The second group, which Davies called modal excitation, draws on developments at University College for HF communications systems. If many closely-spaced radiators on a circular array are excited in phase, then the radiation pattern will be omni. It will also be omni if the radiators are fed with a linear-phase progression such that there is a 360° change-of-phase around the circle. The proper phasing for this may be obtained from a Butler matrix. The sum of these patterns contains a null that can be rotated as the phase between them is changed. The scheme can be extended by adding harmonics so that the phase around the circle changes by a multiple of 2π, adding more directivity. Problems may arise, however, in matching the elements to the various modes. Davies claimed that advantages accrue from the use of directive elements, particularly giving wider bandwidth.

The Cassegrainian twist reflector antenna is frequently used in radar and communication systems. It employs a wire-grid primary reflector and a polarization-twist secondary reflector. J.D. Mahony (Marconi Avionics Ltd., UK) analyzed one version of the twist reflector, comprising a wire-grid embedded in a multi-layered dielectric backed by a perfectly conducting ground plane. Though the method of analysis is not new, the results

for the cross-polar energy level presented in Mahony's paper have not appeared elsewhere and can be quite important in many applications. They were studied both theoretically and experimentally and good correlation was obtained between the two. This paper should prove to be a useful design tool for twist reflectors.

A second paper on the Cassagrainian twist reflector antenna was given by M. Scorer, also from Marconi Avionics Ltd. Scorer analyzed this antenna using a combination of the aperture field method and the geometrical theory of diffraction (GTD). He showed that this analytical method is accurate for predicting the measured performance of the antenna quite satisfactorily. It was also demonstrated that the flat-plate twist reflector antenna is capable of achieving good scan performance over a wide range of angles and, in fact, can scan over more than a hemisphere.

Results of a study related to the problem of scattering by objects in translational motion were reported by D. De Zutter (Univ. of Ghent, Belgium). The author demonstrated that the scattered power is nonmonochromatic, and he presented computer results for the spectral power density of the field scattered by a small dielectric sphere as a function of the frequency. In this method the spectrum of the scattered field is computed for the case of a limited receiver turn-on time and when the incident field has a Gaussian time dependence. The main contribution of the paper was that it considered the problem of three-dimensional scattering whereas the previous efforts in this direction were limited to two-dimensional scattering geometries. It should be noted that the effect of the motion of the scatterer is significant only when its speed is relativistic. The computed curves are for $\beta = v/c = 0.4$.

Two new antennas were described in a session on millimeter wave antennas. Both of these utilize planar dielectric waveguides and modulate the uniform guides to induce radiation from them. However, the similarity essentially ends there as the antenna configurations studied in the two papers are considerably different.

The first paper in the session, presented by M.T. Birand, N. Williams, and M. Inggs (ERA Technology Ltd., UK), was concerned with a slow-wave, periodically-modulated antenna which takes advantage of the low-loss characteristics of the insular dielectric waveguide. The authors claimed the following advantages for the antenna: (1) reduced losses, (2) low cost, (3) light weight, and (4) suitability of integration with dielectric-based integrated circuits. They provided design considerations and experimental results in the 30 GHz range, and they compared these with the theoretical results they derived. Good agreement was reported.

In the second paper, presented by K. Solbach and I. Wolff, the use of a dielectric image line with a set of grooves in the ground plane was described. The grooves serve to interrupt the current flow in the ground plane thereby causing the image line to radiate. The half-power beamwidth of the antenna is 6° in the E-plane, which is also the plane of scan, and the H-plane beamwidth is 36° which is remarkably narrow for a leaky-wave antenna.

In addition to the developments described in the above two presentations, a waveguide slot array for use at millimeter wavelengths was reported by R.V. Gelsthorpe and M.J. Aylward (ERA Technology Ltd.). However, except for the obvious aspects of scaling down the sizes, the millimeter-wave antenna described did not differ from a microwave antenna. The design frequency of the antenna was in the 30 GHz range. The slots were formed in a top plate that was then fixed to a waveguide channel. Different assembly techniques were tried; soft soldering was found the most satisfactory way.

An interesting limited-scan antenna system making use of a reflector with what amounts to a phased array in its focal region, was described in a paper by D.J. Browning, N.A. Adia, and A.W. Rudge (the conference chairman) from ERA Technology Ltd., UK. The paper, "An Aperture-Phase Compensation Technique for Off-Axis Beam Synthesis in Parabolic Reflector Antennas," discussed beam steering with parabolic reflectors and pointed out how the serious scanning aberrations (with short, focal length systems) can be compensated by a complex feed. The focal array can be fed with a beamforming network like a Butler matrix, where each input to the matrix then corresponds to a beam from the array illuminating a different part of the reflector. Aberrations due to feed displacement may be compensated by combining all the inputs of the Butler matrix after adding a phase correction term. Scanning is obtained by further including a linear phase shifter. Experimental systems included one with a focal array fed by a 16-element Butler matrix.

The characteristics of Schwarzschild's dual reflector antenna systems, the design for which has been well known for 70 years, were discussed by J.H.A.W. Van de Sande, M.H.A.J. Herben, and E.J. Maanders of the Netherlands, reporting on work carried out at the Eindhoven University of Technology. Some of the main conclusions of the paper were that the dual antenna system is relatively straightforward to design and that its polarization efficiency is comparable to that of a standard Cassegrainian reflector system.

In a paper presented by G. Bjøntegaard and T. Pettersen (Norwegian Telecommunications Administration Research Establishment), a novel extension of a recently developed synthesis technique for a shaped offset dual reflector antenna system was described. The technique is very promising for satellite-communications applications, as the antenna can be designed to have high efficiency and low sidelobes. The antenna designs described by the authors achieve high gain, low-cross-polarization, low sidelobe levels, and a steering capability of approximately two beamwidths.

There were nine papers presented in two sessions of reflector antenna analysis—an area where considerable progress has been made in the last few years. The proceedings started with an invited review paper by G. Franceschetti, who is professor at the University of Naples. Franceschetti outlined a number of analytical techniques currently available for the computation of the secondary pattern of reflector antennas. He described

the conventional brute-force integration, the series expansion technique, sampling and sampling-like approaches, and the scope, limitations, and relative advantages, as well as the shortcomings, of these techniques.

Franceschetti's remarks on sampling and sampling-like techniques were amplified in a paper presented by G. D'Elia, E.L. Marinoni, and R. Pierri, also from the University of Naples. Another interesting paper in this session was by H. Bach, A. Frandsen, and F.H. Larsen, reporting on work carried out at the Technical University of Denmark. They described a novel technique for combining the GTD method with spherical near-field to far-field transformation for computing the secondary pattern of focused reflector antennas. The paper included numerical results illustrating and validating the technique.

The planar microstrip antenna that is widely used in many microwave systems has been investigated by J.R. Mosig and E. Gardiol (Ecole Polytechnique Fédérale de Lausanne, Switzerland) using numerical techniques. One of the principal contributions of the paper they presented was the development of a transformation for evaluating the Sommerfeld integrals that appear in the formulation of the problem. Numerical results for the effective dielectric constant and the magnitude and phase of the current distribution on the patch were also presented in the paper.

Beam waveguides are frequently used in satellite communication systems for transposing energy from a transmitter/receiver on the ground through a multiple-mirror system to a rotatable, large, reflector antenna; the waveguides also perform a secondary function of providing an equivalent to a rotating joint. K.K. Chan and A.R. Raab (Spar Aerospace Ltd., Quebec, Canada), in their paper, "Characteristics of Beam Waveguides," gave design curves showing high efficiency and low cross-polarization. Interestingly enough, they found depolarization effects due to paint on the reflectors, giving as much as a -30 to -35 dB cross-polarization with a paint thickness of .002 wavelengths.

There is much interest at this time in measuring and testing antennas indoors by taking near-field measurements and computing the far-field radiation pattern. The method is particularly suitable for large antenna structures such as are used for satellite communications or phased arrays. Six papers were devoted to this subject. New thoughts were introduced in a paper by J.C. Bennett and N.E. Muntanga (Univ. of Sheffield, UK). They described firstly a method that combines near-field measurements with compact-range techniques where a planar wavefront is created in the near field of an instrumentation antenna in which the antenna under test is measured. This is accomplished by using a line-array of elements as a probe, sweeping it in a direction orthogonal to the line. This method very appreciably reduces the normally considerable time required to perform and process near-field antenna measurements. Secondly, they described a receiving system which, although recording amplitude only, still measures amplitude and phase as required. This is done by mixing the signal with a reference signal in four subsequent operations, with the reference signal

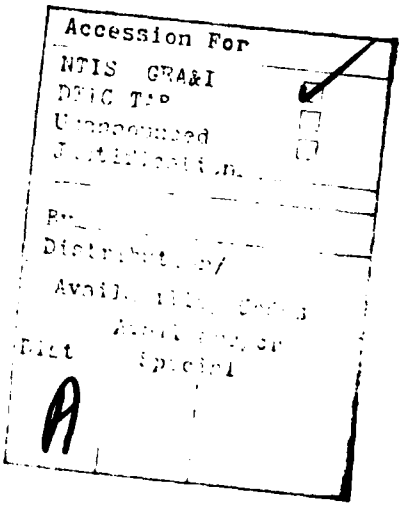
phase being changed sequentially in four steps of 90°. Four amplitude values which contain the phase information are therefore obtained for each measurement point.

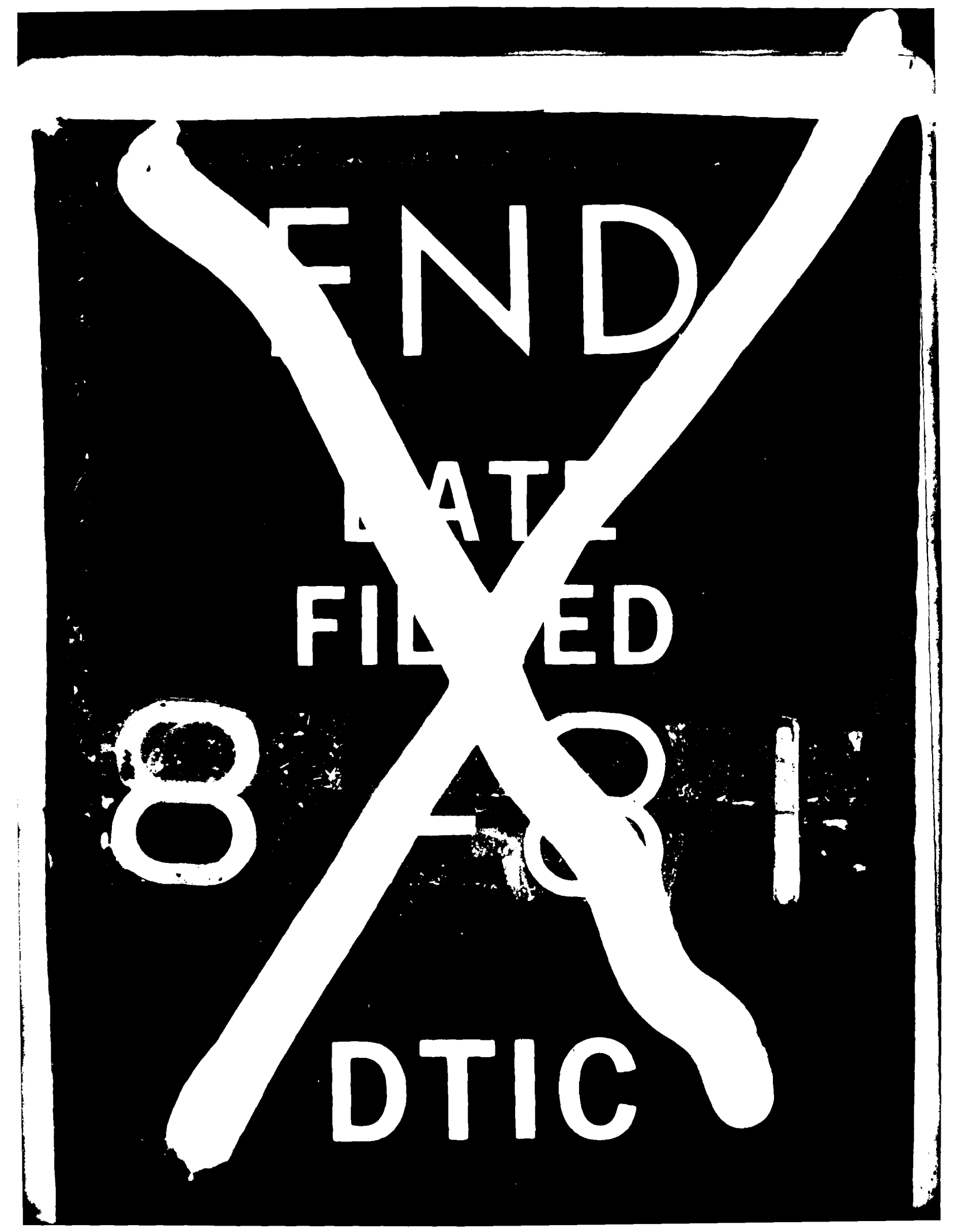
Horns and primary feeds were addressed in four papers, the first of which was an invited review by P.J.B. Clarricoats (Queen Mary College, London), who had a most active part in the development of corrugated horns. These hybrid-mode feeds can give very low cross-polarization over wide bands and are therefore used in satellite communications systems where orthogonal polarizations are employed to provide an extra channel. Clarricoats reviewed pure-mode and multi-mode feeds, round and ellyptical apertures, and multi-feed systems.

F.M. Landstorfer and R.R. Sacher (Technical Univ., Munich) discussed a new horn design which gives maximun gain using a computer-aided optimization technique. The authors achieved an increase in gain of 1.5 dB over conventional conical horns by using a design in which the mouth of the horn is actually smaller than the throat. In another design they reduce sidelobes in the E-plane of a horn by introducing wedges which led to binary amplitude distributions. A similar approach was reported by A.S. Marincić (Univ. of Belgrade, Yugoslavia), who had investigated aperture-dividing metal plates that redistribute the amplitude in the E-plane of a horn. Marincić investigated 3- and 5-section apertures and showed how considerable improvements could be achieved. He gave design curves relating the various parameters.

A most impressively-engineered complex feed system which uses mode-extraction networks for on-board satellite application was described by B.K. Watson, N.D. Dang, and S. Ghosh (ERA Technology Ltd., UK). The design includes a short, conical, corrugated horn with a cosine-squared cross-sectional profile, and covers in three separate bands from 11.7 to 18.1 GHz. High-polarization purity is obtained (40 dB). The network includes monopulse outputs for tracking a beacon on the ground as well as down- and up-links. High-channel isolation is achieved.

The conference was unquestionably a success, interesting work was reported, and ample opportunities were available for instructive, detailed discussions and shoptalk with colleagues.

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DEPARTMENT OF THE NAVY

OFFICE OF NAVAL RESEARCH, BRANCH OFFICE, LONDON
BOX 39 FPO NEW YORK 09510
TELEPHONE: AUTOVON 314 - 235 - 4511 INT'L: [redacted] (01) 409-4511

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1. It is regretted that the name of Professor R. Mittra, the coauthor of ONRL Report C-1-81, "2nd International Conference on Antennas and Propagation," was inadvertently omitted from the report.

2. It is requested that you remove the cover page and documentation page from all copies of the report received by you, and substitute the corrected pages, enclosures (1) and (2).

Donald J. Peters

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ONR LONDON CONFERENCE REPORT

C-1-81

OFFICE OF NAVAL RESEARCH

BRANCH OFFICE LONDON ENGLAND

2ND INTERNATIONAL CONFERENCE ON ANTENNAS AND PROPAGATION

T. C. Cheston
R. Mittra*

15 May 1981

*University of Illinois

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