

# US ARMY RADIO WAVE PROPAGATION AND ANTENNAS

WAVE PROPAGATION AND SCATTERING IN RANDOM MEDIA WAVE PROPAGATION AND GROUP VELOCITY WAVE PROPAGATION AND SCATTERING WAVE PROPAGATION IN THE IONOSPHERE ELECTROMAGNETIC THEORY AND WAVE PROPAGATION ELECTROMAGNETIC WAVES PROPAGATION IN COMPLEX MATTER RADIO WAVE PROPAGATION AND THE IONOSPHERE: PROPAGATION OF ELECTROMAGNETIC WAVES NEAR THE EARTH RADIO WAVE PROPAGATION AND ANTENNAS WAVE PROPAGATION AND TIME REVERSAL IN RANDOMLY LAYERED MEDIA RADIO WAVE PROPAGATION RADIO WAVE PROPAGATION AND THE IONOSPHERE RADIO WAVE PROPAGATION SEISMIC WAVE PROPAGATION AND SCATTERING IN THE HETEROGENOUS EARTH WAVE PROPAGATION AND RADIATION IN GYROTROPIC AND ANISOTROPIC MEDIA WAVE PROPAGATION AND SCATTERING IN RANDOM MEDIA: SINGLE SCATTERING AND TRANSPORT THEORY THE PROPAGATION OF ELECTROMAGNETIC WAVES IN PLASMAS WAVE PROPAGATION AND TURBULENT MEDIA ANTENNA AND WAVE PROPAGATION HYBRID FORMULATION OF WAVE PROPAGATION AND SCATTERING WAVE PROPAGATION IN RANDOM MEDIA. AKIRA ISHIMARU L. BRILLOUIN B.J. USCINSKI K. RAWER S. N. GHOSH GUSTAF KRON ТАКОВ L. VOVICH AL. PERT JOHN GRIFFITHS JEAN-PIERRE FOUQUE JOHN A. RICHARDS ТАКОВ L. VOVICH AL. PERT CHAS. R. BURROWS HARUO SATO ABDULLAH EROGLU AKIRA ISHIMARU VITALI LAZAREVICH GINZBURG ROY N. ADAMS KAMAL KISHORE L.B. FELSEN

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ELECTRICAL ENGINEERING WAVE PROPAGATION AND SCATTERING IN RANDOM MEDIA A VOLUME IN THE IEEE OUP SERIES ON ELECTROMAGNETIC WAVE THEORY DONALD G DUDLEY SERIES EDITOR THIS IEEE CLASSIC REISSUE PRESENTS A UNIFIED INTRODUCTION TO THE FUNDAMENTAL THEORIES AND APPLICATIONS OF WAVE PROPAGATION AND SCATTERING IN RANDOM MEDIA NOW FOR THE FIRST TIME THE TWO VOLUMES OF WAVE PROPAGATION AND SCATTERING IN RANDOM MEDIA PREVIOUSLY PUBLISHED BY ACADEMIC PRESS IN 1978 ARE COMBINED INTO ONE COMPREHENSIVE VOLUME THIS BOOK PRESENTS A CLEAR PICTURE OF HOW WAVES INTERACT WITH THE ATMOSPHERE TERRAIN OCEAN TURBULENCE AEROSOLS RAIN SNOW BIOLOGICAL TISSUES COMPOSITE MATERIAL AND OTHER MEDIA THE THEORIES PRESENTED WILL

ENABLE YOU TO SOLVE A VARIETY OF PROBLEMS RELATING TO CLUTTER INTERFERENCE IMAGING OBJECT DETECTION AND COMMUNICATION THEORY FOR VARIOUS MEDIA THIS BOOK IS EXPRESSLY DESIGNED FOR ENGINEERS AND SCIENTISTS WHO HAVE AN INTEREST IN OPTICAL MICROWAVE OR ACOUSTIC WAVE PROPAGATION AND SCATTERING TOPICS COVERED INCLUDE WAVE CHARACTERISTICS IN AEROSOLS AND HYDROMETEORS OPTICAL AND ACOUSTIC SCATTERING IN SEA WATER SCATTERING FROM BIOLOGICAL MATERIALS PULSE SCATTERING AND BEAM WAVE PROPAGATION IN SUCH MEDIA OPTICAL DIFFUSION IN TISSUES AND BLOOD TRANSPORT AND RADIATIVE TRANSFER THEORY KUBELKA MUNK FLUX THEORY AND PLANE PARALLEL PROBLEM MULTIPLE SCATTERING THEORY WAVE FLUCTUATIONS IN TURBULENCE STRONG FLUCTUATION THEORY ROUGH SURFACE SCATTERING REMOTE SENSING AND INVERSION TECHNIQUES IMAGING THROUGH VARIOUS MEDIA ABOUT THE IEEE OUP SERIES ON ELECTROMAGNETIC WAVE THEORY FORMERLY THE IEEE PRESS SERIES ON ELECTROMAGNETIC WAVES THIS JOINT SERIES BETWEEN IEEE PRESS AND OXFORD UNIVERSITY PRESS OFFERS OUTSTANDING COVERAGE OF THE FIELD WITH NEW TITLES AS WELL AS REPRINTINGS AND REVISIONS OF RECOGNIZED CLASSICS THAT MAINTAIN LONG TERM ARCHIVAL SIGNIFICANCE IN ELECTROMAGNETIC WAVES AND APPLICATIONS DESIGNED SPECIFICALLY FOR GRADUATE STUDENTS PRACTICING ENGINEERS AND RESEARCHERS THIS SERIES PROVIDES AFFORDABLE VOLUMES THAT EXPLORE ELECTROMAGNETIC WAVES AND APPLICATIONS BEYOND THE UNDERGRADUATE LEVEL SEE PAGE II OF THE FRONT MATTER FOR A LISTING OF BOOKS IN THIS SERIES

WAVE PROPAGATION AND GROUP VELOCITY CONTAINS PAPERS ON GROUP VELOCITY WHICH WERE PUBLISHED DURING THE FIRST WORLD WAR AND ARE MISSING IN MANY LIBRARIES IT INTRODUCES THREE DIFFERENT DEFINITIONS OF VELOCITIES THE GROUP VELOCITY OF LORD RAYLEIGH THE SIGNAL VELOCITY OF SOMMERFELD AND THE VELOCITY OF ENERGY TRANSFER WHICH YIELDS THE RATE OF ENERGY FLOW THROUGH A CONTINUOUS WAVE AND IS STRONGLY RELATED TO THE CHARACTERISTIC IMPEDANCE THESE THREE VELOCITIES ARE IDENTICAL FOR NONABSORBING MEDIA BUT THEY DIFFER CONSIDERABLY IN AN ABSORPTION BAND SOME EXAMPLES ARE DISCUSSED IN THE LAST CHAPTER DEALING WITH GUIDED WAVES AND MANY OTHER CASES OF APPLICATION OF THESE DEFINITIONS ARE QUOTED THESE PROBLEMS HAVE COME AGAIN INTO THE FOREGROUND IN CONNECTION WITH THE PROPAGATION OF RADIO SIGNALS AND RADAR REFLECTION IN THE HEAVISIDE LAYERS REQUIRES A REAL KNOWLEDGE OF ALL THESE DIFFERENT DEFINITIONS GROUP VELOCITY ALSO PLAYS A VERY IMPORTANT ROLE IN WAVE MECHANICS AND CORRESPONDS TO THE SPEED OF A PARTICLE THE PRESENT BOOK SHOULD BE VERY USEFUL TO PHYSICISTS AND RADIO ENGINEERS AND SHOULD GIVE THEM A GOOD BASIS FOR NEW DISCUSSIONS AND APPLICATIONS

IN THIS BOOK THE AUTHOR DRAWS ON HIS BROAD EXPERIENCE TO DESCRIBE BOTH THE THEORY AND THE APPLICATIONS OF WAVE PROPAGATIONS THE CONTENTS ARE PRESENTED IN FOUR PARTS AND THE SEQUENCE OF THESE PARTS REFLECT THE DEVELOPMENT OF IONOSPHERIC AND PROPAGATIONAL RESEARCH IN AREAS SUCH AS SPACE RESEARCH GEOPHYSICS AND COMMUNICATIONS THE FIRST PART OF THE BOOK PRESENTS AN OUTLINE OF THE THEORY OF ELECTROMAGNETIC WAVES PROPAGATING IN A COLD ELECTRON PLASMA FOR REFERENCE VECTOR ANALYSIS DYADICS AND EIGENVALUES INTRODUCED IN THIS PART ARE PRESENTED IN THE APPENDICES PRACTICAL ASPECTS OF RADIO WAVE PROPAGATION ARE THE SUBJECT OF THE SECOND PART THE TYPICAL CONDITIONS IN DIFFERENT FREQUENCY RANGES ARE DISCUSSED AND THE IRREGULAR FEATURES OF THE IONOSPHERIC STRUCTURE SUCH AS SOUND AND GRAVITY WAVES ARE ALSO CONSIDERED WARM PLASMA AND THE EFFECTS OF IONS ARE CONSIDERED IN THE THIRD PART WHICH INCLUDES A DISCUSSION OF SOUND LIKE WAVES IN ELECTRON AND ION PLASMAS NONLINEAR EFFECTS AND INSTABILITIES ARE DESCRIBED IN THE FOURTH PART

ALTHOUGH THE FUNDAMENTAL CONCEPTS OF MAXWELL REMAIN FOR THE MOST PART UNCHANGED SINCE THEIR INCEPTION ELECTROMAGNETIC THEORY HAS CONTINUED TO EVOLVE EXTENDING MOST SIGNIFICANTLY TO SHORTER AND SHORTER WAVELENGTHS THIS HAS REVEALED MANY OF NATURE S MYSTERIES AND LED TO A MYRIAD OF

APPLICATIONS THAT HAVE LITERALLY CHANGED OUR WORLD THE SECOND EDITION OF ELECTROMAGNETIC THEORY AND WAVE PROPAGATION BEGINS BY PRESENTING THE BASIC CONCEPTS OF ELECTROMAGNETIC THEORY THEN EXPLORES THE FIELD S EXTENDED AREAS PRIMARILY DISCOVERED AFTER WORLD WAR II THE AUTHOR ELABORATES ON THE WORK OF PIONEER INVESTIGATORS PARTICULARLY WITH RESPECT TO THE IDENTITY OF LIGHT AND ELECTROMAGNETIC WAVES AND THEN DERIVES THE FUNDAMENTAL LAWS OF OPTICS FROM ELECTROMAGNETIC CONSIDERATIONS HE HAS ALSO ADDED SEVERAL NEW TOPICS INCLUDING METEOR ASTRONOMY REMOTE SENSING AND MOST NOTABLY DISCUSSIONS ON RELATIVISTIC ELECTRODYNAMICS

ELECTROMAGNETIC WAVES ARE WAVES WHICH CAN TRAVEL THROUGH THE VACUUM OF OUTER SPACE MECHANICAL WAVES UNLIKE ELECTROMAGNETIC WAVES REQUIRE THE PRESENCE OF A MATERIAL MEDIUM IN ORDER TO TRANSPORT THEIR ENERGY FROM ONE LOCATION TO ANOTHER LIGHT MICROWAVES XRAYS AND TV AND RADIO TRANSMISSIONS ARE ALL KINDS OF ELECTROMAGNETIC WAVES THEY ARE ALL THE SAME KIND OF WAVY DISTURBANCE THAT REPEATS ITSELF OVER A DISTANCE CALLED THE WAVELENGTH THE MECHANISM OF ENERGY TRANSPORT THROUGH A MEDIUM INVOLVES THE ABSORPTION AND REEMISSION OF THE WAVE ENERGY BY THE ATOMS OF THE MATERIAL WHEN AN ELECTROMAGNETIC WAVE IMPINGES UPON THE ATOMS OF A MATERIAL THE ENERGY OF THAT WAVE IS ABSORBED THE ABSORPTION OF ENERGY CAUSES THE ELECTRONS WITHIN THE ATOMS TO UNDERGO VIBRATIONS AFTER A SHORT PERIOD OF VIBRATIONAL MOTION THE VIBRATING ELECTRONS CREATE A NEW ELECTROMAGNETIC WAVE WITH THE SAME FREQUENCY AS THE FIRST ELECTROMAGNETIC WAVE WHILE THESE VIBRATIONS OCCUR FOR ONLY A VERY SHORT TIME THEY DELAY THE MOTION OF THE WAVE THROUGH THE MEDIUM ONCE THE ENERGY OF THE ELECTROMAGNETIC WAVE IS REEMITTED BY AN ATOM IT TRAVELS THROUGH A SMALL REGION OF SPACE BETWEEN ATOMS ONCE IT REACHES THE NEXT ATOM THE ELECTROMAGNETIC WAVE IS ABSORBED TRANSFORMED INTO ELECTRON VIBRATIONS AND THEN REEMITTED AS AN ELECTROMAGNETIC WAVE ELECTROMAGNETIC WAVES PROPAGATION IN COMPLEX MATTER EMPHASIZES THE TOPICS OF WAVE PROPAGATION AND INTERACTION WITH MATTERS THE BOOK BRIDGES THE GAP BETWEEN PHYSICS AND ENGINEERING IN THESE ISSUES

OUR MOTIVATION FOR WRITING THIS BOOK IS TWOFOLD FIRST THE THEORY OF WAVES PROPAGATING IN RANDOMLY LAYERED MEDIA HAS BEEN STUDIED EXTENSIVELY DURING THE LAST THIRTY YEARS BUT THE RESULTS ARE SCATTERED IN MANY DI ERENT PAPERS THIS THEORY IS NOW IN A MATURE STATE ESPECIALLY IN THE VERY INTERESTING REGIME OF SEPARATION OF SCALES AS INTRODUCED BY G PAPANICOLAOU AND HIS COAUTHORS AND DESCRIBED IN 8 WHICH IS A BUILDING BLOCK FOR THIS BOOK SECOND WE WERE MOTIVATEDBYTHE TIME REVERSALEXPERIMENTSOFM FINKANDHIS GROUPINPARIS THEY WERE DONE WITH ULTRASONIC WAVES AND HAVE ATTRACTED CONSIDERABLE ATT TION BECAUSE OF THE SURPRISING E ECTS OF ENHANCED SPATIAL FOCUSING AND TIME COMPRESSION IN RANDOM MEDIA AN EXPOSITION OF THIS WORK AND ITS APPLI TIONS IS PRESENTED IN 56 TIME REVERSAL EXPERIMENTS WERE ALSO CARRIED OUT WITH SONAR ARRAYS IN SHALLOW WATER BY W KUPERMAN 113 AND HIS GROUP IN SAN DIEGO THE ENHANCED SPATIAL FOCUSING AND TIME COMPRESSION OF SIGNALS IN TIME REVERSAL IN RANDOMMEDIA HAVE MANY DIVERSE APPLICATIONS IN DETECTION AND IN FOCUSED ENERGY DELIVERY ON SMALL TARGETS AS FOR EXAMPLE IN THE STRUCTION OF KIDNEY STONES ENHANCED SPATIAL FOCUSING IS ALSO USEFUL IN SONAR AND WIRELESS COMMUNICATIONS FOR REDUCING INTERFERENCE TIME REVERSAL IDEAS HAVE PLAYED AN IMPORTANT ROLE IN THE DEVELOPMENT OF NEW METHODS FOR ARRAY IMAGING IN RANDOM MEDIA AS PRESENTED IN 19

THIS WORK TREATS THE ESSENTIAL ELEMENTS OF RADIO WAVE PROPAGATION WITHOUT REQUIRING RECOURSE TO ADVANCED ELECTROMAGNETIC CONCEPTS AND EQUATIONS HOWEVER IT PROVIDES SUFFICIENT DETAIL TO ALLOW THOSE CONCERNED WITH WIRELESS SYSTEMS TO ACQUIRE QUICKLY A PRACTICAL WORKING KNOWLEDGE OF THE IMPORTANT CONCEPTS RADIO WAVE PROPAGATION IS PLACED IN A PRACTICAL CONTEXT BY CONSIDERING THE DESIGN ASPECTS OF COMMUNICATIONS SYSTEMS AT MICROWAVE FREQUENCIES A FULLER CONSIDERATION OF THE ELECTROMAGNETIC PROPERTIES OF MATERIALS IS GIVEN LATE IN THE BOOK

RATHER THAN AS AN INTRODUCTORY CHAPTER

RADIO WAVE PROPAGATION CONSOLIDATED SUMMARY TECHNICAL REPORT OF THE COMMITTEE ON PROPAGATION OF THE NATIONAL DEFENSE RESEARCH COMMITTEE PRESENTS ALL THE SCIENTIFIC INFORMATION AND REPORT OF EXPERIMENTS THIS BOOK DISCUSSES THE PROBLEMS ENCOUNTERED IN THE PROPAGATION OF RADIO WAVES ORGANIZED INTO THREE VOLUMES THIS BOOK BEGINS WITH AN OVERVIEW OF THE TECHNICAL DEVELOPMENTS IN THE STUDY OF TROPOSPHERIC PROPAGATION THIS TEXT THEN OUTLINES THE GENERAL THEORY OF STANDARD AND NONSTANDARD PROPAGATION TOGETHER WITH DESCRIPTIONS AND RESULTS OF TRANSMISSION EXPERIMENTS DESIGNED TO TEST THE THEORY OTHER CHAPTERS CONSIDER THE MORE UNUSUAL PROBLEMS CONCERNING THE RADAR BEHAVIOR OF TARGETS THIS BOOK DISCUSSES AS WELL THE PROBLEMS OF RADIO WAVE PROPAGATION IN THE STANDARD ATMOSPHERE AT FREQUENCIES ABOVE 30 MEGACYCLES THE FINAL CHAPTER DEALS WITH THE SELECTION AND UTILIZATION OF LOCAL TERRAIN FEATURES THAT AFFECT PROPAGATION AND THE PERFORMANCE OF EQUIPMENT THIS BOOK IS A VALUABLE RESOURCE FOR SCIENTISTS AND ENGINEERS IN THE FIELD OF RADIO WAVE PROPAGATION

SEISMIC WAVES GENERATED BOTH BY NATURAL EARTHQUAKES AND BY MAN MADE SOURCES HAVE PRODUCED AN ENORMOUS AMOUNT OF INFORMATION ABOUT THE EARTH S INTERIOR IN CLASSICAL SEISMOLOGY THE EARTH IS MODELED AS A SEQUENCE OF UNIFORM HORIZONTAL LAYERS OR SPHERICAL SHELLS HAVING DIFFERENT ELASTIC PROPERTIES AND ONE DETERMINES THESE PROPERTIES FROM TRAVEL TIMES AND DISPERSION OF SEISMIC WAVES THE EARTH HOWEVER IS NOT MADE OF HORIZONTALLY UNIFORM LAYERS AND CLASSIC SEISMIC METHODS CAN TAKE LARGE SCALE INHOMOGENEITIES INTO ACCOUNT SMALLER SCALE IRREGULARITIES ON THE OTHER HAND REQUIRE OTHER METHODS OBSERVATIONS OF CONTINUOUS WAVE TRAINS THAT FOLLOW CLASSIC DIRECT S WAVES KNOWN AS CODA WAVES HAVE SHOWN THAT THERE ARE HETEROGENEITIES OF RANDOM SIZE SCATTERED RANDOMLY THROUGHOUT THE LAYERS OF THE CLASSIC SEISMIC MODEL THIS BOOK FOCUSES ON RECENT DEVELOPMENTS IN THE AREA OF SEISMIC WAVE PROPAGATION AND SCATTERING THROUGH THE RANDOMLY HETEROGENEOUS STRUCTURE OF THE EARTH WITH EMPHASIS ON THE LITHOSPHERE THE PRESENTATION COMBINES INFORMATION FROM MANY SOURCES TO PRESENT A COHERENT INTRODUCTION TO THE THEORY OF SCATTERING IN ACOUSTIC AND ELASTIC MATERIALS AND INCLUDES ANALYSES OF OBSERVATIONS USING THE THEORETICAL METHODS DEVELOPED

AS TECHNOLOGY MATURES COMMUNICATION SYSTEM OPERATION REGIONS SHIFT FROM MIC WAVE AND MILLIMETER RANGES TO SUB MILLIMETER RANGES HOWEVER DEVICE PERFORMANCE AT VERY HIGH FREQUENCIES SUFFERS DRASTICALLY FROM THE MATERIAL DEFICIENCIES AS A RESULT ENGINEERS AND SCIENTISTS ARE RELENTLESSLY IN SEARCH FOR THE NEW TYPES OF MATERIALS AND COMPOSITES WHICH WILL MEET THE DEVICE PERFORMANCE REQUIREMENTS AND NOT PRESENT ANY DEFICIENCIES DUE TO MATERIAL ELECTRICAL AND MAGNETIC PROPERTIES ANISOTROPIC AND GYROTROPIC MATERIALS ARE THE CLASS OF THE MATERIALS WHICH ARE VERY IMPORTANT IN THE DEVELOPMENT HIGH PERFORMANCE MICROWAVE DEVICES AND NEW TYPES COMPOSITE LAYERED STRUCTURES AS A RESULT IT IS A NEED TO UNDERSTAND THE WAVE PROPAGATION AND RADIATION CHARACTERISTICS OF THESE MATERIALS TO BE ABLE TO REALIZE THEM IN PRACTICE THIS BOOK IS INTENDED TO PROVIDE ENGINEERS AND SCIENTISTS THE REQUIRED SKILL SET TO DESIGN HIGH FREQUENCY DEVICES USING ANISOTROPIC AND GYROTROPIC MATERIALS BY PROVIDING THEM THE THEORETICAL BACKGROUND WHICH IS BLENDED WITH THE REAL WORLD ENGINEERING APPLICATION EXAMPLES IT IS THE AUTHOR S HOPE THAT THIS BOOK WILL HELP TO FILL THE GAP IN THE AREA OF APPLIED ELECTROMAGNETICS FOR THE DESIGN OF MICROWAVE AND MILLIMETER WAVE DEVICES USING NEW TYPES OF MATERIALS EACH CHAPTER IN THE BOOK IS DESIGNED TO GIVE THE THEORY FIRST ON THE SUBJECT AND SOLIDIFY IT WITH APPLICATION EXAMPLES GIVEN IN THE LAST CHAPTER THE APPLICATION EXAMPLES FOR THE RADIATION PROBLEMS ARE GIVEN AT THE END OF CHAP 5 AND CHAP 6 FOR ANISOTROPIC AND GYROTROPIC MATERIALS RESPECTIVELY AFTER THE THEORY SECTION

MUCH ATTENTION HAS BEEN GIVEN ALSO TO VARIOUS SPECIFIC PROBLEMS IN PARTICULAR THE PROPAGATION AND GENERATION OF WAVES IN THE EARTH'S IONOSPHERE AND MAGNETOSPHERE IN THE INTERPLANETARY PLASMA AND IN LABORATORY APPARATUS AS WELL AS SOLID STATE PLASMAS PAGE XIII

THE AIM OF THIS BOOK IS TO GIVE AN INTRODUCTION TO THE FUNDAMENTAL PRINCIPLES OF ANTENNAS AND WAVE PROPAGATION UNLIKE OTHER BOOKS AVAILABLE THERE IS MORE EMPHASIS ON MATHEMATICAL EXPLANATION IN ADDITION TO PHYSICAL UNDERSTANDING PHYSICAL PRINCIPLES ARE EXPLAINED IN DETAIL WITH CLEAR DIAGRAMS TO SUPPORT THE THEORY

THE WORKSHOP ON HYBRID FORMULATIONS OF WAVE PROPAGATION AND SCATTERING UNDERWENT A SEQUENCE OF ITERATIONS BEFORE EMERGING IN THE FORMAT RECORDED HERE THESE ITERATIONS WERE CAUSED BY VARIOUS ADMINISTRATIVE AND LOGISTICAL PROBLEMS WHICH NEED NOT BE DETAILED HOWEVER ITS DIRECTION BEING SET INITIALLY THE ITERATIONS LED TO MODIFICATIONS OF THE ORIGINAL CONCEPT SO THAT THE FINAL FORM WAS ARRIVED AT THROUGH AN INDIRECT APPROACH THIS CIRCUMSTANCE MAY EXPLAIN SOME POSSIBLE DEFICIENCIES WHICH MIGHT HAVE BEEN REMOVED HAD THE FINAL CONCEPT BEEN IMPLEMENTED DIRECTLY THE MOTIVATION AROSE FROM A PERCEPTION THAT THE NEWLY RESTORED INTEREST COUPLED WITH NEW DEVELOPMENTS IN HYBRID METHODS EMPLOYING PROGRESSING WAVE FIELDS AND OSCILLATORY WAVE FIELDS FOR TIME HARMONIC AND TRANSIENT GUIDED PROPAGATION IN MANMADE OR GENERAL GEO PHYSICAL ENVIRONMENTS AND FOR SCATTERING BY TARGETS AND IRREGULARITIES MERITS EXPOSURE TO THE WIDER SCIENTIFIC COMMUNITY ACCORDINGLY A MEETING WITH HIGHLY TUTORIAL CONTENT WAS ENVISAGED FOR ADMINISTRATIVE REASONS RELATED TO SPONSORSHIP AND ORGANIZATIONAL STRUCTURE THIS OBJECTIVE COULD NOT BE REALIZED BUT EVENTUALLY THERE EMERGED THE POSSIBILITY OF CONVENING AN ADVANCED RESEARCH WORKSHOP ARW UNDER THE AUSPICES OF THE NATO ADVANCED STUDY INSTITUTE SERIES THE ORIGINAL CONCEPT WAS THEN MODIFIED TO ACCOMMODATE A WORKSHOP WHEREIN STATE OF THE ART SCIENCE IS DISCUSSED BY A RELATIVELY SMALL GROUP OF SPECIALISTS INSTEAD OF TUTORIAL PRESENTATIONS OF MORE BASIC MATERIAL

WAVE PROPAGATION AND RANDOM MEDIA ARE DEFINED AND THE NATURE OF THE MATHEMATICAL PROBLEMS ARISING IN RANDOM MEDIA IS DESCRIBED THE TWO PRINCIPAL TYPES OF METHODS FOR SOLVING THESE PROBLEMS HONEST AND DISHONEST METHODS ARE EXPLAINED THESE METHODS ARE FIRST ILLUSTRATED BY CONSIDERING THE GEOMETRICAL OPTICS OF A RANDOM MEDIUM BY ONE METHOD OF EACH TYPE SOME NEW RESULTS ARE OBTAINED BY AN HONEST METHOD AND SOME ERRORS IN A PREVIOUS WORK ARE POINTED OUT COMPARISON IS MADE BETWEEN THE RESULTS OF THE TWO METHODS AND THE REASONS WHY THEY DISAGREE ARE EXPLAINED AS THE PROPAGATION IN RANDOM MEDIA IS DESCRIBED THE TWO PRINCIPAL TYPES OF METHODS FOR SOLVING THESE PROBLEMS HONEST AND DISHONEST METHODS ARE EXPLAINED THESE METHODS ARE FIRST ILLUSTRATED BY CONSIDERING THE GEOMETRICAL OPTICS OF A RANDOM MEDIUM BY ONE METHOD OF EACH TYPE SOME NEW RESULTS ARE OBTAINED BY AN HONEST METHOD AND SOME ERRORS IN A PREVIOUS WORK ARE POINTED OUT COMPARISON IS MADE BETWEEN THE RESULTS OF THE TWO METHODS AND THE REASONS WHY THEY DISAGREE ARE EXPLAINED AS A SECOND ILLUSTRATION OF AN HONEST METHOD AN ANALYSIS OF THE REDUCED WAVE EQUATION IN A RANDOM MEDIUM IS PRESENTED SOME KNOWN RESULTS ARE OBTAINED IN A NEW WAY WHICH IS SIMPLER THAN THE USUAL ONE AND WHICH APPEARS TO BE CAPABLE OF YIELDING FURTHER RESULTS

RECOGNIZING THE PRETENTIOUSNESS WAYS TO ACQUIRE THIS BOOK **US ARMY RADIO WAVE PROPAGATION AND ANTENNAS** IS ADDITIONALLY USEFUL. YOU

HAVE REMAINED IN RIGHT SITE TO BEGIN GETTING THIS INFO. GET THE **US ARMY RADIO WAVE PROPAGATION AND ANTENNAS** COLLEAGUE THAT WE PRESENT

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