XV. ELECTRODYNAMICS OF MEDIA

Academic and Research Staff

Prof. Jin Au Kong
Dr. Ruey-Shi Chu
Dr. Leung Tsang

Graduate Students

Michael F. Caulfield
Weng C. Chew
Shun-Lien Chuang
Boucar Djermakoye
Amin K. Ezzeddine
Henry G. Fiorentini
Tarek M. Habashy
Michael E. McGillan
Dennis Ng
Roger S. Putnam
Robert H. Shin
Francesco J. Vallese
Michael A. Zuniga

1. ELECTROMAGNETIC WAVES

Joint Services Electronics Program (Contract DAAG29-78-C-0020)

Jin Au Kong

Electromagnetic waves are studied with applications to remote sensing of the earth, geophysical subsurface probing and communication with a dipole antenna, microstrip antennas, and beam diffraction by periodic structures. We also studied acoustic waves in geophysical exploration. Papers on research in the past year which have been published, accepted for publication, submitted for publication, or presented at meetings are listed in the references.[1-14] Second-order coupled-mode equations have been developed to treat diffraction of plane waves as well as beams by periodic structures.[1-3] Geophysical probing and communication with dipole antennas has been studied for half-space and two-layer media.[4-6] Microstrip antennas are being studied.[7] Extensive work has been done in the field of active and passive microwave remote sensing.[8-22] The use of acoustic waves in geophysical exploration has been investigated.[23-24]

References

1. J.A. Kong, "Second-Order Coupled Mode Equations for Spatially Periodic Media," J. Opt. Soc. Am. 67, 825-829 (1977).
2. R.S. Chu, J.A. Kong, and T. Tamir, "The Diffraction of Gaussian Beams by a Layer of Periodic Medium," J. Opt. Soc. Am. 67, 1555-1561 (1977).
3. R.S. Chu and J.A. Kong, "Diffraction of Optical Beams with Arbitrary Profile by a Periodically Modulated Layer," Optical Society of America Annual Meeting, Oct. 30-Nov. 3, San Francisco, CA, 1978.
4. D. Cheng, J.A. Kong, and L. Tsang, "Geophysical Subsurface Probing of a Two-Layer Uniaxial with a Horizontal Magnetic Dipole," IEEE Transactions on Antennas and Propagation, Vol. AP-25, No. 6, pp. 766-769, November 1977.
5. J.A. Kong, L.C. Shen, and L. Tsang, "Field of an Antenna Submerged in a Dissipative Dielectric Medium," IEEE Transactions on Antennas and Propagation, Vol. AP-25, No. 6, pp. 887-889, November 1977.

6. W. C. Chew and J. A. Kong, "Geometrical Optics Theory for Electromagnetic Fields of Dipoles on Two-Layer Media," submitted for publication, May 1978.

7. W. C. Chew and J. A. Kong, "Effects of Fringing Fields on the Capacitance of Circular Microstrip Disk," submitted for publication.

8. E. G. Njoku and J. A. Kong, "Theory for Passive Microwave Remote Sensing of Near-Surface Soil Moisture," J. Geophys. Res. 82, 3108-3118 (1977).

9. L. Tsang and J. A. Kong, "Theory for Thermal Microwave Emission from a Bounded Medium Containing Spherical Scatterers," J. Allp. Phys. 48, 3593-3599 (1977).

10. L. Tsang, J. A. Kong, E. Njoku, D. H. Staelin, and J. W. Waters, "Theory of Microwave Thermal Emission from a Layer of Cloud or Rain," IEEE Transactions on Antennas and Propagation, Vol. AP-25, No. 5, pp. 650-657, September 1977.

11. L. Tsang and J. A. Kong, "Radiative Transfer Theory for Active Remote Sensing of Half-Space Random Media," Radio Sci. 13, 763-774 (1978).

12. L. Tsang and J. A. Kong, "Radiative Transfer Theory for the Remote Sensing of Scattering Layer," J. Appl. Phys., accepted for publication.

13. L. Tsang and J. A. Kong, "Wave Theory for Microwave Remote Sensing of a Half-Space Random Medium with Three-Dimensional Variations," Radio Sci. 14 (1979).

14. B. Djermakoye and J. A. Kong, "Radiative Transfer Theory for the Remote Sensing of Layered Random Media," submitted for publication, 1978.

15. L. Tsang and J. A. Kong, "Energy Conservation for Reflectivity and Transmissivity at a Very Rough Surface," submitted for publication, 1978.

16. L. Tsang and J. A. Kong, "Asymptotic Solution for the Reflectivity of a Very Rough Surface," submitted for publication, 1978.

17. J. A. Kong, R. Shin, J. C. Shiue, and L. Tsang, "Theory and Experiment for Passive Microwave Remote Sensing of Snowpacks," submitted for publication, 1978.

18. J. A. Kong, L. Tsang, and B. Djermakoye, "Remote Sensing of a Buried Scattering Layer," URSI/USNC Symposium, May 18, 1978.

19. J. C. Shiue, J. A. Kong, H. A. Boyne, A. T. Chang, D. A. Ellerbruch, and L. Tsang, "Microwave Remote Sensing of Snowpack Characteristics," URSI/USNC Symposium, May 18, 1978.

20. J. A. Kong, M. Caulfield, J. C. Shiue, R. Shin, and L. Tsang, "Single Frequency Microwave Remote Sensing of Snow on an Aluminum Plate," International Symposium on Antennas and Propagation, Japan, August 1978.

21. L. Tsang and J. A. Kong, "Transient Fields Due to a Line Source in a Slab Medium," International Symposium on Antennas and Propagation, Japan, August 1978.

22. J. A. Kong, L. Tsang, B. Djermakoye, R. Shin, and J. C. Shiue, "Passive Microwave Remote Sensing of Snowpacks," National Radio Science Meeting, November 1978.

23. L. Tsang and J. A. Kong, "Modified Modal Theory for Transient Response in Layered Media," accepted for publication in J. Math. Phys.

24. L. Tsang and J. A. Kong, "Asymptotic Methods for the First Compressional Head Wave Arrival in a Fluid-Filled Borehole," accepted for publication in J. Acoust. Soc. Am.

2. REMOTE SENSING WITH ELECTROMAGNETIC WAVES

National Science Foundation (Grant ENG76-01654)

Jin Au Kong

Active sensing with dipole antennas has been studied[1-6] for both monochromatic and pulse excitations. Extensive work has been accomplished on theoretical modelling and data interpretation for passive microwave remote sensing with radiometers.[7-22] Active remote sensing with radars has also been investigated.[23-26]

References

1. D. Cheng, J.A. Kong, and L. Tsang, "Geophysical Subsurface Probing of a Two-Layer Uniaxial Medium with a Horizontal Magnetic Dipole," IEEE Transactions on Antennas and Propagation, Vol. AP-25, No. 6, pp. 766-769, November 1977.
2. J.A. Kong, L.C. Shen, and L. Tsang, "Field of an Antenna Submerged in a Dissipative Dielectric Medium," IEEE Transactions on Antennas and Propagation Vol. AP-25, No. 6, pp. 887-889, November 1977.
3. W.C. Chew and J.A. Kong, "Geometrical Optics Theory for Electromagnetic Fields of Dipoles on Two-Layer Media," submitted for publication, 1978.
4. J.A. Kong, D. Cheng, and L. Tsang, "Geophysical Subsurface Probing with Horizontal Electrical and Magnetic Dipole Antennas," USNC/URSI Meeting, Amherst, MA, October 14, 1976.
5. L. Tsang and J.A. Kong, "Modified Modal Theory for Transient Response in Layered Media," J. Math. Phys., accepted for publication, 1978.
6. L. Tsang and J.A. Kong, "Transient Fields Due to a Line Source in a Slab Medium," International Symposium on Antennas and Propagation, Japan, August 1978.
7. L. Tsang and J.A. Kong, "Thermal Microwave Emission from a Random Inhomogeneous Medium Using the Method of Invariant Imbedding," Radio Sci. 12, 185-194 (1977).
8. E.G. Njoku and J.A. Kong, "Theory for Passive Microwave Remote Sensing of Near-Surface Soil Moisture," J. Geophys. Res. 82, 3108-3118, July 1977.
9. L. Tsang, J.A. Kong, E. Njoku, D.H. Staelin, and J.W. Waters, "Theory for Microwave Remote Sensing of Cloud and Rainfall," IEEE Transactions on Antennas and Propagation, Vol. AP-25, No. 5, pp. 650-657, September 1977.
10. L. Tsang and J.A. Kong, "Theory for Thermal Microwave Emission from a Bounded Medium Containing Spherical Scatterers," J. Appl. Phys. 48, 3593-3599 (1977).
11. L. Tsang, J.A. Kong, D.H. Staelin, E. Njoku, and J.W. Waters, "Passive Remote Sensing of Cloud and Rainfall," International USNC/URSI Meeting, Amherst, MA, October 12, 1976.
12. L. Tsang and J.A. Kong, "Radiative Transfer Theory for Microwave Remote Sensing of Two-Layer Media," International IEEE/AP-S Symposium, Amherst, MA, October 15, 1967.
13. E. Njoku and J.A. Kong, "Passive Microwave Remote Sensing of Near-Surface Soil Moisture," URSI/USNC Symposium, June 24, 1977.

14. J.A. Kong and L. Tsang, "Microwave Thermal Emission from a Bounded Medium Containing Spherical Scatterers," URSI/USNC Symposium, June 24, 1977.

15. J.C. Shiue, J.A. Kong, H.A. Boyne, A.T. Chang, D.A. Ellerbruch, and L. Tsang, "Microwave Remote Sensing of Snowpack Characteristics," URSI/USNC Symposium, May 18, 1978.

16. J.A. Kong, L. Tsang, and B. Djermakoye, "Remote Sensing of a Burier Scattering Layer," URSI/USNC Symposium, May 18, 1978.

17. J.A. Kong, M. Caulfield, J.C. Shiue, R. Shin, and L. Tsang, "Single Frequency Microwave Remote Sensing of Snow on an Aluminum Plate," International Symposium on Antennas and Propagation, Japan, August 1978.

18. J.A. Kong, L. Tsang, B. Djermakoye, R. Shin, and J.C. Shiue, "Passive Microwave Remote Sensing of Snowpacks," URSI Meeting, Boulder, CO, November 6-9, 1978.

19. L. Tsang and J.A. Kong, "Wave Theory for Microwave Remote Sensing of a Half-Space Random Medium with Three-Dimensional Variations," Radio Science 14, (1979).

20. B. Djermakoye and J.A. Kong, "Radiative Transfer Theory for the Remote Sensing of Layered Random Media," submitted for publication, 1978.

21. J.A. Kong, R. Shin, J.C. Shiue, and L. Tsang, "Theory and Experiment for Passive Microwave Remote Sensing of Snowpacks," submitted for publication, 1978.

22. L. Tsang and J.A. Kong, "Radiative Transfer Theory for the Remote Sensing of a Scattering Layer," J. Appl. Phys., accepted for publication, 1978.

23. L. Tsang and J.A. Kong, "Radiative Transfer Theory for Active Remote Sensing of Half-Space Random Media," Radio Sci. 13, 763-774 (1978).

24. L. Tsang and J.A. Kong, "Backscattering from a Half-Space Random Medium with the Radiative Transfer Approach," URSI/USNC Symposium, June 24, 1977.

25. L. Tsang and J.A. Kong, "Energy Conservation for Reflectivity and Transmissivity at a Very Rough Surface," submitted for publication, 1978.

26. L. Tsang and J.A. Kong, "Asymptotic Solution for the Reflectivity of a Very Rough Surface," submitted for publication, 1978.

3. ACTIVE AND PASSIVE MICROWAVE REMOTE SENSING

National Aeronautics and Space Administration (Contract NAS5-24139)

Jin Au Kong

In active microwave remote sensing radiative transfer theory[1-2] has been applied and derived from the wave theory. Energy conservation and asymptotic solution for the reflectivity of a very rough surface are being studied.[3-4] In passive remote sensing theoretical modeling, experimentation, and data matching have been extensively investigated and conclusive results are being documented.[5-11]

References

1. L. Tsang and J. A. Kong, "Radiative Transfer Theory for Active Remote Sensing of Half-Space Random Media," Radio Sci. 13, 763-774 (1978).

2. L. Tsang and J. A. Kong, "Wave Theory for Microwave Remote Sensing of a Half-Space Random Medium with Three-Dimensional Variations," Radio Sci. 14 (1979).

3. L. Tsang and J. A. Kong, "Energy Conservation for Reflectivity and Transmissivity at a Very Rough Surface," submitted for publication, 1978.

4. L. Tsang and J. A. Kong, "Asymptotic Solution for the Reflectivity of a Very Rough Surface," submitted for publication, 1978.

5. L. Tsang and J. A. Kong, "Radiative Transfer Theory for the Remote Sensing of a Scattering Layer," J. Appl. Phys., accepted for publication, 1978.

6. J. C. Shiue, J. A. Kong, H. A. Boyne, A. T. Chang, D. A. Ellerbruch, and L. Tsang, "Microwave Remote Sensing of Snowpack Characteristics," URSI/USNC Symposium, May 18, 1978.

7. J. A. Kong, L. Tsang, and B. Djermakoye, "Remote Sensing of a Burier Scattering Layer," URSI/USNC Symposium, May 18, 1978.

8. J. A. Kong, M. Caulfield, J. C. Shiue, R. Shin, and L. Tsang, "Single Frequency Microwave Remote Sensing of Snow on an Aluminum Plate," International Symposium on Antennas and Propagation, Japan, August 1978.

9. J. A. Kong, L. Tsang, B. Djermakoye, R. Shin, and J. C. Shiue, "Passive Microwave Remote Sensing of Snowpacks," URSI Meeting, Boulder, CO, November 6-9, 1978.

10. B. Djermakoye and J. A. Kong, "Radiative Transfer Theory for the Remote Sensing of Layered Random Media," submitted for publication, 1978.

11. J. A. Kong, R. Shin, J. C. Shiue, and L. Tsang, "Theory and Experiment for Passive Microwave Remote Sensing of Snowpacks," submitted for publication, 1978.

4. PREDICTION OF BACKSCATTER AND EMISSIVITY OF SNOW AT MILLIMETER WAVELENGTHS

U. S. Air Force – Eglin (Contract F08635-78-C-0115)

Jin Au Kong

Radiative transfer theory has been applied to the active remote sensing of half-space random media.[1] The validity of the radiative transfer theory was justified by a rigorous wave theoretical approach.[2] Energy conservation and asymptotic solutions for remote sensing of rough surfaces are being considered.[3-4] Passive microwave remote sensing of snow fields has been extensively investigated.[5-10]

References

1. L. Tsang and J. A. Kong, "Radiative Transfer Theory for Active Remote Sensing of Half-Space Random Media," Radio Sci. 13, 763-774 (1978).
2. L. Tsang and J. A. Kong, "Wave Theory for Microwave Remote Sensing of a Half-Space Random Medium with Three-Dimensional Variations," Radio Sci. 14 (1979).
3. L. Tsang and J. A. Kong, "Energy Conservation for Reflectivity and Transmissivity at a Very Rough Surface," submitted for publication, 1978.
4. L. Tsang and J. A. Kong, "Asymptotic Solution for the Reflectivity of a Very Rough Surface," submitted for publication, 1978.
5. L. Tsang and J. A. Kong, "Radiative Transfer Theory for the Remote Sensing of a Scattering Layer," J. Appl. Phys., accepted for publication, 1978.
6. J. A. Kong, R. Shin, J. C. Shiue, and L. Tsang, "Theory and Experiment for Passive Microwave Remote Sensing of Snowpacks," submitted for publication, 1978.
7. J. C. Shiue, J. A. Kong, H. A. Boyne, A. T. Chang, D. A. Ellerbruch, and L. Tsang, "Microwave Remote Sensing of Snowpack Characteristics," URSI/USNC Symposium, May 18, 1978.
8. J. A. Kong, L. Tsang, and B. Djermakoye, "Remote Sensing of a Burier Scattering Layer," URSI/USNC Symposium, May 18, 1978.
9. J. A. Kong, M. Caulfield, J. C. Shiue, R. Shin, and L. Tsang, "Single Frequency Microwave Remote Sensing of Snow on an Aluminum Plate," International Symposium on Antennas and Propagation, Japan, August 1978.
10. J. A. Kong, L. Tsang, B. Djermakoye, R. Shin, and J. C. Shiue, "Passive Microwave Remote Sensing of Snowpacks," URSI Meeting, Boulder, CO, November 6-9, 1978.

5. ACOUSTIC-WAVE PROPAGATION STUDIES

Schlumberger Doll Research Center

Jin Au Kong, Leung Tsang

Transient solutions due to a line source in a slab medium have been obtained with a modified modal theory applying the technique of double deformation.[1,2] Asymptotic solutions for the first compressional head wave arrival in a fluid-filled borehole are also being investigated.[3]

References

1. L. Tsang and J. A. Kong, "Transient Fields Due to a Line Source in a Slab Medium," International Symposium on Antennas and Propagation, Japan, August 1978.
2. L. Tsang and J. A. Kong, "Modified Modal Theory for Transient Response in Layered Media," J. Math. Phys., to be published.
3. L. Tsang and J. A. Kong, "Asymptotic Methods for the First Compressional Head Wave Arrival in a Fluid-Filled Borehole," J. Acoust. Soc. Am., to be published.