Personal information

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About the Author

Wolfgang-Martin Boerner was born in Finschhafen, Papua New Guinea (formerly Deutsch-Ost Neu-Guinea) in 1937, spent his childhood in Oceania & Austral-Asia, received the B.S. (Abitur) degree from the August von Platen Gymnasium, Ansbach, Germany, the M.S. (Dipl.-Ing.) degree from the Technical University of Munich, Munich, Germany, and the Ph.D. degree from the Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, in 1958, 1963, and 1967, respectively. From 1967 to 1968, he was a Research Assistant Engineer at the Department of Electrical and Computer Engineering, Radiation Laboratory, University of Michigan, Ann Arbor. From 1968 to 1978, he was with the Electrical Engineering Department, University of Manitoba in Winnipeg, MB, Canada. In 1978, he joined the Department of Electrical Engineering and Computer Science, University of Illinois at Chicago as Professor and Director of its Communications, Sensing & Imaging and Navigation Laboratory, where he serves now a Professor Emeritus and Distinguished Research Scientist. He served as international moderator and promoter of vector (polarization) electromagnetic inverse scattering and wide-band multi-modal polarimetry since its inception (he is credited for introducing the term ‘polarimetry’), and elevated POL-IN/TOMO-SAR theory & technology to an accepted science worldwide. Dr. Boerner was elected Life Fellow of IEEE and Fellow of the OSA, SPIE, AAAS, IEICE and CIE for his contributions to the “advancement of vector electromagnetic inverse scattering and extra-wideband polarimetric imaging radar & SAR theory and technology”. WMB is renowned for developing strong international collaboration on advancing multi-modal Polarimetric SAR Interferometry and its application to monitoring of global natural habitats and wetlands.

Research interest

Electromagnetic (e-m) remote sensing of terrestrial & planetary environments; electromagnetic deep-sounding & seismo-electromagnetology; polarimetric radar signal image processing, radar target identification & radio-frequency interference reduction; modern optics & holographic imaging, e-m vector tomography & topographic interferometry; wide-band polarimetric SAR (Synthetic Aperture Radar) interferometry; e-m ocean marine and land-cover sensing & imaging in wide area terrestrial. & planetary environmental stress-change monitoring; global satellite navigation systems.

Summary

Basics of Radar Polarimetry

A comprehensive overview of the basic principles of radar polarimetry is presented. The relevant fundamental field equations are first provided. The importance of the propagation and scattering behavior in various frequency bands, the electrodynamic foundations such as Maxwell’s equations, the Helmholtz vector wave equation and especially the fundamental laws of polarization will first be introduced: The fundamental terms which represent the polarization state will be introduced, defined and explained. Main points of view are the polarization Ellipse, the polarization ratio, the Stokes Parameter and the Stokes and Jones vector formalisms as well as its presentation on the Poincaré sphere and on relevant map projections. The Polarization Fork descriptor and the van Zyl polarimetric power density signatures will be introduced also in order to make understandable the polarization state formulations of electromagnetic waves in the frequency domain. The polarization state of electromagnetic waves under scattering conditions i.e. in the radar case will be described by matrix formalisms. Each scatterer is a polarization transformer; under normal conditions the transformation from the transmitted wave vector to the received wave vector is linear and this behavior, principally, will be described by a matrix called scattering matrix. This matrix contains all the information about the scattering process and the scatterer itself. The different relevant matrices, the respective terms like Jones Matrix, S -matrix, Müller Matrix, Kennaugh matrix, etc. and its interconnections will be defined and described together with change of polarization bases transformation operators, where upon the optimal (Characteristic) polarization states are determined for the coherent and partially coherent cases, respectively. The lecture is concluded with a set of simple examples