

# Introduction to Special Issue on Microwave and Millimeter Wave Photonics

THE RAPID evolution of photonics and microwave and millimeter wave electronics and their related technologies is resulting in new device developments and novel system configurations. The interface between microwaves and millimeter waves on the one hand and lightwaves on the other is an area of growing interest with a broad range of emerging applications. This Special Joint Issue of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES and the JOURNAL OF LIGHTWAVE TECHNOLOGY is devoted to Microwave and Millimeter Wave Photonics.

The vitality of the microwave-photonics research area is evidenced by the nearly 70 papers that were considered for this special issue. Papers were received from all five continents—from universities as well as industrial and governmental laboratories. The transnational aspect of this effort is reflected by the fact that the five guest editors represent Australia, Asia, Europe, and both North and South America. It should be noted that manuscripts submitted by any of the guest editors were handled independently by two of the other guest editors.

The quality of the papers was generally excellent and the editors are grateful to reviewers for their thorough and timely response. We selected 38 papers for publication in the Special Issue from those submitted. In a few cases, it was not possible to complete the review/revision process in the tight time-frame

allowed for this Special Issue. Therefore, a few papers that could not be included here will appear in a subsequent regular issue of the TRANSACTIONS.

The Special Issue is divided into six sections. The first two groups of papers deal with optical modulators and transmitters and the optical generation of microwaves and millimeter waves. The next two groups are concerned with optical detectors and receivers. The fifth group contains articles on photonic signal processing and its application in microwave systems. The final group covers optical-microwave interaction in devices and circuits.

It is clear that the field of microwave and millimeter wave photonics represents a rapidly developing area of research with inspiring new results. We hope that this present Special Issue will provide a useful picture of the current state of the technology and serve as a stimulus for further advances.

PETER R. HERCZFIELD  
 HIROYO OGAWA  
 ALVARO AUGUSTO A. DE SALLAS  
 ALWYN SEEDS  
 RODNEY S. TUCKER  
*Guest Editors*



**Peter R. Herczfeld** (S'66–M'67–SM'89–F'91), born in Budapest, Hungary, in 1936 and now a U.S. citizen, received the B.S. degree in physics from Colorado State University in 1961, the M.S. degree in physics in 1963, and the Ph.D. degree in electrical engineering in 1967, both from the University of Minnesota.

Since 1967, he has been on the faculty of Drexel University, where he is a Professor of Electrical and Computer Engineering. He has published over 300 papers in solid-state electronics, microwaves, photonics, solar energy, and biomedical engineering. He is the Director of the Center for Microwave-Lightwave Engineering at Drexel, a Center of Excellence that conducts research in microwaves and photonics. He has served as project director for more than 70 projects.

Dr. Herczfeld, a member of APS, SPIE, and the ISEC, is a recipient of several research and publication awards, including the Microwave Prize (1986 and 1994).



**Hiroyo Ogawa** (M'84) received the B.S., M.S., and Dr.Eng. degrees in electrical engineering from Hokkaido University, Sapporo, in 1974, 1976, and 1983, respectively.

He joined the Yokosuka Electrical Communication Laboratories, Nippon Telegraph and Telephone Public Corporation, Yokosuka, in 1976. He has been engaged in research on microwave and millimeter-wave integrated circuits, monolithic integrated circuits, and development of subscriber radio systems. From 1985 to 1986, he was a Postdoctoral Research Associate at the University of Texas at Austin, on leave from NTT. From 1987 to 1988, he was engaged in design of the subscriber radio equipment at the Network System Development Center of NTT. From 1990–1992, he was engaged in the research of optical/microwave monolithic integrated circuits and microwave and millimeter-wave fiber-optic links for personal communication systems at ATR Optical and Radio Communication Research Laboratories. Since 1993, he has been researching microwave and millimeter-wave photonics for communication satellites at NTT Wireless Systems Laboratories.

Dr. Ogawa is a member of the Institute of Electronics, Information and Communication Engineers (IEICE) of Japan.

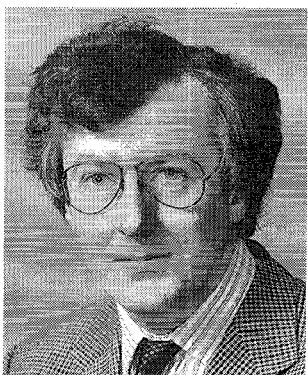


**Alvaro Augusto A. de Salles** was born in Bagé, RGS, Brazil, on March 6, 1946. He received the B.Sc. degree in electrical engineering from the Federal University of Rio Grande do Sul (UFRGS), Pôrto Alegre, Brazil, in 1968, the M.Sc. degree in electrical engineering from the Catholic University of Rio de Janeiro (PUC/RJ), Brazil, in 1971, and the Ph.D. degree in electrical engineering from University College London, England, in 1982.

From 1970–1978 he was an Assistant Professor at the Catholic University Center for Research and Development in Telecommunications (CETUC), in Rio de Janeiro, where his major interest was microstrip passive devices, including circulators and filters. From 1978–1982 he was at University College London working on solid-state phased array radars design and development and on optical control of GaAs MESFET oscillators and amplifiers. From 1982–1990 he was at CETUC, performing research and development on microwave and optical communication semiconductor devices and components. From 1991–1994 he was a Visiting Professor at the Federal University of Rio Grande do Sul (UFRGS) in Pôrto Alegre, RGS, Brazil, where he

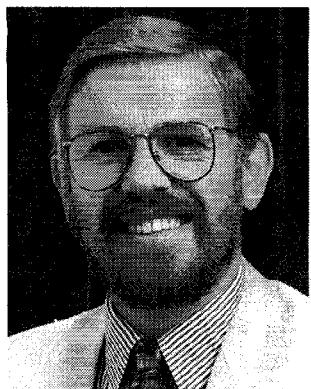
is now Professor. He was also an Associate Professor at PUC/RJ. His area of research interest is optical interactions with semiconductor devices, including HEMT's and HBT's, for microwave and optical communication applications. He has authored more than 50 papers in Brazilian and international periodicals and conferences.

Dr. de Salles was Chairman of the 1987 SBMO (Brazilian Microwave and Optoelectronics Society) International Microwave Symposium and is a founding member of SBMO and of the Brazilian Telecommunication Society (SBT).



**Alwyn Seeds** (M'81–SM'92) received the B.Sc. degree in electronics in 1976 and the Ph.D. degree in electronic engineering in 1980, both from the University of London.

From 1980–1983 he was a Staff Member at Lincoln Laboratory, Massachusetts Institute of Technology, where he worked on monolithic millimetre-wave integrated circuits for use in phased-array radar. He was appointed Lecturer in Telecommunications at Queen Mary College, University of London, in 1983. In 1986 he moved to University College London, where he is currently BNR Professor of Opto-electronics and leader of the Microwave Opto-electronics Group. He is author of over 100 papers on microwave and opto-electronic devices and their systems applications and presenter of the video "Microwave Opto-electronics" in the IEEE Emerging Technologies series. His current research interests include microwave bandwidth tunable lasers, optical control of microwave devices, mode-locked lasers, optical phase-lock loops, optical frequency synthesis, dense WDM networks, optical soliton transmission and the application of optical techniques to microwave systems.



**Rodney S. Tucker** (S'72-M'75-SM'85-F'90) was born in Melbourne, Australia, in 1948. He received the B.E. and Ph.D. degrees from the University of Melbourne, Australia, in 1969 and 1975, respectively.

From 1973-1975 he was a Lecturer in Electrical Engineering at the University of Melbourne. During 1975 and 1976 he was a Harkness Fellow with the Department of Electrical Engineering and Computer Sciences, University of California, Berkeley, and from 1976-1977 he was a Harkness Fellow with the School of Electrical Engineering, Cornell University, New York. From 1977 to 1978 he was with Plessey Research (Caswell) Ltd., UK, and from 1978-1983 he was with the Department of Electrical Engineering at the University of Queensland, Brisbane, Australia. During the period from 1973-1983 he worked on high-speed electronic and optoelectronic devices, the synthesis of ultra-wideband amplifiers, and modelling of high-speed semiconductor lasers. From 1984-1990 he was with AT&T Bell Laboratories, Crawford Hill Laboratory, Holmdel, NJ, where he worked in the area of high-speed optoelectronics and lightwave communications. He is presently with the Department of Electrical and Electronic Engineering at the University of Melbourne, where he is a Professor of Electrical Engineering, Director of the Photonics Research Laboratory, and a Director and Deputy Chief Executive officer of the Australian Photonics Cooperative Research Center. His research interests are in the areas of high-speed semiconductor lasers and photonic networks and systems.

Dr. Tucker has served on the Technical Program Committee of a number of international conferences. From 1989-1990 he was Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. He is a member of the Optical Society of America, a Fellow of the Institution of Engineers, Australia, and a Fellow of the Australian Academy of Technological Sciences and Engineering.