

Fig. 1.

well, but with enough energy to greatly increase the possibility of tunneling to another well. This type of rotational tunneling has been demonstrated in a number of different circumstances for ionic defects in crystals [5]. Both of these effects lead to the same type of structural changes; covalent molecular structure remains unchanged, but the relative position of one segment of the molecule with respect to the remainder of the molecule is altered. Furthermore, in the interior of large molecules, the infrequency of collisions will increase the probability of multiple excitations and resultant structural changes.

There are many biological processes that depend on steric structure. The molecular absorption, with the resulting change in non-covalent chemical structure outlined above, provides a model for the direct interference of microwave radiation with biomolecular func-

tion, where the internal three-dimensional structure of the absorbing molecule is critical to its biological function. The effect of microwave radiation on these processes will depend on the details of the process itself. From our previous discussion we would expect any effect to be frequency dependent, and if allowed a long enough time, to be reversible. Biological considerations, however, may not allow enough time for reversibility to become apparent.

CONCLUSION

In this letter, a possible mechanism for the direct influence of microwave radiation on biomolecular processes has been elucidated. Intermolecular interactions that are dependent on steric conformation in regions essentially shielded from collisions are the processes one would expect to be influenced.

ACKNOWLEDGMENT

The author wishes to thank Dr. M. Eisenbud for suggesting the topic of this paper and for many discussions that led to the concepts outlined here.

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Contributors



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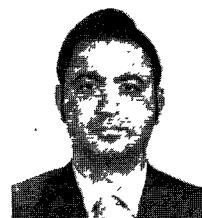
At Wayne State he worked on defect centers in solids. In 1967, he joined the Quantum Optics Branch at the Naval Research Laboratory, Washington, D. C., and has done research in the general areas of optical parametric processes, nonlinear optics, integrated

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was an Assistant Professor. In 1967 he joined the Department of Electrical Engineering, University of Nebraska, Lincoln, as an Associate Professor and in 1972 became Professor of Electrical Engineering. His field of research is electromagnetic theory, propagation, and microwave theory. He has employed EM model studies to investigate the problem of propagation in nonuniform terrestrial waveguides. He has developed transform techniques to obtain full-wave solution to problems of depolarization, diffraction and scattering of radio waves in nonuniform layered structures, and derived generalized WKB techniques to solve problems of propagation in inhomogeneous media.

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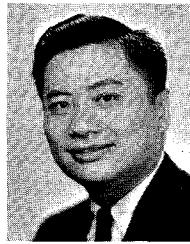


John W. Bandler (S'66-M'66) was born in Jerusalem, Palestine, on November 9, 1941. He received the B.Sc. (Eng.) degree of the University of London in electrical engineering at the Imperial College of Science and Technology, London, England, in 1963, and the Ph.D. degree of the University of London and the Diploma of Imperial College in 1967.

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From 1937 to 1939 he was with the Radio Corporation of America. Since 1940 he has been with the Raytheon Company, Waltham, Mass., where he has held various positions in research, development, and engineering management. His early work was primarily in the area of crossed-field tube development, which included several improvements in magnetron design and the development of the first reentrant-beam crossed-field amplifier. A successful program of generating super power at microwave frequencies based upon this new development led to an investigation of new applications of microwaves requiring high power levels. These applications included the areas of industrial processing and microwave power transmission in which he has been most recently engaged.

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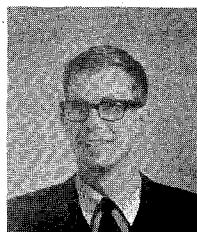
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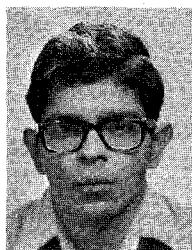
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Arthur B. Dreeben received the Ph.D. degree in inorganic and solid-state chemistry and physics from the Polytechnic Institute of Brooklyn, Brooklyn, N. Y., in 1950.

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Arthur W. Guy (S'54-M'57) was born in Helena, Mont., on December 10, 1928. He received the B.S. degree in electrical engineering in 1955, and the M.S. and Ph.D. degrees in 1957 and 1966, respectively, all from the University of Washington, Seattle.

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Thomas G. Giallorenzi was born in New York, N. Y., on February 28, 1943. He received the B.S. and M.S. degrees in engineering physics and the Ph.D. degree in applied physics, all from Cornell University, Ithaca, N. Y., in 1965, 1966, and 1969, respectively.

At Cornell, he worked on theoretical and experimental aspects of optical parametric scattering. During the period 1969-1970 he was employed at the General Telephone and Electronics Laboratories, Inc., where he was

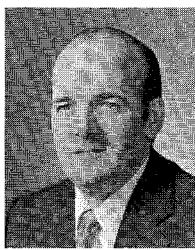
engaged in research on plasma processes in gaseous lasers and arc lamps. He joined the Quantum Optics Branch of the Naval Research Laboratory, Washington, D. C., in November 1970. His research at NRL included studies in Raman and parametric scattering, and in optical parametric oscillation. Presently, he heads the integrated and fiber optics program at NRL and is working to develop this technology for the Department of Defense.



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John J. Hughes (M'64) was born in Orange, N. J., in 1931. He attended the Seventh Army Electronics School in Germany and is presently attending Middlesex County College, N. J.

He joined the ITT Federal Laboratories in 1950, where he worked in the Chemical Department, the Countermeasures Department, and the Microwave Tube Department. From 1958 to 1961 he was assigned to the Associated Testing Laboratories as a representative

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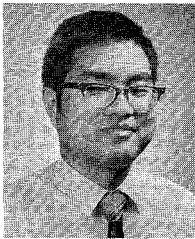
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Motohisa Kanda was born in Kanagawa, Japan, on September 10, 1943. He received the B.S. degree from Keio University, Tokyo, Japan, in 1966, and the M.S. and Ph.D. degrees in electrical engineering from the University of Colorado, Boulder, in 1968 and 1971, respectively.

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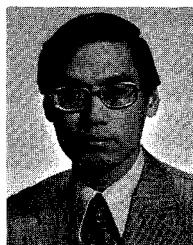


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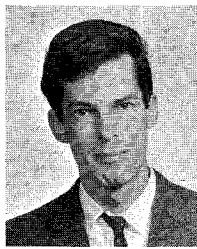
Dr. Lin is a member of ANSI C-95 Subcommittee IV on radiation hazard with respect to personnel. He is the current Secretary of Seattle Chapter of the IEEE Society on Microwave Theory and Techniques.

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Ralph J. Matarese was born in Princeton, N. J., on September 28, 1944. He attended Trenton Junior College, and Mercer County Community College Evening Division, N. J.

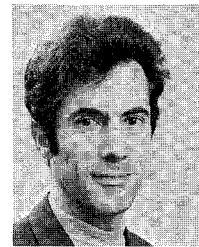
He has been employed by RCA Laboratories, Princeton, N. J., since 1962, and has been engaged in circuit construction, photolithographic processing of silicon and mercury cadmium telluride infrared imaging devices, and currently with gallium arsenide for Schottky-barrier FET's and "traveling-wave" transistors,



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Mr. Napoli is a member of Sigma Xi, Tau Beta Pi, and Eta Kappa Nu.



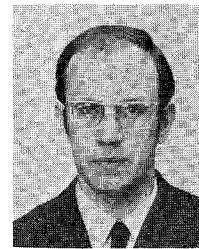
Lotfollah Shafai (S'67-M'69) was born in Maragheh, Azarbaijan, Iran, on March 17, 1941. He received the B.S. degree from the University of Tehran, Tehran, Iran, in 1963 and the M.A. and Ph.D. degrees from the University of Toronto, Toronto, Ont., Canada, in 1966 and 1969, respectively, all in electrical engineering.

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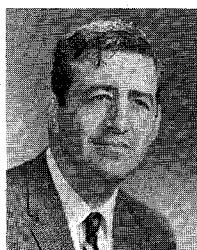
A. Fenner Milton was born in New York, N. Y., on October 16, 1940. He received the B.A. degree from Williams College, Williamsburg, Mass., in 1962, and the M.A. and Ph.D. degrees in applied physics, both from Harvard University, Cambridge, Mass., in 1963 and 1968, respectively.

He was a Technical Staff Member of the Science and Technology Division of the Institute for Defense Analyses from 1968 to 1971 when he joined the staff of the Naval Research Laboratory, Washington, D. C., as a Consultant to the Optical Sciences Division. His research interests have included photoconductivity, photo emission, nonlinear optics, and integrated optics.



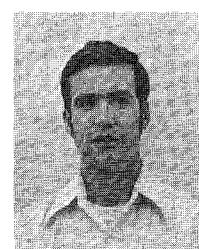
John Warner graduated from the Pure Physics Faculty of Nottingham University, Nottingham, England, in 1960 and received the Ph.D. degree from the same university in 1963.

Since 1963 he has been with the Royal Radar Establishment, Malvern, Worcs., England, where he has worked in the area of electrooptics and nonlinear optics. He has carried out pioneer research in up-conversion at optical frequencies, paying particular attention to the preservation of image information during the frequency changing. In 1972 he joined the Optical Physics Branch, Naval Research Laboratory, Washington, D. C., as an exchange scientist and will return to the Royal Radar Establishment in the spring of 1974. He is coauthor of a book on nonlinear optics to be published by Academic and has published articles in various journals.



Louis S. Napoli (S'58-M'62) was born in Bristol, Pa., on August 3, 1931. He received the B.S. degree in 1959 and the M. S. degree in 1961 in electrical engineering, both from Rutgers University, New Brunswick, N. J. He has pursued further studies in electro-physics at the Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Since joining the Technical Staff of RCA Laboratories, Princeton, N. J., in June 1959, he has been engaged in research in phase-locked oscillators as a microwave logic device. He has specialized in research relating to microwave phenomena in gaseous plasmas, solid-state microwave devices, and is now engaged in research on solid-state microwave integrated circuits. His work in collaboration with Dr. G. Swartz on amplification at 24 GHz by the interaction of an electron beam with a cesium plasma was cited by *Industrial Research Magazine* as one of the 100 most important achievements in 1963. He was the recipient of RCA Laboratories Achievement Awards in 1963, 1965, and 1968. He has published or presented several papers concerned with plasmas, solid-state microwave devices, and microwave integrated circuits.



John G. Webb (M'69) was born in Concord, Mass., on October 1, 1941. He received the B.S.E.E. and M.S.E.E. degrees from the Massachusetts Institute of Technology, Cambridge, in 1969.

From 1969 to the present he has been a member of the Technical Staff at Sandia Laboratories, Albuquerque, N. Mex., where he is responsible for microwave circuit design in the Advanced Radar Development Division.

Mr. Webb is a member of Tau Beta Pi, Eta Kappa Nu, and Sigma Xi.