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A Bibliography of Laser Applications

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Abstract

This bibliography of laser applications contains 644 entries from the open literature for the period 1961 through September 1966. The entries are divided into the following major areas: mechanical measurements and standards; communications applications; radar and tracking applications; military applications; optical signal processing; interferometry and testing of optical components; applications to scientific studies; applications in chemistry; photographic applications; metalworking; and miscellaneous applications. The entries are further subdivided into 78 other categories. Applications in medical and biological research are not included; complete coverage in the other areas is not guaranteed. Under some topics (detection techniques, spectroscopy, interaction with acoustic waves, plasma diagnostics, nonlinear optics, gas breakdown, scattering, holography) so much has been published that only review articles, articles of major importance, and very recent articles could be included.

Preface

The motivation for the compilation of this bibliography was originally provided by the Research and Education Association, 420 Madison Avenue, New York, N. Y.; it was distributed at a lecture sponsored by that organization along with descriptive lecture notes dealing with the same subject. Later it was updated thru September 1966 for inclusion as an appendix to the chapter on applications of lasers in Lasers: Principles and Applications, McGraw-Hill Book Company; however, it had to be deleted at the last moment because of the length of the book. Descriptive material on laser applications that partially follows the outline of this bibliography can be found in that book. An earlier version of this material was published as Applications of Lasers by C. Martin Stickley, AFCRL 64-914 (AD 609 846). At the present time there are no plans for further updating of this bibliography.

The second author of this bibliography, Arthur Gingrande, Lt. Col. AFRes, participated in the preparation of this during a two-week reserve duty tour at AFCRL during the summer of 1966; he is presently at the Western Electric Co., Lawrence, Massachusetts.

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1.0 MECHANICAL MEASUREMENTS AND STANDARDS

1.1 Length Measurements

McNish, A. G., "Laser for length measurement", *Science* 146, pp. 177-182; 9 Oct 1964

Mielenz, K. D., H. D. Cook, K. E. Gilliland, and R. B. Stephens, "Accurate length measurement of meter bar with He-Ne laser", *Science* 146, pp. 1672-1673; 25 Dec 1964

Loewen, E. G., "Optical systems - answer to precise positioning", *Control Engineering* 12, pp. 118-124; Sept 1965

1.2 Alignment

Raternick, H. J., "Application of a cw laser as a light source in an optical alignment method", *Zeit. f. Ang. Math. und Physik* 16, pp. 126-128; 25 Jan 1965

Anonymous, "Laser optical alignment system", *STAR* 3, pg. 1481(A); 8 May 1965

Bloom, A. L., "Application of cw lasers to surveying, precision optical testing, and alignment", *Ann. N. Y. Acad. Sci.* 122, pp. 658-660; 28 May 1965

(Received for publication 3 April 1967)

Herrmannsfeldt, W. B., "Linac alignment techniques", IEEE Trans. on Nuclear Science NS-12, pp. 9-18; June 1965

Everett, P. N., "Technique for aligning laser mirrors using gas laser", Rev. Sci. Instr. 37, pg. 375; Mar 1966

Williamson, T., "Laser guides monster mole", Cont. Eng. 13, pg. 127, May 1966

1.3 Flow and Rotation Rate Measurement

Macek, W. M., D. T. M. Davis, Jr., R. W. Olthuis, J. R. Schneider, and G. R. White, "Ring laser rotation rate sensor", in Proc. of the Symp. on Optical Masers, Polytechnic Press of the Polytechnic Institute of Brooklyn, Brooklyn, N. Y., pp. 199-207; 1963

Macek, W. M., and D. T. M. Davis, Jr., "Rotation rate sensing with traveling wave ring lasers", Appl. Phys. Letters 2, pp. 67-68; 1 Feb 1963

Yeh, Y., H. Z. Cummins, "Localized fluid flow measurements with an He-Ne laser spectrometer", Appl. Phys. Letters 4, pp. 176-178; May 1964

Macek, W. M., J. R. Schneider, and R. M. Salamon, "Measurement of Fresnel drag with the ring laser", J. Appl. Phys. 35, pp. 2556-2557; Aug 1964

Anonymous, "Velocity measured by laser diffraction", Aviation Week and Space Technology 81, pp. 87-89; 16 Nov 1964

Foreman, J. W., E. W. George, and R. D. Lewis, "Measurement of localized flow velocities in gases", Appl. Phys. Letters 7, pp. 77-78; 15 Aug 1965

Foreman, J. W., R. D. Lewis, J. R. Thornton, and H. J. Watson, "Laser doppler velocimeter for measurement of localized flow velocities in liquids", Proc. IEEE 54, pp. 424-425; Mar 1966

Chen, C. J., "Velocity-profile measurement in plasma flows using tracers produced by a laser beam", J. Appl. Phys. 37, pp. 3092-3095; July 1966

1.4 Stress Analysis

North, W., "A laser light source in dynamic photoelasticity", Dias. Abstr. 26, pg. 289(A); July 1965

Taylor, C. E., C. E. Bowman, W. P. North, and W. F. Swinson, "Applications of lasers to photoelasticity", STAR 3, pg. 3122(A); 23 Sept 1965

Ennos, A. E., "Stresses developed in optical film coatings", Appl. Optics 5, pp. 51-61; Jan 1966

1.5 Wavelength and Frequency Stabilization

Jaseja, T. S., A. Javan and C. H. Townes, "Frequency stability of He-Ne masers and measurements of length", Phys. Rev. Letters 10, pp. 165-167, 1 Mar 1963

Mollenauer, L. F., G. F. Imbusch, H. W. Moos, and A. L. Schawlow, "The high gain laser as a wavelength standard", in Proc. of the Symp. on Optical Masers, Polytechnic Press of the Polytechnic Institute of Brooklyn, Brooklyn, N. Y., pp. 51-65; 1963

Gould, G. and W. Bennett, Jr., "Laser wavelength and frequency standards", J. Opt. Soc. Am. 53, pg. 515(A); Apr 1963

- Bennett, W. R., Jr., S. F. Jacobs, J. T. Latourette, and P. Rabinowitz, "Dispersion characteristics and frequency stabilization of a He-Ne gas laser", *Appl. Phys. Letters* 5, pp. 56-58; Aug 1964
- McFarlane, R. A., "Frequency pushing and pulling in a He-Ne gas laser", *Phys. Rev.* 135, pp. A543-A550; 3 Aug 1964
- White, A. D., E. I. Gordon, and E. F. Labuda, "Frequency stabilization of single mode gas lasers", *Appl. Phys. Letters* 5, pp. 97-98; 1 Sept 1964
- Shimoda, K., "Frequency stabilization of the He-Ne maser", *IEEE Trans. on Instrumentation and Measurement*, Vol. IM-13, pg. 170; Dec 1964
- Enloe, L. G., and J. L. Rodda, "Laser phase-locked loop", *Proc. IEEE* 53, pp. 165-166; Feb 1965
- Shimoda, K., and A. Javan, "Stabilization of the He-Ne maser on the atomic line center", *J. Appl. Phys.* 36, pp. 718-726; Mar 1965
- White, J. A., "Stability of traveling waves in lasers", *Phys. Rev.* 137, pp. A1651-A1654; 5 Mar 1965
- White, A. D., "Frequency stabilization of gas lasers", *IEEE J. Quan. Elec.* QE-1, pp. 349-357; Nov 1965
- Mielenz, K. D., P. B. Stephens, K. E. Gilliland, and K. F. Nefflen, "Measurement of absolute wavelength stability of lasers", *J. Opt. Soc. Am.* 56, pp. 156-162; Feb 1966
- LaTourrette, J. T., P. Rabinowitz, S. Jacobs, and G. Gould, "Experimental comparison of pairs of frequency stabilized He-Ne lasers", *IEEE J. Quan. Elec.* QE-2, pg. xxxviii; Apr 1966
- Chakravarti, A. N., "Improvement of frequency stability and spectral purity of p-n junction laser beams", *Indian J. Pure and Appl. Phys.* 4, pp. 81-83; Feb 1966
- Stover, H. L., and W. H. Steier, "Locking of laser oscillators by light injection", *Appl. Phys. Letters* 8, pp. 91-93; 15 Feb 1966
- Ambartsumyan, R. V., N. G. Basov, P. G. Kryukov, V. S. Letokhov, "Laser with nonresonant feedback", *JETP Letters* 3, pp. 167-169; 15 Mar 1966
- Letokhov, V. S., "Autoresonant feedback in lasers", *JETP Letters* 3, pp. 269-271; 15 May 1966
- Lipsett, M. S., and P. H. Lee, "Laser wavelength stabilization with a passive interferometer", *Appl. Opt.* 5, pp. 823-826; June 1966
- Smith, P. W., "On the stabilization of a high-power single-frequency laser", *IEEE J. Quan. Elec.* QE-2, pp. 666-668; Sept 1966
- Bloom, A. L., and D. L. Wright, "Pressure shifts in a stabilized single wavelength helium-neon laser", *Proc. IEEE* 54, pp. 1262-1276, and *Appl. Opt.* 5, pp. 1500-1514, Joint Issue on Optical Electronics; Oct 1966
- Harris, S. E., "Stabilization and modulation of laser oscillators by internal time-varying perturbation", *Proc. IEEE* 54, pp. 1401-1413, and *Appl. Opt.* 5, pp. 1639-1651, Joint Issue on Optical Electronics; Oct 1966

2.0 COMMUNICATIONS APPLICATIONS

2.1 Summary Articles

- Oliver, B. M., "Some potentialities of optical masers", *Proc. IRE* 50, pp. 135-141; Feb 1962

Fusca, J. A., "Laser communication", *Space/Aeronautics* 41, pp. 58-77; May 1964

Sette, D., "Laser applications to communications", *Zeit. f. Ang. Math. und Physik* 13, pp. 156-169; 25 Jan 1965

Kompfner, R., "Optical communications", *Science* 150, pp. 149-155; 8 Oct 1965

Cooper, B., "Optical communications in the earth's atmosphere", *IEEE Spectrum* 3, pp. 83-88; July 1966

2.2 Communications Systems Components

2.2.1 SINGLE FREQUENCY GENERATION

Rabinowitz, P., S. Jacobs, R. Targ and G. Gould, "Mode suppression and single frequency operation in gaseous optical masers", *Proc. IRE* 50, pp. 2365-2366; Nov 1962

Massey, G. A., M. Kenneth Oshman, and Russel Targ, "Generation of single frequency light using the FM laser", *Appl. Phys. Letters* 5, pp. 10-12; 1 Jan 1963

Tang, C. L., H. Stutz, G. A. deMars, and D. T. Wilson, "Spectral properties of a single-mode ruby laser: evidence of homogeneous broadening of the zero-photon lines in solids", *Phys. Rev.* 136, pp. A1-A8; 5 Oct 1964

Hercher, M., "Single-mode operation of a Q-switched ruby laser", *Appl. Phys. Letters* 7, pp. 39-41; 15 July 1965

Collinson, J. A., "A stable, single-frequency R-F excited gas laser 6328A", *Bell Sys. Tech. J.* 44, pp. 1511-1519; Sept 1965

Harris, S. E., and B. J. McMurtry, "Frequency selective coupling to the FM laser", *Appl. Phys. Letters* 7, pp. 265-267; Nov 1965

Smith, P. W., "Stabilized single frequency output from a long laser cavity", *IEEE J. Quan. Elec.* QE-1, pp. 343-348; Nov 1965

DiDomenico, M., "A single frequency TEM₀₀ mode gas laser with high output power", *Appl. Phys. Letters* 8, pp. 20-22; 1 Jan 1966

Roess, D., "Single-mode operation of a room temperature cw ruby laser", *Appl. Phys. Letters* 8, pp. 109-110; 1 Mar 1966

Goldstein, L., and A. Chabot, "Characteristics of a traveling-wave ruby single-mode laser as a laser radar transmitter", *IEEE J. Quan. Elec.* QE-2, pg. xlvi, Apr 1966 and pp. 519-523, Sept 1966

DiDomenico, M., Jr., "Characteristics of a single-frequency Michelson-type He-Ne gas laser", *IEEE J. Quan. Elec.* QE-2, pp. 311-322; Aug 1966

Daino, B., "The measurement of the frequency fluctuations of a laser field", *IEEE J. Quan. Elec.* QE-2, pp. 351-354; Sept 1966

2.2.2 FREQUENCY TRANSLATION

Melingalis, I., and R. H. Rediker, "Magnetically tunable cw InAs diode maser", *Appl. Phys. Letters* 3, pp. 202-204; 1 June 1963

Siegman, A. E., C. F. Quate, J. Bjorkholm and G. Francois, "Frequency translation of He-Ne lasers output frequency by acoustic output coupling inside the resonant cavity", *Appl. Phys. Letters* 5, pp. 1-2; 1 July 1964

Targ, R., and G. A. Massey, "Laser frequency translation by means of electro-optic coupling control", Proc. IEEE 52, pp. 1247-1248; Oct 1964

Giordmaine, J. A., and R. C. Miller, "Tunable coherent parametric oscillation in LiNbO₃ at optical frequencies", Phys. Rev. Letters 14, pp. 973-976; 14 June 1965

Peters, C. J., "Optical frequency translator using two phase modulators in tandem", Appl. Opt 4, pp. 857-861; July 1965

Eckhardt, G., "Selection of Raman laser materials", IEEE J. Quan. Elec. QE-2, pp. 1-8; Jan 1966

Snitzer, E., "Frequency control of a Nd. glass laser", Appl. Optics 5, pp. 121-125; Jan 1966

Puthoff, H. E., R. H. Pantell, and B. G. Huth, "Tunability of the Raman laser", J. Appl. Phys. 37, pp. 860-864; Feb 1966

Goodwin, F. E., and M. E. Pedinoff, "Application of CCl₄ and CC₂: CCl₂ ultrasonic modulators to infrared optical heterodyne experiments," Appl. Phys. Letters 8, pp. 60-61; 1 Feb 1966

Akhmanov, S. A., A. I. Kovrigin, V. A. Kolosov, A. S. Piskarskas, V. V. Fadeev, and R. V. Khokhlov, "Tunable parametric light generator with KDP crystal", JETP Letters 3, pp. 241-245; 1 May 1966

Wolff, P. A., "Theory of a tunable Raman laser", IEEE J. Quan. Elec. QE-2, pp. 659-665; Sept 1966

2.2.3 MODULATION

Kaminow, I. P., "Microwave modulation of the electro-optic effect in KH₂ PO₄", Phys. Rev. Letters 6, pp. 528-530; 15 May 1961

Holshausen, D. F., H. vonForester, and G. L. Clark, "Microwave modulation of light using the Kerr effect", J. Opt. Soc. Am. 51, pp. 1360-1365; Dec 1961

Blumenthal, R. H., "Design of a microwave frequency light modulator", Proc. IRE 50, pp. 452-456; Apr 1962

Buhrer, C. F., V. J. Fowler, L. R. Bloom, "Single-side band suppressed-carrier modulation of coherent light beams", Proc. IEEE 50, pp. 1827-1828; Aug 1962

Pankove, J. I., and J. E. Berkeyhauser, "A proposed first order relativity test using lasers", Proc. IRE 50, pp. 1976-1977; Sept 1962

Harris, S. E., B. J. McMurtry, and A. E. Siegmen, "Modulation and direct demodulation of coherent and incoherent light at a microwave frequency", Appl. Phys. Letters 1, pp. 37-39; 1 Oct 1962

Chen, D., "Modulation of ruby laser output by absorption", Proc. IEEE 51, pp. 227-228; Jan 1963

Gordon, E. I., and J. D. Rigden, "The Fabry-Perot electro-optic modulator", Bell Sys. Tech. J. 42, pp. 155-179; Jan 1963

Kaminow, I. P., and J. Lin, "Propagation characteristics of partially loaded two-conductor transmission line for broadband light modulators", Proc. IEEE 51, pp. 132-137; Jan 1963

Peters, C. J., "Gigacycle bandwidth coherent light traveling-wave phase modulator", Proc. IEEE 51, pp. 147-153; Jan 1963

- Rigrod, W. W. and I. P. Kaminow, "Wideband microwave light modulation", Proc. IEEE 51, pp. 137-140; Jan 1963
- White, R. M., and C. E. Enderly, "Electro-optical modulators employing "intermittent interaction," Proc. IEEE 51, pp. 214-215; Jan 1963
- Kaminow, I. P., "Splitting of Fabry-Perot rings by microwave modulation of light", Appl. Phys. Letters 2, pp. 41-42; 15 Jan 1963
- Harris, S. E., "Conversion of FM light to AM light using birefringent crystals", Appl. Phys. Letters 2, pp. 47-49; 1 Feb 1963
- Buhrer, C. F., "Optical modulation by light bunching", Proc. IEEE 51, pg. 1151; Aug 1963
- Cummins, H. Z. and N. Knable, "Single-sideband modulation of coherent light by Bragg reflection from acoustical waves", Proc. IEEE 51, pg. 1246; Sept 1963
- DeMaria, A. J., "Ultrasonic shutters for optical maser oscillators", J. Appl. Phys. 34, pp. 2984-2988; Oct 1963
- Renton, C. A., "Amplitude modulation of light by reverse biased p-n junctions", Proc. IEEE 52, pp. 93-94; Jan 1964
- Goldstein, B. S., and J. D. Welch, "Microwave modulation of a Ga-As injection laser", Proc. IEEE 52, pg. 715; June 1964
- Nelson, D. F. and F. K. Reinhart, "Light modulation by the electro-optic effect in reverse biased GaP p-n junctions", Appl. Phys. Letters 5, pp. 148-150; 1 Oct 1964
- Harris, S. E. and R. Targ, "FM oscillation of the He-Ne laser", Appl. Phys. Letters 5, pp. 202-204; 15 Nov 1964
- Myers, R. A. and P. S. Pershan, "Light modulation experiments at 16Gc/sec", J. Appl. Phys. 36, pp. 22-28; Jan 1965
- Schiffner, G., O. Hintringer, "Internal modulation of a He-Ne laser with a TV signal", Proc. IEEE 53, pp. 172-173; Feb 1965
- Schein, T. R., "Modulation of light by acoustic standing waves in glass" NEREM Record 7, pp. 194-195; Nov 1965
- Chen, F. S., J. E. Geusic, S. K. Kurtz, J. G. Skinner, and S. H. Wemple, "Light modulation and diffraction with potassium tantalate-niobate crystals", J. Appl. Phys. 37, pp. 388-398; Jan 1966
- Walters, W. L., "Electro-optic effect in reverse-biased GaAs p-n junctions", J. Appl. Phys. 37, pg. 916; Feb 1966
- Cohen, M. G., S. Knight, and J. P. Elward, "Optical modulation in bulk GaAs using the Gunn effect", IEEE J. Quan. Elec. QE-2, pg. xxxviii; Apr 1966
- Rees, H. D., "20 Gc/s modulation of light by electro-absorption in GaAs", Phys. Letters 21, pp. 629-631; 1 July 1966
- Yariv, A., C. A. Mead, and J. V. Parker, "GaAs as an infrared electro-optic modulation material", IEEE J. Quan. Elec. QE-2, pp. 243-245; Aug 1966
- Carleton, H. R., and R. A. Soref, "Modulation of 10.6 micron laser radiation by ultrasonic diffraction", Appl. Phys. Letters 9, pp. 110-112; 1 Aug 1966
- Gordon, E. I., "A review of acousto-optical deflection and modulation devices", Proc. IEEE 54, pp. 1391-1401, and Appl. Opt. 5, pp. 1629-1639, Joint Issue on Optical Elec; Oct 1966

Harris, S. E., "Stabilization and modulation of laser oscillators by internal time-varying perturbation", Proc. IEEE 54, pp. 1401-1413, and Appl. Opt 5, pp. 1639-1651, Joint Issue on Optical Elec.; Oct 1966

Kaminow, I. P., and E. H. Turner, "Electrooptic light modulators", Proc. IEEE 54, pp. 1374-1390, and Appl. Opt 5, pp. 1612-1628, Joint Issue on Optical Elec.; Oct 1966

2.2.4 DETECTION

Blattner, D. J. and F. Sterzer, "Heterodyne receivers for RF modulated light beams", RCA Review 23, pp. 407-412; Sept 1962

Rabinowitz, P., S. Jacobs, R. Targ and G. Gould, "Mode suppression and single frequency operation in gaseous optical masers", Proc. IRE 50, pp. 2365-2366; Nov 1962

Lucovsky, G., M. E. Lasser and R. B. Emmons, "Coherent light detection in solid-state photodiodes", Proc. IEEE 51, pp. 166-172; Jan 1963

Bloom, L. R., and C. F. Buhner, "Reception of single-sideband suppressed carrier signals by optical mixing", Proc. IEEE 51, pp. 610-611; Apr 1963

Rabinowitz, P., S. La Tourette, and G. Gould, "AFC optical heterodyne detector", Proc. IEEE 51, pp. 857-858; May 1963

DiDomenico, M., Jr., and O. Svelto, "Solid-state photodetection; a comparison between photodiodes and photoconductors", Proc. IEEE 52, pp. 136-144; Feb 1964

Targ, R., "Optical-heterodyne detection of microwave-modulated light", Proc. IEEE 52, pp. 303-304; Mar 1964

Anderson, L. K., "Detectors for microwave modulated light", Electro-Technology 75, pp. 44-48; May 1965

Lucovsky, G. and R. B. Emmons, "High frequency photodiodes", Appl. Optics 4, 697-702; June 1965

Ross, M., Laser Receivers, John Wylie and Sons; New York, 1966

Lasser, M. E., "Detection of coherent optical radiation", IEEE Spectrum 3, pp. 73-78; Apr 1966

Pao, Y. H., R. N. Zitter, and J. E. Griffiths, "New method of detecting weak light signals", J. Opt. Soc. Am. 56, pp. 1133-1134; Aug 1966

Anderson, L. K., and B. J. McMurtry, "High speed photodetectors", Proc. IEEE 54, pp. 1573-1587, and Appl. Opt 5, pp. 1335-1349, Joint Issue on Optical Elec.; Oct 1966

Goodman, J. W., "Comparative performance of optical-radar detection techniques", IEEE Trans on Aero. and Elec. Sys. AES-2; pp. 526-535, Sept 1966

Siegman, A. E., "The antenna properties of optical heterodyne receivers", Proc. IEEE 54, pp. 1350-1356, and Appl. Opt 5, pp. 1588-1594, Joint Issue on Optical Elec.; Oct 1966

2.3 Communication Systems

Vallese, L. M., and M. King, "A feasibility investigation of frequency modulated laser communication system", presented at Military Electronics Conf., Washington, D. C.; Sept 1964

- Doyle, W. M., and M. B. White, "Dual polarization FM laser communications", Proc. IEEE 52, pg. 1353; Nov 1964
- Dalrymple, G. F., B. S. Goldstein, and T. M. Quist, "A solid-state room temperature operated GaAs laser transmitter", Proc. IEEE 52, pp. 1742-1743; Dec 1964
- Leith, E. N. et. al., "Requirements for a wavefront reconstruction television facsimile system", presented at the 1965 Tech. Conf. of the Op. Soc. Am., Los Angeles, Calif.
- Boerscheg, R. A., "A light modulated data link", SCP and Solid State Tech. 8, pp. 36-39; Jan 1965
- Fowler, V. J., and L. R. Bloom, "Optical time multiplexing, a method for extremely wideband optical communication", Zeit. f. Ang. Math, und Physik 35, pg. 170; 25 Jan 1965
- Hannan, W. J., J. Bordogna, and T. E. Penn., "Electro-optic TV communication system", Proc. IEEE 53, pp. 171-172; Feb 1965
- King, M., and S. Kainer, "Some parameters of a laser-type beyond-the-horizon communication link", Proc. IEEE 53, pp. 137-141; Feb 1965
- Peters, C. J., R. F. Lucy, K. T. Lang, E. L. McGann, and G. Ratcliffe, "Laser-television system developed with off-the-shelf equipment", Electronics 38, pp. 75-78; 8 Feb 1965
- Davies, A. T., "A technique for the transmission of digital information over short distances using infrared radiation", The Radio and Electronic Engineer 29, pp. 369-373; June 1965
- Doyle, W. M., W. D. Gerber, P. M. Sutton, M. B. White, "FM laser communications through a highly turbulent atmosphere", IEEE J. Quan. Elec. QE-2, pp. 181-182; July 1965
- Chatterton, E. J., "Semiconductor laser communications through multiple-scatter paths", Proc. IEEE 53, pp. 2114-2115; Dec 1965
- Enloe, L. H., J. A. Murphy, and C. B. Rubinstein, "Hologram transmission via television", Bell Sys. Tech. J. 45, pp. 335-339; Feb 1966
- Kock, W. E., "Hologram television", Proc. IEEE 54, pg. 331; Feb 1966
- Kerr, J. R., "The FM laser and optical communication systems", Appl. Opt. 5, pp. 671-672; Apr 1966

2.4 Communications in Space

- Schwartz, R. N., and C. H. Townes, "Interstellar and interplanetary communications by optical masers", Nature 190, pp. 205-208; 15 Apr 1961
- Luck, D. G. C., "Some factors affecting applicability of optical-band radio (coherent light) to communication", RCA Review 22, pp. 359-409; Sept 1961
- B. M. Oliver, "Some potentialities of optical masers", Proc. IRE 50, pp. 135-141; Feb 1962
- Bittman, L. R., and M. C. Bolt, "Limitations on lasers for deep space communications", IEEE Trans. on Comm. and Elect. 33, pp 170-173; Mar 1964
- Simpson, G. R., "Continuous sun-pumped room temperature glass laser operation", Appl. Optics 3, pp. 783-784; June 1964
- Iliff, R., "Laser-satellite reflection parameters", STAR 2, pg. 2967(A); 8 Nov 1964

Brinkman, K. L., and W. K. Pratt, "Design of a laser deep space communication system", STAR 2, pg. 3140(A); 23 Nov 1964

Plotkin, H. H., T. S. Johnson, P. Spadin, and J. Moye, "Reflection of ruby laser radiation from explorer XXII", Proc. IEEE 53, pp. 301-302; Mar 1965

Marsten, R. B., S. Gubin, D. Silverman, "Lasers vs. microwaves in space communications", Nat'l Space Navigation and Spacecraft Comm. Mtg. Inst of Navigation; Houston, Texas; 30 Apr 1965

Ross, M., "Search via laser receivers for interstellar communications", Proc. IEEE 53, pg. 1780; Nov 1965

Reno, C. W., "Solar-pumped modulated laser", RCA Review 27, pp. 149-157; Mar 1966

2.5 Communications Via Guided Waves

Christian, J. R., and G. Goubau, "Experimental studies on a beam waveguide for millimeter waves", IRE Trans. on Antennas and Prop. AP-9, pp. 256-263; May 1961

Goubau, G., and F. Schwering, "On the guided propagation of electromagnetic wave beams", IRE Trans. on Antennas and Prop. AP-9, pp. 248-256; May 1961

Christian, J. R., and G. Goubau, "Some measurements on an iris beam waveguide", Proc. IRE 49, pp. 1679-1680; Nov 1961

Delange, O. E., "Long-distance light propagation", Proc. IEEE 51, pg. 1361; Oct 1963

Goubau, G., and J. R. Christian, "Some aspects of beam waveguides for long distance transmission at optical frequencies", IEEE Trans. on Microwave Th. and Tech. MTT-12, pp. 212-220; Mar 1964

Berreman, D. W., "A lens or light guide using convectively distorted thermal gradients in gases", Bell Sys. Tech. J. 43, pp. 1469-1475; July 1964

Degerford, J. E., M. D. Sirkis, and W. H. Steier, "Reflecting beam waveguide", IEEE Trans. on Microwave Th. and Tech. MTT-12, pp. 445-452 July 1964

Marcuse, D., and S. E. Miller, "Analysis of a tubular gas lens", Bell Sys. Tech. J. 43, pp. 1759-1782; July 1964

Marcattili, E. A. J., and R. A. Schmeltzer, "Hollow metallic and dielectric waveguides for long distance optical transmission and lasers", Bell Sys. Tech. J. 43, pp. 1783-1809; July 1964

Anonymous, "Gas lenses show promise for long distance laser communications", Bell Labs. Rec. 42, pp. 294-295; Sept 1964

Hirano, Y., and Y. Fukatsu, "Stability of a light beam in a beam waveguide", Proc. IEEE 52, pp. 1284-1292; Nov 1964

Goubau, G., and J. R. Christian, "Loss measurements with a beam waveguide for long distance transmission at optical frequencies", Proc. IEEE 52, pg. 1739; Dec 1964

Goubau, G., "Guided optical transmission", NEREM Record 7, pp. 190-191; 1965

Miller, S. E., "Light propagation in imperfect lens-like media", NEREM Record 7, pp. 192-193; 1965

Karbowiak, A. E., "New type of waveguide for light and infrared waves", *Elec. Letters* 1, pp. 47-48; Apr 1965

Berreman, D. W., "Growth of oscillations of a ray about the irregularly wavy axis of a lens light guide", *Bell Sys. Tech. J.* 44, pp. 2117-2132; Nov 1965

Marcuse, D., "Statistical treatment of light-ray propagation in beam-waveguides", *Bell Sys. Tech. J.* 44, pp. 2065-2081; Nov 1965

Marcuse, D., "Properties of periodic gas lenses", *Bell Sys. Tech. J.* 44, pp. 2083-2116; Nov 1965

Miller, S. E., "Light propagation in generalized lens-like media", *Bell Sys. Tech. J.* 44, pp. 2017-2064; Nov 1965

Miller, S. E., and L. C. Tillotson, "Optical transmission research", *Proc. IEEE* 54, pp. 1300-1311; and *Appl. Opt.* 5, pp. 1538-1549; Joint Issue on Optical Elec.; Oct 1966

2.6 Propagation in Water

Mutschlecher, J. P., D. K. Burge, and E. Regelson, "Sea water measurements with a ruby laser", *Appl. Opt.* 2, pp. 1202-1203; Nov 1963

Grant, R. M., R. L. Lillie, and N. E. Barnett, "Underwater holography", *J. Opt. Soc. Am.* 56, pg. 1142; Aug 1966

Okoomian, H. J., "Underwater transmission characteristics for laser radiation", *Appl. Opt.* 5, pp. 1441-1446; Sept 1966

3.0 RADAR AND TRACKING APPLICATIONS

Stitch, M. L., E. J. Woodbury, and J. H. Morse, "Optical ranging system uses laser transmitters", *Electronics* 34, pp. 51-53; 21 Apr 1961

Katzman, J. and E. Frost, "Correlation optical radar", *Proc. IRE* 49, pg. 1684; Nov 1961

Benson, R., R. Godwin, and M. Mirachi, "New laser technique for ranging application", *NEREM Record* 4, pp. 34-35; Nov 1962

Johnson, T. S., and H. H. Plotkin, "A laser satellite tracking experiment", *Lasers and Applications*, Ohio State U. Press pp. 224-234; 1963

Smith, G. F., "Lasers for communications and optical ranging", in *Light and Heat*, edited by H. J. Merrill, Pergamon Press, New York, pp. 221-234; 1963

Biernson, E., and R. F. Lucy, "Requirements of a coherent laser pulse-doppler radar", *Proc. IEEE* 51, pp. 202-213; Jan 1963

Flint, G. W., "Analysis and optimization of laser ranging techniques", *IEEE Trans. in Mil. Elec.* MIL-8, pp. 22-28; Jan 1964

Harrison, A., "Solid-state light source for distance measuring equipment", *Proc. IEEE* 52, pg. 101; Jan 1964

Miller, B., "Optical radar employs multiple lasers", *Aviation Week & Space Tech.* 80, pp. 62-65; 9 Mar 1964

Jansen, G., J. V. O'Hern, and H. R. Schindler, "High speed counting for laser ranging to one foot resolution", *Proc. Nat'l Elec. Conf.* 22, pp. 257-262; Oct 1964

- Nicholson, A. F., "Towards a laser radar for near-horizon use", *IEEE Trans. on Mil. Elect.*, Vol. MIL-8, pp. 70-72; Jan 1965
- Snyder, G. L., S. R. Hurst, A. B. Grafinger, and H. W. Halsey, "Satellite laser ranging experiment", *Proc. IEEE* 53, pp. 298-299; Mar 1965
- Birbeck, F. E., and K. G. Hambleton, "A gallium arsenide laser rangefinder used as an aircraft altimeter", *J. Sci. Inst.* 42, pg. 541; Aug 1965
- Davy, J. R., "The Barr and Stroud laser rangefinder", *J. Sci. Inst.* 42, pg. 536; Aug 1965
- Goodman, J., "Optical radar techniques", presented at the 1965 WESCON; Aug 1965
- Goldstein, I., P. A. Miles, and A. Chabot, "Heterodyne measurements of light propagation through atmospheric turbulence", *Proc. IEEE* 53, pp. 1172-1180; Sept 1965
- Johnson, C. M., "Injection laser systems for communications and tracking", *Electronics* 36, pp. 34-39; 13 Dec 1965
- Chase, D. M., "Power loss in propagation through a turbulent medium for an optical heterodyne system with angle tracking", *J. Opt. Soc. Am.* 56, pp. 33-44; Jan 1966

4.0 MILITARY APPLICATIONS

- Rempel, R. C., "An information note on an airborne laser terrain profiler for micro-relief studies", *STAR* 3, pg. 3827(A); 23 Nov 1965
- Kogelnick, H., "Holographic image projection through inhomogeneous media", *Bell Sys. Tech. J.* 44, pp. 2451-2455; Dec 1965
- Leith, E. N., and J. Upatnieks, "Holographic imagery through diffusing media", *J. Opt. Soc. Am.* 56, pg. 523; Apr 1966
- Goodman, J. W., W. H. Huntley, Jr., D. W. Jackson and M. Lehman, "Wavefront-reconstruction imaging through random media", *Appl. Phys. Letters* 8, pp. 311-313; June 1966
- Gillespie, L., "Apparent illuminance as a function of range in gated, laser night-viewing system", *J. Opt. Soc. Am.* 56, pp. 883-887; July 1966
- Ross, R. T., "Thermodynamic limitations on the conversion of radiant energy into work", *J. Chem. Phys.* 45, pp. 1-7; 1 July 1966
- Anonymous, "A laser intrusion detector", *Microwaves* 5, pg. 6; Aug 1966

5.0 OPTICAL SIGNAL PROCESSING

5.1 Optoelectronics

- Koester, C. J., "Possible uses of laser in optical logic functions", *Proc. 1963 Pacific Computer Conf. IEEE: Pasadena, Calif.* pp. 54-63; 15-16 Mar 1963
- Yamamoto, T., "Light emitting characteristics of a GaAs diode having negative resistance", *Proc. IEEE* 52, pg. 409; Apr 1964
- Lasher, G. J., and A. B. Fowler, "Mutually quenched injection lasers as bistable devices", *IBM J. Res. and Develop.* 8, pp. 471-475; Sept 1964
- Blard, J. M., E. L. Bonin, W. T. Matsen, and J. D. Merryman, "Optoelectronics as applied to functional electronic blocks", *Proc. IEEE* 52, pp. 1529-1556; Dec 1964

Kosonocky, W. F., "Laser digital devices", Optical and Electro-Optical Information Processing, MIT Press, pp. 269-304; 1965

Koster, C. J., and C. H. Swope, "Some laser effects potentially useful in optical logic functions", Optical and Electro-Optical Information Processing, MIT Press; 1965

Agusta, B., and R. L. Anderson, "Opto-electric effects in Ge - GaAs p-n heterojunctions", J. Appl. Phys. 36, pp. 206-210; Jan 1965

Kosonocky, W. F., R. Cornely, F. Marlowe, "GaAs laser inverter", 1965 Int. Solid State Circuits Conf., Phil., Penn., Conference Digest; Feb 1965

Bray, T. E., "Switching with light", Electronics 38, pp. 58-65; 1 Nov 1965

5.2 Display Devices and Imaging

Anonymous, "Laser camera takes bright picture", Electronics 37, pp. 44-45; 28 Feb 1964

Hardy, W. A., "Active image formation in lasers", IBM J. Res. and Develop. 9, pp. 31-46; Jan 1965

Bass, J. C., "Saturation of electroluminescent image-retaining panels by laser beams", Appl. Opt. 5, pp. 169-170; Jan 1966

Myers, R. A., H. Wieder, and R. V. Pole, "Wide-field active imaging", IEEE J. Quan. Elec. QE-2, pg. lxiii, Apr 1966, and pp. 270-275; Aug 1966

Anonymous, "Toward larger color displays; eliminating film from the picture", Electronics 39, pp. 143-146; 25 July 1966

Brand, H., B. Hill, E. Holtz, and G. Wencker, "External light modulation with low microwave power", Elec. Letters 2, pp. 317-318; Aug 1966

Cathey, W. T., Jr., "Comparison of single-lens and two-lens coherent imaging of complex distributions", J. Opt. Soc. Am. 56, pp. 1015-1017; Aug 1966

Considine, P. S., "Effects of coherence on imaging systems", J. Opt. Soc. Am. 56, pp. 1001-1009; Aug 1966

Northrup, D. C., and N. G. Shepherd, "Short range data link using a gallium arsenide lamp", Elec. Letters 2, pg. 304; Aug 1966

Korpel, A., R. Adler, P. Desmares, and W. Watson, "A television display using acoustic deflection and modulation of coherent light", Proc. IEEE 54, pp. 1424-1437, and Appl. Opt. 5, pp. 1667-1675, Joint Issue on Optical Elec.; Oct 1966

5.3 Beam Deflection

Kulcke, W., T. J. Harris, K. Kosanke, and E. Max, "A fast digital-indexed light deflector", IBM J. Res. and Develop. 8, pp. 64-67; Jan 1964

Fowler, V. J., C. F. Buhner, L. R. Bloom, "Electro-optic light beam deflector", Proc. IEEE 52, pp. 193-194; Feb 1964

Nelson, T. J., "Digital light deflection", Bell Sys. Tech. J. 43, pp. 821-845; May 1964

Lipnick, R., A. Reich, and G. A. Scheon, "Non-mechanical scanning of light using acoustic waves", Proc. IEEE 52, pp. 853-854; July 1964

Chen, F. S., J. E. Geusic, S. K. Kurtz, J. G. Skinner, and S. H. Wemple, "The use of perovskite paraelectrics in beam deflectors and light modulators", Proc. IEEE 52, pp. 1258-1260; Oct 1964

- Myers, R. A., R. V. Pole and J. Nunez, "Laser deflection with the conjugate plano-concentric resonator", *Appl. Opt.* 4, pp. 140-141; Jan 1965
- Lax, B., "Scanatron - a scanning beam semiconductor laser", *Solid State Design* 6, pp. 19-23; Mar 1965
- Korpel, A., R. Adler, P. Desmares, and T. M. Smith, "An ultrasonic light deflection system", *IEEE J. Quan. Elec.* QE-1, pp. 60-61; Apr 1965
- Flinchbaugh, E. E., "Focusing ultrasonic system applicable to two dimensional optical beam scanning and laser output modulation", *J. Acous. Soc. Amer.* 37, pp. 975-985; June 1965
- Herschberg, J. G., "Device for accurately changing the direction of a light beam through small angles", *App. Opt.* 4, pg. 759; June 1965
- Kleinhans, W., and D. L. Fried, "Efficient diffraction of light from acoustic waves in water", *Appl. Phys. Letters* 7, pp. 19-21; 1 July 1965
- Zweig, H. J., "Two-dimensional laser deflection using Fourier optics", *IBM J. Res. and Develop.* 9, pp. 333-335; July 1965
- Gordon, E. I., and M. G. Cohen, "Electro-optic diffraction grating for light beam modulation", *IEEE J. Quan. Elec.* QE-1, pp. 191-198; Aug 1965
- Kalibjian, R., T. Huen, C. Maninger, and J. Yee, "Laser deflection modulation in a CdS prism", *Proc. IEEE* 53, pg. 539, May 1965, and *Proc. IEEE* 53, pg. 1225; Sept 1965
- Smith, A. E., and R. E. Whitney, "A coherent flexible optical coupling", *Appl. Opt.* 4, pp. 1197-1199; Sept 1965
- Korpel, A., "Phased array type scanning of a laser beam", *Proc. IEEE* 53, pp. 1666-1667; Oct 1965
- Skinner, J. G., "Increasing the memory capacity of the digital light deflector by "color coding"", *Bell Sys. Tech. J.* 45, pp. 597-608; Apr 1966
- Kohn, E. S., and V. J. Fowler, "An internally scanned laser", *IEEE J. Quan. Elec.* QE-2, pg. xxxvi, Apr 1966 and pp. 464-466, Sept 1966
- Buck, W. E., and T. E. Holland, "Optical beam deflector", *Appl. Phys. Letters* 9, pp. 198-199; 15 Apr 1966
- Klein, W. R., "Theoretical efficiency of Bragg devices", *Proc. IEEE* 54, pp. 803-804; May 1966
- Kulcke, W., K. Kosanke, E. Max, H. Fleisher, and T. J. Harris, "High-resolution digital light deflector", *Appl. Phys. Letters* 9, pp. 266-268; 15 May 1966
- Ippen, E. P., "Electro-optic deflection with BaTiO₃ prisms", *IEEE J. Quan. Elec.* QE-2, pg. 152; June 1966
- Habegger, M. A., T. J. Harris, and J. Lip, "Total internal reflection light deflector", *Appl. Opt.* 5, pp. 1403-1405; Sept 1966
- Fowler, V., and J. Schlafer, "A survey of laser beam deflection techniques", *Proc. IEEE* 54, pp. 1437-1444, and *Appl. Opt.* 5, pp. 1676-1682, Joint Issue on Optical Elec.; Oct. 1966
- Gordon, E. I., "A review of acousto-optical deflection and modulation devices", *Proc. IEEE* 54, pp. 1391-1401, and *Appl. Opt.* 5, pp. 1629-1639, Joint Issue on Optical Elec.; Oct 1966

Kulcke, W., K. Kosanke, E. Max, M. A. Habegger, T. J. Harris, and H. Fleisher, "Digital light deflectors", Proc. IEEE 54, pp. 1419-1429, and Appl. Opt. 5, pp. 1657-1667, Joint Issue on Optical Elec.; Oct 1966

5.4 Spatial Filtering

O'Neill, E. L., "Introduction to statistical optics", Addison Wesley Publishing Co., Inc., Reading, Mass.; 1963

Vander Lugt, A., "Signal detection by complex spatial filtering", IEEE Trans. on Information Theory IT-10, pp. 139-145; Apr 1964

Weaver, C. S., "Optical signal processing and applications to pattern recognition", presented at 1965 WESCON; Aug 1965

Cutrona, L. J., E. N. Leith, L. J. Porcello, and W. E. Vivian, "On the application of coherent optical processing techniques to synthetic-aperture radar", Proc. IEEE 54, pp. 1026-1032; Aug 1966

5.5 Data Recording

Becker, C. A., "Coherent light recording techniques", NEREM Record 7, pp. 196-197; 1965

Anonymous, "Laser writes data for new trillion bit memory", Laser Focus 1, pg. 3; 1 Mar 1965

Koester, C. J., "Further study of glass fiber lasers for optical data processing", STAR 4, pg. 247(A); Jan 1966

Soref, R. A., "Optical memory characteristics of a SrS(Eu, Sm) phosphor", Proc. IEEE 54, pp. 425-426; Mar 1966

Forlani, F., and N. Minnaja, "A proposal for a magneto-optical variable memory", Proc. IEEE 54, pp. 711-712; Apr 1966

Falconer, D. G., "Optical processing of bubble chamber photographs", Appl. Opt. 5, pp. 1365-1368; Sept 1966

5.6 Optical Computers

Reimann, O. A., "On all-optical computer techniques", Optical and Electro-Optical Information Processing, MIT Press, pp. 247-252; 1965

Kosonocky, W. F., and O. A. Reimann, "Progress in optical computer research", IEEE Spectrum 2, pp. 181-195; Mar 1965

Preston, K., "Computing at the speed of light", Electronics 38, pp. 72-83; 6 Sept 1965

Vander Lugt, A., "Operational notation for the analysis and synthesis of optical data-processing systems", Proc. IEEE 54, pp. 1055-1063; Aug 1966

Smith, W. V., "Computer applications of lasers", Proc. IEEE 54, pp. 1295-1307, and Appl. Opt. 5, pp. 1533-1538, Joint Issue on Optical Elec.; Oct 1966

6.0 INTERFEROMETRY AND OPTICAL COMPONENT TESTING

6.1 Interferometry

6.1.1 HOLOGRAPHY APPLIED TO INTERFEROMETRY

Burch, J. M., "The application of lasers in production engineering", *Prod. Eng.* 44, pp. 431-442; Sept 1965

Collier, R. J., E. T. Doherty, and K. S. Pennington, "Application of Moire' techniques to holography", *Appl. Phys. Letters* 7, pp. 223-225; 15 Oct 1965

Barker, L. M., and R. E. Hollenbach, "Interferometer technique for measuring the dynamic mechanical properties of materials", *Rev. Sci. Instr.* 36, pp. 1617-1620; Nov 1965

Wuerker, R. F., R. E. Brooks, and L. O. Heflinger, "Interferometry with a holographically reconstructed comparison beam", *Bull. Am. Phys. Soc.* 10, pg. 1187(A); Nov 1965

Stetson, K. A., and R. L. Powell, "Interferometric hologram evaluation and real-time vibration analysis of diffuse objects", *J. Opt. Soc. Am. Letters* 55, pp. 1694-1695, Dec 1965

Powell, R. L., and K. A. Stetson, "Interferometric vibration analysis by wavefront reconstruction", *J. Opt. Soc. Am.* 55, pp. 1593-1598; Dec 1965

Hildebrand, B. P., and K. A. Haines, "Interferometric measurement using the wavefront reconstruction technique", *Appl. Opt.* 5, pp. 172-173; Jan 1966

Heflinger, L. O., R. F. Wuerker, and R. E. Brooks, "Holographic interferometry", *J. Appl. Phys.* 37, pp. 642-649; Feb 1966

Burch, J. M., A. E. Ennos, "Dual-and multiple-beam interferometry by wavefront reconstruction", *Nature* 209, pp. 1015-1016; 5 Mar 1966

Haines, K. A., and B. P. Hildebrand, "Surface-deformation measurement using the wavefront reconstruction technique", *Appl. Opt.* 5, pp. 595-602; Apr 1966

Kopylov, G. I., "On some possible properties of the hologram", *Phys. Letters* 21, pp. 645-646; 1 July 1966

6.1.2 NON-HOLOGRAPHIC INTERFEROMETRY

Moos, F. W., G. F. Imbusch, L. F. Mollenauer, and A. L. Schawlow, "Tilted plate interferometry with large plate separations", *Appl. Opt.* 2, pp. 817-822; Aug 1963

Anonymous, "Exhaust gas pictures" (flow fields of rocket engines), *Electronics* 37, pp. 51-53; 6 Mar 1964

Murty, N. V. R. K., "Use of single plane-parallel plates as lateral shearing interferometer with visible gas laser source", *Appl. Opt.* 3, pp. 531-534; Apr 1964

Clunie, D. M., and N. H. Rock, "The laser feedback interferometer", *J. Sci. Instr.* 41, pp. 489-492; Aug 1964

Zoot, R. M., "Laser interferometry of pentaprisms", *Appl. Opt.* 3, pp. 1187-1188; Oct 1964

London, F. H., "Laser interferometry", *Instr. and Control Sys.* 37, pp. 87-89; Nov 1964

Fork, R. I., D. R. Herriott, H. Kogelnik, "A scanning spherical mirror interferometer for spectral analysis of laser radiation", *Appl. Opt.* 3, pp. 1471-1484; Dec 1964

Stroke, G. W., "Interferometry with rotation-insensitive 'corner-cube' systems and lasers", *J. Opt. Soc. Am.* 55, pp. 330-331; Mar 1965

Jackson, R. A., "The laser as a light source for the Mach-Zender interferometer", *J. Sci. Instr.* 42, pp. 282-283; Apr 1965

Sterrett, J. R., J. C. Emery, J. B. Barber, "A laser grating interferometer", *AIAA Jour.* 3, pp. 963-964; May 1965

Freeman, G. H. C., "The use of a gas laser in studying the wavefront from an echelle grating at large angles of incidence", *J. Sci. Instr.* 42, pp. 437-438; June 1965

Brackenridge, J. B., and W. P. Gilbert, "Schlieren interferometry - an optical method for determining temperature and velocity distributions in liquids", *Appl. Opt.* 4, pp. 819-821; July 1965

Oppenheim, A. K., P. A. Urtiew, and F. J. Weinberg, "On the use of laser light sources in Schlieren - interferometer systems", *Proc. Roy. Soc.* 291, pp. 279-290; 5 Apr 1966

O'Brien, R. N., "Laser interferometry of a dropping mercury electrode", *Nature* 210, pp. 1217-1219; 18 June 1966

6.1.3 LONG PATH INTERFEROMETRY

Moos, H., G. Imbusch, L. Mollenauer, and A. L. Schawlow, "Multiple-beam interferometry with large plate separations", *Bull. Am. Phys. Soc.* 7, pg. 445; 27 Aug 1962

Arecchi, F. T., and A. Sona, "Long distance interferometry with an He-Ne laser", *Proc. Symp. on Quasi-Optics, Polytech. Inst. of Brooklyn, N. Y. MRI Symp. Series 14*, pp. 623-633; 1964

Arecchi, F. T., G. Lepre, and A. Sona, "A new reversible high-speed fringe counter for laser interferometry", *Alta Freq.* 33, pp. 534-540; Aug 1964

Herriott, D. R., "Long-path multiple-wavelength multiple-beam interference fringes", *J. Opt. Soc. Am.* 56, pp. 719-723; June 1966

6.2 Optical Component Testing

Hercher, M. M., "Relationship between the near field characteristics of a ruby laser and its optical quality", *Appl. Opt.* 1, pp. 665-670; Sept 1962

Aagard, R. L., "Index of refraction measurement by double slit diffraction of coherent light from a gas laser", *Appl. Opt.* 3, pp. 643-644; May 1964

Toolin, P., P. Main, M. G. Rossman, G. W. Stroke, and R. C. Restrick, "Holography and its crystallographic equivalent", *Nature* 209, pp. 603-604 5 Feb 1966

Upatnieks, J., A. Vanderlugt, E. Leith, "Correction of lens aberrations by means of holograms", *Appl. Opt.* 5, pp. 589-593; Apr 1966

Rosenberry, F. W., "The measurement of homogeneity of optical materials in the visible and near infrared", *Appl. Opt.* 5, pp. 961-966; June 1966

Vand, V., K. Vedem, and R. Stein, "The laser as a light source for ultramicroscopy and light scattering by imperfections in crystals. Investigation of imperfections in LiF, MgO, and ruby", *J. Appl. Phys.* 37, pp. 2551-2557; June 1966

Met, V., "Determination of small wedge angles using a gas laser", *Appl. Opt.* 5, pp. 1242-1244; July 1966

7.0 APPLICATION TO SCIENTIFIC STUDIES

7.1 Spectroscopy

Porto, S. P. S., and D. L. Wood, "Ruby optical maser as a Raman source", *J. Opt. Soc. Am.* 52, pp. 251-252; Mar 1962

Eckhardt, G., R. W. Hellwarth, F. J. McClung, S. E. Schwarz, D. Weiner and E. J. Woodbury, "Stimulated Raman scattering from organic liquids", *Phys. Rev. Letters*, pp. 455-457; 1 Dec 1962

Heller, Z. H., "Rowland ghosts observed with laser illumination", *J. Opt. Soc. Am.* 53, pp. 395-397; Mar 1963

Kogelnik, H., and S. P. S. Porto, "Continuous helium-neon red laser as a Raman source", *J. Opt. Soc. Am.*, 53, pp. 1446-1447; Dec 1963

Gerritsen, H. J., and S. A. Ahmed, "Measurement of absolute optical collision diameters in methane using tuned laser spectroscopy", *Phys. Letters* 13, pp. 41-42; 1 Nov 1964

Petrash, G. G., and S. G. Rautian, "Spectroscopic application of gas laser spectroscopy", *Optika Spektroskopiya* 13, pp. 188-189; Feb 1965

Weber, A., S. P. S. Porto, "He-Ne laser as a light source for high resolution Raman spectroscopy", *Jour. Opt. Soc. Am.* 55, pp. 1033-1034; Aug 1965

Feld, M. S., J. H. Parks, H. R. Schlossberg, and A. Javan, "Spectroscopy with gas lasers", in *Physics of Quantum Electronics*, edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 587-580; 1966

Garrett, C. G. B., "Far-infrared masers and their applications to spectroscopy", in *Physics of Quantum Electronics*, edited by Kelley Lax, and Tannenwald, McGraw-Hill Book Co., pp. 557-566; 1966

Gerritsen, H. J., "Tuned laser spectroscopy of organic vapors", in *Physics of Quantum Electronics*, edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 581-590; 1966

Javan, A., P. R. Schroeder, M. S. Presshaus, and J. G. Mavroides, "High-resolution magnetospectroscopy of graphite using an infrared laser source", *Bull. Am. Phys. Soc.* 11, pp. 91-92(A); Jan 1966

Hansch, Th., and P. Toschek, "Measurement of neon atomic level parameters by laser differential spectrometry", *Phys. Letters* 20, pp. 273-275; 15 Feb 1966

McCubbin, T. K., Jr., R. Darone, and J. Sorrell, "Determination of vibration - rotational line strengths and widths in CO₂ using a CO₂ - N₂ laser", *Appl. Phys. Letter* 8, pp. 118-119; 1 Mar 1966

Jacoby, B. F., and R. M. Long, "High-resolution absorption measurements in CO_2 - with a tuned laser", *Appl. Phys. Letters* 8, pp. 202-204; 15 Apr 1966

Basov, N. G., A. N. Oraevskii, G. M. Strakhovskii, and A. V. Uspenskii, "Two-cavity laser as high resolution spectroscopy", *JETP Letters* 3, pp. 305-306; 15 June 1966

McFarlane, R. A., "Precision spectroscopy of new infrared emission systems of molecular nitrogen", *IEEE J. Quan. Elec.* QE-2, pp. 229-232; Aug 1966

Brunet, H., "High-resolution spectroscopy by Zeeman-tuned infrared laser", *IEEE J. Quan. Elec.* QE-2, pp. 382-384; Sept 1966

7.2 Interaction With Acoustic Waves

Cohen, M. G., and E. I. Gordon, "Acoustic beam probing using optical techniques", *Bell Sys. Tech. J.* 44, pp. 693-721; Apr 1965

Quate, C. F., C. D. W. Wilkinson, and D. K. Winslow, "Interaction of light and microwave sound", *Proc. IEEE* 53, pg. 1604; Oct 1965

7.3 Relativity Experiments

Townes, C. H., "Some applications of optical and infrared masers", in *Advances in Quantum Electronics*, edited by J. Singer, Columbia Univ. Press pp. 3-11; 1961

Carnahan, C. W., "A proposed first-order relativity test using lasers", *Proc. IEEE* 52, pg. 1976; Sept 1964

Bay, A., and H. S. Bayne, "The use of terahertz photobeats for precise velocity-of-light measurements", *Academic Press, Proc. Int. School of Physics*, pg. 352; 1964

Gerhars, R., "Detection of the transverse doppler effect with laser light", *Proc. IEEE* 52, pg. 218; Feb 1964

Jaseja, T. S., A. Javan, J. Murray, and C. H. Townes, "Test of special relativity or of the isotropy of space by use of infrared masers", *Phys. Rev.* 133, pp. A1221-A1225; 2 Mar 1964

Censon, D., "Detection of the transverse doppler effect with laser light", *Proc. IEEE* 52, pg. 987; Aug 1964

Shamir, J., and R. Fox, "A proposed first-order relativity test using lasers", *Proc. IEEE* 53, pp. 1155-1156; Aug 1965

Shamir, J., and R. Fox, "Comment on lasers and ether drift", *Phys. Letters* 18, pp. 277-278; 1 Sept 1965

Saake, A., "New ether drift experiment using lasers", *Phys. Letters* 18, pp. 267-268; 1 Sept 1965

7.4 Plasma Diagnostics

Flocco, G. and E. Thompson, "Thompson scattering of optical radiation from an electron beam", *Phys. Rev. Letters* 10, pp. 89-91; 1 Feb 1963

Schwars, S. E., "Scattering of optical pulses from a non-equilibrium plasma", *Proc. IEEE* 51, pg. 1362; Oct 1963

Kronast, B., "Laser applications in the field of plasma physics", *Z. Ang. Math. und Physik* 16, pp. 120-121; 25 Jan 1965

Schwarz, S. E., "Plasma diagnosis by means of optical scattering", *J. Appl. Phys.* 36, pp. 1836-1841; June 1965

Gerardo, J. B., J. T. Verdeyen, and M. A. Gusinow, "High frequency laser interferometry in plasma diagnostics", *J. Appl. Phys.* 36, pp. 2146-2151; July 1965

7.5 Nonlinear Optics

7.5.1 BOOKS

Bloembergen, N., *Nonlinear Optics*, New York: W. A. Benjamin, Inc.; 1965

Butcher, P. N., *Nonlinear Optical Phenomena*, Bulletin 200, Engineering Experiment Station, Ohio State Univ., Columbus, Ohio; 1965

7.5.2 REVIEW ARTICLES

Armstrong, J. A., N. Bloembergen, J. Ducuing, and P. S. Pershan, "Interactions between light waves in a nonlinear dielectric", *Phys. Rev.* 127, pp. 1918-1939; Sept 1962

Franklin, P. A., and J. F. Ward, "Optical harmonics and nonlinear phenomena", *Rev. Mod. Phys.* 35, pp. 23-29; Jan 1963

Kaminow, I. P., "Parametric principles in optics", *IEEE Spectrum* 2, pp. 35-43; Apr 1965

Ovander, L. N., "Nonlinear optical effects in crystals", *Soviet Phys. Uspekhi* 8, pg. 337; Nov-Dec 1965

Pershan, P. S., "Nonlinear optics", in *Progress in Optics*, Vol. 5, New York: North-Holland Publishing Co. - Amsterdam, Interscience Publishers, Inc.; 1966 (in progress)

Broer, L. J. F., "Wave propagation in nonlinear media", *Zeit. f. Ang. Math. und Physik* 16, pp. 18-26; 25 Jan 1966

Terhune, R. W., R. W. Minck, and C.C. Wang, "Nonlinear optics", *Proc. IEEE* 54, pp. 1357-1374, and *Appl. Opt.* 5, pp. 1595-1612, Joint Issue on Optical Elec.; Oct 1966

7.6 Geophysical Applications

7.6.1 MEASUREMENT OF EARTH PHENOMENA

Leaf, H. W., "Use of optical masers as transducers for seismographs", *OAR Research Rev. (USAF)* 2, pg. 8; Sept 1963

Honig, W., "Measurement of continental drift and earth movement with lasers", *Proc. IEEE* 52, pg 430; Apr 1964

Newby, H. D., Jr., "Measurement of differential earth tides", *Proc. IEEE* 53, pg. 296; Mar 1965

Bali, V. R. S., Krogstad, R. W. Moss, "Laser interferometer for earth strain measurements", *Rev. Sci. Inst.* 36, pg. 1352; Sept 1965

Vall, V., R. S. Krogstad, and R. W. Moss, "Observation of earth tides using a laser interferometer", *J. Appl. Phys.* 37, pp. 580-582; Feb 1966

7.6.2 ATMOSPHERIC PROBING

7.6.2.1 Effects of Turbulence

Collins, R. R., "LIDAR detection of CAT", *Astronautics and Aeronautics* 2, pp. 52-54; Dec 1964

Goldstein, I., P. A. Miles, and A. Chabot, "Heterodyne measurements of light propagation thru atmospheric turbulence", *Proc. IEEE* 53, pp. 1172-1180; Sept 1965

Consortini, A., L. Ronchi, A. M. Scheggi, and G. Toraldo di Francia, "Deterioration of the coherence properties of a laser beam by atmospheric turbulence and molecular scattering", *Radio Science* 1, pp. 523-530; Apr 1966

Davis, J. I., "Consideration of atmospheric turbulence in laser systems design", *Appl. Opt.* 5, pp. 159-146; June 1966

Hohn, D. H., "Effects of atmospheric turbulence on the transmission of a laser beam at 6328A. I - Distribution of intensity", *Appl. Opt.* 5, pp. 1427-1431; Sept 1966

Hohn, D. H., "Effects of atmospheric turbulence on the transmission of a laser beam at 6328A. II - Frequency spectra", *Appl. Opt.* 5, pp. 1433-1436; Sept 1966

7.6.2.2 Effects in the Lower Atmosphere (<60km)

Honey, R., and M. Ligda, "Lidar - newest tool for meteorology", *SRI Research for Industry* 16, pg. 8; Jan - Feb 1964

Deirinendjian, D., "Scattering and polarization properties of water clouds and hazes in the visible and infrared", *Appl. Opt.* 3, pp. 187-196; Feb 1964

Hinchman, W. R. and A. L. Buck, "Fluctuations in a laser beam over 9- and 90-mile path", *Proc. IEEE* 52, pp. 305-306; Mar 1964

Flocco, G., and G. Frams, "Observations of the aerosol layer at 20 km by optical radar", *J. Atmospheric Sci.* 21, pp. 323-324; May 1964

Palmer, E. P., W. G. Zdunkowski, "Absolute scattering functions and transmission values for interpreting laser light scattering in the mesosphere", *J. Geophys. Res.* 69, pp. 2369-2377; 1 June 1964

Collis, R. T. H., M. G. H. Ligda, "Laser radar echoes from the clear atmosphere", *Nature* 203, pg. 508; 1 Aug 1964

Collis, R. T. H., F. G. Fernald, M. G. H. Ligda, "Laser radar echoes from a stratified clear atmosphere", *Nature* 203, pp. 1274-1275; 19 Sept 1964

Silverman, B. A., B. J. Thompson, and J. H. Ward, "A laser fog disdrometer", *Appl. Meteorology* 3, pp. 792-801; Dec 1964

Deirinendjian, D., "Note on laser detection of atmospheric dust layers", *J. Geophys. Res.* 70, pp. 743-745; 1 Feb 1965

Ligda, M. G. H., "The laser in meteorology", *Discovery* 26, pp. 30-35; July 1965

Cooney, J., "Remote observations using Raman components of laser backscatter", *Proceedings of the 2nd Int'l Symp. on Electromagnetic Sensing of the Earth from Satellites*, Miami Beach, Florida; Nov 1965

Lawrence, J. D., "Measurement of light scattered from a laser beam by the atmosphere", STAR 3, pg 4168(A); 23 Dec 1965

Clemish, B. R., G. S. Kent, and R. H. W. Wright, "Laser probing the lower atmospheres", Nature 209, pp. 184-185; 8 Jan 1966

Chu, T. S., and D. C. Hogg, "The attenuation of 3.392 micron He-Ne laser radiation by methane in the atmosphere", Bell Sys. Tech. J. 45, pp. 301-306; Feb 1966

Inaba, H., T. Kobayashi, T. Ichimura, M. Morihisa, "Laser radar applications in atmospheric physics research", IEEE J. Quan. Elec. QE-2, pg. ix; Apr 1966

Northend, C. A., R. C. Honey, and W. E. Evers, "Laser radar (lidar) for meteorological observations", Rev. Sci. Instr. 37, pp. 393-400; Apr 1966

Hamilton, P. M., K. W. James, D. J. Moore, "Observations of power station plumes using a pulsed ruby laser rangefinder", Nature 210, pp. 723-724; 14 May 1966

7.6.2.3 Effects in the Upper Atmosphere (>60km)

Fiocco, G., and L. D. Smullin, "Detection of scattering layers in the upper atmosphere (60-140 km) by optical radar", Nature 199, pp. 1275-1276; 28 Sept 1963

McCormick, P. D., J. K. Poultney, V. Van Wijik, C. O. Alley, R. T. Bettinger, and J. A. Perschy, "Backscattering from the upper atmosphere (75-160 km) detected by optical radar", Nature 209, pp. 798-799; 19 Feb 1966

Barn, W. C., M. C. W. Sandford, and K. K. Bedford, "Light scatter from a laser beam in the upper atmosphere", IEEE J. Quan. Elec. QE-2, pg ix; Apr 1966

Bain, W. C., and M. C. W. Sandford, "Backscattering from the upper atmosphere (75-160 km) detected by optical radar", Nature 210, pg. 826; 21 May 1966

7.6.3 GEODESY AND SATELLITES

Tavener, M. S., "Largos: A suggested method of stereo-triangulation", J. Geophys. Res. 67, pp. 3602-3603; Aug 1962

Snyder, G. L., S. R. Hurst, A. B. Graflinger, and H. W. Halsey, "Satellite laser ranging experiment", Proc. IEEE 53, pp. 298-299; Mar 1965

Plotkin, H. H., T. S. Johnson, P. Spadin, and J. Maye, "Reflection of ruby laser radiation from Explorer XXII", Proc. IEEE 53, pp. 301-302; Mar 1965

Hilff, R. L., "Photographing satellite-relected laser pulses for geodetic stereo triangulation", J. Geophys. Res. 70, pp. 3505-3508; 15 July 1965

Anderson, P. H., C. G. Lehr, L. A. Maestre, H. W. Halsey, and G. L. Snyder, "The two-way transmission of a ruby laser beam between earth and a retroreflecting satellite", Proc. IEEE 54, pp. 426-427; Mar 1966

Anderson, P. H., C. G. Lehr, L. A. Maestre, and G. L. Snyder, "The use of lasers for the precise determination of satellite orbits", IEEE J. Quan. Elec. QE-2, pg. xviii, Apr 1966 and pp. 215-219, Aug 1966

7.6.4 LUNAR MEASUREMENTS

Smullin, L. D., and G. Fiocco, "Project luna see", Proc. IRE 50, pp. 1703-1704; July 1962

Wilcox, C. H., and A. D. Jacobson, "Laser reflection for the analysis of lunar topography", Trans. Am. Geophys. Union 43, pg. 462; Dec 1962

Collinson, J., and J. Renau, "Measurements of electro-magnetic backscattering from known rough surfaces", Bell Sys. Tech. J. 44, pp. 2203-2226; Dec 1965

Orszag, A., "Moon distance measurement by laser", NBS J. Res., Section F. Radio Science 69D, pp. 1681-1689; Dec 1965

Kokurin, Yu. L., V. V. Kurbasov, V. F. Lobanov, V. M. Moyzhherin, A. N. Sukhanovskii, and N. S. Chernykh, "Measurement of the distance to the moon by optical radar", JETP Letters 3, pp. 139-141; 1 Mar 1966

7.6.5 METEOROID PHENOMENA

Fiocco, G., and G. Columbo, "Optical radar results and meteoric fragmentation", J. Geophys. Res. 69, pp. 1795-1803; 1 May 1964

Roe, W. J., and A. Hertzberg, "On the possibility of simulating meteorid impact by the use of lasers", STAR 2, pg. 1476(A); 23 June 1964

Hudson, D. K., "Meteoroid simulation using lasers", STAR 3, pg. 1287(A); 23 Apr 1965

7.7 Gas Breakdowns

Meyerand, R. G., Jr., and A. F. Haught, "Gas breakdown at optical frequencies", Phys. Rev. Letters 11, pp. 401-403; 1 Nov 1963

Minck, R. W., "Optical frequency electrical discharges in gases", J. Appl. Phys. 35, pp. 252-254; Jan 1964

Meyerand, R. G., Jr., and A. F. Haught, "Optical energy absorption and high density plasma production", Phys. Rev. Letters 13, pp. 7-9; July 1964

Wright, J. K., "Theory of the electrical breakdown of gases by intense pulses of light", Proc. Phys. (London) 84, pp. 41-46; July 1964

Gold, A., and H. B. Bebb, "Theory of multiphoton ionization", Phys. Rev. Letters 14, pp. 60-63; 18 Jan 1965

Zel'dovich, Ya. B., and Yu. P. Raiser, "Cascade ionization of a gas by a light pulse", Soviet Phys. - JETP 20, pp. 772-780; Mar 1965

Tozer, B. A., "Theory of the ionization of gases by laser beams", Phys. Rev. 137, pp. A1665-A1667; 15 Mar 1965

Tomlinson, R. G., "Multiphoton ionization and the breakdown of noble gases", Phys. Rev. Letters 14, pp. 489-490; 29 May 1965

D. D. Ryutov, "Theory of breakdown of noble gases at optical frequencies", Soviet Phys. - JETP 20, pp. 1472-1475; June 1965

Buscher, H. T., R. G. Tomlinson, and E. K. Damon, "Frequency dependence of optically induced gas breakdown", Phys. Rev. Letters 15, pp. 847-849; 29 Nov 1965

Bebb, H. B., and A. Gold, "Multiphoton ionization of rare gas and hydrogen atoms", in *Phys. of Quan. Elec.*, edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 489-498; 1966

Haught, A. F., R. G. Meyerand, Jr., and D. C. Smith, "Electrical breakdown of gas by optical frequency radiation", in *Phys. of Quan. Elec.*, edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 509-519; 1966

Mandelstam, S. L., P. P. Pashinin, A. M. Prokhorov, and N. K. Sukhodrev, "Optical frequency electrical discharge in air", in *Phys. of Quan. Elec.*, edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 548-553; 1966

Minck, R. W., and W. G. Rado, "Investigation of optical frequency breakdown phenomena", in *Phys. of Quan. Elec.*, edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 527-537; 1966

Peressini, E. R., "Field emission from atoms in intense fields", in *Phys. of Quan. Elec.*, edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 499-508; 1966

Phelps, A. V., "Theory of growth of ionization during laser breakdown", in *Phys. of Quan. Elec.*, edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 538-545; 1966

Tomlinson, R. G., E. K. Damon, and H. T. Buscher, "The breakdown of noble and atmospheric gases by ruby and neodymium laser pulses", in *Phys. of Quan. Elec.*, edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 520-536; 1966

Raizer, Yu. P., "Breakdown and heating of gases under the influence of a laser beam", *Soviet Phys. - Uspekhi* 8, pp. 650-673; Mar - Apr 1966

Chen, C. J., "Experimental evidence of inverse bremsstrahlung and electron-impact ionization in low pressure argon ionized by a giant-pulse laser", *Phys. Rev. Letters* 16, pp. 833-835; 9 May 1966

7.8 Interaction With Materials

7.8.1 DAMAGE IN INSULATORS

Hercher, M., "Laser-induced damage in transparent media", *J. Opt. Soc. Am.* 54, pg. 563A; Apr 1964

Cullom, J. H., and R. W. Waynant, "Determination of laser damage threshold for various glasses", *Appl. Opt.* 3, pp. 989-990; Aug 1964

Giuliano, C. R., "Laser-induced damage to transparent dielectric materials", *Appl. Phys. Letters* 5, pp. 137-139; 1 Oct 1964

Harper, D. W., "Laser damage in glass", *Brit. J. Appl. Phys.* 16, pp. 751-752; May 1965

Belikova, T. P., and E. A. Sviridenkov, "Effect of a focused ruby laser on the ruby", *JETP Letters* 1, pp. 171-172; 15 June 1965

Whiteman, P., and G. W. Wilson, "Laser-induced damage in natural white diamond", *Nature* 206, pp. 66-67; 2 Oct 1965

Avizonis, P. V., and T. Farrington, "Internal self-damage of ruby and Nd-glass lasers", *Appl. Phys. Letters* 7, pp. 205-206; 15 Oct 1965

Bradley, D. J., M. Engwell, and H. Komatsu, "Laser-induced damage in diamond", *Nature* 208, pp. 1081-1082; 11 Dec 1965

Martinelli, J., "Laser-induced damage thresholds for various glasses", *J. Appl. Phys.* 37, pp. 1939-1940; 15 Mar 1966

Bradley, D. J., M. Engwell, A. McCullough, H. Komatsu, and P. D. Smith, "Laser-induced damage in ruby and diamond", *IEEE J. Quan. Elec.* QE-2, pg. xliii; Apr 1966

O'neal, D., "Laser damage thresholds in NaCl crystals", *Appl. Phys. Letters* 8, pp. 283-285; 1 June 1966

Gregg, David W., and S. J. Thomas, "Momentum transfer produced by focused laser giant pulses", *J. Appl. Phys.* 37, pp. 2787-2789; June 1966

Belikova, T. P., and E. A. Sviridenkov, "Photoconductivity of ruby when strongly irradiated by a ruby laser", *JETP Letters* 3, pp. 257-259; 15 May 1966

Conners, G. H., and R. A. Thompson, "A continuum mechanical model for laser-induced fracture in transparent media", *J. App. Phys.* 37, pp. 3434-3440; Aug 1966

7.8.2 PHOTOCONDUCTIVITY, MAGNETIZATION, AND RECOMBINATION

Hasegawa, K., and W. G. Schneider, "Ruby laser excited photo-currents in anthracene", *J. Chem. Phys.* 40, pp. 2533-2537; 1 May 1964

Yoshino, Y., Watabe, and Y. Inuishi, "Laser-induced photoconductivity in CdS crystal", *Japanese J. Appl. Phys.* 4, pg. 312; Apr 1965

van der Ziel, J. P., and N. Bloembergen, "Optical induced magnetization in ruby", *Phys. Rev.* 138, pp. A1287-A1292; 17 May 1965

Saura, J., and R. H. Bube, "Laser-quenching of photoconductivity and recombination process in sensitive photoconductors", *J. Appl. Phys.* 36, pp. 3660-3662; Nov 1965

Winogradoff, N. N., and H. K. Kessler, "Radiative recombination lifetimes in laser-excited silicon", *Appl. Phys. Letters* 8, pp. 98-99; 15 Feb 1966

Belikova, T. P., and E. A. Sviridenkov, "Photoconductivity of ruby when strongly irradiated by a ruby laser", *JETP Letters* 3, pp. 257-259; 15 May 1966

Dneprovskii, V.S., D. N. Klyshko, and A. N. Penin, "Photoconductivity of dielectrics under the influence of laser radiation", *JETP Letters* 3, pp. 251-253; 15 May 1966

Maeda, K., and S. Iida, "Behavior of CdS crystals under laser light excitation", *Appl. Phys. Letters* 9, pp. 92-94; 15 July 1966

7.8.3 NUCLEATION

Naiman, C. S., M. Y. DeWalt, and J. Schwarz, "Study of nucleation induced by laser irradiation", *Bull. Am. Phys. Soc. Series II* **10**, pg. 493-EH7; Apr 1965

Stamberg, R. C., and D. E. Gillespie, "Laser-stimulated nucleation in a bubble chamber", *J. Appl. Phys.* **37**, pp. 459-461; Jan 1966

Gorbunkov, V. M., V. V. Korobkin, and A. M. Leontovich, "Illumination of a bubble chamber using a ruby laser", *Soviet-Phys. Doklady* **10**, pg. 329; Mar 1966

Schuster, B. G., and W. B. Good, "Homogeneous nucleation of water vapor determined by scattering of a laser beam", *J. Chem. Phys.* **44**, pp. 3132-3133; 15 Apr 1966

Falconer, D. G., "Optical processing of bubble chamber photographs", *Appl. Opt.* **5**, pp. 1365-1367; Sept 1966

7.8.4 INTERACTION WITH CONDUCTORS

7.8.4.1 Cratering and Plasma Creation

Verber, C. M., and A. H. Adelman, "Laser-induced thermionic emission", *Appl. Phys. Letters* **2**, pp. 220-222; 1 June 1963

Ready, J. F., "Development of plume of material vaporized by giant pulse laser", *Appl. Phys. Letters* **3**, pp. 11-13; 1 July 1963

Berkowitz, J., and W. Chupka, "Mass spectrographic study of vapor ejected from graphite and other solids by focused laser beam", *J. Chem. Phys.* **40**, pp. 2735-2736; 1 May 1964

Neuman, F., "Momentum transfer and cratering effects by giant laser pulses", *Appl. Phys. Letters* **4**, pp. 167-169; 1 May 1965

Ehler, A. W., "Description of the plasma produced by a laser pulse striking an aluminum surface", *Bull. Am. Phys. Soc., Series II* **10**, pg. 227-Q10; Feb 1965

Gilmour, A. S. Jr., and F. A. Giori, "Plasma generation by the laser illumination of a tungsten surface", *Bull. Am. Phys. Soc. Series II* **10**, pg. 199; Feb 1965

Haight, A. F., and R. G. Meyerand, Jr., "Plasma production by laser-beam irradiation of solid particles", *Bull. Am. Phys. Soc., Series II* **10**, pg. 127-A9; Feb 1965

Namba, S., and P. H. Kim, "The surface temperature of metals heated with laser", *Japanese J. Appl. Phys.* **4**, pg. 153; Feb 1965

Ready, J. F., "Effects of laser radiation", *Industrial Research* **7**, pp. 44-56; Aug 1965

Birnbaum, M., "Semiconductor surface damage produced by ruby lasers", *J. Appl. Phys.* **36**, pp. 3688-3689; Nov 1965

Silberg, P. A., "Laser interaction with a mercury surface", *Canad. J. Phys.* **43**, pp. 2078-2085; Nov 1965

Ambartsumyan, R. T., "Heating of matter by focused laser radiation", *Soviet Phys. JETP*, **21**, pp. 1061-1064; Dec 1965

Knecht, W. L., "Surface temperature of laser-heated metal", *Proc. IEEE* **54**, pg. 683-683; Apr 1966

Her, R., G. J., and R. J. Murphy, "Laser-induced thermal etching of crystal surfaces", IEEE J. Quan. Elec. QE-2, pg. xliii; Apr 1966

Penner, S. S., and O. P. Sharma, "Interaction of laser radiation with an absorbing semi-infinite solid bar", J. Appl. Phys. 37, pp. 2304-2308; May 1966

Vanyukov, M. P., V. I. Isenko, V. V. Lyubinov, V. A. Serenbraykov, O. A. Shorkov, "Use of a laser operating in the spike mode to obtain a high temperature plasma", JETP Letters 3, pg. 205; 15 Apr 1966

Afanasyev, Yu. V., O. N. Krokhin, and G. V. Sklizkov, "Evaporation and heating of a substance due to laser radiation", IEEE J. Quan. Elec. QE-2, pp. 483-486; Sept 1966

David, C., P. V. Avizonis, H. Weichel, C. Bruce, and K. D. Pyatt, "Density and temperature of a laser-induced plasma", IEEE J. Quantum Elec. QE-2, pp. 493-499; Sept 1966

7.8.4.2 Emission of Particles

Hornig, R. E., and J. R. Woolston, "Laser induced emission of electrons, ions, and neutral atoms from solid surfaces", Appl. Phys. Letters 2, pp. 138-139; 1 Apr 1963

Lichtman, D., and J. F. Ready, "Laser beam induced electron emission", Phys. Rev. Letters 10, pp. 342-345; 15 Apr 1963

Hornig, R. E., "Laser-induced emission of electrons and positive ions from metals and semiconductors", Appl. Phys. Letters 3, pp. 8-11; 1 July 1963

Lichtman, D., and J. F. Ready, "Reverse photoelectric effect and positive ion emission caused by Nd-in-glass laser emission", Appl. Phys. Letters 3, pp. 115-116; 1 Oct 1963

Linlor, W. I., "Ion energies produced by laser giant pulse", Appl. Phys. Letters 3, pp. 210-211; Dec 1963

Alcock, A. J., M. Ianzzi, H. Motz, and D. Walsh, "Laser-induced electron emission from tungsten points", J. Elec. Cont. 18, pp. 75-77; Jan 1964

Dalman, G. C., and T. S. Wen, "Laser-heated cathode", Proc. IEEE 52, pp. 200-201; Feb 1964

Wolga, G., and H. Bowers, "Double-quantum photoelectric emission", STAR 2, pg. 626(A); 8 Mar 1964

Isegor, N. R., "Metal ion emission velocity dependence on laser giant pulse height", Appl. Phys. Letters 4, pp. 152-153; 15 Apr 1964

Isegor, N. R., "High energy ions from a Q-switched laser", Canadian J. of Phys. 42, pp. 1413-1416; July 1964

Chang, T. Y., and C. K. Birdsall, "Laser-induced emission of electrons, ions and neutrals from Ti and Ti-D surfaces", Appl. Phys. Letters 5, pp. 171-172; 1 Nov 1964

Isegor, N. R., "Effect of background gas on laser-induced electron emission from metal surfaces", J. Appl. Phys., 35, pp. 316-317; Jan 1964

Ready, J. F., "Mechanisms of electron emission produced by a giant pulse laser", *Phys. Rev.* 137, pp. A620-A623; 18 June 1965

Knecht, W. L., "Initial energies of laser-induced electron emission from tungsten", *Appl. Phys. Letters* 6, pp. 99-100; Mar 1965

Verber, C. M., and A. H. Adelman, "Laser-induced thermionic emission from tantalum", *J. Appl. Phys.* Vol. 36, pp. 1522-1525; May 1965

Bernal, E., J. F. Ready, and L. P. Levine, "Absorbed ion emission from laser-irradiated tungsten", *Phys. Letters* 19, pp. 645-647; 1 Jan 1966

Bogdankevich, O. V., V. Yu. Sudzilovskii, and A. A. Lozhnikov, "Use of laser radiation to create a strong electron source", *Soviet Physics - Technical Physics* 10, pp. 1573-1574; May 1966

Fenner, N. C., and N. R. Daly, "Laser used for mass analysis", *Rev. Sci. Instr.* 37, pp. 1068-1070; Aug 1966

Bernal, E., J. F. Ready, and L. P. Levine, "Emission from laser-irradiated tungsten", *IEEE J. Quan. Elec.* QE-2, pg. xlii. Apr 1966, and pp. 480-482, Sept 1966

Longer, P., G. Tonan, and F. Floux, "Laser-induced emission of electrons, ions, and X rays from solid targets", *IEEE J. Quan. Elec.* QE-2, pp. 499-506; Sept 1966

7.9 Rayleigh Scattering

George, T. V., L. Slama, M. Yokoyama, and I. Goldstein, "Scattering of ruby laser beam by gases", *Phys. Rev. Letters* 11, pp. 403-406; 1 Nov 1963

George, T. V., L. Goldstein, L. Slama, and M. Yokoyama, "Molecular scattering of ruby laser light", *Phys. Rev.* 137A, pp. A369-A380; 18 Jan 1965

Tertune, R. W., P. D. Maker, and C. M. Savage, "Measurements of nonlinear light scattering", *Phys. Rev. Letters* 14, pp. 681-684; 26 Apr 1965

Watson, R. D., M. K. Clard, "Rayleigh scattering of 6943A laser radiation in a nitrogen atmosphere", *Phys. Rev. Letters* 14, pp. 1057-1058; 28 June 1965

Tertune, R. W., "Nonlinear scattering of light", *NEREM Record* 7, pp. 242-243; 1965

Maker, P. D., "Nonlinear light scattering in methane", *Physics of Quantum Electronics*, edited by Kelly, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 60-66; 1966

May, A. D., E. G. Rawson, H. L. Welsh, "Rayleigh scattering from low density gases", *Physics of Quantum Electronics*, edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 260-264; 1966

Shustin, O. A., "Scattering of light in the phase transition of the NH_4Cl crystal", *JETP Letters* 3, pp. 330-331; 15 June 1966

Kochelaev, B. I., "Hyperfine structure of the Rayleigh scattering of light in a paramagnet", Soviet Physics Doklady 11, pp. 130-131; Aug 1966

7.10 Scattering From Fluids

Carome, E. F., N. A. Clark, and C. E. Moeller, "Generation of acoustic signals in liquid by ruby laser-induced thermal stress transients", Appl. Phys. Letters 4, pp. 95-97; 15 Mar 1964

Chiao, R. Y., C. H. Townes, and B. P. Stoicheff, "Stimulated Brillouin scattering and coherent generation of intense hypersonic waves", Phys. Rev. Letters 2, pp. 592-594; 25 May 1964

Benedek, G. B., J. B. Lastovka, K. Fritsch, and T. Greytak, "Brillouin scattering in liquids and solids using low-power lasers", J. Opt. Soc. Am. 54, pp. 1284-1285; Oct 1964

Chiao, R. Y., and B. P. Stoicheff, "Brillouin scattering in liquids excited by the He-Ne maser", J. Opt. Soc. Am. 54, pp. 1286-1287; Oct 1964

Ford, N. C. Jr., and G. B. Benedek, Proceedings of the Conference on Phenomena in the Neighborhood of Critical Points, National Bureau of Standards, Washington, D. C. 1965 (to be published)

Ford, N. C. Jr., and G. B. Benedek, "Observation of the spectrum of light scattered from a pure fluid near its critical point", Phys. Rev. Letters 15, pp. 649-653; 18 Oct 1965

Yulmetev, R. M., "Theory of Rayleigh scattering of light in liquids", Optics and Spec. 19, pg. 532; Dec 1965

Alpert, S. S., D. Balzarini, R. Novick, L. Siegel, and Y. Yeh, "Observation of the time-dependent density fluctuations in carbon dioxide near the critical point using an He-Ne laser", Phys. of Quan. Elec., edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 253-259; 1966

Chiao, R. Y., and F. A. Fleury, "Brillouin scattering and the dispersion of hypersonic waves", Phys. of Quan. Elec., edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 241-252; 1966

Lastovka, J. B., and G. B. Benedek, "Light beating techniques for the study of the Rayleigh-Brillouin spectrum", Phys. of Quan. Elec., edited by Kelley, Lax, and Tannenwald, McGraw-Hill Book Co., pp. 231-240; 1966

Mountain, R. D., "Spectral distribution of scattered light in a simple fluid", Rev. Mod. Phys. 38, pp. 205-214; 1966

Fabelinski, I. L., "Study of the fine structure of the lines of scattered light and the propagation of hypersound", Soviet Physics Uspekhi 8, pp. 637-641; Mar - Apr 1966

Cummins, H. Z., and R. W. Gamman, "Rayleigh and Brillouin scattering in liquids; the Landau-Placzek ratio", J. Chem. Phys. 44, pp. 2785-2786; 1 Apr 1966

Marsh, D. I., V. S. Starnov, E. V., Tiganov, and I. L. Fabelinski, "Intensity and width of the fine structure components of scattered light in liquids and the attenuation of hypersound", *Soviet Phys. - JETP* 22, pp. 1205-1211; June 1966

Dexelic, G., "Evaluation of light - scattering data of liquids from physical constants", *J. Chem. Phys.* 45, pp. 185-191; 1 July 1966

Greytak, T. J., and G. B. Benedek, "Spectrum of light scattered from thermal fluctuations in gases", *Phys. Rev. Letters* 17, pp. 179-182; 25 July 1966

Rank, D. H., A. Hollinger, and D. P. Eastman, "Depolarization of the components of Rayleigh scattering in liquids", *J. Opt. Soc. Am.* 56, pp. 1057-1058; Aug 1966

Cornali, W. S., G. I. A. Stegeman, B. P. Stoicheff, R. H. Stolen, and V. Volterra, "Identification of a new spectral component in Brillouin scattering of liquids", *Phys. Rev. Letters* 17, pp. 297-299; 8 Aug 1966

Wolf, Michael A., P. M. Platzman, and M. G. Cohen "Brillouin scattering in liquid helium II", *Phys. Rev. Letters* 17, pp. 294-297; 8 Aug 1966

Gori, F., and D. Sette, "Spatial coherence of light scattered from liquids", *Phys. Rev. Letters* 17, pp. 361-363; 15 Aug 1966

7.11 Other Scientific Applications

7.11.1 INSTRUCTIONAL AIDS

Dutton, D., M. P. Givens, R. E. Hopkins, "Demonstration experiments in optics with gas laser", *Am. J. of Phys.* 32, pp. 355-361; May 1964

Sinclair, D., M. P. Givens, "Determination of the velocity of light using the laser as a source", *J. Opt. Soc. Am.* 54, pp. 795-797; June 1964

Whiteside, H., "Laser optics experiments and demonstrations", *Am. J. Phys.* 33, pg. 487; June 1965

Abella, I. D., M. Bass, D. Dutton, W. L. Fause, E. Mintz, and H. W. Moos, "Laser experiments and apparatus for teaching purposes", *Am. J. Phys.* 33, pp. 98-103; Feb 1966

Velichkina, T. S., O. A. Shustin, and I. A. Yakovlev, "Gas laser-demonstration experiments of its operation and application in physical laboratory", *Usp. Fiz. Nauk* 88, pp. 753-756; Apr 1966

Landry, J., "Coffee-table holography", *J. Opt. Soc. Am.* 56, pg. 1133; Aug 1966

7.11.2 POWER GENERATION IN THE INFRARED

Fox, A. J., and N. W. W. Smith, "Proposal for obtaining laser beat frequency radiation in the far infrared by the Smith-Purcell effect", *Proc. IEEE* 52, pp. 429-430; Apr 1964

Zernike, F. Jr., and P. R. Berman, "Generation of far-infrared as a difference frequency", *Phys. Rev. Letter* 15, pp. 999-1001; 27 Dec 1965

Martin, M. D., and E. L. Thomas, "The generation of molecular vibrational frequencies by optical mixing", *Phys. Letters* 19, pp. 651-652; 1 Jan 1966

Zernike, F. Jr., "Generation of coherent far infrared difference frequencies", *IEEE J. Quan. Elec.* QE-2, pg xv; Apr 1966

Martin, M. D., and E. L. Thomas, "Infrared difference frequency generation", *IEEE J. Quan. Elec.* QE-2, pg. xv; Apr 1966

..11.3 COMPTON SCATTERING

Kibble, T. W., "Frequency shift in high-intensity Compton scattering", *Phys. Rev.* 138, pp. B740-B753; 10 May 1965

Bartell, L. S., H. B. Thompson, R. R. Roskos, "Observation of stimulated Compton scattering of electrons by a laser beam", *Phys. Rev. Letters* 14, pp. 851-852; 24 May 1965

Frantz, L. M., "Compton scattering of an intense photon beam", *Phys. Rev.* 139, pp. B1326-B1336; 6 Sept 1965

Altshuler, S., and L. M. Frantz, "Reflection of atoms from standing light waves", *Phys. Rev. Letters* 17, pp. 231-232; 1 Aug 1966

7.11.4 SEMICONDUCTOR ANALYSIS

Markowska, E., J. Swiderski, "Application of laser to measurement of homogeneity and diffusion length of minority carriers in semiconductors", *Bulletin de L'Academie Polonaise des Sciences* 13, pg. 257; 1965

Winogradoff, N. N., and H. K. Kessler, "Radiative recombination lifetimes in laser-excited silicon", *Appl. Phys. Letters* 8, pp. 98-99; 15 Feb 1966

Murphy, R. J., and G. J. Ritter, "Laser-induced thermal etching of metal and semiconductor surfaces", *Nature* 210, pp. 191-192; 9 Apr 1966

7.11.5 OBSERVATION OF MAGNETIC DOMAINS

Tomlinson, J. F., "Observation of magnetic domains by means of He-Ne laser light", *STAR* 3, pg. 2759(A); 23 Aug 1965

7.11.6 REFLECTIVE DENSITOMETER

Met, V., "A reflective densitometer technique for spectrographic measurements using a He-Ne gas laser", *J. Sci. Inst.* 41, pp. 784-785; Dec 1964

7.11.7 INTERFERENCE FILTER

Smiley, V. N., "Backward wave optical amplification by an asymmetric active interference filter", *Appl. Opt.* 5, pp. 977-980; June 1966

7.11.8 ELECTRON ACCELERATOR

Shimoda, K., "Proposal for an electron accelerator using an optical maser", *Appl. Opt.* 1, pp. 33-35; Jan 1962

7.11.9 SPACE PROPULSION

Marx, G., "Interstellar vehicle propelled by terrestrial laser beam", *Nature* 211, pp. 22-23; 2 July 1966

7.11.10 HIGH TEMPERATURE PLASMA PRODUCTION

Tozer, B. A., P. R. Smy, and J. K. Wright, "The production of high temperature plasmas by intense laser pulses", *Proc. Phys. Soc. (London)* 85, pp. 45-51; 1965

Ehler, A. L., and G. L. Weissler, "Vacuum ultraviolet radiation from plasmas formed by a laser on metal surfaces", *Appl. Phys. Letters* 8, pp. 89-91; 15 Feb 1966

Daiber, J. W., A. Hertzberg, and C. E. Wittliff, "Laser-generated implosions", *Phys. Fluids* 9, pp. 617-619; Mar 1966

Vanyukov, M. P., V. I. Isaenok, V. V. Lyubinov, V. A. Serebraykov, O. A. Shorokhov, "Use of a laser operating in the spike mode to obtain a high temperature plasma", *JETP Letters* 3, pg. 205; 15 Apr 1966

8.0 APPLICATIONS IN CHEMISTRY

8.1 Survey Articles and Notes

Chemical Lasers, edited by W. R. Bennett, Jr., and K. E. Schuler; Supplement No. 2, *Appl. Opt.*; 1965

vonHagnek, W. D., "Anwendung von Lasern bei der Material untersuchung", *Zeit. f. Ang. Math. und Physik* 16, pp. 130-138; 25 Jan 1965

Wiley, R. H., "Laser organic chemistry", *Ann. N. Y. Acad. Sci.* 122, pp. 685-688; 28 May 1965

Editor's column, "The two photon effect can cause a chemical reaction", *Analyt. Chem.* 37, pg. 85A; June 1965

Kasper, J. V. V., "Infrared chemiluminescence and stimulated emission", *Diss. Abstracts* 26, pg. 66-3619; Mar 1966

Pimentel, G. C., "Chemical reactions provide the energy for two lasers, and more are in prospect", *Sci. Am.* 214, pp. 32-39; Apr 1966

Houle, M. J., and K. Grossaint, "Some advantages of using a He-Ne gas laser as a light source at 632.8 nm as compared to a tungsten lamp", *Anal. Chem.* 38, pg. 766; May 1966

8.2 Flash Photolysis

Pao, Y. H., P. M. Rentsepis, "Laser-induced production of free radicals in organic compounds", *Appl. Phys. Letters* 6, pp. 93-95; 1 Mar 1965

Verdieck, J. F., "Free-radical production by laser photolysis", *Bull. Am. Phys. Soc., Series II* 10, pp. 87-GG12; Jan 1965

Schnieper, P. A., "Flash photolysis", *NEREM Record* 7, pp. 158-159; 1965

8.3 Spectrochemical Analysis

Brech, F., and J. P. Marling, "Laser excited spectrochemical analysis", *Eleventh Inter. Coll. on Spectros., Belgrad*, part P-4; 1963

Runge, E. F., R. W. Minck, and F. R. Bryan, "Spectrochemical analysis using a pulsed laser source", *Spectrochimica Acta* 20, pp. 733-736; Apr 1964

8.4 Acoustic Velocity Measurements

Chiao, R. Y., C. H. Townes, and B. P. Stoicheff, "Stimulated Brillouin scattering and coherent generation of intense hypersonic waves", *Phys. Rev. Letters* 12, pp. 592-595; 25 May 1964

Garmire, E., and C. H. Townes, "Stimulated Brillouin scattering in liquids", *Appl. Phys. Letters* 5, pp. 84-86; 15 Aug 1964

Brewer, R. G., and K. E. Rieckhoff, "Stimulated Brillouin scattering in liquids", *Phys. Rev. Letters* 13, pp. 334a-336a; 14 Sept 1964

Jeunehomme, M., and R. P. Schwenker, "Focused laser-beam experiment and the oscillator strength of the swan system", *J. Chem. Phys.* 42, pp. 2406-2408; 1 Apr 1965

Marsh, D. I., V. V. Morozov, V. S. Starvuncy, E. V. Tiganov, and I. L. Fabelinski, "Induced Mandel'shtam-Brillouin scattering in solid amorphous bodies and in liquids", *JETP Letters* 2, pp. 157-160; 1 Sept 1965

Fabelinski, I. L., "Study of the structure of the lines of scattered light and the propagation of hypersound", *Soviet Physics Uspekhi* 8, pp. 637-641; Mar-Apr 1966

Rentzepts, P. M., and Y. H. Pao, "Generation of sound waves in liquids accompanying two-photon absorption", *J. Chem. Phys.* 44, pp. 2931-2934; 15 Apr 1966

Clark, N. A., C. E. Moeller, J. A. Bucaro, and E. F. Carome, "Hypersonic velocity measurements in liquid dichloromethane", *J. Chem. Phys.* 44, pp. 2528-2529; 15 May 1966

Brewer, R. G., "Stimulated Brillouin shifts by optical beats", *App. Phys. Letters* 9, pp. 51-53; 1 July 1966

Stone, J., "Hypersonic velocity measurements in aqueous alkali halide solutions", *J. Opt. Soc. Am.* 56, pp. 1136-1137; Aug 1966

9.0 PHOTOGRAPHIC APPLICATIONS

9.1 Holography

9.1.1 INTRODUCTORY AND REVIEW ARTICLES

Stroke, G. W., "Lensless photography", *Internat'l Sci. Tech.* 41, pp. 52-60; May 1965

Leith, E. N. and J. Upatnieks, "Photography by laser", *Sci. Am.* 212, pp. 24-35; June 1965

Leith, E., and J. Upatnieks, "Wavefront reconstruction photography", *Phys. Today* 18, pp. 26-30; Aug 1965

Pennington, K. S., "How to make laser holograms", *Micro-waves* 4, pp. 35-40; Oct 1965

Eaglesfield, C. C., "Holograms: what uses have they?", *Discovery* 27, pg. 23; June 1966

Collier, R. J., "Some current views on holography", *IEEE Spectrum* 3, pp. 67-74; July 1966

9.1.2 EARLY THEORY OF HOLOGRAPHY

Gabor, D., "Microscopy by reconstructed wavefront", *Proc. Roy. Soc. (London), Ser. A*, 197, pp. 454-487; 7 July 1949

Rogers, G. L., "Experiments in diffraction microscopy", *Proc. Roy. Soc. (Edinburgh), Sec. A*, 63, pp. 193-221; 1952

Leith, E. N., and J. Upatnieks, "Wavefront reconstruction with diffused illumination and three dimensional objects", *J. Opt. Soc. Am.* 54, pp. 1295-1301; Nov 1964

9.1.3 VOLUME ASPECTS OF HOLOGRAPHY

Denisyuk, Yu N., "Representation of optical properties of an objective by means of wave pattern of light scattered by it", *Soviet Phys. Doklady* 7, pp. 543-545; Dec 1962

van Heerden, P. J., "Theory of optical information storage in solids", *Appl. Opt.* 2, pp. 393-400; Apr 1963

Denisyuk, Yu N., "On the reproduction of an object by the wave field of its scattered radiation", *Opt. Spectros.* 15, pp. 279-284, Oct. 1963; 18, pp. 152-157; Jan 1965

Pennington, K. S., and Lin, L. H., "Multicolor wavefront reconstruction", *Appl. Phys. Letters* 7, pp. 56-57; 1 Aug 1965

Leith, E. N., A. Lozma, J. Upatnieks, J. Marks, and N. Massey, "Holographic data storage in three dimensional media", *Appl. Opt.* 5, pp. 1303-1311; Aug 1966

9.1.4 HOLOGRAM IMAGING PROPERTIES

Armstrong, J. A., "Fresnel holograms: their imaging properties and aberrations", *IBM J. Res. Develop* 9, pp. 171-178; May 1965

Leith, E. N., Upatnieks, J. and K. A., Haines, "Microscopy by wavefront reconstruction", *J. Opt. Soc. Am.* 55, pp. 981-986; Aug 1965

Meier, R. W., "Magnification and third order aberrations in holography", *J. Opt. Soc. Am.* 55, pp. 987-992; Aug 1965

Meier, R. W., "Cardinal points and the novel imaging points of a holographic system", *J. Opt. Soc. Am.* 56, pp. 219-223; Feb 1966

9.1.5 TECHNIQUES IN HOLOGRAPHY

Stroke, G. W., D. Brumm, and A. Funkhauser, "Three-dimensional holography with "lensless" Fourier transform holograms and coarse P/N Polaroid film", *J. Opt. Soc. Am.* 55, pp. 1327-1328; Oct 1965

Stroke, G. W., and Labeyrie, A. E., "White-light reconstruction of holographic images using the Lippman-Bragg diffraction effect", *Phys. Letters* 20, pp. 367-369; 1 Mar 1966

Lin, L. H., Pennington, K. S., G. W. Stroke, and A. E. Labeyrie, "Multicolor image construction with white light illumination", *Bell Sys. Tech. J.* 45, pp. 659-661; Apr 1966

Harris, F. S., G. C. Sherman, and B. H. Billings, "Copying holograms", *Appl. Opt.* 5, pp. 665-666; Apr 1966

Urbach, J. C., and R. W. Meir, "Thermoplastic xerographic holography", *Appl. Opt.* 5, pp. 666-667; Apr 1966

Wilmot, D. R., E. R. Schineller, and R. W. Heuman, "Hologram illumination with a flashlight", *Proc. IEEE* 54, pp. 690-692; Apr 1966

Pole, R. V., H. Wieder, and R.A. Myers, "Reactive processing of phase objects", *Appl. Phys. Letters* 8, pp. 229-231; 1 May 1966

9.2 High-Speed Photography

Courtney-Pratt, J. S., "Some uses of optical masers in photography", *J. Soc. Motion Picture and TV Engineers* 70, pp. 507-511; July 1961

Yajima, T., F. Shimizu, and K. Shimoda, "High speed photography using a ruby optical maser", *Appl. Opt.* 1, pp. 770-771; Nov 1962

Ellis, A. T., and M. E. Fourney, "Application of a ruby laser to high speed photography", *Proc. IEEE* 51, pp. 942-943; June 1963

Ebeling, D., "High speed cinematography with Q-switched laser flashes", *Zeit. f. Ang. Math. und Physik* 16, pp. 121-122; 25 Jan 1965

Tanner, L. H., "The application of lasers to time-resolved flow visualization", *J. Sci. Instr.* 42, pg. 125; June 1965

Brooks, R. E., L. O. Heflinger, R. F. Wuerker, and R. A. Briones, "Holographic photography of high speed phenomena with conventional and Q-switched lasers", *Appl. Phys. Letters* 7, pp. 92-94; 15 Aug 1965

Trammell, W. V., "Laser photography of hypervelocity projectiles", *Rev. Sci. Instr.* 36, pp. 1551-1553; Nov 1965

Christensen, A. B., and W. M. Isbell, "Technique for streak camera writing rate calibration using pulsed laser", *Rev. Sci. Instr.* 37, pp. 559-561; May 1966

9.3 Micrography

Rogers, G. L., "Experiments in diffraction microscopy", Proc. Roy. Soc. (Edinburgh), Sec. A. 63, pp. 193-221; 1952

Courtney-Pratt, J. S., "Optical masers and micrography", Bell Lab. Record 39, pg. 143; Apr 1961

Rosan, R. C., M. K. Healy, and W. F. McNary, "Spectroscopic ultra-microanalysis with a laser", Sci. 142, pp. 236-237; 11 Oct 1963

Peppers, N. A., "A laser microscope", Appl. Opt. 4, pg. 555-558; May 1965

Stroke, G. W., "Lensless photography", Internat'l Sci. Tech. pp. 52-60; May 1965

Carter, W. H., and A. A. Dougal, "High-quality three-dimensional records of microscope specimens on single microholograms utilizing gas laser illumination", IEEE J. Quan. Elec. QE-2, pg. lxiv; Apr 1966

Vand, V., K. Vedam, and R. Stein, "The laser as a light source for ultramicroscopy and light scattering by imperfections in crystals. Investigation of imperfections in LiF, MgO, and ruby", J. Appl. Phys. 37, pp. 2551-2557; June 1966

Gabor, D., and W. P. Goss, "Interference microscope with total wavefront reconstruction", J. Opt. Soc. Am. 56, pp. 849-858; July 1966

10.0 METALWORKING APPLICATIONS

10.1 Survey Articles

Missio, D. V., "Effects of the laser beam", Proc. Nat. Elec. Conf. 19, pp. 569-573; 1963

Kobrin, C. L., "Lasers: The piercing power of pure light", Iron Age 192, pp. 125-132; 15 Aug 1963

Buddenhagen, D. D., "Laser goes miniature", SAE J. 72, pp. 40-45; Mar 1964

Bahun, C. J., and R. D. Engquist, "Metals joining in the space age - by lasers", J. Metals 16, pp. 242-243; Mar 1964

Ready, J. F., "Interaction of high power laser radiation with absorbing surfaces", Proc. Nat. Elec. Conf. 22, pp. 67-71; Oct 1964

Young, D. S., "The laser as an industrial tool", The Engineer (Western Electric) 8, pp. 2-10; Oct 1964

Panzer, V. S., "Die Anwendung des Lasers für die Materialbearbeitung", Zeit. f. Ang. Math. und Physik 16, pp. 138-155; 25 Jan 1965

Zuyev, V. S., "The industrial possibilities of lasers", STAR 3, pg. 2202(A); 8 July 1965

Ready, J. F., "Effects of laser radiation", *Industrial Research* 7, pp. 44-50; Aug 1965

10.2 Welding

10.2.1 WELDING OF METALS

Sherman, R. A., "Microwelding and microdrilling with lasers", *Ann. N. Y. Acad. Sci.* 122, pp. 650-657; 28 May 1965

Miller, K. J., J. D. Nunnikhoven, "Laser welding", *Machine Design* 37, pg. 120; 5 Aug 1965

"Laser welding and machining", *Engineering Proceedings P-44*, 15 papers presented at the Engineering Seminar on New Industrial Technologies, Penn. State Univ.; 27 June to 2 July 1965

Schakleton, J. R., "Laser microwelding", *Semicon. Prod.* 8, pp. 15-19; May 1965

Schmidt, A. O., "An evaluation of laser performance in micro-welding", *Welding Journal* 44, pp. 481s-489s; Nov 1965

Anderson, J. E., and J. E. Jackson, "An evaluation of pulsed laser welding", *Proc. Electron and Laser Beam Symposium*, edited by A. B. El-Kareh, sponsored by Penn. State Univ. and Alloyed General Corp., pp. 17-50; 31 Mar - 2 Apr 1965

Rykalin, N. N., "Heating of thin sheets in laser welding", *DOKL. AKAD. NAUK SSSR* 165, pg. 319; 1965

Fairbanks, R. H., C. M. Adams, "Laser beam fusion welding", *Welding Journal* 43, pp. 97s-1020s; Mar 1964

Rykalin, N. N., Iu. L. Krasulin, "Estimation of energy parameters when metals are welded by a laser light flux", *Dokl. Akad. Nauk SSSR* 163, pp. 60-62; Jan 1965

10.2.2 WELDING OF MICROCIRCUITS

Rischall, H., "Laser welding of microelectronic interconnections", *IEEE Trans. on Comp. Parts CP-11*, pp. 145-151; June 1964

Price, T. E., "Laser welding of semiconductor integrated circuit interconnections", *Ind. Elec.* 2, pg. 478; Oct 1964

Osial, T. A., K. B. Steinbruegge, and P. S. Charf, "Laser welding of microcircuits", *Proc. Electron and Laser Beam Symposium*, edited by A. B. El-Kareh, sponsored by Penn. State Univ. and Alloyed General Corp., pp. 343-368; 31 Mar - 2 Apr 1965

Maas, P. A., "Laser beam welding electronic-component leads", *Welding Journal* 44, pp. 264s-269s; June 1965

Nichols, K. G., "Laser and microelectronics", *British Comm. and Electronics* 12, pg. 368; June 1965

Rykalin, N. N., A. A. Uglov, "Heating of thin sheets in laser welding", *Soviet Physics - Doklady* 10, pg. 1106; May 1966

10.3 Micromachining

Rothstein, J., "Some dynamic aspects of theoretical laser micromachining limitations", Proc. Nat. Elec. Conf. 19, pp. 554-563; 1963

Forbes, N. "Laser beam machining", Microelectronics and Reliability 4, pp. 105-108; Mar 1965

Kim, P. H., S. Namba, I. Ida, and S. Nakayama, "Laser beam micro-processing", Proc. Electron and Laser Beam Symposium, edited by A. B. El-Kareh, sponsored by Penn. State Univ. and Alloyd General Corp; 31 Mar - 2 Apr 1965

Boot, H. A. H., D. M. Clunie, and R. S. A. Thorn, "Micro-machining with a pulsed gas laser", Electronics Letters 2, pg. 1; Jan 1966

Murphy, R. J., and G. J. Ritter, "Laser-induced thermal etching of metal and semiconductor surfaces", Nature 210, pp. 191-192; 9 Apr 1966

10.4 Hole-Drilling

Williams, D. L., "The laser as a machine tool", Proc. Nat'l. Elec. Conf. 19, pp. 574-587; 1963

Norton, J., and J. McMullen, "Laser-formed apertures for electron beam instruments", J. Appl. Phys. 34, pp. 3640-3641; Dec 1963

Williams, D. L., "Laser - new competitor for drilling tiny holes", J. Soc. Auto. Eng. 72, pg. 61; May 1964

Adams, C. M. Jr., and G. A. Hardway, "Fundamentals of laser beam machining and drilling", IEEE Trans. on Industry and General Applications IGA-1, pp. 90-96; Mar-Apr 1965

Epperson, J. Phil, R. W. Dyer, and J. C. Graywa, "The laser now a production tool", Western Electric Engineer 10, pp. 2-9; Apr 1966

Mela, M. J., "Microperforation with laser beam in the preparation of microelectrodes", IEEE Trans. Bio-medical Eng. BME-13, pp. 70-76; Apr 1966

11.0 MISCELLANEOUS APPLICATIONS

Honig, A., "Cooling to very low temperatures by means of lasers", Bull. Am. Phys. Soc., Ser II, 8, pg. 233; Mar 1963

Gerhars, R., "Optical lattice filters from the wave field laser radiation", Proc. IEEE 51, pp. 862-863; May 1963

Hilsum, C., "Gallium arsenide semiconductor lamps", British Communication and Electronics 10, pp. 450-452; June 1963

Wandinger, I., and K. Kohn, "Laser-alloyed tunnel diodes for microwave applications", Proc. IEEE 51, pp. 938-939; June 1963

Smith, G. F., "Applications of lasers to instrumentation", *Inst. Soc. Am. Trans.* 3, pp. 353-365; Oct 1964

Anonymous, "Laser beam trims resistors", *Electronics* 37, pp. 46-47; 21 Feb 1964

Heckscher, H., "Contact printing with coherent light", *Photographic Sci. and Eng.* 8, pg. 260; Sept - Oct 1964

Anonymous, "Fiber optics and laser team-up to monitor HV current", *Power Engineering* 68, pg. 51; Dec 1964

Segre, J. P., "Use of lasers for microcircuit resistance trimming", *Proc. Nat'l Elec. Conf.* pp. 48-51; 1965

Smith, H. M., and A. F. Turner, "Vacuum deposited thin films using a ruby laser", *Appl. Opt.* 4, pp. 147-148; Jan 1965

Staerk, H., and G. Cserlindki, "Nanosecond heating of aqueous systems by giant laser pulses", *Nature* 205, pp. 63-64; 2 Jan 1965

Tanver, L. H., "Some applications of holography in fluid mechanics", *J. Sci. Inst.* 42, pp. 81-83; June 1965

Perry, E. R., "Laser measurement - describes how a laser is used to develop an optical signal proportional to current", *Instruments and Control Systems* 38, pg. 123; July 1965

Korff, S. A., "Lasers coherent light sources for science and industry: the Princeton report", *Am. J. Phys.* 33, pg. 859; Oct 1965

Pendleton, W. K., and A. H. Guenther, "Investigation of a laser triggered spark gap", *Rev. Sci. Inst.* 36, pp. 1546-1550; Nov 1965

Green, R. E. Jr., "Optical crystallographic orientation determination using a He-Ne laser", *Rev. Sci. Inst.* 36, pp. 1668-1669; Nov 1965

Rawson, E. G., and A. D. May, "Propulsion and angular stabilization of dust particles in a laser cavity", *Appl. Phys. Letters* 8, pp. 93-95; 18 Feb 1966

Saito, S., Y. Fujii, K. Yokoyama, and Y. Ono, "The laser current transformer for EHV power transmission lines", *IEEE J. Quant. Elec.* QE-2, pg. lix, Apr 1966 and pp. 255-259, Aug 1966

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13. ABSTRACT // This bibliography of laser applications contains 644 entries from the open literature for the period 1961 through September 1966. The entries are divided into the following major areas: mechanical measurements and standards; communications applications; radar and tracking applications; military applications; optical signal processing; interferometry and testing of optical components; applications to scientific studies; applications in chemistry; photographic applications; metalworking; and miscellaneous applications. The entries are further subdivided into 78 other categories. Applications in medical and biological research are not included; complete coverage in the other areas is not guaranteed. Under some topics (detection techniques, spectroscopy, interaction with acoustic waves, plasma diagnostics, nonlinear optics, gas breakdown, scattering, holography) so much has been published that only review articles, articles of major importance, and very recent articles could be included.		

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