



**LMSC PUBLISHED CONTRIBUTIONS
1967 IMPRINTS**

A Citation Bibliography

AD 666597

**COMPILED BY W. A. KOZUMPLIK
AND B. VALLEJO**

**FEBRUARY 1968
CB 68-2**



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**LOCKHEED MISSILES & SPACE COMPANY
A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION
SUNNYVALE, CALIFORNIA**

FOREWORD

This booklet lists the contributions published by Lockheed Missiles & Space Company authors during 1967 which had been deposited in our Technical Information Center by year-end. Also listed are several imprints of earlier years which were either received too late to be included in last years' compilation or never before deposited with the Technical Information Center.

Our purpose in issuing this work is to provide an indication of the Company's capabilities, as well as to offer a convenient reference to individual publications. All items listed have been catalogued by the Technical Information Center and may be consulted in its two libraries. Reprints of many of the journal articles are also available from the authors directly.

A handwritten signature in black ink, appearing to read 'L. E. Root', with a stylized flourish at the end.

L. E. Root, President
Lockheed Missiles & Space Company

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PHYSICAL SCIENCES

The work of the Physical Sciences Laboratory is concerned mainly with the following fields of endeavor: space physics, atomic physics, and nuclear physics. The area of interest for space physics research extends from the upper atmosphere outward including the ionosphere, the magnetosphere, the interplanetary medium, and finally the interstellar region of deep space. Another phase of space physics research is concerned with the Earth's magnetic field and its interaction with charged particles and neutral plasmas. Atomic physics research is concerned with such basic properties of the atom as energies of the excited states of particles, the probability of spontaneous transitions between levels, and the cross section for excitation both by photon absorption and by collision with other particles. The direct experimental investigation of the solar system space environment and opportunities to view deep space from beyond the Earth's atmosphere have focused attention on nuclear processes in geophysics and astrophysics and have revealed a space nuclear radiation effects problem of a most immediate and serious nature, the solution of which depends upon nuclear physics research. The vigor with which work in all these areas of research has been pursued in the Physical Sciences Laboratory is indicated by the following publications.

1. ACTON, L. W. (with H. Zirin), "Spectrographic Observations of the Flare of July 20, 1961," *Astrophys. J.*, 148, 501
_____ See 10
ALBER, R. A., See 36
2. ANDERSON, A. D., "Spherical Particle Terminal Velocities in the Martian Daytime Atmosphere From 0 to 50 Kilometers," *Geophys. Res.*, 72, 1951
_____ See 5
BAKKE, J. C., See 40
3. BECKER, J. A. (with L. F. Chase and R. E. McDonald), "Levels of Si²⁹ Below 4.1 MeV Excitation Energy," *Phys. Rev.*, 157, 967
_____ See 31
BURKE, P. G., See 37, 38
4. BUTTREY, D. E., "A Streak Spectrograph With Microsecond Resolution," *Appl. Optics*, 6, 881
CARR, D. L., See 39

- CHALMERS, R. A., See 11
- CHASE, L. F., See 3
- COOP, K. L., See 15, 16
- COOPER, J. W., See 37
5. DAVIDSON, G. T. (with A. D. Anderson), "Venus: Volcanic Eruptions May Cause Obscuration," Science, 156, 1729
 - DOWELL, J. T., See 44
 6. EVANS, J. E. (with E. G. Joki, R. G. Johnson, and R. D. Sharp), "Austral and Boreal Zone Precipitation Patterns for Low-Energy Protons," Space Research, VI, p. 773 (1966)
 7. _____ "Coordinated Experiments on Auroras," Symposium on Recent Advances in Cosmic Ray Research, p. 261 (1966)
 8. _____ (with R. G. Johnson, R. D. Sharp, and J. B. Reagan), "Recent Results From Satellite Measurements of Low-Energy Particles Precipitated at High Latitudes," Space Sci. Rev., 7, 263
 _____ See 25
 9. FISHER, P. C. (with P. Kirkpatrick), "Measurement of Stellar X-Ray Spectra," Astron. J., 71, 854 (1966)
 10. _____ (with W. C. Jordan, A. J. Meyerott, L. W. Acton, and D. T. Roethig), "X-Ray Spectra of Several Cosmic Sources," Astrophys. J., 147, 1209
 11. FOSSAN, D. B. (with R. A. Chalmers, S. R. Salisbury, and F. J. Vaughn), "Study of N^{16} by $N^{15} + n$ Total Cross-Section Measurement," Phys. Rev., 152, 980 (1966)
 12. FRASER-SMITH, A. C., "Simultaneity of Pc 3 Micropulsations at Conjugate Points," Proceedings, Conjugate Point Symposium, Vol. 2, p. 7-1
 13. GAINES, E. E., "The Penetrating Radiation Environment in Space," Science of Advanced Materials and Process Engineering Proceedings, Vol. 11, p. 9
 14. GRENCH, H. A., "Comments on Calculations of Fast Neutron Activation Cross Sections," J. Nucl. Energy, 21, 577
 15. _____ (with K. L. Coop and H. C. Menlove), "Fast Neutron Bombardment of Ni^{64} and the Decay of Fe^{61} ," Phys. Rev., 161, 1118
 16. _____ (with K. L. Coop, H. O. Menlove, and F. J. Vaughn), "A Study of the Spin Dependence of the Nuclear Level Density by Means of the $^{89}Y(n, \gamma)^{90g, 90m}Y$ Reactions With Fast Neutrons," Nucl. Phys., A94, 157

17. HART, P. J., Universal Tables for Magnetic Fields of Filamentary and Distributed Circular Currents (American Elsevier, Publishers)
- HUMPHREY, C. H., See 37
18. IMHOF, W. L. (with J. B. Reagan and R. V. Smith), "Long-Term Study of Electrons Trapped on Low L Shells," J. Geophys. Res., 72, 2371
19. JOHNSON, H. M. (with R. L. Minkowski), "Peculiar Nebula NGC 6302," Astron. J., 72, 312
20. _____ "The Peculiar Nebula NGC 6302," Astrophys. J., 148, 659
21. _____ (with H. Spinrad, B. J. Taylor, and M. Peimbert), "Photoelectric Scanner Spectrophotometry of SCO X-1," Astron. J., 72, 1352
22. _____ (with H. Spinrad, B. J. Taylor, and M. Peimbert), "Photoelectric Scanner Spectrophotometry of SCO X-1," Astrophys. J., 149, L45
23. _____ "Physical Characteristics of SCO X-1," Astrophys. J., 146, 960 (1966)
24. _____ "Physical Characteristics of SCO X-1: II," Astrophys. J., 147, 1213
25. JOHNSON, R. G. (with R. E. Meyerott and J. E. Evans), "Coordinated Satellite, Ground-Based, and Aircraft-Based Measurements on Auroras," NATO Advanced Study Institute "Aurora and Airglow" (Reinhold Publishing Corp.), p. 169 (1966)
- _____ See 6, 8, 43
26. JOHNSTON, R. R. (with B. H. Armstrong, P. S. Kelly, H. E. Dewitt, and S. G. Brush), "Opacity of High-Temperature Air," Progress in High Temperature Physics and Chemistry (Pergamon Press), Vol. I, p. 139 (1966)
- JOKI, E. G., See 6
- JORDAN, W. C., See 10
27. KELLY, P. S. (with M. Cohen), "Hartree-Fock Wave Functions for Excited States: II, Simplification of the Orbital Equations," Can. J. Phys., 44, 3227 (1966)
- _____ See 26
28. KNUDSEN, W. C. (with G. W. Sharp), "Ion Temperatures Measured Around a Dawn-Dusk Auroral-Zone Satellite Orbit," J. Geophys. Res., 72, 1061
29. _____ (with G. W. Sharp), "Molecular Ion Concentration Around a Dawn-Dusk Auroral-Zone Satellite Orbit," J. Geophys. Res., 72, 1941
30. KULANDER, J. L., "The Velocity-Dependent Non-LTE Source Function. I. Discontinuous Velocity - Semi-Infinite Atmosphere," Astrophys. J., 147, 1063
- McDANIEL, J. B., See 39

31. McDONALD, R. E. (with J. A. Becker), "Lifetime of the F^{21} 0.28 MeV Level," *Phys. Rev.*, 154, 1101
 _____ See 3
 MENLOVE, H. O., See 15, 16
 MEYEROTT, A. J., See 10
32. MOROZUMI, H. M., "Auroral-Zone Geophysical Events and Their Relationship to the Magnetosphere," Proceedings, Symposium on Pacific-Antarctic Sciences, p. 53
33. _____ "Diurnal Variation of Aurora Zone Geophysical Disturbances," Ionosphere and Space Research in Japan, Vol. 19, p. 286 (1965)
34. _____ "Examples of Positive Correlation Between VLF Chorus and CNA," Planet. & Space Sci., 15, 207
35. _____ "Sudden Decrease of VLF Chorus Intensity at the Time of SC and SI," Ionosphere and Space Research in Japan, Vol. 20, p. 326 (1966)
36. NOBLES, R. A. (with R. A. Alber, E. B. Hughes, L. L. Newkirk, and M. Walt), "Neutron Multiplicity Monitor Observations During 1965," *J. Geophys. Res.*, 72, 3817
 NEWKIRK, L. L., See 36
37. ORMONDE, S. (with C. H. Humphrey, J. W. Cooper, and P. G. Burke), "Autoionizing D States in He Below the $n = 2$ Level of He^+ ," *Proc. Phys. Soc.*, 91, 285
38. _____ (with P. G. Burke and W. Whitaker), "Threshold Behavior of the $n = 2$ Excitation Cross Section in Atomic Hydrogen," *Phys. Rev. Letters*, 17, 800 (1966)
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39. REAGAN, J. B. (with D. L. Carr, J. B. McDaniel, and T. C. Sanders), "Low-Energy Electron and Proton Satellite Instrumentation for Auroral Studies," *IEEE Trans.*, NS-14, 49
40. _____ (with R. D. Reed and J. C. Bakke), "A Versatile Satellite Data-Handling System for Space Radiation Measurements," *IEEE Trans.*, NS-14, 620
 _____ See 8, 18, 45
 REED, R. D., See 40
 ROETHIG, D. T., See 10
41. ROMICK, G. J. (with R. D. Sharp), "Simultaneous Measurements of an Incident Hydrogen Flux and the Resulting Hydrogen Balmer Alpha Emission in an Auroral Hydrogen Arc," *J. Geophys. Res.*, 72, 4791

42. ROSENBLUM, M., "Design Requirements of a Reactor-Rankine Power System for a Lunar-Base Mission," ASME, Advances in Energy Conversion Engineering, p. 689
- SALISBURY, S. R., See 11
- SANDERS, T. C., See 39, 45
43. SHARP, R. D. (with R. G. Johnson, M. F. Shea, and G. B. Shook), "Satellite Measurements of Precipitating Protons in the Auroral Zone," J. Geophys. Res., 72, 227
- SHARP, R. D., See 6, 8, 28, 29, 41
44. SHARP, T. E. (with J. T. Dowell), "isotope Effects in Dissociative Attachment of Electrons in Methane," J. Chem. Phys., 46, 1530
45. SHEA, M. F. (with G. B. Shook, J. B. Reagan, L. F. Smith, and T. C. Sanders), "Channel Multiplier Instrumentation for the Measurement of Low-Energy Auroral Particles," IEEE Trans., NS-14, 96
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- SHOOK, G. B., See 43, 45
- SMITH, L. F., See 45
- SMITH, R. V., See 18
46. TEPLEY, L. R., "Recent Investigations of Hydromagnetic Emissions: Part I, Experimental Observations," J. Geomag. & Geoelect., 18, 227 (1966)
- VAUGHN, F. J., See 11, 16
47. WALT, M., "Conference Summary," NATO Advanced Study Institute "Aurora and Airglow" (Reinhold Publishing Corp.), p. 651
48. _____ "Penetration of Electrons Into the Atmosphere," NATO Advanced Study Institute "Aurora and Airglow" (Reinhold Publishing Corp.), p. 287
- _____ See 36
49. WENTWORTH, R. C., "Recent Investigations of Hydromagnetic Emissions: Part II, Theoretical Interpretation," J. Geomag. & Geoelect., 18, 257 (1966)
50. WONG, H. (with D. Bershader), "Theoretical Equilibration Behind an Ionizing Shock," J. Fluid Mech., 26, 459 (1966)

AEROSPACE SCIENCES

Research within the Aerospace Sciences Laboratory covers such fields of endeavor as thermophysics, fluid mechanics, solid and analytical mechanics, mathematics, and astrodynamics. Thermal energy transfer, cryogenics, and thermal and atmospheric control of manual vehicles are subjects of immediate concern of thermophysics. Fluid mechanics research is oriented toward exploring the physics of planetary re-entry as well as investigating the characteristics of disturbed airflow environment around hypervelocity vehicles. The extreme constraints of reliability and weightsaving imposed upon aerospace vehicles make it imperative that the analytical prediction of their mechanical response, such as stresses, deformations, and failure mode be as realistic as possible. Solid and analytical mechanics solves these problems through research in both their theoretical and experimental phases. Current research in mathematics at LMSC covers statistics, numerical analysis, and differential equations. The astrodynamics research deals with flight performance, navigation, guidance, and the development of new tools and techniques for solving astrodynamical problems. The following list of open-literature publications may be taken as a measure of the depth of research conducted by the Aerospace Sciences Laboratory.

- ANDREW, A., See 79
- ANDREWS, J. C., See 90
51. BILLIK, M., "Idempot Reynolds Operators," *J. Math. Anal. & Applications*, 18, 135
52. BREAKWELL, J. V. (with H. E. Rauch), "Asymptotic Matching in Power-Limited Interplanetary Transfers," Space Flight Mechanics Specialists Conference, p. 291
- BREUCH, R. A., See 63
53. BROWNE, M. E. (with W. I. Dobrov), "Magnetic Resonance Absorption of Hypersonic Waves in Paramagnetic Crystals," International Conference on Magnetism and Crystallography, p. 469 (1961)
- _____ See 76
54. BURNS, A. B., "Optimum, Axially Compressed, Foam-Core Sandwich Cylinders," *J. Spacecraft & Rockets*, 3, 1557 (1966)
55. _____ "Optimum Cylinders With Contrasting Materials and Various Ring/Stringer Configurations," *J. Spacecraft & Rockets*, 4, 375
- _____ See 88, 157

56. BUSHNELL, D., "Bifurcation Phenomena in Spherical Shells Under Concentrated and Ring Loads," AIAA J., 5, 2034
57. _____ "Buckling of Spherical Shells Ring-Supported at the Edges," AIAA J., 5, 2041
58. _____ "Machine Computation of Trigonometric Expansions," J. Eng. Mech. ASCE, 92, 157 (1966)
59. _____ "Nonlinear Axisymmetric Behavior of Shells of Revolution," AIAA J., 5, 432
60. _____ "Symmetric and Nonsymmetric Buckling of Finitely Deformed Eccentrically Stiffened Shells of Revolution," AIAA J., 5, 1455
61. CLINE, G. B. (with W. E. Jahsman), "Response of a Rigid-Plastic Ring to Impulse Loading," J. Appl. Mech., 34, 329
62. DAVIS, W. R., "Drag Make-Up Sensor for Low-Altitude Satellites," First Aerospace Mechanisms Symposium, p. 91 (1966)
- DOBROV, W. I., See 53
63. DOUGLAS, N. J. (with R. A. Breuch, M. McCargo, and R. E. Starkey), "Solar Wind-Plus-Ultraviolet Exposure Studies on Spacecraft Thermal Coatings Using In-Situ Optical Property Measurement Techniques," ASTM, IES, AIAA Space Simulation Conference, p. 110
- _____ See 74
64. FORSBERG, K. (with S. K. Ferriera), "Computer Graphics - A Powerful Tool for the Structural Dynamicist," AIAA ASME 8th Structures, Structural Dynamics and Materials Conference, p. 413
65. _____ with W. Flügge, "Point Load on a Shallow Elliptic Paraboloid," J. Appl. Mech., 33, 575 (1966)
66. FRYE, W. E., "Analysis of a Satellite Angle-of-Attack Sensor," First Aerospace Mechanisms Symposium, p. 277 (1966)
- GREENBERG, S. A., See 91
67. HANSEN, E. R. (with R. R. Smith), "Interval Arithmetic in Matrix Computation. Part II," SIAM. J. Num. Anal., 4, 1
68. HOFFMAN, O., "The Brittle Strength of Orthotropic Materials," J. Comp. Mats., 1, 200
69. HOSHIZAKI, H. (with K. H. Wilson), "Convective and Radiative Heat Transfer During Superorbital Entry." AIAA J., 5, 25
- JAHSMAN, W. E., See 61
70. LASHER, L. E. (with K. H. Wilson and G. Greif), "Radiation From an Isothermal Hydrogen Plasma at Temperatures Up to 40,000 Degrees K," JSRT, 7, 305

71. LIU, D. T. (with E. H. Lee), "Finite-Strain Elastic-Plastic Theory With Application to Plane-Wave Analysis," *J. Appl. Phys.*, 38, 19
McCARGO, M., See 63
72. MARK, R. M., "On the Theory of Asymmetric Shear Flows Past Flat Plates," *J. Fluid Mech.*, 25, 475 (1966)
73. MARLOW, W. C., "Hakenmethode," *Appl. Optics*, 6, 1715
74. MARSHALL, K. N. (with N. J. Douglas, H. F. Pollard, and R. E. Rolling), "Laboratory and Flight Test Program to Evaluate the Space Stability of Highly Specular Reflective Surfaces," *J. Spacecraft & Rockets*, 4, 912

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MASSARD, J. M., See 87
75. MILLER, E., "Erosive Burning of Composite Solid Propellants," *Combustion and Flame*, 10, 330 (1966)
76. OTTENBERG, A. (with M. E. Browne), "Anomalous Behavior of the Resistivity of Some Donor-Acceptor Complexes," *J. Polymer Sci., Part C*, 17, 135
77. PERKO, L. M., "A Method of Error Estimation in Singular Perturbation Problems With Application to the Restricted Three Body Problem," *SIAM J. Appl. Math.*, 15, 738
POLLARD, H. E., See 74
78. PRICE, D. A., Jr., "Sources, Mechanisms, and Control of Roll Resonance Phenomena for Sounding Rockets," *J. Spacecraft & Rockets*, 4, 1516
79. RAUCH, J. E. (with A. Andrew), "Breakdown of Dielectrics Due to Pulsed Electrons," *IEEE Trans.*, NS-13, 109 (1966)

See 52
80. ROLLING, R. E., "Measurement of the Thermal Radiation Properties of Materials," *Instrument Society of America 22nd Annual Conference*, p. 1
81. _____ (with J. P. Kirkpatrick and K. N. Marshall), "Thermal Testing Techniques at High Solar Intensities," *ASTM, IES, AIAA Space Simulation Conference*, p. 141
82. _____ (with C. L. Tien), "Total Specular Reflectance of Rough Metallic Surfaces," *J. Spacecraft & Rockets*, 3, 1719 (1966)

See 74
83. ROSENBAUM, R., "A Combination Numerical-Analytical Approach to Ascent Trajectory Optimization," *Space Flight Mechanics Specialist Conference*, p. 243
84. SCHWIND, R. G. (with R. S. Scotti and C. J. Skogh), "Analysis of Flexible Baffles for Damping Tank Sloshing," *J. Spacecraft & Rockets*, 4, 47

85. SKLENSKY, A. F. (with J. H. Anderson and K. A. Wickersheim), "Method for Obtaining Improved Diffuse Reflectance Spectra in the Near Infrared," Appl. Spectroscopy, 21, 339
- SKOGH, C. J., See 84
- SMITH, R. R., See 67
86. SOBEL, L. H. (with W. Flugge), "Stability of Toroidal Shells Under Uniform External Pressure," AIAA J., 5, 425
87. TSUI, E. Y. (with J. M. Massard), "Bending Behavior of Toroidal Shells," Proceedings, ASCE Engineering Mechanics Specialty Conference, p. 85 (1966)
88. _____ (with A. B. Burns), "Optimum Thickness Transitions for Cylindrical Pressure Vessels With Hemispherical Heads," J. Spacecraft & Rockets, 4, 716
- WILSON, K. H., See 69, 70
89. WONG, H., "Radiative Behavior of a Shock-Heated Argon Plasma Flow," J. Plasma Phys., 1, 157
90. WOOD, A. D. (with J. C. Andrews), "Fast Response Total Thermal Radiation Detectors," IEEE Trans., AES-3, 356

MATERIALS SCIENCES

The research efforts of the Materials Sciences Laboratory are concentrated in two areas: metallurgy-ceramics and chemistry. The significant engineering properties of materials depend uniquely on their structure. Physical properties of the metals, alloys, and ceramics, including the ability to deform plastically and to cohere as solids are strongly influenced by both the type and spatial arrangement of the atoms that comprise the material. Since the interrelation between structure and properties is basic to both metals and ceramics, the Materials Sciences Laboratory undertakes experimental and theoretical investigations that are concerned with phase equilibria and transformations, diffusion kinetics, plastic deformation, fracture phenomena, and surface effects on mechanical properties, as well as with the general role of impurities in crystalline imperfections and substructure in determining material characteristics. The chemistry research at LMSC has three facets: organic chemistry - ranging from the synthesis of new polymers, adhesives and high-energy chemicals to kinetic studies hot-atom chemistry; surface chemistry - dealing with chemical effects at the solid-gas and solid-liquid interfaces; general chemistry - involving principally fuel cells. The following open-literature publications indicate the extent of the research conducted by the Materials Sciences Laboratory.

- ADAMS, G. B., See 91
91. ANDERSON, L. B. (with S. A. Greenberg and G. B. Adams), "Thermally and Photochemically Regenerative Electrochemical Systems," Regenerative EMF Cells (American Chemical Society). p. 213
- ALLEN, G. W., See 97, 109
92. BOTOSAN, R. A. (with T. Katan). "Electroformed Fuel Cell Electrode Matrices," Electrochemical Technology, 5, 315
- ELLIOT, A. G., See 98
93. HERMAN, F., "Atomic Structure " An Atomistic Approach to the Nature and Properties of Materials (John Wiley & Sons), p. 7
94. _____ (with R. L. Kortum, C. D. Kuglin, and R. A. Short), "New Studies of the Band Structure of Silicon, Germanium, and Grey Tin," Quantum Theory of Atoms, Molecules, and the Solid State (Academic Press), p. 381 (1966)
95. _____ (with R. L. Kortum, C. D. Kuglin, and R. A. Short), "New Studies of the Bond Structure of the Diamond-Type Crystals," International Conference on the Physics of Semiconductors, p. 7 (1966)

96. _____ (with J. L. Shay and W. E. Spicer), "Photoemission Study of the Electronic Structures of CdTe," *Phys. Rev. Letters*, 18, 649
97. KATAN, T. (with G. W. Allen), "Vapor Pressure of Liquids by Measurement of Flow Induced Through Microporous Media," *J. Chem. Phys.*, 47, 1868
- _____ See 92
- KORTUM, R. L., See 94, 95
- KUGLIN, C. D., See 94, 95
98. LAVENDEL, H. W. (with A. G. Elliot), "Evaluation of Silicide Coatings on Columbium and Tantalum and a Means for Improving Their Oxidation Resistance," *Trans. Metallurg. Soc. AIME*, 239, 143
- LEVY, D. J., See 99
- MISSEL, L., See 105, 279
- MITCHELL, M. J., See 104
99. MOMYER, W. R. (with D. J. Levy), "Aerosol Copper Plating at Ambient Temperature," *Electrochemical Technology*, 5, 293
100. PACKER, C. M. (with O. D. Sherby), "An Interpretation of the Superplasticity Phenomenon in Two-Phase Alloys," *ASM Trans. Quarterly*, 60, 21
101. RITTENHOUSE, J. B., "The Performance of Unmanned Spacecraft in Space," *Fourth Space Congress*, 6, 7
- ROBINSON, J. C., See 104
102. ROWCLIFFE, D. J. (with A. Kelly), "Deformation of Polycrystalline Transition Metal Carbides," *J. Am. Cer. Soc.*, 50, 253
- SHORT, R. A., See 94, 95
103. SINGLETARY, J. B., "The Effects of Space Environment on Spacecraft Reliability," *Annual Symposium on Reliability*, p. 305
104. SOBON, L. E. (with K. A. Wickersheim, J. C. Robinson, and M. J. Mitchell), "Lead Contamination of Flux-Grown Garnets and the Effect on Optical Properties," *J. Appl. Phys.*, 38, 1021
105. TITUS, R. K. (with L. Missel), "Plating of Beryllium for Brazing," *Metal Finishing*, 65, 59
106. YUE, A. S., "Analytical Applications of Fractional Solidification," *Fractional Solidification* (Marcel Dekker, Publishers), p. 547
107. _____ "Decanted Interface Morphology of Dilute Al-Fe Alloys," *International Conference on Crystal Growth*, p. 197

ELECTRONIC SCIENCES

The chief research areas of the Electronic Sciences Laboratory are physical electronics, solid state physics, and information sciences. Understanding the elements of electronic and molecular structure and the collisions of electrons, ions, and excited molecules with atoms, molecules, and surfaces is within the domain of physical electronics. Solid state physics is generally concerned with a microscopic or atomistic approach to such topics as super-conductivity, ferroelectricity, intermetallic and organic semiconductors, ferromagnetism, rare earth crystals and phosphors, and solid state lasers. The information sciences encompass the disciplines falling within the broad spectrum of activity that relates to information transmission, processing, and display including the topics of communications and computers. The following list of 1967 open-literature publications indicates the extent of the research done in the Electronic Sciences Laboratory.

- ANDERSON, J. H. , See 85
- BAILEY, H. N. , See 143
108. BROWN, A. E. (with H. K. Hopkins), "Interaction of the Auditory and Visual Sensory Modalities," J. Acoust. Soc. Am., 41, 1
109. _____ (with G. W. Allen), "Ultrasonic Flow Measurement," Instruments and Control Systems, 40, 130
110. BUCHANAN, R. A. (with K. A. Wickersheim, J. J. Pearson, and G. F. Herrmann), "Energy Levels of Yb³ in Gallium and Aluminum Garnets: I. Spectra," Phys. Rev., 159, 245
_____ See 135, 149
111. COMSTOCK, R. L. (with N. Kusnezov), "Magnetoelastic-Elastic Wave Scattering," J. Appl. Phys., 38, 3740
112. _____ (with J. J. Raymond), "Magnetostriction of Ytterbium and Cerium in YIG," J. Appl. Phys., 38, 3737
113. _____ (with B. A. Auld), "Parametric Coupling Between Modes of Propagation in Nonconservative Systems," IEEE Proc., 55, 532
- CUFF, K. F. , See 118
114. CULSHAW, W. (with J. Kannelaud), "Mode Interaction in a Zeeman Laser," Phys. Rev., 156, 308
_____ See 128

115. DOBROV, W. I., "Magnetic Absorption of Ultrasonics in Yttrium Gallium Garnet," *Phys. Letters*, 24A, 501
116. EARL, L. L., "Structural Definition of Affixes From Multisyllable Words," *Mechanical Translation and Computational Linguistics*, 9, 34 (1966)
117. _____ "Part-of-Speech Implications of Affixes," *Mechanical Translation and Computational Linguistics*, 9, 38 (1966)
118. ELLETT, M. R. (with R. B. Horst, L. R. Williams, and K. F. Cuff), "Shubnikov-de Haas Investigations of the $\text{Bi}_{1-x}\text{Sb}_x$ ($0 < x < 0.3$) System," *International Conference on the Physics of Semiconductors*, p. 666 (1966)
119. EPPLER, W. G. (with R. W. Angel), "Synergy of Contralateral Muscles in Normal Subjects and Patients With Neurologic Disease," *Archives of Physical Medicine and Rehabilitation*, 40, 233
- GIELOW, K. R., See 196
120. GOLDEN, D. E., "Comparison of Low-Energy Total and Momentum Transfer Scattering Cross Sections for Electrons on Helium and Argon," *Phys. Rev.*, 151, 48 (1966)
121. HALPERN, M., "Foundations of the Case for Natural Language Programming," *IEEE Spectrum*, 4, 140
- HAMAMOTO, A. S., See 130
122. HANCE, H. V. (with J. K. Parks and C. S. Tsai), "Optical Imaging of a Complex Ultrasonic Field by Diffraction of a Laser Beam," *J. Appl. Phys.*, 38, 1981
- HARSHMAN, J. H., See 123
123. HAWKINS, S. R. (with J. H. Harshman), "Lightweight 50 kG Superconducting Magnet System for Optical Research Instrumentation," *Rev. Sci. Instr.*, 38, 50
124. HERRMANN, G. F. (with R. M. Hill and D. E. Kaplan), "Cyclotron Echoes in Plasmas," *Phys. Rev.*, 156, 118
- _____ See 110, 125, 134, 135
125. HILL, R. M. (with D. E. Kaplan, G. F. Herrmann, and S. K. Ichiki), "Emission Microwave Spectroscopy: OCS," *Phys. Rev. Letters*, 18, 105
126. _____ (with D. E. Kaplan and S. K. Ichiki), "Stimulated Emission From the Upper-Hybrid Resonance in Magnetoplasma," *Phys. Rev. Letters*, 19, 154
- _____ See 124
- HORST, R. B., See 118
127. HU, S. T., Threshold Logic (University of California Press) (1965)
- ICHIKI, S. K., See 125, 126

128. KANNELAUD, J. (with D. G. Peterson and W. Culshaw), "Frequency Stabilization of the Zeeman Laser," *Appl. Phys. Letters*, 10, 94
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Parallel to the main concentration of system-oriented activity, is a necessary effort in advanced technology which seeks to translate research findings or engineering innovations into practical techniques for missiles, spacecraft, and diversified applications. The 1967 contributions to the open literature reflect this scope of engineering activity and concentration of emphasis.

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STATISTICAL SUMMARY

During 1967, LMSC authors deposited 296 published contributions in the Technical Information Center. Several works were published prior to 1967 but were never deposited heretofore; these are listed. On the other hand, 1967 imprints not received by year end as this booklet goes to press will be listed in next year's booklet.

These publications are statistically summarized here in three categories: publishing medium, funding source, and initiating organization.

Category	1967	1966	1965	1964
Publishing Medium				
Journals and Society Transactions	202	181	239	198
Symposium or Conference Proceedings	71	19	54	74
Chapters in Books	17	32	34	0
Books	6	5	4	7
Total	296	237	331	279
Funding Source				
IR/ID*	48	49	65	47
Contract	43	34	55	49
IR/Contract	32	22	28	24
Grant	1	3	1	1
Not Stated	172	129	182	158
Total	296	237	331	279
Initiating Organization				
President's Office	0	0	1	2
Administration	3	3	4	2
Operations	11	1	5	0
R&D	240	219	300	246
SSD	28	10	13	14
MSD	14	4	8	15
Total	296	237	331	279

*IR/ID - Independent Research/Independent Development programs sponsored by Lockheed.