

AIAA

Progress in Astronautics and Aeronautics Series

Volumes 50-57, published in 1977, are indexed in this issue of the Combined Index

Prices and descriptions of Volumes 24-57 are given below. For information on Volumes 1-23 and on forthcoming volumes, write to AIAA Special Publications Department, 1290 Avenue of the Americas, New York, New York 10019

SPACE-BASED MANUFACTURING FROM NONTERRESTRIAL MATERIALS

v. 57

Editor: Gerard K. O'Neill, Assistant Editor: Brian O'Leary

Some of the most important engineering problems are dealt with in this book in a series of papers derived from a NASA-sponsored study organized by Prof. Gerard K. O'Neill: how to gather material resources from the nearby moon or nearby asteroids, how to convert the materials chemically and physically to useful forms, how to construct such gigantic space structures, and necessarily, how to plan and finance so vast a program.

192 pp., 6x9, illus., \$15.00 Member \$23.00 List

THERMOPHYSICS OF SPACECRAFT AND OUTER PLANET ENTRY PROBES

v. 56

Edited by Allie M. Smith, ARO, Inc., Arnold Air Force Station, Tennessee

Stimulated by the ever-advancing challenge of space technology in the past 20 years, the science of thermophysics has grown dramatically in content and technical sophistication. The practical goals are to solve problems of heat transfer and temperature control, but the reach of the field is well beyond the conventional subject of heat transfer. As the name implies, the advances in the subject have demanded detailed studies of the underlying physics, including such topics as the processes of radiation, reflection and absorption, the radiation transfer with material, contact phenomena affecting thermal resistance, energy exchange, deep cryogenic temperature, and so forth. This volume is intended to bring the most recent progress in these fields to the attention of the

physical scientist as well as to the heat-transfer engineer.

467 pp., 6x9, illus., \$20.00 Member \$40.00 List

SATELLITE COMMUNICATIONS: FUTURE SYSTEMS

v. 54

SATELLITE COMMUNICATIONS: ADVANCED TECHNOLOGIES

v. 55

Edited by David Jarett, TRW, Inc.

Volume 54 and its companion, Volume 55, provide a comprehensive treatment of the satellite communication systems that are expected to be operational in the 1980's and of the technologies that will make these new systems possible. Cost effectiveness is emphasized in each volume, along with the technical content.

Volume 54 on future systems contains authoritative papers on future communication satellite systems in each of the following four classes: North American Domestic Systems, Intelsat Systems, National and Regional Systems, and Defense Systems. A significant part of the material has never been published before.

Volume 55 on advanced technologies presents a series of new and relevant papers on advanced spacecraft engineering mechanics, representing advances in the state of the art. It includes new and improved spacecraft attitude control subsystems, spacecraft electric power, propulsion subsystems, spacecraft antennas, spacecraft RF subsystems, and new earth station technologies.

Volume 54—541 pp., 6x9, illus., \$19.00 Member \$35.00 List

Volume 55—489 pp., 6x9, illus., \$19.00 Member \$35.00 List

Two-Volume Set (Vol. 54 & 55) \$55.00 Mem. & List

EXPERIMENTAL DIAGNOSTICS IN GAS PHASE COMBUSTION SYSTEMS

v. 53

Editor: Ben T. Zinn; Associate Editors: Craig T. Bowman, Daniel L. Hartley, Edward Price, and James F. Skifstad

Our scientific understanding of combustion systems has progressed in the past only as rapidly as penetrating experimental techniques were discovered to clarify the details of the elemental processes of such systems. Modern problems in combustion are not simple ones, and they involve much more than chemistry. The important problems of today often involve nonsteady phenomena, diffusional processes among initially unmixed reactants, and heterogeneous solid-liquid-gas reactions. To clarify the innermost details of such complex systems required the development of new experimental tools. The diagnostic methods described in this volume were largely undeveloped a decade ago. These powerful methods make possible a far deeper understanding of the complex processes of combustion than we had thought possible only a short time ago. This book has been planned as a means of disseminating to a wide audience of research and development engineers the techniques that had heretofore been known mainly to specialists.

671 pp., 6x9, illus., \$20.00 Member \$37.00 List

MATERIALS SCIENCES IN SPACE WITH APPLICATIONS TO SPACE PROCESSING

v. 52

Edited by Leo Steg

The newly acquired ability of man to project scientific instruments into space and to place himself on orbital and lunar spacecraft to spend long periods in extraterrestrial space has brought a vastly enlarged scope to many fields of science and technology. Revolutionary advances have been made as a direct result of our new space technology in astrophysics, ecology, meteorology, communications, resource planning, etc. Another field that may well acquire new dimensions as a result of space technology is that of materials science and materials processing. The environment of space is very much different from that on Earth, a fact that raises the possibility of creating materials with novel properties and perhaps exceptionally valuable uses. This book is a pioneer collection of papers describing the first efforts in this new and exciting field.

564 pp., 6x9, illus., \$20.00 Member \$35.00 List

RAREFIED GAS DYNAMICS: PART I AND PART II

v. 51

Edited by J. Leith Potter

Research on phenomena in rarefied gases supports many diverse fields of science and technology, with new applications continually emerging in hitherto unexpected areas.

Recently, aerodynamics concerned with forces on high-altitude aircraft, and on spacecraft flying in the fringes of the atmosphere, became deeply involved

in the application of fundamental kinetic theory to aerodynamics as an engineering discipline. Then, as this particular branch of rarefied gas dynamics reached its maturity, new fields again opened up.

This two-volume set offers important papers in a wide variety of fields of rarefied gas dynamics, each providing insight into a significant phase of research.

Volume 51 sold only as a two-volume set

Part I—658 pp., 6x9, illus.

Part II—679 pp., 6x9, illus.

\$37.50 Mem. \$70.00 List

EXPLORATION OF THE OUTER SOLAR SYSTEM

v. 50

Edited by Eugene W. Greenstadt, Murray Dryer and Devrie S. Intriligator

This volume of the AIAA Progress in Astronautics and Aeronautics series offers a collection of original articles on the first results of outer solar system exploration. It encompasses three distinct field of inquiry: the major planets and satellites beyond Mars, comets entering the solar system, and the interplanetary medium containing mainly the particle emanations from the Sun.

251 pp., 6x9 illus., \$15.00 Mem. \$24.00 List

RADIATIVE TRANSFER AND THERMAL CONTROL

v. 49

Edited by Allie M. Smith, ARO, Inc., Arnold Air Force Station, Tennessee

This volume is concerned with the mechanisms of heat transfer, a subject that is regarded as classical in the field of engineering. Problems of radiative transfer in empty space, conductance and contact resistances among conductors within a spacecraft, gaseous radiation in complex environments, interactions with solar radiation, the physical properties of materials under space conditions, and the novel characteristics of that rather special device, the heat pipe—all of these are the subject of this volume.

569 pp., 6x9, illus., \$19.00 Mem. \$40.00 List

SCIENTIFIC INVESTIGATIONS ON THE SKYLAB SATELLITE

v. 48

Edited by Marion I. Kent and Ernst Stuhlinger, NASA George C. Marshall Space Flight Center; Shi-Tsan Wu, the University of Alabama

The papers published in this volume represent much of what was accomplished on Skylab. They will provide the stimulus for many future programs to be conducted by means of the Space Shuttle, which will be able eventually to ferry experimenters and laboratory apparatus into near and far orbits on a routine basis.

The papers in this volume also describe work done in solar physics; in observations of comets, stars, and Earth's airglow; and in direct observations of

planet Earth. They also describe some initial attempts to develop novel processes and novel materials, a field of work that is being called space processing or space manufacturing.

552 pp., 6x9, illus., plus 8 pages of color plates,
\$19.00 Mem. \$45.00 List

SPACECRAFT CHARGING BY MAGNETOSPHERIC PLASMAS

v. 47

Edited by Alan Rosen, TRW, Inc.

Spacecraft charging by magnetospheric plasma is a recently identified space hazard that can virtually destroy a spacecraft in Earth orbit or a space probe in extra terrestrial flight by leading to sudden high-current electrical discharges during flight.

The problem of eliminating this type of hazard has prompted the development of a specialized field of research into the possible interactions between a spacecraft and the charged planetary and interplanetary mediums through which its path takes it.

The results of this research have a bearing on diverse fields of physics and astrophysics, as well as on the engineering design of spacecraft.

304 pp., 6x9, illus., \$16.00 Mem. \$28.00 List

AEROACOUSTICS: JET NOISE, COMBUSTION AND CORE ENGINE NOISE

v.43

AEROACOUSTICS: FAN NOISE AND CONTROL; DUCT ACOUSTICS; ROTOR NOISE

v.44

AEROACOUSTICS: STOL NOISE; AIRFRAME AND AIRFOIL NOISE

v.45

AEROACOUSTICS: ACOUSTIC WAVE PROPAGATION; AIRCRAFT NOISE PREDICTION; AEROACOUSTIC INSTRUMENTATION

v.46

*Edited by Ira R. Schwartz, NASA Ames Research Center,
Henry T. Nagamatsu, General Electric Research and
Development Center,
and Warren C. Strahle, Georgia Institute of Technology*

The demands placed upon today's air transportation systems, in the United States and around the world, have dictated the construction and use of larger and faster aircraft. At the same time, the population density around airports has been steadily increasing causing a rising protest against the noise levels generated by the high-frequency traffic at the major centers. The modern field of aeroacoustics research is the direct result of public concern about airport noise.

Today there is need for organized information at the research and development level to make it possible for today's scientists and engineers to cope with today's environmental demands. It is to fulfill both these functions that the present set of books on aeroacoustics has been published.

The technical papers in this four-book set are an outgrowth of the Second International Symposium on Aeroacoustics held in 1975 and later updated and revised and organized into the four volumes listed above. Each volume was planned as a unit, so that potential users would be able to find within a single volume the papers pertaining to their special interest.

Volume 43—613 pp. 6x9 illus.

\$19.00 Member \$40.00 List

Volume 44—635 pp. 6x9 illus.

\$19.00 Member \$40.00 List

Volume 45—445 pp. 6x9 illus.

\$18.00 Member \$33.00 List

Volume 46—307 pp. 6x9 illus.

\$16.00 Member \$28.00 List

Four—Volume Set (Vols. 43-46)

\$65.00 Member \$125.00 List

COMMUNICATION SATELLITE DEVELOPMENTS: TECHNOLOGY

v. 41

This volume has been published simultaneously with its companion,

COMMUNICATION SATELLITE DEVELOPMENTS: SYSTEMS

v. 42

*Edited by William G. Schmidt, CML Satellite Corp., and
Gilbert E. LaVean, Defense Communications Agency*

The AIAA 5th Communications Satellite Systems Conference was organized with a greater emphasis on the overall system aspects of communication satellites. This emphasis resulted in introducing sessions on U.S. national and foreign telecommunication policy, spectrum utilization, and geopolitical/economic/national requirements, in addition to the usual sessions on technology and system applications. This was considered essential because, as the communications satellite industry continues to mature during the next decade, especially with its new role in U.S. domestic communications, it must assume an even more productive and responsible role in the world community. Therefore, the professional systems engineer must develop an ever-increasing awareness of the world environment, the most likely needs to be satisfied by communication satellites, and the geopolitical constraints that will determine the acceptance of this capability and the ultimate success of the technology. The papers from the Conference are organized into two volumes of the AIAA Progress in Astronautics and Aeronautics series; the first book (Volume 41) emphasizes the system aspects, and the second book (Volume 42) highlights recent technological innovations.

The systematic coverage provided by this two-volume set will serve on the one hand to expose the reader new to the field to a comprehensive coverage of communications satellite systems and technology, and on the other hand to provide also a valuable reference source for the professional satellite communication systems engineer.

v.41 - Communication Satellite Developments: Systems \$19.00 Mem. \$35.00 List

v.42 - Communication Satellite Developments: Technology \$19.00 Mem. \$35.00 List

For volumes 41 & 42 purchased as a two-volume set: \$35.00 Mem. \$55.00 List

v. 41, 334 pp., 6×9, illus.

v.42, 419 pp., 6×9, illus.

AERODYNAMICS OF BASE COMBUSTION

v.40

Edited by S.N.B. Murthy, J.R. Osborn, Purdue University, A.W. Barrows and J.R. Ward, Ballistics Research Laboratories

The various aspects of base flow control through injection and combustion in the base region are presented in this volume. The first paper in this volume is an extensive review of the fluid-mechanical literature on wakes and base flows, which may serve as a guide to the reader in his study of this aspect of the base pressure control problem. This book deals with both base and external combustion under small and large injection conditions.

Other papers include Base Flow Phenomena with and without Injection; Experimental Results, Theories, and Bibliography; Component Analysis and Synthesis for Fully Separated Flows with Special Consideration of Base Drag Reduction Combustion; A Discussion of Transonic Base Flows in the Presence of a Propulsive Jet; Development of Fumers for Small Caliber Ammunition; etc.

For the study of metal combustion, the reader is referred especially to the two previous volumes in the series: Volume 1, Solid Propellant Rocket Research, and Volume 15, Heterogeneous Combustion.

522 pp., 6×9, illus. \$19.00 Mem. \$35.00 List

HEAT TRANSFER WITH THERMAL CONTROL APPLICATIONS

v. 39

Edited by M. Michæl Yovanovich, University of Waterloo

This volume is concerned with the application of principles of heat transfer to one of the most complex engineering tasks in environmental control, the maintenance of thermal equilibrium in an isolated spacecraft thermal control system have necessitated a wide expansion of knowledge in fields such as surface emission and absorption characteristics, radiative exchange in complicated geometries, thermal contact resistance conduction in heterogeneous media, heat pipe phenomena, etc. The knowledge thus developed in the field of heat transfer, stimulated by the special requirements of spacecraft thermal balance and control, is directly applicable to many other engineering heat transfer projects. The book is recommended, therefore, to the broad community of heat transfer engineers as well as to the more specialized engineering community.

409 pp., 6×9, illus. \$19.00 Mem. \$35.00 List

AEROACOUSTICS: FAN, STOL, AND BOUNDARY LAYER NOISE; SONIC BOOM; AEROACOUSTIC INSTRUMENTATION v. 38

Edited by Henry T. Nagamatsu, General Electric Research and Development Center; Jack V. O'Keefe, The Boeing Company; and Ira R. Schwartz, NASA Ames Development Center

A companion to Aeroacoustics: Jet and Combustion Noise; Duct Acoustics, volume 37 in the series.

Twenty-nine papers, with summaries of panel discussions, comprise this volume, covering fan noise, STOL and rotor noise, acoustics of boundary layers and structural response, broadband noise generation, airfoil-wake interactions, blade spacing, supersonic fan, and inlet geometry. Studies of STOL and rotor noise cover mechanisms and prediction, suppression, spectral trends, and an engine-over-the-wing concept. Structural phenomena include panel response, high-temperature fatigue, and reentry vehicle loads, and boundary layer studies examine attached and separated turbulent pressure fluctuations, supersonic and hypersonic.

Sonic boom studies examine high-altitude overpressure, space shuttle boom, a low-boom supersonic transport, shock wave distortion, nonlinear acoustics, and far-field effects. Instrumentation includes a directional microphone, jet flow source location, various sensors, shear flow measurement, laser velocimeters, and comparisons of wind tunnel and flight test data.

509 pp. 6 x 9, illus. \$19.00 Mem. \$30.00 List

AEROACOUSTICS: JET AND COMBUSTION NOISE; DUCT ACOUSTICS v. 37

Edited by Henry T. Nagamatsu, General Electric Research and Development Center; Jack V. O'Keefe, The Boeing Company; and Ira R. Schwartz, NASA Ames Research Center

A companion to Aeroacoustics: Fan, STOL, and Boundary Layer Noise; Sonic Boom; Aeroacoustic Instrumentation, volume 38 in the series.

This volume includes twenty-eight papers covering jet noise, combustion and core engine noise, and duct acoustics, with summaries of panel discussions. The papers on jet noise include theory and applications, jet noise formulation, sound distribution, acoustic radiation refraction, temperature effects, jets and suppressor characteristics, jets as acoustic shields, and acoustics of swirling jets.

Papers on combustion and core-generated noise cover both theory and practice, examining ducted combustion, open flames, and some early results of core noise studies.

Studies of duct acoustics discuss cross section variations and sheared flow, radiation in and from lined shear flow, helical flow interactions, emission from aircraft ducts, plane wave propagation in a variable area duct, nozzle wave propagation, mean flow in a lined duct, nonuniform waveguide propagation, flow noise in turbofans, annular duct phenomena, freestream turbulent acoustics, and vortex shedding in cavities.

541 pp., 6 x 9, illus. \$19.00 Mem. \$30.00 List

THERMAL POLLUTION ANALYSIS

v. 36

Edited by Joseph A. Schetz, Virginia Polytechnic Institute and State University

This volume presents seventeen papers concerned with the state of the art in dealing with the unnatural heating of waterways by industrial discharges, principally condenser cooling water attendant to electric power generation. The term "pollution" is used advisedly in this instance, since such heating of a waterway is not always necessarily detrimental. It is, however, true that the process is usually harmful, and thus the term has come into general use to describe the problem under consideration.

The magnitude of the Btu per hour so discharged into the waterways of the United States is astronomical. Although the temperature difference between the water received and that discharged seems small, it can strongly affect its biological system. And the general public often has a distorted view of the laws of thermodynamics and the causes of such heat rejection. This volume aims to provide a status report on the development of predictive analyses for temperature patterns in waterways with heated discharges, and to provide a concise reference work for those who wish to enter the field or need to use the results of such studies.

The papers range over a wide area of theory and practice, from theoretical mixing and system simulation to actual field measurements in real-time operations.

304 pp., 6 x 9, illus. \$9.50 Mem. \$16.00 List

THERMOPHYSICS AND SPACECRAFT THERMAL CONTROL

v. 35

Edited by Robert C. Hering, University of Iowa

This collection of thirty papers covers some of the most important current problems in thermophysics research and technology, including radiative heat transfer, surface radiation properties, conduction and joint conductance, heat pipes, and thermal control of spacecraft systems.

Radiative transfer papers examine the radiative transport equation, polluted atmospheres, zoning methods, perforated shielding, gas spectra, and thermal modeling. Surface radiation papers report on dielectric coatings, refractive index and scattering, and coatings of still-orbiting spacecraft. These papers also cover high-temperature thermophysical measurements and optical characteristics of coatings.

Conduction studies examine metals and gaskets, joint shapes, materials, contamination effects, and prediction mechanisms.

Heat pipe studies include gas occlusions in pipes, mathematical methods in pipe design, cryogenic pipe design and test, a variable-conductance pipe, a pipe for the space shuttle electronics package, and OAO-C heat pipe performance data. Spacecraft thermal modeling and evaluating covers the Large Space Telescope, a Saturn/Uranus probe, a lunar instrumentation package, and the Mariner spacecraft.

551 pp., 6 x 9, illus. \$14.00 Mem. \$20.00 List

INSTRUMENTATION FOR AIRBREATHING PROPULSION

v. 34

Edited By Allen Fuhs, Naval Postgraduate School, and Marshall Kingery, Arnold Engineering Development Center

This volume presents thirty-nine studies in advanced instrumentation for turbojet engines, covering measurement and monitoring of internal inlet flow, compressor internal aerodynamics, turbojet, ramjet, and composite combustors, turbines, propulsion controls, and engine condition monitoring. Includes applications of techniques of holography, laser velocimetry, Raman scattering, fluorescence, and ultrasonics, in addition to refinements of existing techniques.

Both inflight and research instrumentation requirements are considered in evaluating what to measure and how to measure it. Critical new parameters for engine controls must be measured with improved instrumentation. Inlet flow monitoring covers transducers, test requirements, dynamic distortion, and advanced instrumentation applications. Compressor studies examine both basic phenomena and dynamic flow, with special monitoring parameters.

Combustor applications review the state-of-the-art, proposing flowfield diagnosis and holography to monitor jets, nozzles, droplets, sprays, and particle combustion. Turbine monitoring, propulsion control sensing and pyrometry, and total engine condition monitoring, with cost factors, conclude the coverage.

547 pp. 6 x 9, illus. \$14.00 Mem. \$20.00 List

COMMUNICATIONS SATELLITE TECHNOLOGY

v. 33

Edited by P. L. Bargellini, Comsat Laboratories
A companion to Communications Satellite Systems, volume 32 in the series.

The twenty-two papers in this volume deal with communications satellite operations, including orbit positioning and stability, propulsion and power requirements, and operations of the electronic communications system and network.

The orbit and attitude control papers cover stability, nutation dynamics, attitude determination, and three-axis control. Propulsion requirements examined include low-thrust stationkeeping requirements and auxiliary power systems for the satellite themselves.

Communications aspects include dual-beam reflector antennas, a method for measuring gain and noise temperature ratio of earth station antennas, and the Intelsat IV transponder. The time-division multiple access system for Intelsat, the synchronization of earth stations to satellite sequences, time division multiple access systems, and echo cancellation are also considered.

Multiple applications include single satellites for communications, air traffic control, television broadcasting, and a microwave telemetry and command band.

540 pp., 6 x 9, illus. \$14.00 Mem. \$20.00 List

COMMUNICATIONS SATELLITE SYSTEMS

v. 32

*Edited by P. L. Bargellini, Comsat Laboratories
A companion to Communications Satellite Technology,
volume 33 in the series.*

The twenty papers in this volume deal with international applications, advanced concepts, and special topics, covering the lessons and technical advancements resulting from the Intelsat II program of eight launches in the years 1966-1970. Includes Intelsat V system concepts and technology, with implications for multiple access, power generation and storage, and propellant utilization. It also includes proposals for U.S.-European cooperation in satellite applications programs of the Intelsat system.

Advanced concepts discussed include the coming generation of flexible communications satellites, with variations in switching, applications, and payloads; a dual-beam antenna for broadcast band service; high-powered, three-axis stabilized, position-keeping satellites; commercial communications with ships or aircraft via stationary satellites; multiple beam phased antennas; complex ground stations and relatively straightforward equipment on the satellite; and research in manned orbital laboratories.

Special topics include two-way telephonic communication via satellite, various education and information transfer systems, and a centralized radio-frequency data base for satellite communication system design.

480 pp., 6 x 9, illus. \$14.00 Mem. \$20.00 List

THERMAL CONTROL AND RADIATION

v. 31

Edited by C.-L. Tien, University of California, Berkeley

Twenty-eight papers concern the most important advances in thermal control as related to spacecraft thermal design, and in radiation phenomena in the thermal environment of space, covering heat pipes, thermal control by other means, gaseous radiation, and surface radiation.

Heat pipe section examines characteristics of several wick materials, a self-priming pipe and development models, and the design and fabrication of a twelve-foot pipe for the Orbiting Astronomical Observatory C, and the 26-inch diode for the ATS-F Satellite.

Other thermal control methods examined include alloys, thermal control coatings, and plasma cleaning of such coatings. Papers examine the thermal contact resistance of bolted joints and electrical contacts, with role of surface roughness in thermal conductivity.

Gaseous radiation studies examine multidimensional heat transfer, thermal shielding by injection of absorbing gases into the boundary layer, and various gases as thermal absorbing media. Surface studies deal with real surface effects on roughened, real-time contaminated surfaces, and with new computational techniques to compute heat transfer for complex geometries, to enhance the capabilities and accuracy of radiation computing.

523 pp., 6 x 9, illus. \$12.95 Mem. \$18.50 List

SOLAR ACTIVITY OBSERVATIONS AND PREDICTIONS

v. 30

*Edited by Patrick S. McIntosh and Murray Dryer, National
Oceanic and Atmospheric Administration*

The twenty-five papers in this volume present a representative view of solar-terrestrial physics, with emphasis on the sun, and on predicting solar activity affecting the space environment. It summarizes current knowledge of solar observations and theories, the interplanetary medium, geophysical responses to solar activity, and progress in the technology of forecasting such phenomena.

Solar activity variations, properties, and organization are reviewed in evaluating solar active regions and directions for further study. The structure of the solar magnetic field is explored, and current knowledge of solar flares and other activity is presented. Solar flares are modeled as an explosive release of magnetic energy associated with a current sheet in the solar magnetic field.

Interplanetary medium studies concern the solar wind and solar cosmic rays, with spacecraft observations of both. Solar activity effects on the earth's atmosphere, and relation of such activity to geomagnetic phenomena, are explored. Solar activity forecasting relates to flare activity prediction, both proton and nonproton, forecasting both incidence and solar flare location.

444 pp., 6 x 9, illus. \$12.25 Mem. \$17.50 List

FUNDAMENTALS OF SPACECRAFT THERMAL DESIGN

v. 29

Edited by John W. Lucas, Jet Propulsion Laboratory

The thirty-two papers in this volume review the development of thermophysics and its constituent disciplines in relation to the space program, together with concerns for future development, in fields of surface radiation properties, thermal analysis, heat pipes, and thermal design.

Surface radiation covers ultraviolet and particle radiation of pigments, paints, and other surfaces, both coated and uncoated, in thermal control applications. Optical characteristics of variously degraded and exposed surfaces are also considered. Thermal analysis studies consider radiative heat transfer, thermal resistance, reentry thermal analysis, and modeling for spacecraft thermal analysis.

Heta pipes section covers friction, electro-osmosis, grooved pipes, organic-fluid pipes, gas-controlled pipes, variable-conductance pipes, and specific heat pipe designs and applications.

Thermal design topics include the Apollo telescope mount, the space shuttle orbiter wing cooling system, and methods and selection criteria for thermal control of a twelve-person space station.

599 pp., 6 x 9, illus. \$14.00 Mem. \$20.00 List

THERMAL CHARACTERISTICS OF THE MOON

v. 28

Edited by John W. Lucas, Jet Propulsion Laboratory

The eleven papers in this volume detail recent important discoveries in the lunar thermal situation, including measurements made from earth,

measurements made on the moon, studies of materials returned to earth from the moon, and an overall historical survey of the interior of the moon from a thermal standpoint.

Earth-based measurements concern infrared emission and hot spots, microwave emission from the moon, and radar reflection mapping of the surface, with comparisons of radar and infrared measurements.

In situ measurements summarize five unmanned Surveyor probes, using thermal sensor and solar panel data, plus various Apollo science experiments packages used to measure lunar surface brightness and heat flow.

Section on earth study of returned lunar materials reviews thermophysical properties of such materials, with descriptions of processes and tabular and graphic data. Data relate lunar surface roughness and thermal characteristics both in daytime and during nighttime and eclipses.

The historical geophysical interpretation of lunar thermal history, based on all available data from many sources, covers origins, energy balance, and models of thermal history, with comparisons of models and directions for future work.

340 pp., 6 x 9, illus. \$10.50 Mem. \$15.00 List

THERMOSPHERIC CIRCULATION

v. 27

Edited by Willis L. Webb, White Sands Missile Range, and University of Texas at El Paso

The fifteen papers in this volume concern the geocirculation system occupying the atmospheric region above an altitude of 80 kilometers. They deal with the physical processes forming the structure of the base of the thermosphere, using data from sounding rockets and from radar observations of meteor trail ionization tracks.

Upper atmosphere dynamics summary presents a current model of thermosphere dynamics, proposing a program of synoptic exploration. Other papers explore lower ionospheric phenomena, the topside ionosphere, the magnetosphere, the upper atmosphere, and the origin and structure of noctilucent clouds.

Radar observations of wind structure height and time, based on meteor radar tracking, are presented, with implications of and for various terrestrial weather phenomena. Other studies cover automated digital signal processing and monitoring of radar data from meteor trails.

Other papers explore the morphology of the D-region, the chemistry of the upper mesosphere and the lower thermosphere, airglow phenomena, and proposals for data collection, reduction, and dissemination for study.

372 pp., 6 x 9 illus. \$10.50 Mem. \$14.95 List

COMMUNICATIONS SATELLITES FOR THE 70's: SYSTEMS

v. 26

Edited by Nathaniel E. Feldman, The Rand Corporation, and Charles M. Kelly, The Aerospace Corporation
A companion to Communication Satellites for the 70's: Technology, volume 25 in the series.

This collection of thirty-seven papers discusses a wide variety of operational, experimental, and proposed specific satellite systems, including the Canadian domestic communications satellite system, European projects, systems for emerging nations, United States domestic systems, aeronautical service systems, earth resources satellites, defense systems, systems engineering, and the relative merits of various stabilization systems for future synchronous satellites.

Both Telesat Canada and Canadian Broadcasting Corporation satellites are discussed. European projects include efforts of France, Germany, and Italy. Emerging nations systems include those for Brazil and India.

Unites States instructional and educational systems are described, with extensions for earth resources monitoring. The Defense Satellite Communication System is examined, and a global network using both satellites and submarine cables is proposed. Bandwidth frequency assignment is proposed for maximum utility and service.

657 pp., 6 x 9, illus. \$13.25 Mem. \$18.95 List

COMMUNICATION SATELLITES FOR THE 70's: TECHNOLOGY

v. 25

Edited by Nathaniel E. Feldman, The Rand Corporation, and Charles M. Kelly, The Aerospace Corporation
A companion to Communication Satellites for the 70's: Systems, volume 26 in the series.

The thirty-six papers in this volume cover developments in satellite transponders, subsystems, antennas, high-power transmission, integration and testing, launch vehicles, digital techniques, and earth station technology.

Equipment analyzed and evaluated includes traveling-wave tubes for space applications, S-band power amplifier tubes, and complex multiplexed filters for waveguide combinations. Antennas evaluated for communications satellites include phased-array, mechanically despun, variable-coverage, and narrow-bandwidth types.

Stabilization systems examined include spin-stabilization, three-axis attitude control, horizon sensing, and visible light earth sensors for satellites in equatorial orbit.

Power studies examine high-power satellite design, fabrication, and testing, and high-power television transmitters. Interference between satellite and terrestrial transmissions is explored. A low-cost microwave converter is proposed.

Various switching options for multiple-access and demand switching are proposed, and various low-cost, low-power ground stations are presented.

614 pp., 6 x 9, illus. \$12.95 Mem. \$18.50 List

HEAT TRANSFER AND SPACECRAFT THERMAL CONTROL

v. 24

Edited by John W. Lucas, Jet Propulsion Laboratory

This volume presents a review of the state of the art of thermophysics in aerospace, surface radiation properties, thermal joint conductance, heat transfer, multilayer insulation, and thermal control devices.

A critical review of aerospace thermophysics examines the tasks presented by the space shuttle and

space stations, including thermal control surfaces having lifetimes up to 20 years. Other studies examine degradation and stabilization of thermal control coatings, with radiant heat transfer calculations. The emittance of several coated and uncoated metal surfaces is calculated, with data on time and exposure degradation.

Thermal joint conductance studies examine prediction of conductance, heating rates, and the influence of interstitial fillers on heat transfer. Other

papers cover heat transfer modeling, transient heat flow in structures, and the special heat transfer problems of multilayer insulations, both in structures and in space suits.

Papers dealing with thermal control devices discuss selection criteria, mutual interaction between electric and thermal conduction, and thermal efficiency of various materials used in spacecraft structures.

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