

TABLE OF CONTENTS

GENERAL PHYSICS

I.	Molecule Microscopy	1
	Scanning Desorption Molecule Microscopy (SDMM)	1
	Scanning Micropipette Molecule Microscope (SMMM)	3
II.	Developmental Electron Optics Laboratory	9
	The Auger Electron Microscope	9
III.	Semiconductor Surface Studies	11
	Excitations at Surfaces and Interfaces of Solids	11
	Surface and Defect Excitations in Covalently Bonded Solids	11
IV.	Photoemission Spectroscopy	13
V.	Atomic Resonance and Scattering	15
	Studies of Rotational Energy Transfer	15
	Level-to-Level Inelastic Differential Cross Sections by Doppler Velocity Analysis	18
	Spectroscopy of Weakly Bound Molecules	20
	Collisional Line-Broadening Studies	21
VI.	Interfacial Chemistry	23
	Photoacoustic Spectroscopy and Chemically Modified Surfaces	23
VII.	X-Ray Diffuse Scattering	25
	Melting and the Commensurate-Incommensurate Transition of Monolayer Krypton on Graphite	26
	Melting of 1.2 Monolayer Xenon on Graphite	26
	Structure, Phase Diagram and Transitions of Monolayer and Bilayer Molecular Oxygen on Graphite	27
	Nematic, Smectic A and Smectic C Phase Transitions and Critical Behavior in $\overline{8S5}$ - $\overline{7S5}$ Mixtures	28
	Structure of Well-Ordered Smectic Phases	28

CONTENTS

VIII.	Quantum Electronics	31
	Laser Applications	31
	Ultrahigh-Resolution Spectroscopy and Frequency Standards in the Microwave and FIR Regions Using Optical Lasers	31
	Interaction of Phase-Modulated Laser Fields with Resonant Systems	34
	Phase Modulation Absorption Spectroscopy	36
	Studies of Atom-Field Interactions in Atomic Beams	39
	High-Resolution Studies in Folded Doppler-Broadened Systems	42
	Doppler-Free Spectroscopy via Resonant Degenerate Four-Wave Mixing	45
	Single-Frequency, Stimulated Brillouin Scattering Fiber-Optic Laser	47
	Measurement of Inertial Rotation Using a Passive-Ring Resonator	48
	Measurement of Inertial Rotation Using a Multiturn Fiberoptic Sagnac Interferometer	50
	Nonlinear Phenomena	52
	Segmented-Contact GaAs/GaAlAs Double-Heterojunction Laser Diodes	52
	Picosecond Sampling	54
	Devices for High-Rate Optical Communications	55
	Grating Structures	58
	Surface Acoustic Wave Gratings	58
IX.	Time-Resolved Spectroscopy of Condensed Matter	61
	Microviscosity in Gels and Polymer Sols	61
	Molecular Reorientation in Critical Mixtures	63
	Time-Resolved Spectroscopy in Liquid Crystals	65
X.	Infrared Nonlinear Optics	67
	Infrared Nonlinear Processes in Semiconductors	67

CONTENTS

XI.	Quantum Optics and Electronics	69
	Nonlinear Optical Interaction in Semiconductors	69
	Picosecond Dye Laser Optics	70
	Nonlinear Spectroscopy of Atoms and Molecules	71
XII.	Microwave and Millimeter Wave Techniques	73
	Research Objectives	73
XIII.	Microwave and Quantum Magnetism	75
	Magnetostatic Modes Bound by DC H-Field Gradients	76
	Optical Detection of Magnetostatic Resonances	78
	Mode Synthesis	79
	New Techniques to Guide and Control Magnetostatic Waves	82
	Magnetostatic Wave-Dispersion Theory	85
	Magnetoelastic Waves and Devices	86
XIV.	Microwave Thermography	87
XV.	Radio Astronomy	89
	Microwave Spectroscopy of the Interstellar Medium	89
	Research Objectives	90
	Long-Baseline Astrometric Interferometer	91
	Controlled Thin-Film Antenna	91
	Improved Microwave Retrieval Techniques	92
	Communications Satellites	92
	Video-Bandwidth Compression Techniques	93
	Scanning Multichannel Microwave Radiometer (SMMR)	93
	TIROS-N Satellite Microwave Sounder	94
XVI.	Electromagnetic Wave Theory and Remote Sensing	95
	Electromagnetic Waves	95
	Remote Sensing with Electromagnetic Waves	96
	Active and Passive Microwave Remote Sensing	96

CONTENTS

	Acoustic-Wave Propagation Studies	97
	Effect of Earth Terrain on Millimeter Wave Propagation	97
	Theories for Microwave Remote Sensing of Snow	98
	SAR Image Prediction, Simulation, and Analysis	99
XVII.	Electronic Properties of Intrinsic Defects in Amorphous Silicon Dioxide	103
XVIII.	Photon Correlation Spectroscopy and Applications	105
	Research Program	105
XIX.	Submicron Structure Fabrication and Research	107
	Operation of Submicron Structures Laboratory	107
	Development of Microfabrication Techniques	109
	X-Ray Lenses and Gratings	110
	Graphoepitaxy	111
	One-Dimensional Conduction in Silicon	112
	Reactive Ion Etching	112

PLASMA DYNAMICS

XX.	Plasma Dynamics	115
	Basic Plasma Research	116
	Nonlinear Wave Interactions	116
	Renormalization Methods in Plasma Turbulence Theory	119
	Intense Relativistic Electron Beams	119
	Plasma Research Related to Fusion	120
	Physics of Thermonuclear Plasmas	120
	RF Heating and Nonlinear Waves in Toroidal Plasmas	123
	Nonlinear Theory of Plasma Instabilities	127
	Tokamak Research: RF Heating and Current Drive	128
	Mirror-Confined Plasmas	135

CONTENTS

COMMUNICATION SCIENCES AND ENGINEERING

XXI.	Optical Propagation and Communication	139
	Improved Low-Visibility Communication	139
	Fiber-Coupled External-Cavity Semiconductor High-Power Laser	142
	Atmospheric Propagation Effects on Infrared Radars	143
XXII.	Digital Signal Processing	145
	The Parabolic Wave Equation	148
	Linear Shift-Invariant Form-Invariant Filtering	149
	Event Compression with Recursive Least Squares Signal Processing	150
	Seismic Signal Modeling and Processing	151
	A New Design of PCM Speech Coding System	152
	Effect of Noise in Signal Reconstruction from Its Fourier Transform Phase	153
	Signal Reconstruction from Phase or Magnitude	154
	Formation Parameter Estimation in Sonic Well Logging	155
	Wavenumber Spectral Estimation	156
	Time Delay Estimation of Multiple Arrivals	157
	Two-Dimensional Maximum Entropy Power Spectrum Estimation	157
	The Determination of the Acoustic Reflection Coefficient of the Ocean Bottom from Its Response to a Point Source	158
	Optimal Signal Enhancement and Parameter Estimation in the Presence of Noise	159
	Noise Reduction in Speech by Spectral Subtraction	159
	Signal Noise Reduction	160
	Importance of Phase in Speech Enhancement	160
XXIII.	Speech Communication	163
XXIV.	Linguistics	167

CONTENTS

XXV.	Cognitive Information Processing	171
	Natural Language Processing	171
	Digital Wirephoto System	173
	Data Processing for the Graphic Arts	174
	Image Processing for the Graphic Arts	175
XXVI.	Custom Integrated Circuits	177
	Conversion of Algorithms to Custom Integrated Circuits	177
XXVII.	Communications Biophysics	179
	Signal Transmission in the Auditory System	179
	Basic and Clinical Studies of the Auditory System	179
	Auditory Psychophysics and Aids for the Deaf	182
	Intensity Perception and Loudness	182
	Binaural Hearing	188
	Hearing Aid Research	193
	Tactile Communication of Speech	199
	Musical Pitch	203
	Transduction Mechanisms in Hair Cell Organs	206
	Mechanical Response Properties of the Basilar Papilla in Alligator Lizard: Failure to Find a Basis for Tonotopic Organization	206
	Biomedical Engineering	208
XXVIII.	Neurophysiology	209
	Basal Optic Projection in the Frog (<u>Rana pipiens</u>)	209
	Old and New Directions in the Theory of Color Constancy	210
	Tristimulus Spaces in Which Schroedinger Object Colors Are Not Optimal	219
	Publications and Reports	223
	Personnel	247
	Author Index	257
	Research Support Index	260