

TABLE OF CONTENTS

GENERAL PHYSICS

I.	Molecule Microscopy	1
	Scanning Desorption Molecule Microscopy	1
	Cell-Surface Studies	2
	Scanning Micropipette Molecule Microscope	2
	Pathways of Transepithelial Water Flow	3
II.	Developmental Electron Optics Laboratory	5
	The Auger Electron Microscope	5
III.	Semiconductor Surface Studies	9
	Excitations at Surfaces and Interfaces of Solids	9
	Surface and Defect Excitations in Covalently Bonded Solids	10
IV.	Photoemission Spectroscopy	11
	Investigations of Molecular Chemisorption on Semiconductors by Angle-Resolved Photoemission Spectroscopy	11
	Studies of Semiconductor Surface Reactivity	13
V.	Atomic Resonance and Scattering	15
	Studies of Rotational Energy Transfer	15
	Level-to-Level Energy-Transfer Differential Cross Sections Using Doppler Velocity Analysis	19
	Molecular Spectroscopy	21
VI.	Interfacial Chemistry	23
	Photoacoustic Spectroscopy and Chemically Modified Surfaces	23
VII.	X-Ray Diffuse Scattering	25
	Commensurate-Incommensurate Transition of Monolayer Krypton on Graphite	26
	Structure, Phase Diagram and Melting of Xenon on Graphite	26
	Structure, Phase Diagram and Transitions of Monolayer and Bilayer Molecular Oxygen on Graphite	27
	Structure of Well-Ordered Smectic Phases	27
	Critical Behavior of the SmA-SmC Transition of $\bar{8}S5$	28
	Observation of Algebraic Decay of Positional Order in a Smectic Liquid Crystal	28

CONTENTS

VIII.	Quantum Electronics	31
	Laser Applications	31
	High-Resolution Studies of the AC Stark Effect in an Atomic Beam and the Influence of Atomic Recoil	31
	Folded Doppler-Broadened Three-Level Molecules in Intense Monochromatic Fields: High-Resolution Study in I ₂ Vapor	34
	Observation of Rotational Dependence in Collisional Self-Broadening of Stimulated Vibrational Raman Spectra in O ₂	35
	Measurement of Inertial Rotation Using a Passive Ring Resonator	37
	Measurement of Inertial Rotation Using a Multiturn Fiberoptic Sagnac Interferometer	38
	Observation of Natural Width Differences in I ₂ Hyperfine Structure Using High-Resolution Two-Step Spectroscopy	39
	Nonlinear Phenomena	41
	Picosecond Opto-Electronics	41
	Distributed Feedback Structures	44
	Surface Acoustic Wave Gratings	44
IX.	Time-Resolved Spectroscopy of Condensed Matter	47
	Microviscosity in Gels and Polymer Solutions	47
	Molecular Reorientation near the Consolute Critical Point	48
	Future Directions	50
X.	Infrared Nonlinear Optics	51
	Infrared Nonlinear Processes in Semiconductors	51
XI.	Quantum Optics and Electronics	53
	Picosecond Dye Laser Optics	53
	Nonlinear Spectroscopy of Atoms and Molecules	54
XII.	Microwave and Millimeter Wave Techniques	55
	Research Objectives	55
XIII.	Electronic and Optical Materials and Applications	57
	Magnetostatic Modes Bound by DC H-Field Gradients	58

CONTENTS

	Optical Detection of Magnetostatic Resonances	59
	Magnetostatic Waves and Devices	59
	Mode Synthesis	60
	New Techniques to Guide and Control Magnetostatic Waves	61
XIV.	Microwave Thermography	63
XV.	Radio Astronomy	65
	Long-Baseline Astrometric Interferometer	65
	Controlled Thin-Film Antenna	66
	Scanning Microwave Spectrometer Experiment	67
	Tiros-N Satellite Microwave Sounder	68
	Scanning Multichannel Microwave Radiometer (SMMR)	68
	Communication Satellites	69
	Microwave Spectroscopy of the Interstellar Medium	70
	Research Objectives	71
XVI.	Electromagnetic Wave Theory and Remote Sensing	73
	Electromagnetic Waves	73
	Remote Sensing with Electromagnetic Waves	75
	Active and Passive Microwave Remote Sensing	77
	Prediction of Backscatter and Emissivity of Snow at Millimeter Wavelengths	79
	Acoustic-Wave Propagation Studies	80
XVII.	Electronic Properties of Charged Centers in SiO ₂ -like Glasses	83
XVIII.	Photon Correlation Spectroscopy and Applications	85
	Research Program	85
XIX.	Microstructure Fabrication	87
	Creation of the Submicrometer Structures Laboratory	87
	Development of Microstructure Fabrication Techniques	88
	Graphoepitaxy	89

CONTENTS

Attachment and Properties of Molecules on Submicrometer Structures	89
Electronic Transport in Quasi-One-Dimensional Submicrometer Structures in Silicon Inversion Layers	90
X-Ray Lenses and Diffraction Gratings	90
Submicrometer Structures and Liquid-Crystal Research	91

PLASMA DYNAMICS

XX.	Plasma Dynamics	95
	Basic Plasma Research	96
	Nonlinear Wave Interactions	96
	Renormalization Methods in Plasma Turbulence Theory	97
	Intense Relativistic Electron Beams	98
	Plasma Research Related to Fusion	105
	Physics of Thermonuclear Plasmas	105
	Dynamics of Toroidal Discharges	107
	RF Heating and Nonlinear Waves in Toroidal Plasmas	110
	Nonlinear Theory of Trapped-Particle Instabilities	113
	An Advanced Scientific Computing Environment	113
	Tokamak Research: RF Heating and Current Drive	114
	Mirror-Confined Plasmas	121

COMMUNICATION SCIENCES AND ENGINEERING

XXI.	Optical Propagation and Communication	125
	Improved Low-Visibility Communication	125
	Quantum Communication Theory	127
XXII.	Digital Signal Processing	129
	Linear Predictive Encoding of Seismic Data	131
	Event Detection in Sonic Well Logging	132
	Adaptive Array Processing for High-Resolution Acoustic Imaging	133
	Design of Two-Dimensional Filters	134

CONTENTS

	Signal Reconstruction from Phase or Magnitude	135
	Time-Scale Modification of Speech	137
	The Estimation of Formation Parameters in Sonic Well Logging	137
	Spectral Estimation for Sensor Arrays	138
	Speech Enhancement	139
	Two-Dimensional Power Spectrum Estimation	140
	Extraction of Acoustic Plane-Wave Reflection Coefficient from the Sound Field Generated by a Point Source	141
	Maximum Likelihood Estimation with Noisy Data	142
	Processing of Satellite Imagery	143
	Evaluation of Circularly Symmetric Two-Dimensional Fourier Transforms and Its Application to the Measurement of Ocean-Bottom Reflection Coefficients	143
	Short-Time Fourier Analysis	144
	Phase Estimation	144
XXIII.	Speech Communication	147
	Studies of Speech Production and Perception	148
	Studies of Speech Production by Children and Disorders of Speech Production	154
XXIV.	Linguistics	157
	Research Results	159
XXV.	Cognitive Information Processing	163
	Natural Language Processing	163
	Digital Wirephoto System	164
	Data Processing for the Graphic Arts	166
	Image Processing for the Graphic Arts	166
XXVI.	Custom Integrated Circuits	169
	Conversion of Algorithms to Custom Integrated Circuits	169
XXVII.	Communications Biophysics	171
	Signal Transmission in the Auditory System	171
	Basic and Clinical Studies of the Auditory System	171

CONTENTS

Auditory Psychophysics and Aids for the Deaf	174
Intensity Perception and Loudness	174
Binaural Hearing	179
Hearing Aid Research	184
Tactile Communication of Speech	187
Musical Pitch	194
Transduction Mechanisms in Hair Cell Organs	197
Stiffness Coefficient of the Cupula in the Semicircular Canal of the Skate	197
The Influence of Ampulla, Duct, and Utricular Shape on Semicircular Canal Endolymph Flow Dynamics	199
Biomedical Engineering	201
XXVIII. Neurophysiology	203
Tectal Studies of <u>Ambystoma</u>	203
The Basal Optic System	204
Retinal Operators That Null Out Rigid 3-Space Translations	205
Apparent Reference-Frame Paradox in General Relativity	212
Computer-Simulated Object-Color Recognizer	214
Publications and Reports	223
Personnel	248
Author Index	258
Research Support Index	261