# TABLE OF CONTENTS

Personnel		viii
Publ	lications and Reports	xvi
Intro	oduction	xx
	GENERAL PHYSICS	
I.	Molecular Beams	1
	Helium Beam Experiment	1
	Cesium Beam Tube	2
	Computer-Aided Calculation of Frequency Stability	4
II.	Microwave Spectroscopy	9
	Work Completed	9
	Magnetic Field Dependence of the Temperature Variation of the Hall Coefficient in Indium Antimonide	9
	Thin-Film Bolometer for Detection of Phonons in Quartz and Sapphire	9
	EPR Studies of Irradiated Polystyrene	10
	A Calculation of the Amplitude Envelope Observed in Microwave Phonon Generation	10
	Incoherent Phonon Propagation in X-cut Quartz	10
	Investigation of the Fermi Surface of Gallium by Geometric Resonance at Microwave Frequencies	15
III.	Radio Astronomy	21
	Measurements of Atmospheric Absorption near 1-cm Wavelength	21
	Measurement of Atmospheric Water Vapor and Clouds by Microwave Radiometers	21
	Observations at the Haystack Research Facility	27
IV.	Optical and Infrared Spectroscopy	37
	Work Completed	37
	Normal Models in Hexagonal Boron Nitride	37
	Classical Dispersion Analysis of Cubic Perovskite Fluoride	
	Crystals	45
	Temperature Dependence of the Raman Spectrum of $\operatorname{BaTiO}_3$	51

v.	Geophysics	63
	Plasma Diffusion in a Magnetic Field	63
	Recombination Coefficient Measurement by Langmuir Plasma Probe	65
	Proton Flow into the Magnetosphere	67
VI.	Noise in Electron Devices	71
	Higher Order Moments of Photoelectron Counts	71
VII.	Physical Electronics and Surface Physics	75
	Dependence of Photoemission from Tungsten on Surface Temperature and Radiation Frequency	75
VIII.	Physical Acoustics	77
	Sound Wave Generation and Amplification in Plasmas	77
	Hypersonic Relaxation Effects and Brillouin Scattering	80
	PLASMA DYNAMICS	
IX.	Plasma Physics	85
	Electron Density Measurements with a Laser Interferometer	85
	Reversal of Rotation and Steady-State Characteristics of a Beam-Plasma Discharge	89
x.	Plasma Electronics	97
	Beam Plasma Discharge: System A	97
	Beam Plasma Discharge: System C	99
	Heating of Ions	99
	Electron Temperatures	100
	Beam Plasma Discharge: System D	102
	Instabilities of Transverse Waves along the Magnetic Field	105
	Instabilities of Longitudinal Waves across the Magnetic Field	110
	Dynamics of the Plasma Boundary	114
	Electron Cyclotron Resonance Discharge	120
	Computer Study of Beam-Plasma Interactions	122
	Nonadiabatic Diffusion in Toroidal Geometry	126
	Magnetic Nonadiabatic Scattering in the Magnetosphere	128
	Incoherent Scattering of Light from a Plasma. I.	131
	An Input-Output Approach to the Problems of Optimal Control	136

QPR No. 78

XI.	Plasma Magnetohydrodynamics and Energy Conversion	149
	Condensing Ejector Test Facility	149
	Boundary-Layer Analysis of Turbulent Magnetohydrodynamic Channel Flows	152
	Preliminary Experimental Results on an MHD Induction Generator	160
	Thermionic Characteristics of the (110) and (112) Directions of Tungsten in Cesium Vapor	170
	COMMUNICATION SCIENCES AND ENGINEERING	
XII.	Statistical Communication Theory	177
	Work Completed	177
	Some Techniques for the Synthesis of Nonlinear Systems	177
	A Study of the Spectrum of Waves Phase-Modulated by the Response of a Nonlinear Filter to a Gaussian Input	177
	A Study of Sensitivity Limitations Due to Noise in a Tunnel Diode Threshold Detector	177
	Analysis of Spontaneous Electrical Activity in Embryonic Brain Explants	177
	The Theoretical Accuracy of Monopulse Radar	178
	Active Sonar in Reverberation-Limited Environments	178
	Statistical Study of Evoked Neural Activity in Crayfish Caudal Photoreceptors	178
	Optimum Filtering in Quantization Systems with Gaussian Inputs	178
	Time Jitter in Tunnel Diode Threshold-Crossing Detectors	178
	Analog Communication over Random Dispersive Channels	188
	An Application of an Equation for the Conditional Probability Density Functional of Markov Processes to Nonlinear Mini- mum Variance Filtering and Estimation	192
	Analysis of a Minimum-Variance Phase Estimator by Means of the Fokker-Planck Equation	201
XIII.	Processing and Transmission of Information	207
	Bounds on Multiple-Threshold Functions	207
XIV.	Speech Communication	212
	Model of Larynx Activity during Phonation	212
xv.	Mechanical Translation	221
	The Place of Classifiers in a Generative Grammar of Chinese	221

XVI.	Linguistics	227
	Remarks on the Transformational Reduction of esli-Clauses in Russian	227
XVII.	Cognitive Information Processing	229
	Cognitive Processes	229
	Protracted Practice on Decoding Spatially Transformed Text	229
	Picture Processing	231
	Optimum Binary Fixed-Length Block Codes	231
	Subjective Effect of Spatial and Brightness Quantization on Picture Quality	233
	Sensory Aids	241
	Information Rates for Multidimensional, Multimodality Sensory Stimuli	241
XVIII.	Communications Biophysics	249
	Work Completed	249
	Digital Clock for the PDP-4 Computer	249
	The Effects of Temperature on the Lobster Cardiac Ganglion	250
	Transfer Characteristics of the Cat's Middle Ear	250
	Complex Reaction Times for Pattern Recognition	250
	Communication in the <u>Gymnotus</u> <u>Carapo</u> – A Weakly Electric Fish	251
	Analog Signal Delay by Programming the PDP-4 Computer	251
	Fluctuations in the Excitability of Frog Sciatic Nerve Fibers	251
	Analysis of Spontaneous Electrical Activity in Embryonic Brain Explants	252
	Psychophysics	252
	Application of the EC Model to Data on JND's	253
	Binaural Unmasking as a Function of the Bandwidth of the Masking Noise	257
	Bilocal Cutaneous Unmasking	258
	Cerebral Dominance and the Perception of Verbal Stimuli	259
	Display of the Cumulative Behavior of Evoked Responses	260
	On Evoked Responses in Relation to Temporal Conditioning to Paired Stimuli in Man	263
	Preliminary Studies: Macroelectrode and Microelectrode Recordings of Auditory Responses from the Cat's Cere- bellum	272

XIX.	Neurophysiology	279
	Mammalian Nodes of Ranvier	279
	Recording Methods	279
	Mathematical Axonology	280
	Unmyelinated Fibers in the Dorsal Roots of Cats	281
	Olfaction in the Frog	282
	Retinal Studies in the Frog	283
Autho	r Index	286