

Contents

1. General Principles	1
1.1 Interference of Light	1
1.1.1 Fundamental Relationships	3
1.1.2 Addition of Wave Fields	7
1.1.3 Interference of Two Plane Monochromatic Waves of Identical Frequency.	8
1.1.4 Orientation and Frequency of the Interference Structure	10
1.1.5 Contrast of Interference Pattern	11
1.1.6 Interference of Plane Monochromatic Waves of Different Frequency	12
1.1.7 Interference of Spherical Waves	14
1.1.8 Nonmonochromatic Point Sources	19
1.1.9 Coherence	21
1.1.10 Extended Sources	25
1.1.11 General Requirements on the Elements of an Interference Setup	26
1.2 Optical Interferometry	28
1.2.1 Interferometers and Their Classification	29
1.2.2 Twin-Wave Interferometers with Wavefront Division	30
1.2.3 Twin-Wave Interferometers with Amplitude Division	32
1.2.4 Equivalent Scheme of a Twin-Wave Interferometer with Amplitude Division	33
1.2.5 Distribution of Intensities in a Twin-Wave Interference Pattern	35
1.2.6 Application of Twin-Wave Interferometers	37
1.2.7 Study of the Shape of Wavefronts	38
1.2.8 Metrological Application	42
1.2.9 Spectroscopic Applications	43
1.2.10 Multiple-Wave Interferometers	46

1.2.11	Distribution of Intensities in a Multiple-Wave Interference Pattern	47
1.2.12	Application of Multiple-Wave Interferometers	53
1.3	Holography	54
1.3.1	Brief History of Development of Holography	55
1.3.2	Fundamental Equations	56
1.3.3	Classification of Holograms	59
1.3.4	Basic Properties of Holograms	65
1.3.5	Application of Holography	73
1.4	Holographic Interferometry	74
1.4.1	General Principles	74
1.4.2	Features of Holographic Interferometry	74
1.4.3	Real-Time Method	78
1.4.4	Double-Exposure Method	80
2.	Experimental Techniques	84
2.1	Light Sources	84
2.1.1	Requirements for Light Sources in Holographic Interferometry	84
2.1.2	Gas Lasers	89
2.1.3	Solid-State Lasers	92
2.1.4	Dye Lasers	97
2.2	Hologram Recording Materials	97
2.2.1	Requirements to Recording Materials	97
2.2.2	Silver Halide Photographic Materials	100
2.2.3	Photoconductor-Thermoplastic Devices	111
2.2.4	New Recording Materials	113
2.3	Setups	115
2.3.1	Basic Kinds of Holographic Setups	115
2.4	Experimental Aspects	121
2.4.1	Premises	121
2.4.2	Holographic Slab	122
2.4.3	Protection Against Vibration	123
2.4.4	Setup Elements. Pinhole Diaphragm and Collimator	126
2.4.5	Beam Splitter	128

2.4.6	Light-Scattering Screen	131
2.4.7	Hologram Fasteners	134
3.	Investigation of Transparent Phase Inhomogeneities	141
3.1	Features of Holographic Interferometry of Transparent Objects	141
3.1.1	Methods of Visualization of Phase Inhomogeneities and the Relationship Between the Spatial Distribution of the Refractive Index and the Quantity Being Measured	142
3.1.2	Setups Without Diffusing Screens	147
3.1.3	Setups with a Diffusing Screen	148
3.1.4	Production of Interferograms with Fringes of Finite Width. The Wedge Method	155
3.1.5	Localization of Interference Pattern	157
3.1.6	Calculation of the Spatial Distribution of the Refrac- tive Index from an Interferogram	164
3.1.7	The Two-Dimensional Case	165
3.1.8	The Axisymmetric Case	168
3.1.9	The Three-Dimensional Case	171
3.2	Sensitivity of Holographic Interferometry and Methods of Changing It	176
3.2.1	Sensitivity of Twin-Wave Interferometry	177
3.2.2	Multipass Setups	178
3.2.3	Interference Patterns Formed by Conjugate Waves . . .	179
3.2.4	Three-Wave Interferometry	181
3.2.5	Two-Wavelength Methods of Changing the Sensitivity .	182
3.2.6	The Use of Nonlinear Effects	186
3.2.7	Dispersion Holographic Interferometry	192
3.2.8	Method of Resonance Interferometry	195
3.3	Holographic Diagnostics of Plasma	198
3.3.1	Features and Possibilities of Holographic Plasma Diagnostics Methods	199
3.3.2	Refraction of Plasma	201
3.3.3	Holographic Investigation of a Laser-Induced Spark. Cineholography	202
3.3.4	Two-Wavelength Holographic Interferometry of a Laser- Induced Spark	205
3.3.5	Study of a Laser-Induced Flare on a Solid Target . .	207
3.3.6	Holographic Interferometry of Flash Lamps	211

3.3.7	Holographic Interferometric Investigation of Plasma Jets	212
3.3.8	Investigation of a Spark Breakdown	213
3.3.9	Holographic Investigations of θ and z Pinches	215
3.3.10	Investigation of Plasma in the Vicinity of a Neutral-Current Layer	219
3.4	Use of Holographic Interferometry in Gas-Dynamic Investigations	222
3.4.1	Investigation of Flow Around Freely Flying Bodies . .	222
3.4.2	Investigations in Wind Tunnels	225
4.	Investigation of Displacements and Relief	228
4.1	The Process of Interference-Pattern Formation in Holography	228
4.2	Methods of Interpreting Holographic Interferograms when Displacements are Studied	244
4.2.1	Procedure for Multiple-Hologram Investigation	251
4.2.2	Procedure for Single-Hologram Investigation	252
4.3	Investigation of Surface Relief	266
4.3.1	Two-Wavelength Method	267
4.3.2	Immersion Method	273
4.3.3	Double-Source Method	275
4.4	Flaw Detection by Holographic Interferometry	277
5.	Holographic Studies of Vibrations	287
5.1	Influence of Object Displacement on the Brightness of the Reconstructed Image. The Powell-Stetson Method	289
5.1.1	Motion of an Object with a Constant Velocity	290
5.1.2	Stepwise Motion of an Object	291
5.1.3	Harmonic Vibrations of an Object	292
5.2	The Stroboscopic Method	297
5.3	Phase Modulation of the Reference Beam	307
5.3.1	Determining Large Amplitudes of Vibrations	309
5.3.2	Determining Small Amplitudes of Vibrating	310
5.4	Determining the Phases of Vibrations of an Object	311
	References	313
	Subject Index	328