

Contents

Preface	9
1 ASPHERICAL OPTICAL SYSTEMS	11
1.1 Introduction	11
1.2 Fermat's principle	12
1.2.1 Formulation	12
1.2.2 Kinds of stationariness of the optical path	13
1.2.3 Admitted lines.	17
1.3 Exactly stigmatic systems	21
1.3.1 Image formation by one surface	21
1.3.2 Image formation by two spherical mirrors	24
1.3.3 Spherical and aspherical mirrors. Exact solution	28
1.3.4 A plane-convex lens	30
1.3.5 Calculation of the coordinates of the points of a meridian curve	32
1.3.6 Construction of the points of a meridian curve	33
1.3.7 Iterative methods	37
1.3.8 The Herzberger-Hoadley method.	40
1.3.9 The differential method	41
1.3.10 A differential method involving a polynomial approximation	44
1.4 Exactly aplanatic systems	45
1.4.1 Exactly aplanatic image formation	45
1.4.2 Intermediary image in a single lens	47
1.4.3 Intermediary image in a two-mirror system	51
1.4.4 Two mirrors, object at infinity	54
1.4.5 Two mirrors, object and image both at finite distances.	56
1.4.6 Aplanatic lens	57
1.4.7 Three-surface aplanat with internal spherical surface	59
1.4.8 K. Schwarzschild's formulae	64
1.4.9 A. K. Head's formulae	65
1.4.10 Aplanatic lens, power expansions.	68
1.4.11 The A. K. Head method	69
1.4.11.1 The aplanatic lens with the object at infinity	69
1.4.11.2 The general case	70
1.4.12 Other methods	71
1.5 Spherical surfaces in aplanatic two-surface systems	72
1.5.1 The significance of spherical surfaces in optical systems	72

1.5.2	The first mirror a spherical one, object at infinity	73
1.5.3	The second mirror a spherical one, object at infinity	75
1.5.4	One mirror spherical, object and image at a finite distance	79
1.5.5	Lens, first surface spherical, object at infinity	89
1.5.6	Lens, second surface spherical, object at infinity	91
1.6	Grazing-incidence mirror systems	95
1.6.1	Introduction	95
1.6.2	Basic data of the system	95
1.6.3	Relations of quantities in an aplanatic system	97
1.6.4	Aplanatic system of two mirrors, object at infinity	98
1.6.5	Two-mirror joint system, object at infinity	102
1.6.6	Two-mirror aplanatic system, object at a finite distance	104
1.6.7	Joint aplanatic system of two mirrors, object at a finite distance	108
1.6.8	Central obstruction in joint two-mirror systems	109
1.6.8.1	Object at infinity	110
1.6.8.2	Object and image at finite distances	111
1.6.9	Central obstruction in nucleic two-mirror systems	115
1.6.9.1	The object at infinity	116
1.6.9.2	The object at a finite distance	116
1.7	Numerical methods	117
1.7.1	Methods of numerical computation of the shape of surfaces	117
1.7.2	Method of approximating the solution of a differential equation	121
1.7.2.1	Example	122
1.7.3	Numerico-graphical method of approximation	125
1.7.4	The point of intersection of a tangential ray with an aspherical surface	127
1.7.4.1	The meridian curve is a conic	127
1.7.4.2	The meridian is in Cartesian coordinates	127
1.7.5	Ray tracing, tangential ray	128
1.7.5.1	The meridian is in Cartesian coordinates	128
1.7.5.2	The meridian curve is approximately circular	128
1.7.6	Ray tracing, general case	129
1.8	Astigmatism	130
1.8.1	Origin of astigmatism	130
1.8.2	Spherical mirror with a stop	130
1.8.3	Surface of revolution	132
1.8.4	The third-order theory	133
1.8.5	C. R. Burch's formulae	135
1.9	Perspectives of future development	135
1.9.1	Introduction	135
1.9.2	Inverse problem of geometrical optics	136
1.9.3	Problem of designing refracting systems	138
1.9.3.1	Condition of anastigmatism	140
1.9.4	One-point optical design	142
2	REFLECTING MICROSCOPE OBJECTIVES	145
2.1	Historical outline	145
2.2	Practical problems	146
2.3	Objectives composed of two mirrors	147

2.3.1	Monocentric type	147
2.3.2	Two spherical mirrors	148
2.3.2.1	Calculation of design elements	151
2.3.2.2	Numerical results.	152
2.3.3	Other systems with spherical mirrors	154
2.4	Application of aspherical surfaces	155
2.4.1	Spherical and aspherical surfaces	155
2.4.2	Both mirrors aspherical.	158
2.5	Technical achievements.	159
3	THE STRUCTURE OF REFLECTED WIDE BEAMS	161
3.1	Concave spherical mirror	161
3.1.1	Basic concepts.	161
3.1.2	Equations of tangential image formation	162
3.1.3	Kinds of tangential image formation	163
3.1.4	Confuse tangential image formation	166
3.1.5	Kinds of sagittal image formation	168
3.2	Paraboloidal reflector	170
3.2.1	Tangential image formation	170
3.2.2	Sagittal image formation	172
3.3	Reflectors	173
4	MEASUREMENTS.	175
4.1	Radius of curvature of a spherical surface (B)	175
4.1.1	Ring spherometer (B).	175
4.1.1.1	Principle of the method (B)	177
4.1.1.2	Accuracy (B).	179
4.1.2	Other mechanical methods (B).	181
4.1.3	Interference method (B).	184
4.1.3.1	Measurement of large radii (B)	184
4.1.3.2	Measuring of small radii (B)	186
4.1.3.3	Accuracy (B).	187
4.1.4	Autocollimation	188
4.1.4.1	Principle of the method	188
4.1.4.2	Random errors.	190
4.1.4.3	Systematic errors	192
4.1.4.4	Devices for the elimination of influences of small carriage rotations	194
4.2	Aspherical surfaces.	195
4.2.1	Paraboloid	195
4.2.1.1	The double reflection method	195
4.2.1.2	Shadow methods	196
4.2.2	Aspherical surfaces in general	198
4.2.3	Measuring of deformations	201
4.3	Conclusion	203
References	204
Additional bibliography concerning aspherical surfaces	210