

Contents

1	Python Basics	1
1.1	Using Python	1
1.2	Understanding Expressions and Assignments	3
1.3	Control Structures	8
1.4	Working with Modules and Objects	14
2	Computing and Displaying Data	19
2.1	Spherical Astronomy	19
2.1.1	Declination of the Sun	20
2.1.2	Diurnal Arc	27
2.1.3	Observation of Celestial Objects	35
2.2	Kepler's Laws of Planetary Motion	42
2.3	Tidal Forces	47
3	Functions and Numerical Methods	55
3.1	Blackbody Radiation and Stellar Properties	55
3.1.1	Stefan–Boltzmann Law	56
3.1.2	Planck Spectrum	62
3.2	Physics of Stellar Atmospheres	77
3.2.1	Thermal Excitation and Ionization	78
3.2.2	The Balmer Jump	84
3.3	Planetary Ephemerides	94
4	Solving Differential Equations	105
4.1	Numerical Integration of Initial Value Problems	105
4.1.1	First Order Differential Equations	105
4.1.2	Second Order Differential Equations	116
4.2	Radial Fall	126
4.3	Orbital Mechanics	136
4.4	Galaxy Collisions	151

4.5	Stellar Clusters	167
4.6	Expansion of the Universe	175
5	Astronomical Data Analysis	185
5.1	Spectral Analysis	185
5.2	Transit Light Curves	188
5.3	Survey Data Sets	194
5.4	Image Processing	202
5.5	Machine Learning	207
5.5.1	Image Classification	208
5.5.2	Spectral Classification	216
Appendix A: Object-Oriented Programming in a Nutshell		225
Appendix B: Making Python Faster		233
References		243
Index		245