

Contents

1	Introduction to Observational Cosmology	1
1.1	Cosmic Acceleration.	1
1.1.1	Type Ia Supernovae	2
1.1.2	Baryon Acoustic Oscillations.	2
1.2	Astrophysical Evidence of Dark Matter.	3
1.2.1	Rotation Curves of Galaxies	4
1.2.2	Mass Estimate of Clusters of Galaxies	4
1.2.3	Global Energy Budget of Universe.	5
1.3	Cosmology with Gravitational Lensing	6
1.4	Objective of This Thesis	8
	References	9
2	Structure Formation in the Universe	15
2.1	The Standard Cosmological Model.	15
2.1.1	Friedmann Equation.	15
2.1.2	Cosmological Redshift and Angular-Diameter Distance.	18
2.2	Growth of Matter Density	20
2.2.1	Evolution of Density Fluctuations	20
2.2.2	Linear Perturbation.	20
2.2.3	Non-linear Perturbation.	23
2.3	Statistics of Matter Density Perturbation	25
2.3.1	Two Point Statistics	25
2.3.2	Mass Function and Halo Bias	27
	References	29
3	Weak Gravitational Lensing	31
3.1	Basic Equation.	31
3.2	Observable	35
3.3	Statistics	36
3.3.1	Two Point Correlation Function.	36
3.3.2	Lensing Mass Reconstruction	41
3.3.3	Minkowski Functionals.	42

3.4	Numerical Simulation of Weak Lensing	46
	References	49
4	Weak Lensing Morphological Analysis	53
4.1	Impact of Masked Region	53
4.1.1	Estimation of Lensing MFs from Cosmic Shear Data	54
4.1.2	Data	56
4.1.3	Bias Due to Masking Effect	58
4.1.4	Impact of Masking on Cosmological Parameter Estimation	59
4.1.5	Application to Subaru Suprime-Cam Data	61
4.2	Statistical and Systematic Error of Minkowski Functionals	63
4.2.1	Mock Weak Lensing Catalogs	63
4.2.2	Realistic Forecast of Cosmological Constraints	66
4.2.3	Possible Systematics	72
4.3	Application to CFHTLenS	74
4.3.1	Data Sets	75
4.3.2	Likelihood Analysis of Lensing MFs	76
4.3.3	Breaking Degeneracies	77
	References	80
5	Cross Correlation with Dark Matter Annihilation Sources	85
5.1	Dark Matter Annihilation	85
5.1.1	Relic Density	85
5.1.2	Gamma-Ray Intensity	87
5.2	Extragalactic Gamma-Ray Background	89
5.2.1	Data	90
5.3	Cross Correlation of Extragalactic Gamma-Ray Background and Cosmic Shear	93
5.3.1	Theoretical Model	93
5.3.2	Cross-Correlation Estimator and Covariance	100
5.4	Application to Real Data Sets	102
5.4.1	Analysis	103
5.4.2	Result	106
5.5	Constraint and Forecast	107
5.5.1	DM Annihilation Constraint	107
5.5.2	Future Forecast	109
	References	112
6	Summary and Conclusion	115
6.1	Lensing Minkowski Functionals	115
6.1.1	Subaru Suprime-Cam	115
6.1.2	Canada-France-Hawaii Telescope Lensing Survey	116
6.1.3	Future Work	117

6.2	Cross-Correlation Analysis of Cosmic Shear and Extragalactic Gamma-Ray Background	117
6.2.1	Future Work	119
	References	119
 Appendix A: Effect of Masks on Variance of Smoothed Convergence Field		
		121
 Appendix B: Effect of Source Redshift Clustering on Variance of Smoothed Convergence Field		
		125
 Appendix C: Estimating the Minkowski Functionals Covariance Matrix		
		129
 Appendix D: Effect of Dark Matter Halo Profile Uncertainties on Cross-Correlation Signals		
		131
 Curriculum Vitae		135

Probing Cosmic Dark Matter and Dark Energy with Weak
Gravitational Lensing Statistics

Shirasaki, M.

2016, XI, 136 p. 31 illus., 6 illus. in color., Hardcover

ISBN: 978-981-287-795-6