

Contents

1	Introduction	1
1.1	How Do Galaxies Form and Evolve?	1
1.2	Quantitative Analysis of Galaxy Structure	3
1.3	Relating Galaxy Structure to Physical Processes	6
1.4	Thesis Goals and Overview	11
1.4.1	Probing the Structure and Assembly of Nearby Field Spirals	11
1.4.2	Exploring the Structure and Assembly of Galaxies At the Heart of the Coma Cluster	12
1.4.3	Structure and Assembly of the Most Massive Galaxies Present At $z \sim 2-3$	12
	References	13
2	Probing the Structure and Assembly of Nearby Field Spirals	17
2.1	Introduction	18
2.2	Sample Properties	21
2.2.1	OSUBSGS	21
2.2.2	Stellar Masses	23
2.3	Method and Analysis	31
2.3.1	Image Preparation	32
2.3.2	Decomposition Steps	32
2.3.3	Choosing the Best Fit Between Stage 2 and Stage 3	35
2.4	Extra Tests to Verify Correctness of Fits	47
2.4.1	Varying b/a as a Function of Radius	47
2.4.2	Fitting Artificially Simulated Images	47
2.4.3	Using 1D Decomposition To Generate Guesses for Bulge Parameters	51
2.4.4	Parameter Coupling	53

2.5	Results and Discussion	55
2.5.1	Impact of Bars in 2D Decomposition	55
2.5.2	Mass in Bulges, Disks, and Bars	56
2.5.3	Distribution of Bulge Index and B/T	59
2.5.4	Comparison with Other Work	62
2.5.5	Bar Strength	64
2.5.6	Bar Fraction as a Function of B/T and Bulge Index	68
2.5.7	Formation of Bulges	68
2.5.8	Comparison of B/T with Hierarchical Models of Galaxy Evolution	72
2.6	Summary	83
	References	85
3	Exploring the Structure and Assembly of Galaxies at the Heart of the Coma Cluster	89
3.1	Introduction	90
3.2	Data and Sample Selection	93
3.2.1	Selection of Bright Cluster Members	93
3.2.2	Calculation of Stellar Masses	94
3.2.3	Selection of Final Sample of Massive Galaxies	95
3.3	Method and Analysis	97
3.3.1	Using Sérsic Index as a Proxy for Tracing Disk-Dominated Structures and Classical Bulges/Ellipticals	97
3.3.2	Overview of Our Structural Decomposition Procedure	102
3.3.3	Overview of Our Galaxy Classification Scheme	109
3.4	Empirical Results on Galaxy Structure	115
3.4.1	Galaxy Types and Morphology-Density Relation in the Center of Coma	115
3.4.2	What Fraction of Total Galactic Stellar Mass is in Disk-Dominated Structures Versus Classical Bulges/Ellipticals?	117
3.4.3	What Fraction of Stellar Mass within S0, E, Spirals is in Disk-Dominated Structures Versus Classical Bulges/Ellipticals?	120
3.4.4	Scaling Relations for Outer Disks and Bulges	122
3.4.5	Environmental Processes in Coma	123
3.5	Comparison of Empirical Results with Theoretical Predictions	128
3.5.1	Overview of the Models	128
3.5.2	The Mass Function and Cumulative Number Density in Coma	130
3.5.3	Global Properties of Model Clusters Versus Coma	131
3.5.4	Strong Dependence of Results on Mass Ratio Used to Define Mergers	133

3.5.5	Cold Gas Mass in Coma Galaxies Versus Model Galaxies ...	135
3.5.6	Data versus Model Predictions for Stellar Mass in Dynamically Hot and Cold Components	135
3.6	Summary and Conclusions	140
	Appendix	142
	References	156
4	Structure and Assembly of the Most Massive Galaxies	
	Present at $z \sim 2 - 3$	161
4.1	Introduction	162
4.2	Data and Sample	164
4.2.1	Observations and Pointing Selections for GNS	164
4.2.2	Our Sample of Massive Galaxies at $z = 1 - 3$	165
4.2.3	Properties and Selection Biases in the Sample	169
4.3	Structural Properties of Massive Galaxies	170
4.3.1	Structural Decomposition	170
4.3.2	Derived Structural Properties at $z = 2 - 3$	173
4.3.3	Impact of Systematic Effects on Structural Properties	179
4.4	Star Formation Activity	187
4.4.1	Matching GNS Galaxies to MIPS $24 \mu\text{m}$ Counterparts	187
4.4.2	Star Formation Rates	189
4.4.3	Relation Between Star Formation and Structure	191
4.5	Constraints on Cold Gas Content	194
4.6	AGN in Massive Galaxies at $z = 1 - 3$	197
4.6.1	Frequency of AGN	197
4.6.2	Relation Between AGN Activity and Structure	198
4.7	Discussion	200
4.7.1	Do Massive Galaxies With $n \leq 2$ at $z = 2 - 3$ Host Disks?	200
4.7.2	Formation of Massive Galaxies by $z = 2 - 3$	204
4.7.3	Transformation of Massive Galaxies at $z = 2 - 3$ into Present-Day E and S0s	205
4.8	Summary	208
	Appendix	210
	References	217
5	Summary, Implications, and Future Work	223
5.1	Key Results	224
5.1.1	Probing the Structure and Assembly of Nearby Field Spirals	224
5.1.2	Exploring the Structure and Assembly of Galaxies At the Heart of the Coma Cluster	225
5.1.3	Structure and Assembly of the Most Massive Galaxies Present At $z \sim 2 - 3$	226
5.2	What Has Been Learned About Galaxy Formation/Evolution?	228

5.3 Outlook and Future Work	232
5.3.1 Dynamics and Gas Content of Massive Galaxies at $z = 2 - 3$	232
5.3.2 Chemical Evolution and Stellar Populations of Nearby Galaxies	233
5.3.3 Future Progress for Hierarchical Models	234
References	234

Probing Galaxy Evolution by Unveiling the Structure of
Massive Galaxies Across Cosmic Time and in Diverse
Environments

Weinzirl, T.

2015, XIV, 236 p. 73 illus., 43 illus. in color., Hardcover

ISBN: 978-3-319-06958-6