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0521755778 - Clusters of Galaxies: Probes of Cosmological Structure and Galaxy Evolution

Edited by John S. Mulchaey, Alan Dressler and Augustus Oemler

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Clusters of Galaxies

Probes of Cosmological Structure and Galaxy Evolution

Clusters of galaxies are the largest and most massive collapsed systems in the universe, and as such they are valuable probes of cosmological structure and galaxy evolution. The advent of extensive galaxy surveys, large ground-based facilities, space-based missions such as *HST*, *Chandra*, and *XMM-Newton* and detailed numerical simulations makes now a particularly exciting time to be involved in this field. The review papers in this volume span the full range of current research in this area, including theoretical expectations for the growth of structure, survey techniques to identify clusters, metal production and the intracluster medium, galaxy evolution in the cluster environment and group–cluster connections. With contributions from leading authorities in the field, this volume is appropriate both as an introduction to this topic for physics and astronomy graduate students, and as a reference source for professional research astronomers.

JOHN S. MULCHAEY's research has focused on groups of galaxies. In 1993, he provided some of the strongest evidence to date that galaxy groups are dominated by dark matter. More recently he has played an important role in the discovery and study of "fossil groups," massive systems that contain very few galaxies.

ALAN DRESSLER has made many fundamental contributions to the study of large-scale structure in the Universe over the last 30 years. Recently, he participated in the MORPHS project, using *Hubble Space Telescope* images to show that bursts of star formation were much more common in galaxies 5 billion years ago than they are today.

AUGUSTUS OEMLER has devoted much of his research career to understanding how galaxies have evolved to their present form. In collaboration with H. Butcher, he showed that clusters at intermediate redshifts contain a large excess of blue galaxies (now known as the Butcher–Oemler effect). He recently finished a seven-year term as director of Carnegie Observatories.

All three editors are staff astronomers at the Carnegie Observatories.

This series of four books celebrates the Centennial of the Carnegie Institution of Washington, and is based on a set of four special symposia held by the Observatories in Pasadena. Each symposium explored an astronomical topic of major historical and current interest at the Observatories, and each resulting book contains a set of comprehensive, authoritative review articles by leading experts in the field.

Series Editor: Luis C. Ho.

Luis Ho received his undergraduate education at Harvard University and his Ph.D. in astronomy from the University of California at Berkeley. He is currently a staff astronomer at the Carnegie Observatories, where he conducts research on black holes, accretion physics in galactic nuclei, and star formation processes.

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Carnegie Observatories Astrophysics Series

Volume 3

CLUSTERS OF GALAXIES

Probes of Cosmological Structure and Galaxy Evolution

Edited by

JOHN S. MULCHAEY

ALAN DRESSLER

and

AUGUSTUS OEMLER



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Introduction

While the term “cluster of galaxies” dates back to at least the 18th century (and the work of Charles Messier), it was the discovery of Cepheids in M31 in the 1920’s by Carnegie astronomer Edwin Hubble that established the extragalactic nature of these objects. With this realization, the study of clusters of galaxies was born. In the decades that followed, many Carnegie astronomers made important contributions to this growing field. Milton Humason, Allan Sandage and others measured redshifts for many clusters including Virgo and Coma, at the Mount Wilson and Palomar Observatories. These observations provided an essential database for the early study of clusters and helped establish that few galaxies occur in isolation. These early studies also included much poorer systems (i.e. groups). Edwin Hubble was responsible for noting that we live in such a system, which he named the Local Group. In 1958, Abell published a paper that included his famous cluster catalog. This work extended far beyond the catalog, however. In his paper, Abell showed there was a large variation in cluster richness, and the richness scale he defined is still widely used today. Walter Baade, for which one of the Magellan 6.5 meter telescopes is named, suggested in a 1951 paper with Spitzer that collisions between galaxies in clusters could transform a spiral into an early-type galaxy. This was the first paper on galaxy evolution in clusters.

Given Carnegie’s extensive role in the study of clusters of galaxies, it was an easy decision to dedicate one of the Centennial Symposia to this topic. For me it was a great pleasure to organize this event with two of my colleagues who themselves have made fundamental contributions to this field. In fact, it is fair to say that one could not write a fair history of cluster research in the last three decades without mentioning the work of Alan Dressler and Gus Oemler.

The third Carnegie Observatories Centennial Symposium, “Clusters of Galaxies: Probes of Cosmological Structure and Galaxy Evolution” was held January 27–31, 2003 in Pasadena, California. Although we formally limited the attendance to 140 people, well over 160 people attended the meeting. Over the course of four days, there were 28 invited review talks, 21 contributed talks and over 60 poster presentations. Some of the highlights of the meeting included detailed numerical simulations of clusters, new results from the Sloan and 2dF redshift surveys, and exciting new results from *Chandra*, *XMM-Newton*, *HST* and Sunyaev-Zel’dovich surveys. I had many people tell me during the course of the meeting and in the months since that this was one of the most exciting meetings on clusters of galaxies in recent memory. I believe the quality of the scientific presentations is reflected in the review articles that appear in this volume.

The Symposium was made possible with the help of many people. Steve Wilson, Silvia

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Hutchison and Becky Lynn were responsible for handling the meeting logistics. Scott Rubel was the Symposium photographer. Many people helped referee the invited review papers in this volume and I believe their participation greatly improved the quality of these articles. Finally, I'd like to extend my personal gratitude to Luis Ho for the tremendous amount of effort he put into the entire Centennial series and the resulting volumes. It was Luis' idea to hold these Symposia, and he was involved with every aspect of these events from the very beginning. I'm particularly indebted to him for his work on this volume. His guidance and insight have assured the content of these books will have a long-lasting impact on astronomy.

John Mulchaey
Carnegie Observatories
October 2003

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