

EXPLORING THE DARK SECTOR WITH CLUSTERS OF GALAXIES

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Cosmological measurements indicate that energy density of the Universe is dominated by two unseen components: dark energy and dark matter. A number of pioneering astrophysical techniques are now allowing us to “see” the effect of these two mysterious components. We explain that by studying cluster of galaxies, the largest structures in the Universe, we can explore this dark sector. Clusters of galaxies contain large quantities of dark matter and map out the growth of structure, which is believed to be strongly affected by dark energy.

We first present the deepest X-ray selected serendipitous cluster survey based on a novel joint analysis of data from two X-ray satellites, Chandra and XMM-Newton. The survey demonstrates the rapid growth of clusters from the early Universe to the present day. We present the precision cosmological measurements of dark matter and dark energy by comparing with predictions. We also discuss the physics of clusters of galaxies, and mention attempts to understand the perplexing physics in cores of clusters. New measurements indicate a relatively complicated battle between competing physical processes.

We then discuss a variety of future measurements that will be made with LSST (the Large Synoptic Survey Telescope). We describe the largest and most detailed astrophysical simulations being performed to prepare for some of the most sensitive measurements of the dark sector. With this telescope tens of thousands of new clusters of galaxies will be found, detailed maps of dark matter across the entire sky will be made, and the effect of weak gravitational lensing on the largest scales will be measured. The dark sector will then be explored with unprecedented precision.