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Cosmic Shear Measurements Using Simulations of the Large Synoptic Survey Telescope

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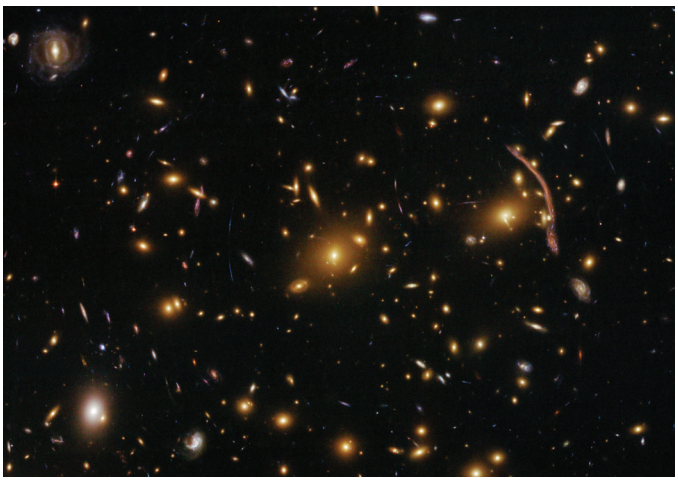
One of the most exciting discoveries in modern astrophysics is that most of the mass in the universe does not come from visible matter, but instead from what is known as dark matter. According to Einstein's theory of general relativity, all matter (visible or dark) bends light gravitationally in a process known as gravitational lensing. The effect of this lensing is that background galaxies may appear distorted by foreground dark matter. However, in most cases, the effects of lensing are small, and can only be detected as a statistical effect on many background sources, known as cosmic shear. To minimize statistical uncertainty, a new telescope called the Large Synoptic Survey Telescope (LSST) is being built. This telescope will be capable of surveying more of the sky than has been possible before. Using simulated images of a galaxy cluster based on expected LSST data, we used the Kaiser, Squires, and Broadhurst (KSB) method in a blind test to measure the gravitational shear input to the simulation, as a check of the capabilities of current lensing analysis techniques, as well as to verify the simulator and understand the anticipated performance of LSST. Our results clearly demonstrate the known bias of KSB as well as the statistical power of LSST.

Research advisor Wei Cui says, "About 95% of the universe is dark and thus little understood. The dark side of the universe can be 'seen' through the distribution of (mostly dark) matter. The work that James described is part of an effort to probe dark matter through its gravitational distortion of the galaxies behind it."



Gravitational lensing occurring around a dense galaxy cluster. The long streaks of light are galaxies behind the cluster that have been strongly lensed by the gravitational field of the dark matter in the cluster. Image courtesy of the Space Telescope Science Institute.

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