

Illuminating The Dark Universe -- A Quest For Physics Beyond The Standard Model



McWilliams Center Cosmology Colloquium
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Abstract:

Measurements of the cosmic microwave background, along with other observations, reveal that our universe is rather dark -- about 22% of its contents are in the form of dark matter, which keeps galaxies bound, and 74% in dark energy, which drives the accelerated cosmic expansion with its strong negative pressure. While we have a very successful standard model for the 4% visible matter, the dark sector remains to be illuminated. Just as planetary motion led to Newton's universal gravitation, astronomical observations are once again opening doors to new physics. For example, vacuum energy, a candidate for dark energy, has the necessary negative pressure, but its density, calculated conventionally, is more than 100 orders of magnitude larger than the "observed" dark energy density; invoking super symmetry would mean a fine tuning of an almost-exact cancelation to the same order; numerous alternatives (such as back-reaction, brane-world gravity, landscape, modified gravity, quintessence, etc.) have also been proposed. I will review evidence for dark matter and dark energy and then discuss how to determine their properties with two particular techniques: gravitational lensing and baryon acoustic oscillations (or statistics of the galaxy spatial distribution in general). With the Large Hadron Collider becoming operational in the near future and several ambitious astronomical surveys to start in the next decade, we are truly at the doorstep of an exciting era for new physics that might just unveil the mystery of the dark sector.

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